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Did the Fiscal Stimulus Work for Universities?

Michael F. Dinerstein, Caroline M. Hoxby, Jonathan Meer, and Pablo Villanueva

9.1 Introduction

The American Recovery and Reinvestment Act (ARRA) was enacted in February 2009 with the objective of "saving and creating jobs" in the immediate future—that is, 2009 and 2010. The ARRA's 831 billion dollars were intended to offset at least some of the decrease in aggregate demand associated with the financial crisis and Great Recession. Other key parts of this essentially Keynesian policy were the federal budget signed by President Obama in March 2009, which contained 400 billion dollars in spending beyond what had been proposed by the G. W. Bush administration for the 2009 fiscal year (October 2008–September 2009), and the unusually high budget (3.72 trillion) enacted for fiscal year 2010 (October 2009–September 2010).

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Postsecondary institutions were important recipients of stimulus funds—both funds officially designated as ARRA and funds contained in the unusually large budgets for fiscal years 2009 and 2010. Federal revenue received by postsecondary institutions comes mainly in two forms: research-related funds (in the form of grants and contracts) and student aid (most of which is directed to low-income students). Between the 2007/8 and 2009/10 school years, federal research-related revenues rose, in real dollars, by 14 percent and federal spending on student aid rose by 80 percent. These funding increases were a stark departure from the 2002/3 to 2007/8 period, when real federal revenues received by postsecondary institutions were approximately flat.

There are a few key criticisms of stimulus policies in general as an antirecessionary tool. First, because budgeting, legislating, disbursing funds, and creating jobs all take time, the revenues may not reach the intended recipients fast enough. Second, the United States is not a closed economy, so some of the intended effect of the stimulus may "leak" out. That is, a recipient of funds may purchase goods produced overseas or hire foreign workers—lessening the effect on domestic aggregate demand. Third, the recipients of the funds may "save" them rather than spend them immediately on employees' wages or purchasing goods. We do not mean to suggest that the recipients might *literally* save the stimulus funds. Rather, they might increase their spending relative to the counterfactual (in which they received no stimulus funds) by only a fraction of the funds they receive. In many expectations scenarios, this is a logical response to explicitly temporary funds. For instance, recipients may expect that stimulus funds they receive now will translate into higher taxes or lower funding in the future, in which case they may save for those eventualities. Or, the stimulus funds may be large relative to what the recipient thinks he can spend productively and quickly on the intended use—a research project, say. In that case, he may withdraw nonfederal funds that he would have spent on the project and save those funds for future projects. Or, the recipient may not wish to hire a person he will be committed to after the stimulus funds disappear. Instead, he may hire only a fraction of the intended employees and save some other funds to keep those employees on when the stimulus funds are gone. It is important to note that "saving" may take the form of a recipient dissaving *less*—that is, borrowing less—than he would have in the absence of stimulus funds.

(Henceforth, we use the word "save" to refer to any change in a postsecondary institution's finances that had the effect of increasing total spending by less than a dollar for dollar of its stimulus-motivated federal funds. It is important to understand this locution because it rarely refers to literal saving. Another phrase that is useful is a "full flypaper effect." This is the phenomenon in which federal funds increase spending in the intended area dollar for dollar.[1]

1. The "flypaper effect" is so named because it describes the phenomenon in which money "sticks where it hits"—that is, spending in the intended area increases by the full amount of the transfer from the government.

If the advent of stimulus-motivated federal funds does not cause a full flypaper effect, then it means that the institution has moved some of its other funds away from the relevant activity—but not necessarily to the future, which would be saving. In this case, we will say that the institution has "reallocated" some of the federal funding. This locution does not refer to literal reallocation that would violate the terms of the federal funding.)

Interestingly, some of the criticisms of stimulus policies likely apply less to postsecondary institutions than to typical contractors. As an administrative matter, postsecondary institutions are well equipped to receive and spend federal funds quickly. Undergraduate students can receive increased aid almost immediately, and revenue can quickly fund graduate and postdoctoral students to work on research projects. Student assistants, postdoctoral students, and non-tenure-track instructors can be hired without the creation of "permanent" positions. Some postsecondary institutions have a queue of research projects in the funding pipeline (already proposed but not yet funded), and the timing of such queued projects can possibly be accelerated with little or no loss of productivity. Although some stimulus funds could be used to purchase equipment that is produced overseas, both instruction and research tend to occur through interpersonal interactions so that leakage to foreign countries is minimal. Commentators have even argued that leakage outside of the institutions' immediate neighborhood is limited so that stimulus funding could buoy up the economy of a "college town" or county dominated by a university.[2]

On the other hand, some criticisms of stimulus policies may be particularly applicable to postsecondary institutions. Colleges and universities may save some of the stimulus funds by reducing (relative to the counterfactual in which they received no funds) their borrowing or their rates of spending from their endowments. Public colleges and universities may receive smaller appropriations from their state legislatures when they receive stimulus funds—that is, it may be the state government that ultimately receives some of the funds. Indeed, some states' financial aid formulas are such that the state automatically reduces the aid it gives students when the Pell grant increases.[3] Both private and public universities may hesitate to create long-term positions and may find it difficult to accelerate the timing of projects because they do not want to invest in capital (labs, equipment, offices) that will be excessive in normal times.

In short, postsecondary institutions provide an important environment for investigating the effects of stimulus funds. They give us a window on how stimulus policies work, and they provide a testing environment that is likely more favorable to stimulus policies than the rest of the economy. Moreover, the question of how the stimulus affected postsecondary insti-

2. See, for instance, Belkin 2012.
3. See Bettinger's chapter 8 in this volume.

tutions is interesting for its own sake because it reveals a great deal about their objectives and constraints. We are especially interested in how federal stimulus spending—whether classified as ARRA or not—affected universities' expenditures (on research, student aid, on other activities), universities' employment, universities' endowment spending, state governments' appropriations to their public universities, and economic activity in the counties containing universities.

It is crucial to understand that we will not argue that postsecondary institutions did something wrong if they saved or reallocated some stimulus dollars by whatever means. To the extent that universities contribute to the economy by producing useful human capital, inventions, and other public goods (as opposed to merely generating make-work jobs and incomes to prop up aggregate demand), society would prefer that universities allocate funds to their most productive use. Such allocation is probably not consistent with a full flypaper effect. We return to this topic in our conclusions.

The main empirical obstacle to our investigation is establishing what would have occurred if little or no stimulus was enacted. Specifically, we face endogeneity and omitted variables problems. The endogeneity problem is particularly obvious in the case of student aid, which—like unemployment insurance—is something of an automatic stabilizer. When a recession hits, family incomes fall and students become more needy. Given the way federal financial aid formulas work, student aid automatically increases—even if Congress enacts no increase in the Pell grant or other aid formulas. Colleges whose local economies are harder hit will experience a larger increase in student need and, thus, a larger increase in federal aid. Thus, with a naive empirical strategy, reverse causality would likely confound the causal effects of increased federal student aid. Such reverse causality may affect research funding as well. If a legislator's local college or university was particularly hard hit by the recession or financial crisis, he may have made greater effort to obtain federal research money for it. A naive strategy would then *understate* the causal effect of stimulus spending. However, there is an omitted variables problem that would likely cause *overstatement*: a university that is particularly "up and coming" in research may have more projects in the pipeline that get funded quickly when stimulus funds arise. Such a university would likely have enjoyed increased spending and employment (relative to other universities) even without the stimulus.

To overcome these empirical challenges, we employ two instrumental variables: (a) a Bartik-style instrument (Bartik 1991) that applies nationwide rates of increase in research funding by agency to universities whose initial dependence on these agencies differs; and (b) a simulated instrument that applies the change in the maximum Pell grant to institutions with varying initial numbers of students eligible for the maximum grant.

To see how the first instrument works, consider two universities, the first of which had most of its federal research funding through the National Aeronautics and Space Administration (NASA) before the recession, and the second of which had most of its federal research funding through the National Institutes of Health (NIH) before the recession. Nationally, NASA research funding grew by 29 percent from the 2007/8 school year to the 2009/10 school year. Over the same period, national NIH research funding grew by 16 percent. If each university simply got its preexisting share of the national increases in funding, then the first university would receive more stimulus spending than the second university. This difference between the two universities' receipt of stimulus spending would *not* be a function of their need for money or of their upward trajectory since it is not plausible that the national spending increases were set with a mind to the impact on these two universities. Indeed, we definitively eliminate this possibility by excluding each university from the calculation of the nationwide increase applied to its initial conditions. Thus, we have a credible instrument for the increases in federal research funding that were experienced by otherwise similar universities.

To see how the second instrument works, consider two universities, the first with numerous students eligible for the maximum Pell grant prior to the recession and the second with few students eligible for the Pell grant prior to the recession. We compute the change in funding that each university would have experienced had each of its students who were initially eligible for the maximum grant received the change in the maximum grant that was enacted between 2006/7 ($4,050) and 2009/10 ($5,350). This increase is solely a function of each university's initial conditions and the national policy change in the maximum Pell grant. It is *not* a function of the change in the neediness of each school's students. This formula-and-initial-conditions change in federal student aid is a plausible instrument—especially for universities that recruit students from the nation or a fairly large region. Below, we elaborate on this and other issues regarding the instruments.

The remainder of the chapter is organized as follows. In section 9.2, we describe federal funding directed to postsecondary institutions before and during the stimulus period. We briefly review what economics predicts that universities should do with stimulus funds in section 9.3. We describe our data in section 9.4 and our empirical strategy in section 9.5. We show results for university outcomes (revenues, expenditures, employment, and so on) in sections 9.6 and 9.7. Results for local economy outcomes are presented in section 9.8. Finally, in section 9.9, we discuss our findings and draw conclusions.

9.2 Federal Funding for Postsecondary Institutions, before and during the Stimulus

The three key events in stimulus spending are the ARRA itself, the much-augmented budget for the 2009 fiscal year, and the large budget for the 2010 fiscal year. Hereafter, we refer to all federal spending for fiscal years 2009 and 2010, not just official ARRA spending, as "stimulus motivated." Given the timing of federal disbursements, we expect most stimulus-motivated funding to affect postsecondary institutions' revenues in the 2009/10 school year, although a small fraction may show up as early as the 2008/9 school year. Of course, institutions may have begun to anticipate increased federal funding as early as midway through the 2008/9 school year.

Federal funds directed to postsecondary institutions come in three basic forms: (a) grants and contracts, (b) student aid, and (c) appropriations. Federal grant and contract funds are revenues intended to support specific research projects or similar activities.[4] Federal student aid is primarily directed toward low-income students, and its most important component by far is the Pell grant.[5] Appropriations are funds received by an institution through an act of Congress, except grants and contracts. Institutions are meant to use appropriations to meet their normal operating expenses, not to conduct specific projects. The most important examples are federal appropriations to land grant institutions, tribal colleges, and historically black colleges and universities. State Fiscal Stabilization Funds, temporary revenues received by universities under ARRA, are also appropriations.

Most federal funds directed to postsecondary institutions fund activities that are closely related to the primary missions of the institutions—undergraduate and/or doctoral instruction and research. We expect closely related funding to be at least somewhat fungible with other streams of revenue—thus allowing at least some of the saving and reallocation described above. For instance, a private institution could presumably use federal revenue to fund research that it would otherwise have funded with income from its endowment. Or, a public institution might be able to use federal revenue to aid students whom it would otherwise have aided with revenue from the state government. However, we recognize that some federal revenue has low fungibility. Most obviously, a small share (slightly less than 10 percent) of grants and contracts fund "independent operations"—federally funded programs directed by postsecondary institutions.[6]

For the purposes of this study, the key distinction is between federal student aid funds (hereafter "federal aid funds") and all other federal funds,

4. In our study, we consistently exclude Pell and all other student aid funds from grants and contracts, even if they are included as nonoperating grants by the institution. In this way, we avoid double-counting Pell and other aid revenue.

5. In terms of federal expenditures, other important forms of aid are Supplemental Educational Opportunity Grants (SEOG) and State Student Incentive Grants (SSIG). However, the Pell program alone made up 87 percent of federal grant aid in 2009/10. There are also a number of federal tax breaks related to higher education—most importantly, the tuition tax credits. These "tax expenditures" are important to the federal budget but they do not flow to postsecondary institutions in a direct way and they were largely unaffected by the recession or urge for stimulus spending.

6. Examples include Argonne National Laboratory at the University of Chicago, the Jet Propulsion Lab at California Institute of Technology, SLAC National Accelerator Laboratory at Stanford University, and the Lawrence Livermore National Laboratory of the University of California.

including appropriations, directed to postsecondary institutions. This distinction is key because (a) the latter type of funds is more likely to be intended for research; (b) the latter type of funds is inherently institution-specific, not driven by a formula that applies to all institutions; and (c) both types of funds can be increased as a stimulus measure, but only the former type of funds automatically increases as the incomes of an institution's students fall (the automatic stabilizer property).

9.2.1 Federal Funding for Postsecondary Institutions in a "Base" Year: 2006/7

Table 9.1 shows how federal funds were distributed among postsecondary institutions in 2006/7, the last school year before the financial crisis and Great Recession hit.[7] The table shows amounts in 2010 dollars, adjusted using the GDP deflator.[8] The first column of the table classifies institutions by their Carnegie classification and their control (private or public).[9] The only classifications that are not fairly intuitive are the two types of research universities. Both types offer a wide range of baccalaureate programs and are "committed to graduate education through the doctorate." However, the "extensive" ones award fifty or more doctoral degrees per year across at least fifteen disciplines, while the "intensive" ones need to award only ten doctoral degrees per year across three or more disciplines, or at least twenty doctoral degrees per year overall.

The second column of table 9.1 shows the number of institutions in each category. For reasons that will become clear in section 9.4, we have omitted for-profit schools, nearly all of which would fit into either the associate or baccalaureate/master's category. The third through fifth columns show the federal funding—grants and contracts, appropriations, student aid—for each category of institution. The next three columns show federal funding *per institution*, and the final three columns show federal funding as a share of the institutions' stable operating revenue. (Appendix table 9A.1 shows alternative versions of the final three columns, with institutions' total revenue defined more broadly than stable operating revenue is defined. The magnitudes differ, but the pattern is similar.)

The first thing to observe in table 9.1 is that the vast majority (86 percent) of federal grant and contract funding goes to research universities and medical schools. There are a fairly small number (302) of such institutions,

7. The 2007/8 school year actually looks very similar because most spending was determined before the financial crisis was recognized. The key data for table 9.1 are from the Delta Cost Project database (US Department of Education 2012), which we describe in section 9.3.

8. Revenue and expenditure patterns are very similar when deflated using the Consumer Price Index (CPI-U). These results are available from the authors.

9. We use the year 2000 Carnegie classifications to exclude the possibility that the impact of the financial crisis or recession might influence a classification. For a detailed description and justification of the Carnegie classifications, see Carnegie Foundation for the Advancement of Teaching (2001).

Table 9.1 **Federal funds directed to postsecondary institutions by category of funds and type of institution, 2006/7**

Institution type:	Number of institutions	Grants & contracts (millions)	Appropriations (millions)	Aid (millions)	Grants & contracts per institution (millions)	Appropriations per institution (millions)	Aid per institution (millions)	Grants & contracts as % of stable operating revenue	Appropriations as % of stable operating revenue	Aid as % of stable operating revenue
Private ext. research	49	11,803.8	280.8	554.4	240.9	5.7	11.3	21.32	0.51	1.00
Public ext. research	102	18,079.8	191.1	2,259.0	177.3	1.9	22.1	15.61	0.16	1.95
Private int. research	42	816.7	0.7	201.2	19.4	0.0	4.8	9.28	0.01	2.29
Public int. research	64	3,060.3	27.0	675.0	47.8	0.4	10.5	13.57	0.12	2.99
Private medical	18	880.4	14.9	7.0	48.9	0.8	0.4	17.34	0.29	0.14
Public medical	27	1,071.6	0.0	14.2	39.7	0.0	0.5	10.69	0.00	0.14
Private engineering	1	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00
Public engineering	2	33.2	0.0	3.7	16.6	0.0	1.8	20.24	0.00	2.25
Private other health	21	10.8	0.0	11.1	0.5	0.0	0.5	2.23	0.00	2.29
Public other health	2	24.8	0.0	0.1	12.4	0.0	0.1	12.87	0.00	0.07
Private BA/MA	781	1,161.3	162.1	1,901.9	1.5	0.2	2.4	3.29	0.46	5.39
Public BA/MA	346	2,228.1	10.6	2,528.9	6.4	0.0	7.3	5.60	0.03	6.36
Private associate	82	18.7	1.3	61.8	0.2	0.0	0.8	4.45	0.32	14.67
Public associate	962	2,348.2	106.1	4,266.5	2.4	0.1	4.4	5.63	0.25	10.23

Notes: The table shows federal funds directed to postsecondary institutions in the 2006/7 school year. Federal funds come in three basic forms: (a) grants and contracts, (b) appropriations, and (c) student aid. These categories are defined further in the text. Institutions are grouped by their 2000 Carnegie classification (Carnegie Foundation for the Advancement of Teaching 2001).

so their per-institution amounts of federal grant and contract funding dwarf the per-institution amounts received by any other category of schools. Federal grant and contract funding represents between 9 and 21 percent of these institutions' stable operating revenue.[10]

Although research universities and medical schools also receive a large share (65 percent) of federal appropriations funding, the per-institution amounts are very small relative to grants and contracts, and appropriations funding never reaches even 1 percent of their stable operating revenues. These institutions receive 30 percent of all federal student aid, and such aid funding represents as much as 3 percent (public intensive research universities) of stable operating revenue.

Summing up, research universities and medical schools play the dominant role in federal grant and contract funding *and* federal grant and contract funding plays an important role in the finances of these schools. Federal student aid also plays a nontrivial role in research universities' finances. Thus, we should expect these institutions to be affected by stimulus-motivated federal funding.

The picture is fairly different for associate and baccalaureate/master's institutions, which are shown toward the bottom of table 9.1. Although they receive 14 percent of federal grant and contract funding, the per-institution amounts are small and such funding represents only 3 to 6 percent of their stable operating revenues. In contrast, they receive 70 percent of all federal aid funds, and such funds represent between 5 and 15 percent of their stable operating revenues. (Appropriations funding plays only a very small role). In short, associate and baccalaureate/master's institutions—of which there are many—have finances in which federal aid funds play an important role and in which federal grants and contracts play a much smaller role.[11]

The remaining categories of institutions are so thinly populated that it is not useful to discuss them here, although we analyze some of them later.

9.2.2 Stimulus Period Increases in Federal Funding for Postsecondary Institutions

Did postsecondary institutions actually receive notable increases in federal funding during the stimulus period—especially in the 2009/10 school year? In this section, we show that they did.[12]

10. Even when their total revenue is most broadly defined (see appendix table 9A.1), federal grant and contract funding represents between 6 and 14 percent of the total revenue of research universities and medical schools.

11. We suspect that the federal grant and contract numbers are overstated for associate and baccalaureate/master's institutions. This is because Pell grants often appear as nonoperating federal grants in their accounts. The Delta Cost Project database attempts to remove Pell and other aid from "grants and contracts," but we believe—based on cross-validation with other data sources—that some share of federal aid is not removed from nonoperating grants.

12. The key data for these figures are from the Delta Cost Project database (2012), which we describe in section 9.4.

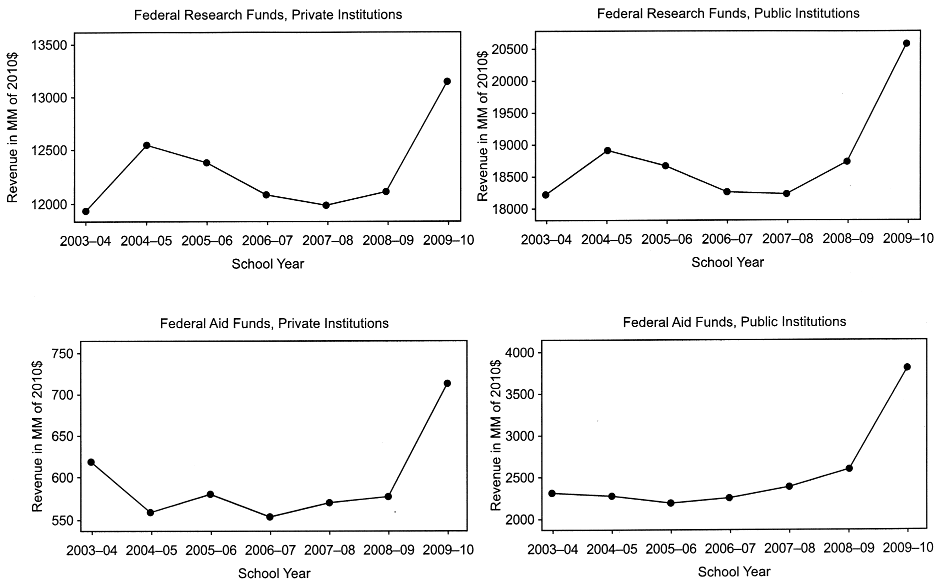

Fig. 9.1 Federal funds received by extensive research universities from 2003/4 to 2009/10

Figures 9.1 through 9.5 show federal funds, by category of institution, from the 2003/4 school year through the 2009/10 school year.[13] All amounts are in 2010 dollars, adjusted using the GDP deflator. Each figure has four subfigures: (a) federal grants, contracts, and appropriations for private institutions; (b) federal grants, contracts, and appropriations for public institutions; (c) federal student aid funds for private institutions; and (d) federal student aid funds for public institutions. We consolidate appropriations with grants and contracts because of their nature (see above) and their small magnitude (table 9.1).

Consider figure 9.1, which focuses on extensive research universities. Between 2006/7 (the base year we employed in table 9.1) and 2009/10, real federal research funds jumped by 16 percent for private extensive research universities and 20 percent for public extensive research universities. Over the same period, federal aid funds jumped by 37 percent for private extensive research universities and by 79 percent for public extensive research universities. (Keep in mind that the larger percentage increases in aid add up to fewer total dollars than the substantial but more modest percentage

13. We select 2003/4 as the first school year in the figures because, prior to that, some institutions were reporting their finances using a form that can be hard to reconcile with the form used from 2003/4 onward (GASB 34/35). To avoid apparent but spurious changes in revenues due solely to reporting, we do not show prior years. However, the period from 2000/1 through 2003/4 was fairly stable for most federal funding streams, and this can be seen for institutions that reported in the same manner throughout.

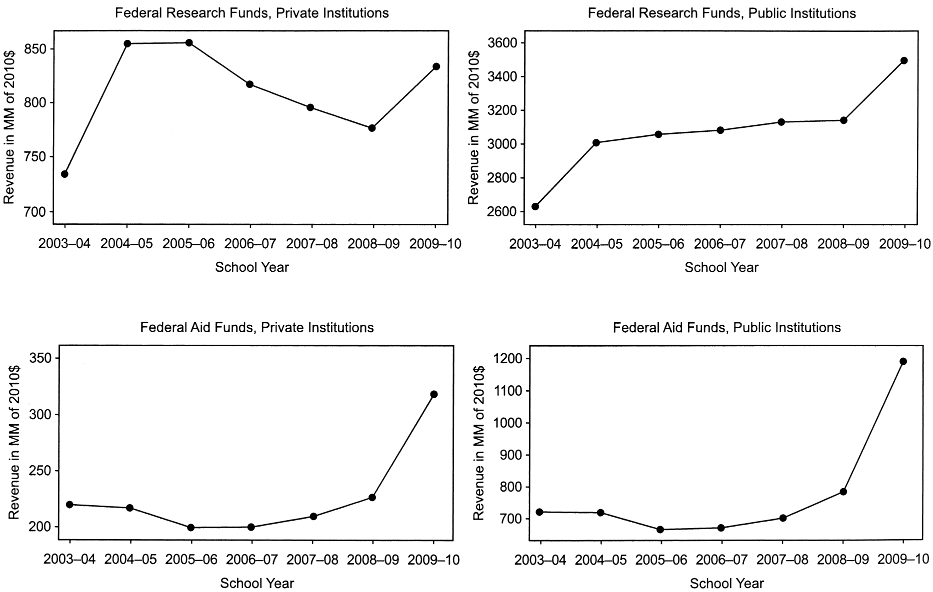

Fig. 9.2 Federal funds received by intensive research universities from 2003/4 to 2009/10

increases in research-related funding. This is because federal aid funds make up much less of extensive research universities' total revenue than do federal research-type funds. This is evident if one looks at the scale of the subfigures' vertical axes.) In any case, the key conclusion from figure 9.1 is that extensive research universities experienced a full dose of the federal stimulus.

The picture is slightly more mixed for intensive research universities, shown in figure 9.2. On the one hand, federal student aid grew between 2006/7 and 2009/10 by a massive 68 percent at private intensive research universities and by an even greater 82 percent at public intensive research universities. Note though that these growth rates were from smaller per-institution bases than those of the extensive research universities. Over the same period, the public intensive research universities saw their federal research-type funding rise by 20 percent. Private intensive research universities also experienced a rise of 8 percent in federal research-type funding in 2009/10, owing to the stimulus. This rise, however, only reversed a fall in such funding from a peak amount in 2005/6. In short, all of the intensive research universities experienced stimulus funding, but the research funding pattern is slightly less consistent than that of extensive research universities. This is probably because the per-institution amounts of research-type funding are sufficiently small in the base year that each year's federal research-type funding represents a fairly small number of grants. Thus, these funding streams are inherently less stable than the parallel streams for extensive research uni-

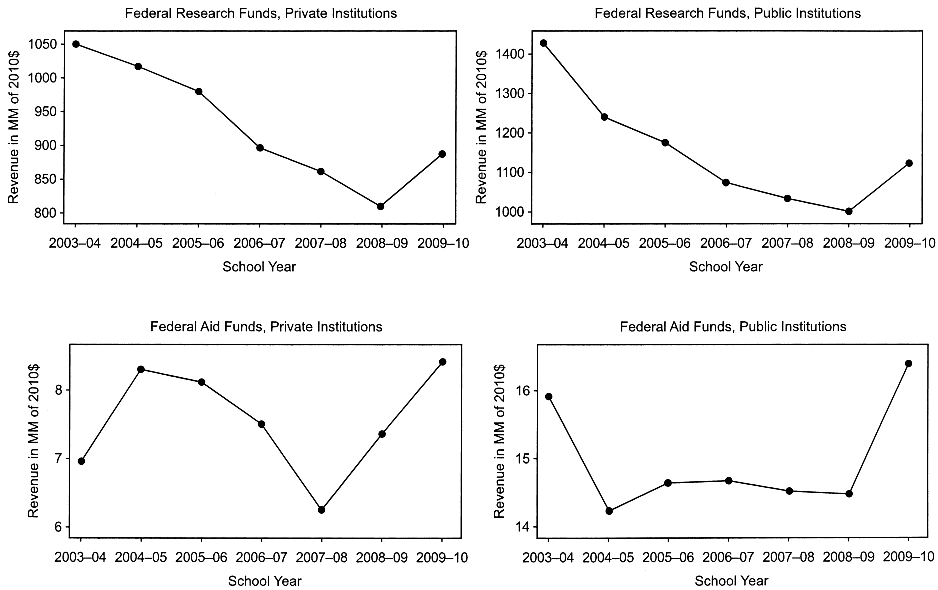

Fig. 9.3 Federal funds received by medical schools from 2003/4 to 2009/10

versities, whose base-year funding per institution is as much as ten times larger.

The story for medical schools (figure 9.3) is also one in which stimulus funding reversed a decline in federal funding rather than caused fairly flat federal funding to peak. Both private and public medical schools experienced falling federal research-type funding from 2003/4 onward—right up until stimulus motives increased their federal funding in 2009/10 (by 11 percent for privates and 13 percent for publics). Their federal student aid also grew substantially in the stimulus period, but it started from such a small base that it is not important to their finances.

The time patterns for baccalaureate/master's and associate schools (figures 9.4 and 9.5) are fairly similar—albeit on a much smaller scale—to those for intensive research universities. Stimulus motives generate massive percentage increases in federal aid funds. The baccalaureate/master's and the public associate schools also see large percentage increases in federal research-type funding.[14] However, for baccalaureate/master's and associate schools, the per-institution amounts of research-type funding are an order of magnitude smaller than those of intensive research universities and as much as two orders of magnitude smaller than those of extensive research universities. Thus, even large percentage increases in research-type funding translate into small per-

14. For private baccalaureate/master's schools, this stimulus-driven increase in research-type funding reverses a previous decline.

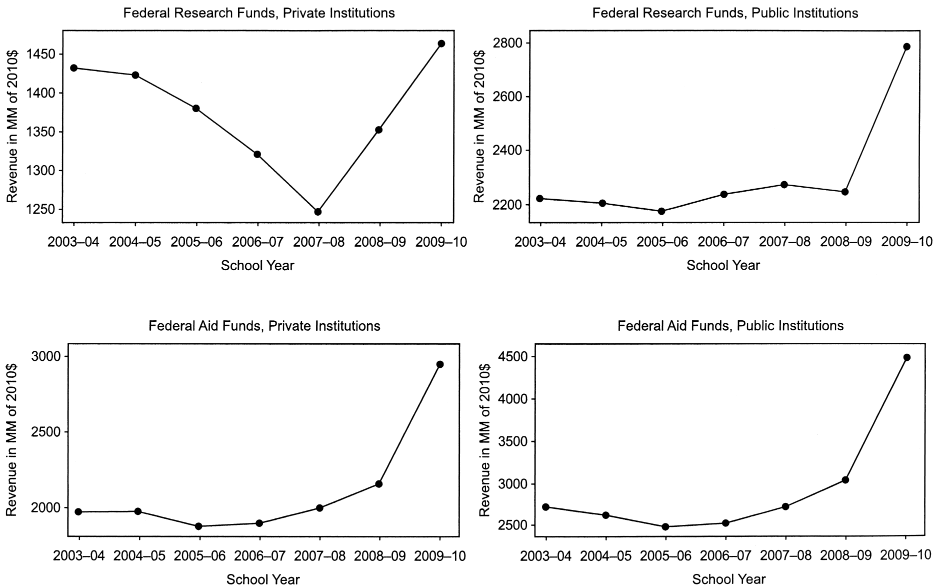

Fig. 9.4 Federal funds received by baccalaureate/master's colleges from 2003/4 to 2009/10

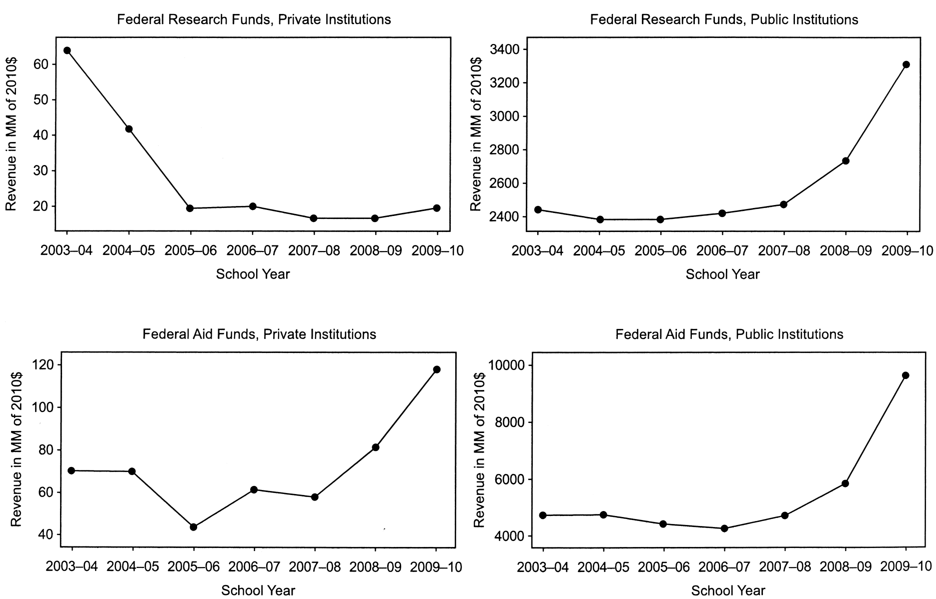

Fig. 9.5 Federal funds received by associate colleges from 2003/4 to 2009/10

centage increases in these schools' total revenues. Thus, it is the increases in federal aid funds that are potentially important for their finances.

Overall, we conclude from figures 9.1 through 9.5 that stimulus motives generated substantial increases in all federal funds directed to postsecondary institutions. Extensive research universities and public intensive research universities are the easiest to analyze because (a) the increases in funding that they experienced were substantial relative to their total revenues, both for research-type and aid funding and (b) their federal funding was fairly flat in the prestimulus period so that it is not difficult to predict what they would have experienced if stimulus funding had not occurred. Other institutions are somewhat harder to analyze because their prestimulus federal funding was falling *or* their federal research-type funding was too small to be important to their finances *or* their federal student aid increased greatly but presents us with an endogeneity problem that we hinted at in the introduction and take up in detail in section 9.5.

9.2.3 Federal Research and Development Funding by Source

As mentioned above, our first instrument exploits the fact that various sources of federal research funding—NIH, NASA, the National Science Foundation (NSF), Defense, Energy, Agriculture, and so on—did not all enjoy the same stimulus-driven increase in federal funding.

We turn to a different database (National Science Foundation 2012) to construct figure 9.6, which shows federal research funding for each of the main agencies or departments that directs funds to postsecondary institutions, from 2003/4 to 2009/10. These are: Agriculture, Defense, Energy, Health and Human Services (HHS, the vast majority of which is NIH), NASA, and the NSF. In each figure, the amount for each year (in real dollars) is shown relative to the amount in 2006/7, the base year. Thus, the value of 1.16 for HHS in 2009/10 shows that federal research funding from HHS increased by 16 percent in real terms between 2006/7 and 2009/10.

Among all the major agencies/departments, only Agriculture shows no stimulus-motivated boost in research funding. The others have quite widely differing percentage increases. The lowest is that of HHS at 16 percent and the highest is Defense at 58 percent. NSF funding jumped by 23 percent, Energy by 28 percent, and NASA by 29 percent.[15]

9.3 What Economic Theory Predicts about Universities' Use of Stimulus Funds

In this section, we briefly review what economic theory predicts about how universities should use federal stimulus funds. This theory is related to fiscal federalist theory regarding the manner in which lower-level govern-

15. We were unable to allocate about 3 percent of ARRA research funding because its agency or department information was unavailable.

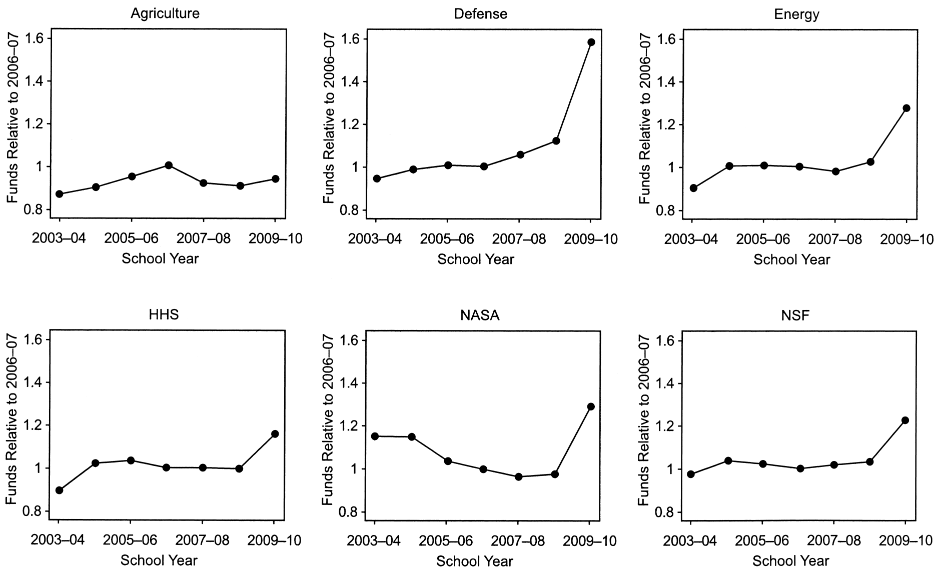

Fig. 9.6 Real federal research funds received by postsecondary institutions relative to the 2006/7 school year

ments, like states or municipalities, should react to grants from higher-level governments, like the federal government.

Consider a federal research grant that arrives at a university owing to the stimulus. It is a windfall that is formally intended to be spent on research. Suppose that the university normally allocates funds among numerous uses of which research spending is only one. Other key uses of funds would typically include instruction, student aid, public service, maintenance and operation of plant and equipment, construction, and saving money for the future through an endowment. In its last prerecession base year, the university might be allocating funds according to figure 9.7, which shows a division of funds between research expenses and all other activities. If the university is allocating money to maximize its objectives, the division of funds will be such that an indifference curve representing those objectives is just tangent to the budget constraint that represents the trade-off between research and all other activities.

The stimulus-motivated federal research funds shift the university's budget constraint out by the amount of the windfall. If the windfall is smaller than what the university planned to spend on research from fairly unrestricted sources, the shift in the budget constraint does not affect its slope: an extra dollar for research might as well be an extra dollar that is unrestricted.[16] This is shown in panel B of figure 9.8. If the windfall is so large that it exceeds

16. By "fairly unrestricted," we do not only mean funds that are classified as "unrestricted," but all funds that can be shifted forward in time to another fiscal year or shifted to a somewhat different research or instructional use.

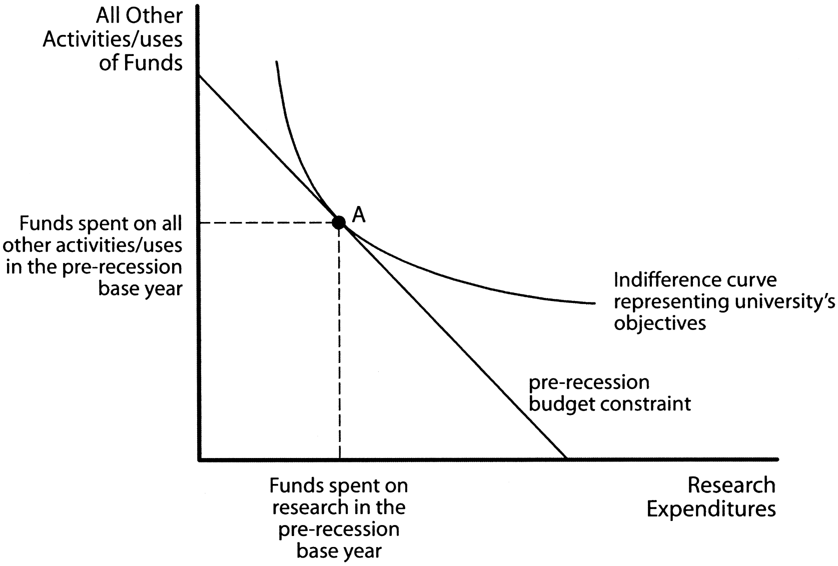

Fig. 9.7 A university maximizing its objectives via spending on research and nonresearch activities

what the university planned to spend from fairly unrestricted sources, it may make a dollar of research effectively less expensive than a dollar allocated to any other activity. As a result, the windfall would not only shift the budget constraint but affect its slope as well, as shown in panel C of figure 9.8.

If the university were to spend every dollar of the windfall on research *and* leave all its other funding allocations unchanged, it would arrive at a point like B in panel A of figure 9.8. This represents a full flypaper effect: every federal research dollar "sticks where it hits" not only because it is itself spent on research (which is legally necessary) but because it does not trigger any reallocation of other revenue. Except under extraordinary conditions, a full flypaper effect is not consistent with a university previously maximizing its objectives. This is shown in panels B and C of figure 9.8, where the university's postwindfall, objectives-maximizing allocations are illustrated by the points marked C. At points like these, the university spends some of each windfall dollar on research but reallocates or saves some of it for other activities. We expect the postwindfall budget to be more skewed toward research when the restrictions on the university's funds are greater.

We have used federal research funds as an example, but the analysis goes through for federal aid funds as well. The main difference is that there are quite different restrictions that constrain institutions' use of aid funds. In particular, an institution that initially has low tuition might be constrained to raise its tuition if it wants to reallocate or save federal aid funds for other activities. See Turner (2012) for an analysis of how an institution might achieve this.

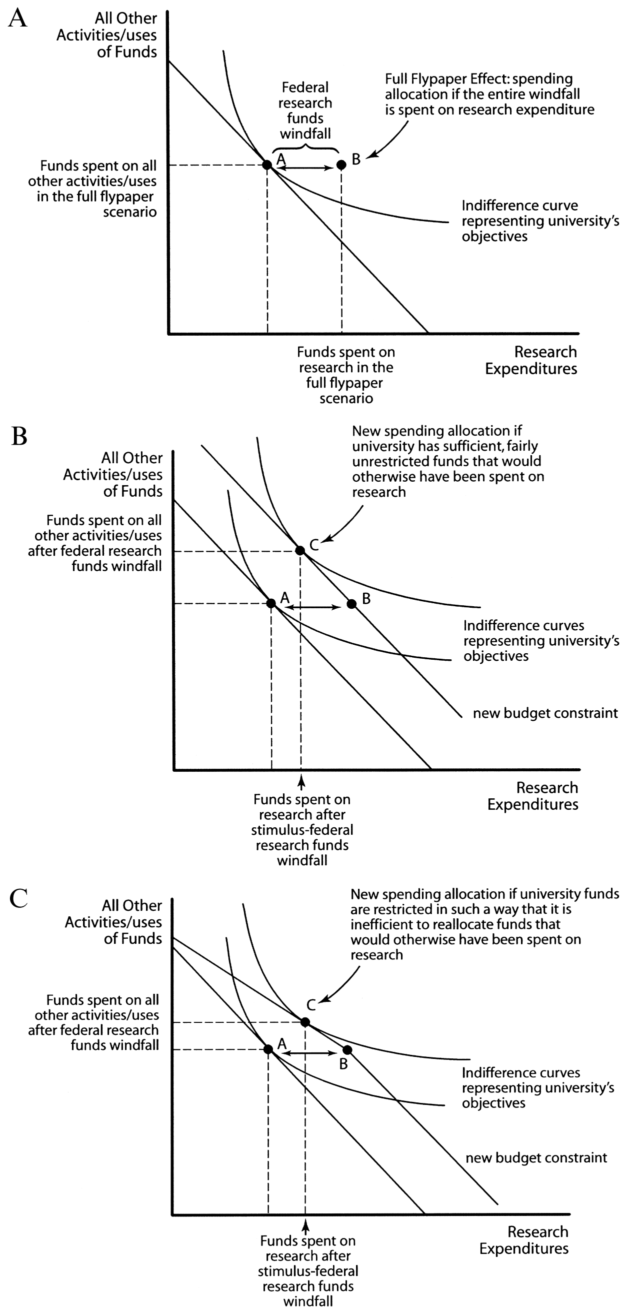

Fig. 9.8 ***A*****, a university's spending in a full flypaper scenario;** ***B*****, a university maximizing its objectives with sufficient prior research spending to make stimulus funds unrestricted;** ***C*****, a university maximizing its objectives with insufficient prior research spending to make stimulus funds unrestricted**

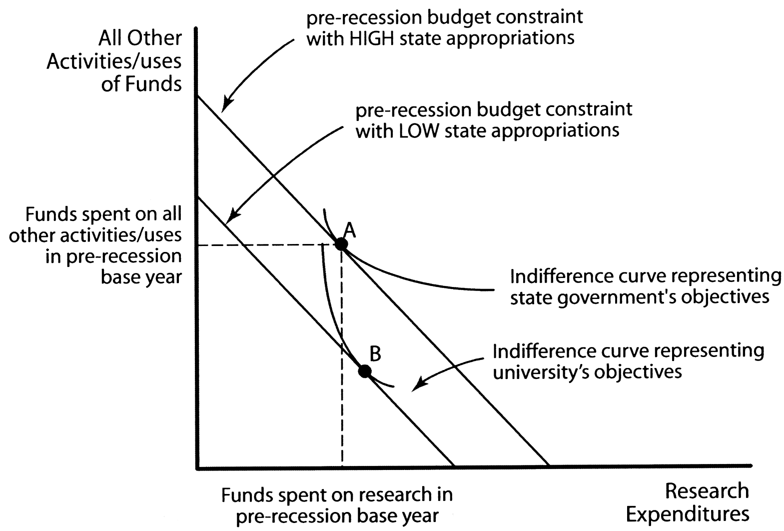

Fig. 9.9 A public university maximizing the state government's objectives rather than suffer a reduced budget in order to maximize its own

Later in this chapter, we discuss the possibility that public universities were not maximizing their objectives prior to the arrival of the windfall. While even private universities might fail to maximize their objectives—owing to restrictions placed on their spending by governments or donors—there is a much more obvious struggle that affects public universities. These universities' decisions can be highly constrained by the state governments that control an important source of their revenues (state appropriations) and that also regulate their admissions (often limiting the number of out-of-state students), tuition, aid programs, public service programs, salaries, and even line-item spending. The degree to which state governments control their public universities differs greatly from state to state and sometimes differs substantially among the institutions within a state.[17]

Consider a public university that, prerecession, had objectives represented by the indifference curve marked "university" in figure 9.9. Its state government's objectives are represented by the indifference curve marked "state" in the same figure. (The objectives shown are such that the university has a stronger preference for research than the state government, but this is not necessarily the case.) Prerecession, the state might offer high appropriations if the university complies with the state government's objectives, creating the possibility of point A, or low appropriations if the university pursues its own objectives, creating point B. The figure is set up so that the university chooses point A, with high appropriations and acceptance of the government's objectives.

17. See Aghion et al. (2009).

Now consider what occurs if the university receives a windfall in the form of federal research funds at the same time that the state government's tax revenue falls. If the state government did nothing, then the university's budget constraint would shift, just as it did in panel C of figure 9.8, and the university might choose a point like that labeled C in panel A of figure 9.10. But, appropriations to the university are more difficult for the state government to fund at just the same time that federal research funds arrive, so it is quite possible that the state's high appropriations offer will become less generous, causing the university to choose the low appropriations state in which it is allowed to pursue its own objectives. This is illustrated by point D in panel B of figure 9.10. Observe that the university has now allocated more money toward research—and not just because of the direct effect of the federal research funds. The federal funds allow the university to switch from the state government's objectives to its own. This switch may have consequences that reach far beyond allocating dollars to research. The university may shift toward *all* activities and policies that it prefers more than the state does. This could include admitting different students, charging different tuition, or allocating aid funds differently.

The theory we have presented is overly simple. Negotiations between universities and state governments are not only complex but repeated over time. Similarly, all universities (private and public) interact with the federal government repeatedly. The repeated nature of the interactions color how universities respond to federal funding. Also, universities' nongovernment sources of revenue are constrained in numerous ways, not only by formal restrictions on how funds are spent but also by fundamental elasticities. A university cannot, for instance, raise tuition without affecting which students enroll. Nevertheless, the theory we have presented brings out some key predictions:

1. Universities will spend more of the stimulus-motivated federal funds on the purposes for which it is statutorily intended when restrictions effectively reduce the cost of intended-area spending relative to spending on all other uses.
2. We should not expect a full flypaper effect unless universities' budget allocations are *highly* restricted.
3. Universities that allocate stimulus-motivated federal funds in a manner that is fairly similar to how they allocated a marginal dollar of funds prerecession are probably demonstrating that they were maximizing their objectives prior to the recession and that they have sufficient fairly unrestricted funds to keep doing this.[18]

18. The alternative interpretation would be that, prerecession, universities were already constrained to spend more on the intended uses for windfall federal funds than they have liked. In this case, if the restrictions imposed by the windfall were very similar to those that constrained the universities prerecession, they would spend the windfall similarly but be maximizing their objectives in neither situation.

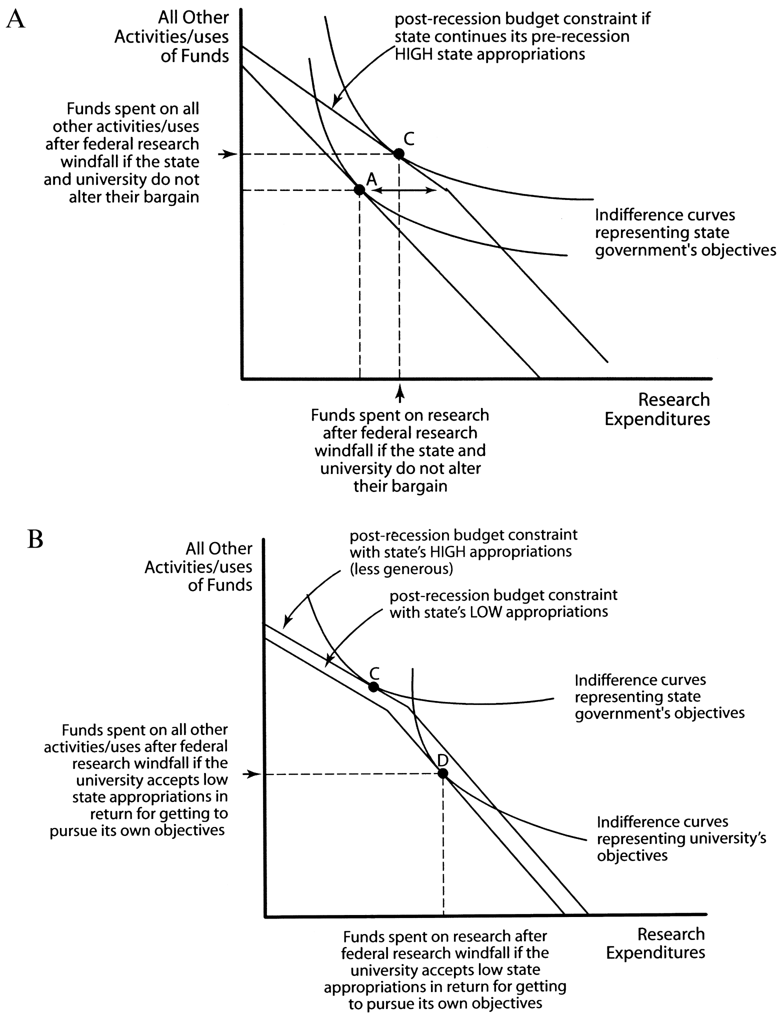

Fig. 9.10 ***A*****, a public university maximizing the state government's objectives even after the receipt of stimulus funds;** ***B*****, a public university maximizing its own objectives after state government appropriations fall in response to the availability of stimulus funds**

4. Universities that were not maximizing their own objectives prerecession (possibly public universities) may be triggered to choose a different bargain with their state governments or other sources of nonfederal funds.

9.4 Data

We use three main types of data: (a) data based on postsecondary institutions' reports of their finances and employment; (b) data based on the federal government's records of its transfers to postsecondary institutions, and (c) data based on states' reports of their workforces.

9.4.1 Data Based on Postsecondary Institutions' Reports of Their Finances and Employment

The "backbone" of our data is the Integrated Postsecondary Education Data System ([IPEDS] US Department of Education 2012), which is based on mandatory self-reporting by institutions. IPEDS contains many elements that we use: institutional characteristics, financial reports, and employment reports. The IPEDS variables relevant to this study are available on an annual basis and cover a specific school year or, in the case of financial variables, an institution's fiscal year. All postsecondary institutions relevant to this study have fiscal years that begin and end in a summer month. For instance, 2006/7 is the school/fiscal year that contains September 2006 through May 2007, plus some combination of summer months.[19]

By combining data from the annual IPEDS surveys, we can construct a fairly complete history for each institution. In the case of financial variables, however, such construction is tricky because the reporting procedures have changed over time, and public and private institutions use somewhat different accounting traditions. Fortunately, the Delta Cost Project Database (US Department of Education 2012) contains IPEDS data that have been translated into consistent measures so that we can confidently conduct longitudinal analyses of trends. We use this version of the IPEDS data for financial variables whenever it is more consistent than the normal IPEDS data.

Because its endowment survey is much more detailed than the IPEDS survey, we use the NACUBO-Commonfund Study of Endowments ([NCSE]; National Association of College and University Business Officers and Commonfund Institute 2009–2010) for outcomes related to endowments.[20] In particular, we take the spending rate on the endowment from this source. This data set has an extraordinarily useful combination of objective data on what universities *do* with their business officers' explanations of *why* they do them.

As of the time of writing, the most recent financial data that are available cover 2009/10.

9.4.2 Data on the Federal Government's Transfers to Postsecondary Institutions

We constructed a history of federal government funds received by the research universities, medical schools, and other health professional schools

19. Among the research universities and medical schools on which we focus our analysis in sections 9.5 and 9.6, 85 percent have a fiscal year that ends on June 30, 10 percent have a fiscal year that ends on August 31, 4 percent have a fiscal year that ends on May 31, and 1 percent have some other fiscal year end date.

20. For years prior to 2009, we use the Commonfund Study of Endowments (see Commonfund Institute 2003–2008).

that received at least one million dollars in 2005/6.[21] Constructing this history is a painstaking process, as described in the data appendix, owing to the fact that federal agencies' records are designed for tracking the history of specific grants, not for constructing time series of federal revenues. These data have important benefits, however. They allow us to identify the exact source and timing of each stream of federal revenue. Since stimulus funding is predicated on the idea that federal spending will affect economic outcomes *soon*, we want to know when federal funds are actually received.

Although not all federal agencies have funding data available, especially for the prestimulus period, we obtained detailed administrative data from the sources that generate the vast majority of transfers to postsecondary institutions: NIH, NSF, NASA, and the Pell grant program. These sources generate 99 percent of all federal transfers to postsecondary institutions and 75 percent of all research-type transfers. Our NIH data come from the Research Portfolio Online Reporting Tool ([RePORT] National Institutes of Health 2013); our NSF and NASA data come from research.gov (National Science Foundation 2013); and our Pell data come from the Federal Student Aid Data Center (US Department of Education 2013). We take other agencies' data (Defense, Energy, and Agriculture are the key ones) from the National Science Foundation (2013).

In the data appendix, we describe these sources and our exact procedures for recording the recipient and timing of each transfer in detail. However, our basic procedure is as follows: data on the number of Pell grant recipients and total aid is matched to the postsecondary institution to which the funds are disbursed and to the quarter when the funds are disbursed.[22] For grants and contracts, we identify each project that has a university as a recipient, taking care to include grants received by university-affiliated hospitals and independent operations. We allocate funding to the relevant university uniformly by month starting with the project's budget start date and ending with the budget end date.[23] We can thus aggregate the disbursements by year or by quarter, as needed. Grants hosted by the National Bureau of Economic Research are matched to the university(ies) of the principal investigator(s).

9.4.3 Data Based on States' Reports of Their Workforce

We obtain accurate, up-to-date data on local economic activity from the Quarterly Workforce Indicators Database ([QWI] US Department of Com-

21. The million dollar threshold is in terms of fiscal year 2010 dollars. We have NSF, NIH, and NASA data on 263 institutions but have data on federal funding for Agriculture, Energy, and Defense for only 206 of these institutions. We include the University of California-Merced despite the fact that it did not have a Carnegie classification in the year 2000.

22. Prior to fiscal year 2007, we can only match disbursements to the year, not the quarter. Therefore, we use the quarterly pattern from fiscal year 2007 to backcast disbursement by quarters in prior years.

23. We use the project start and end dates if budget start and end dates are unavailable.

merce 2013).[24] The QWI contains very current data because it is largely based on administrative data that the US Bureau of the Census gathers from unemployment wage records and from businesses. The key suppliers of these data are the state labor market agencies. The census merges these administrative data with demographic information from the US Census and other surveys.

We obtain the QWI information at the county-by-quarter level—associating each university with the county in which it is located.[25] Our key outcomes from the QWI are employment and payroll variables. Massachusetts is, unfortunately, not included in the QWI.

9.5 Empirical Strategy

If all the variation in federal funds directed to postsecondary institutions were exogenous, we would estimate the following simple regression that is standard for exercises of this sort (for instance, estimating a local government's response to a grant from the federal government):

$$(1) \qquad Exp_{it} = \beta_0 + \beta_1 Federal\ Funds_{it} + \mathbf{X}_{it}\beta_2 + \gamma_i + \varepsilon_{it}$$

or its first-differenced version:

$$(2) \quad Exp_{it} - Exp_{i,t-1} = \beta_1(Federal\ Funds_{it} - Federal\ Funds_{i,t-1}) + (\mathbf{X}_{it} - \mathbf{X}_{it-1})\beta_2 + (\varepsilon_{it} - \varepsilon_{i,t-1}),$$

where i indexes the postsecondary institution, t indexes time, a t-1 subscript indicates a variable lagged one period, Exp_{it} is the institution's expenditure or some other outcome likely to be affected (revenue, research expenditures, the payroll, employment, the spending rate from the endowment), $FederalFunds_{it}$ is federal funding received by institution i in period t, $\boldsymbol{X}_{it}$ is a vector of control variables, γ_i is an institution-specific intercept, and ε_{it} is a white noise error term.

If the outcome is total expenditure, we would interpret an estimated coefficient on $FederalFunds_{it}$ that is not statistically significantly different from one as "no saving." If the outcome and federal funding are aligned—for instance, research spending regressed on federal research funds—then an estimated coefficient that is not statistically significantly different from one is a full flypaper effect. Coefficients less than 1 are generally indicators of the institution reallocating or saving federal funds. An estimated coefficient greater than 1 would suggest that the federal funding induced the institution to match the federal funds with some funds from its other sources.

In practice, we make a few modifications to equation (2), which is the basis of our preferred specification. First, because we observe that different insti-

24. For a useful description of the QWI, see Abowd et al. 2009.

25. There are a few cases in which an institution is located in more than one county. In such cases, we assign an institution to the county in which it primarily operates.

tutions had different typical growth in expenditures (and other outcomes), prior to the base year, we compute each institution's average preexisting growth in each outcome variable using 2003/4 to 2006/7 as the "pre" period. We subtract these preexisting growth estimates from our outcome variables. This ensures that we start from a realistic counterfactual for each institution. We also allow for a nonzero intercept in the estimating equation.[26]

Second, we do not necessarily expect private and public institutions to respond similarly to federal funding, owing to the differences in their governance, alternative funding, and objectives. Thus, we estimate the above equation separately by an institution's control.

Third, we do not expect institutions to respond identically to funds from different sources. Most obviously, responses to research-type funds and aid funds are likely to differ because they are differentially fungible, they are intended for very different uses, and—most obviously—they flow to the institution in somewhat different ways. Unlike research funds, aid funds are intended to flow to students, so an institution can reallocate them only by changing its tuition or changing its institutional grant aid to students.

In short, we estimate regressions of the form:

$$\begin{aligned}(3)\ & Exp_{it} - Exp_{i,t\text{-}1} - PreGrowth_i \\ &= \alpha_0 + \alpha_1(Federal\ Research\ Funds_{it} - Federal\ Research\ Funds_{i,t\text{-}1}) \\ &\quad + \alpha_2(Federal\ Aid\ Funds_{it} - Federal\ Aid\ Funds_{i,t\text{-}1}) \\ &\quad + (\mathbf{X}_{it} - \mathbf{X}_{i,t\text{-}1})\alpha_3 + (\upsilon_{it} - \upsilon_{i,t\text{-}1}),\end{aligned}$$

separately for private and public institutions.[27] $PreGrowth_i$ is the average value of Exp_{it} - $Exp_{i,t\text{-}1}$ for institution i during the period from 2003/4 to 2006/7.[28] We estimate equation (3) using data from our base year (2006/7) onward.

Finally, we slightly modify equation (3) for use with the QWI data in which county employment and payroll are the outcomes. We can do better than estimate a preexisting growth rate because there are many counties that do not contain a relevant postsecondary institution but that are otherwise economically similar to a county that does. We therefore construct a synthetic control county for each county with a relevant institution.[29] We subtract the outcome for the synthetic control county from the dependent variable rather than subtract the preexisting growth rate:

26. We get similar results if we impose a zero intercept.

27. We would like to be able estimate separate effects for each source of research-type funds—the NSF versus the NIH, for instance. We do not believe that we can do this credibly, however. See footnote 30.

28. We do not remove institution-specific preexisting growth in federal funds because, as will be seen, such institutional differences are excluded automatically by our instrumental variable, by construction.

29. Synthetic control methods are described by Abadie, Diamond, and Hainmueller (2010, 2011). We construct a synthetic control county for each county that contains a relevant postsecondary institution.

$$(4)\quad (Exp_{it} - Exp_{i,t\text{-}1})^{university\ county} - (Exp_{it} - Exp_{i,t\text{-}1})^{synthetic\ control\ county}$$
$$= \mu_0 + \mu_1(Federal\ Research\ Funds_{it} - Federal\ Research\ Funds_{i,t\text{-}1})$$
$$+ \mu_2(Federal\ Aid\ Funds_{it} - Federal\ Aid\ Funds_{i,t\text{-}1})$$
$$+ (\mathbf{X}_{it} - \mathbf{X}_{i,t\text{-}1})\boldsymbol{\mu}_3 + (\xi_{it} - \xi_{i,t\text{-}1}).$$

9.5.1 The Potential Endogeneity of Federal Research-Type Stimulus Funding

There are two main reasons why federal research-type stimulus funding may not be exogenous. First, institutions whose revenues are particularly hard hit by the crisis or recession may be more aggressive about obtaining federal research funds, perhaps with the assistance of congressmen and senators from their state. Such reverse causality would cause equations (3) and (4) to understate the stimulative effect of transfers. Second, institutions that are going to have especially fast future growth anyway (regardless of the stimulus) may have a disproportionate share of projects that are "in the pipeline"—with the consequence that their federal funding would increase disproportionately in the stimulus period. This would cause overstatement of the stimulative effect. Overstatement would also occur if the institutions best able to generate research projects that receive stimulus funds happen to be institutions that are unusually *unaffected* by the crisis and recession, perhaps because of their location or their nonfederal sources of funding.

We need an instrument that contains credibly exogenous variation in the stimulus-driven increase in federal research-type funds that institutions experience. We propose an instrument based on (a) an institution's prestimulus funding from each federal source, and (b) the stimulus-period percentage increase in funding from each of these sources that is directed to all institutions other than the institution in question. Specifically, if year $t = 0$ is the base year, our instrument for $(FederalResearchFunds_{it} - FederalResearchFunds_{i,t\text{-}1})$ is:

$$(5)\quad [NIHFunds_{i0} \cdot (1 + p_{-i,0\ to\ t}{}^{NIH}) + NSFFunds_{i0} \cdot (1 + p_{-i,0\ to\ t}{}^{NSF})$$
$$+ NASAFunds_{i0} \cdot (1 + p_{-i,0\ to\ t}{}^{NASA}) + AgricFunds_{i0} \cdot (1 + p_{-i,0\ to\ t}{}^{Agric}) +$$
$$DefenseFunds_{i0} \cdot (1 + p_{-i,0\ to\ t}{}^{Defense}) + EnergyFunds_{i0} \cdot (1 + p_{-i,0\ to\ t}{}^{Energy})]$$
$$-[NIHFunds_{i0} \cdot (1 + p_{-i,0\ to\ t-1}{}^{NIH}) + NSFFunds_{i0} \cdot (1 + p_{-i,0\ to\ t-1}{}^{NSF}) +$$
$$NASAFunds_{i0} \cdot (1 + p_{-i,0\ to\ t-1}{}^{NASA}) + AgricFunds_{i0} \cdot$$
$$(1 + p_{-i,0\ to\ t-1}{}^{Agric}) + DefenseFunds_{i0} \cdot (1 + p_{-i,0\ to\ t-1}{}^{Defense}) +$$
$$EnergyFunds_{i0} \cdot (1 + p_{-i,0\ to\ t-1}{}^{Energy})]$$

where $p_{-i,0\ to\ t}{}^{Source}$ is the percentage increase from year 0 to year t in federal research-type funding from source, *Source* directed to all postsecondary institutions except institution i. By excluding institution i's own funding from the percentage increase calculation, we eliminate the possibility that an intention to affect institution i motivated the percentage increases in the federal funding it received.

Our proposed instrument fulfils the exclusion restriction if (a) the percentage increases in each source of federal funding (excluding the relevant institution) were not motivated by the potential effect on the relevant institution, and (b) institutions with different initial federal funding-by-source allocations were not going to diverge *differentially* from their past behavior anyway (that is, in a world with no stimulus-motivated funding). The latter restriction is a bit complex, so an intuitive example might help. Suppose that there are two types of research universities—(a) those in which NIH accounts for two-thirds of federal funding and NASA accounts for one-third, and (b) those in which NIH accounts for one-third of federal funding and NASA accounts for two-thirds. Then our instrument would indicate that the latter group of universities gets a substantially larger boost in federal research funding in the stimulus period (because NASA's percentage increase was much bigger than NIH's). Since equation (3) is in first-differences—that is, comparing every university to its own previous year—our instrument would only be problematic if the NIH-dominated universities were going to change their behavior anyway (in a world with no stimulus) in a manner that was systemically different from the way the NASA-dominated universities were going to change their behavior anyway (in a world with no stimulus). We are not aware of a narrative that suggests that this problem exists—always remembering that the narrative must be about systematic differences in changes, not systematic differences in levels. Our identifying assumptions are standard for a Bartik-type instrument based on the *interaction* between an entity's initial conditions and policy-driven changes over which the entity itself has no control.[30]

9.5.2 The Endogeneity of Federal Student Aid to Local Family Incomes

In figures 9.1 through 9.5, we demonstrated that postsecondary institutions of all types experienced substantial, stimulus-driven increases in federal aid funds. A key reason was that the aid formulas themselves became more generous. In fact, the formula changes were touted as being one of the best channels for the stimulus because they could take effect quickly and were intended to put money into the hands of young, low-income people who might be especially likely to spend it. The main change in the formula was an increase in the maximum Pell grant from $4,050 in 2006/7 to $5,350 in 2009/10. Thus, a postsecondary institution could expect to receive increased

30. The reader may observe that we could construct an instrument for each separate funding source and thereby estimate a version of equation (3) in which NIH, NSF, NASA, and other federal research-type funding all enter separately. However, the coefficients would then be identified by functional form (specifically, the assumption that all the effects are linear in the scale of federal funding), and we would not argue for the credibility of such estimates. Our proposed instrument is much more credible because it exploits idiosyncratic variation in the federal funding mix among institutions of comparable scale.

federal aid funds roughly in proportion to the number of students it enrolled who already received the maximum Pell grant. Our empirical strategy uses this policy-driven variation in the federal aid revenue that institutions received, and we take steps to ensure that it is exogenous.

Not all of the increases in federal aid funds were driven by stimulus policy. Aid funds also increased because family incomes and liquid assets fell with the crisis and recession, and this creates an endogeneity problem. A student's aid is a function of his expected family contribution (EFC), which is determined by applying the current federal formula to his family's income, liquid assets, and other dependents' needs. The lower are a family's income and assets, the greater is the federal aid for the student—*unless* the student's EFC is such that he already receives the maximum Pell grant.[31]

The relationship between family income and federal aid funds generates an endogeneity problem. Suppose that a postsecondary institution's students suffer owing to the financial crisis or Great Recession. Their families might lose employment, income, or assets. Then, even if the institution were to enroll precisely the same students and the aid formulas did not change, it would likely find that its federal aid funds increased because its students had grown more needy. Such a change in the institution's finances would be caused by the crisis and recession—not by stimulus-motivated changes in federal aid. Thus, a naive correlation between federal aid and a university's outcomes would partly reflect causality that runs from crisis/recession to outcomes, not just from stimulus funding to outcomes.

Our empirical strategy breaks apart the two strands of causality by exploiting the nationwide change in the maximum Pell grant. Recall that a student at the maximum Pell grant does not receive more aid if his family income falls. He only receives more aid if the maximum Pell grant rises—a policy over which he has no control. To form our proposed instrument, we take the prestimulus (2006/7) number of students at each institution who are at the maximum Pell and compute the increase in federal aid funds that the institution would see if every prestimulus student at the maximum got the new maximum *and* there were no change in the students enrolled *and* there were no changes in the incomes of the students already enrolled. That is, our proposed instrument for $(FederalAidFunds_{it} - FederalAidFunds_{i,t\text{-}1})$ is:

$$(6)\quad (NumberAtMaxPell_{i0} \cdot MaxPellGrant_{t}) - (NumberAtMaxPell_{i0} \cdot MaxPellGrant_{t\text{-}1}),$$

31. The formula for a student's EFC is complicated because it takes account of a wide array of possible family circumstances. However, the relationship between a student's family income and his federal aid is strong (R-squared of 0.93) if he is not at the maximum Pell grant and does not come from an above-median income family. The R-squared statistic is based on authors' calculations based on the National Postsecondary Student Aid Survey 2008 (US Department of Education 2009).

where year $t = 0$ is the base year. This is an example of a simulated instrument, the distinctive feature of which is applying a policy change to an unchanging group of actors.[32]

A restriction necessary for validity of this instrument is that schools with different initial conditions (in this case, different numbers of students eligible for the maximum Pell grant) were not going to diverge *differentially* from their past behavior anyway (that is, in a world with no stimulus-motivated boost in the Pell grant). More precisely, the part of a school's counterfactual change in behavior that cannot be predicted by the covariates in X should not be systemically related to its value of the instrument. This assumption will be problematic in the case of schools that recruit their students almost entirely from their local labor market. It should not be problematic in the case of schools that recruit their students on a national or large regional market.

To see this, consider two research universities that both recruit their students nationally. Suppose that although they are otherwise quite similar, the first places more emphasis on fields of study that appeal to high aptitude low-income students (engineering, medicine) and therefore enrolls more students eligible for the maximum Pell grant. When the maximum Pell grant increases, the first research university will receive a bigger increase in its federal aid funds than the second, but there is little reason to think that the two universities' behavior would have diverged differentially anyway at this same time. Even if part of the reason that the first research university recruits more low-income students is that it is located in a low-income neighborhood, the low-income neighborhood is unlikely to determine the school's outcomes in the crisis and recession. For instance, Yale's being located in a low-income neighborhood probably has very little effect on year-over-year changes in its student body, alumni donations, ability to attract research funds, or earnings from its endowment. In the short term, all of these Yale outcomes are determined at a far more national level—on national financial markets, for example. In fact, we can and do control for the initial employment and wages in Yale's and all other research universities' and medical schools' local labor markets and find that our instrument still has ample statistical power. This

32. In practice, constructing our instrument is slightly more complicated because we have to estimate each institution's number of students at the maximum Pell grant in the base year. We estimate it because, unfortunately, this number is not reported in the federal student aid database. We perform the estimation by analyzing how prior (to the stimulus period) changes in the maximum Pell grant affected schools' aid funds. On these prior occasions, the schools' aid funds should have changed only because of students who were at the maximum—at least so long as the economy was not falling into a recession at the same time. Thus, we can back out how many students were at the maximum. Details are in the data appendix. We are not terribly concerned about estimation error in this procedure because (a) the resulting measurement error is likely to be classical and classical measurement error in an instrument is not a problem for estimation, and (b) the stimulus-motivated change in the maximum Pell grant is so large that its change dwarfs minor errors that come from estimating the number of students eligible for the maximum grant.

is evidence that much of these institutions' variation in Pell-eligible students comes from their idiosyncratic recruiting, not their neighborhood.

To see why the instrument is less credible among schools that recruit students very locally, consider two public associate (community) colleges, each of which draws its students almost exclusively from the county whose government supports it. Suppose that the first county is blue collar and the second is white collar. The first community college is initially likely to have more students who are eligible for the maximum Pell grant because its local families have lower incomes. In the counterfactual where no stimulus-motivated change in the Pell grant occurred, the first community college would probably suffer more in the recession than the second. This is because, in the recession, blue-collar employees systemically suffered greater losses in employment and income than white-collar employees.[33] Thus, our proposed instrument would be correlated with the error term—the change in the school's counterfactual behavior that cannot be predicted by the covariates in X. Of course, we could add numerous indicators of the counties' initial labor market conditions (the share of workers in each occupation and so on) to the vector X in an attempt to make our instrument more credible. However, since the differences in the schools' Pell-eligible population came from precisely those labor market conditions, our instrument would then have no statistical power.

Summing up, we have a powerful and, we believe, credible simulated instrument for the stimulus-motivated change in federal aid funds—but only for institutions that do not draw most of their students from a local labor market. This eliminates virtually all the associate institutions and a good share of the baccalaureate/master's institutions as well. Since these two categories of institution could only have been much affected by stimulus-motivated changes in federal aid (federal research funding is unimportant to them), we hereafter focus our analysis on research universities, medical schools, and a few other health institutions that receive very substantial federal funding.[34]

9.6 Informal, Graphical Illustrations of the Effect of Stimulus Funding

Before proceeding to the formal econometric analysis, we illustrate some of our basic results using figures that are the graphical analog of the estimating equations. The advantage of the figures is that they provide solid intuition. The disadvantages, relative to the econometric analysis, are twofold.

33. This fact is shown by numerous studies—for instance, Hoynes, H., Miller, D. L., and Schaller, J. (2012) or US Bureau of Labor Statistics (2012).

34. See below for our exact selection criteria. A small number of very selective liberal arts colleges do, in fact, recruit students from the entire nation. The Pell-based instrument should be credible and have statistical power for them. They should therefore be susceptible to analysis—although not for the effects of federal research funds, of which they have only a small amount. Medical and other health schools are interesting to us because they account for such a large amount of federal research funding.

First, in order to show the results clearly, we focus on the schools that were most or least affected by stimulus-driven funding, omitting the schools in intermediate situations. Thus, although the main graphical findings carry over to the full set of universities, minor aspects of the graphs are probably best ignored because they are insufficiently representative. Second, the figures do not deal with the endogeneity problems that the instrumental variables remedy.[35] Thus, we focus the figures on federal research funding, which is less likely to be endogenous than aid funding.

Figure 9.11 shows sources of revenue (panels A and B) and categories of expenditure (panels C and D) for private institutions from 2003/4 through 2009/10. The left-hand panels (A and C) are based on the twelve institutions that were *most* affected by federal stimulus-driven research funding: each of them experienced at least a 25 percent increase in funding relative to 2006/7. The right-hand panels (B and D) are based on the five institutions that were *least* affected by stimulus-driven research funding: each of them experienced only a minor (inflation-adjusted) increase in funding relative to 2006/7. (There are no private institutions that experienced a zero increase or a decrease in funding.)

Importantly, each revenue or expenditure line in the figure is based on the *residual* of that variable from its 2003/4 through 2006/7 time trend. This allows us to focus on the changes in each variable from its preexisting trend. It is the use of these residuals that makes the figures the analog of the estimating equation. A consequence of using the residuals is that all the lines are centered around zero in the prestimulus period.

Panel A of figure 9.11 shows that, for the most affected schools, revenue from all federal sources rose dramatically in 2009/10 relative to the preexisting trend. There is a smaller increase in 2008/9. This is not surprising because the schools were selected based on the increase in their federal research funding, but it does show that other federal funding did not simultaneously fall to offset the increase in research funding. What is noteworthy is that, during the same period, all other sources of revenue either fell or stayed on trend. Most strikingly, revenue from tuition payments and the sales of educational activities fell substantially.[36]

Panel B of figure 9.11 shows the same revenue streams for the least affected private schools. Of course, their federal revenue rises by a much smaller amount than it does for the most affected schools. What is note-

35. We can construct figures that are the analog of the reduced-form of our instrumental variables procedure. In practice, these figures—which are available from the authors—simply look like muted versions of figures 9.14 and 9.15. This appearance is to be expected since the research instrument and actual research funding are not perfectly correlated. See the results of the first stage regression, below.

36. Revenues from educational activities are revenues from the sales of goods or services that are "incidental to the conduct of instruction, research or public service." For research universities, common examples include the rental of university-owned buildings and equipment, sales of publications, and sales of analytic services.

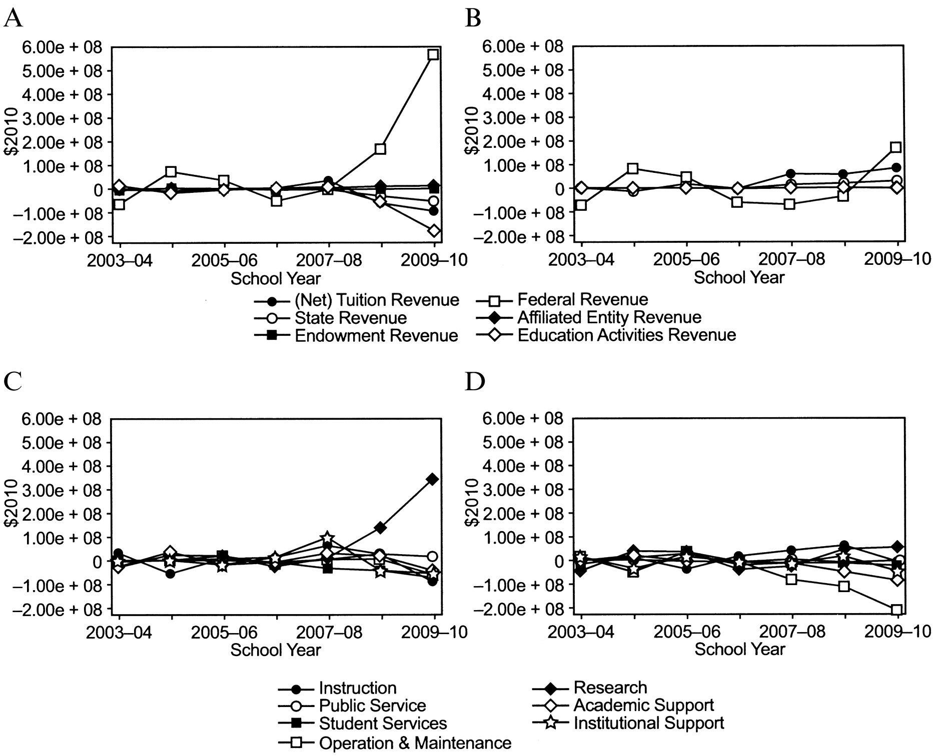

Fig. 9.11 Revenues and expenditures of the private universities most and least affected by stimulus-driven federal research funding

Notes: Panel A, revenues of private universities most affected by stimulus-driven research funding; panel B, revenues of private universities least affected by stimulus-driven research funding; panel C, expenditures of private universities most affected by stimulus-driven research funding; and panel D, expenditures of private universities least affected by stimulus-driven research funding.

worthy, however, is that their revenue from tuition *rises*, and their revenues from other sources also rise modestly or stay on trend. Comparing panels A and B, we surmise that increased federal research funds may have allowed schools to maintain their financial aid promises and otherwise keep tuition down during the recession.

Panel C of figure 9.11 shows the expenditures of the private institutions most affected by stimulus-driven research funding. The first thing to observe is that their research expenditures rise, but not by the full amount of the increase in federal funding (the vast majority of which is research funding for the schools in question). This is because, as we noted in panel A, the schools' other sources of revenue fell when their federal funding rose—making it impossible for them to increase research expenditures by the full amount of the federal funding increase unless they were to cut other categories of expenditure sufficiently to balance the books. The institutions' expenditures on other categories (instruction, academic support, student support, and so on) do fall, but they fall too modestly to balance the books.

Panel D of figure 9.11 shows the same expenditure categories for the private institutions least affected by stimulus-driven federal research funding. Their research expenditures rise modestly—and not by the full extent of their increase in federal funding (compare panels B and D). Notably, their expenditures in some other areas fall substantially: expenditures on operations and maintenance and expenditures on academic support. This fits a narrative in which schools defer maintenance when their budgets are tight.

Considered together, panels A through D suggest that not all of the federal research funding sticks where it hits. Private universities appear to reallocate some of the money that they would otherwise have spent on research to goals such as holding down tuition and keeping up expenditures in areas other than research. We can assess these relationships in a more rigorous, causal manner in the econometric analysis.

Figure 9.12 is the same as figure 9.11 except that it shows data for *public* research universities. The left-hand panels (A and C) are based on the thirteen institutions *most* affected by federal stimulus-driven research funding: each of them experienced at least a 25 percent increase in funding relative to 2006/7. The right-hand panels (B and D) are based on the fourteen institutions that were *least* affected. Each experienced only a modest inflation-adjusted increase in federal research funding

Panel A of figure 9.12 shows that, for the most affected public schools, revenue from federal sources rose dramatically in 2009/10 relative to the preexisting trend. This is to be expected given the selection of schools, so what is striking is that revenue from state sources fell by approximately the same amount as the increase in federal revenue. However, revenue from tuition and from education activities *rose* very substantially in 2009/10. Even with the decrease in state revenue, the public schools that experienced the greatest increases in stimulus-driven federal research funding ended up with *greater* revenue in 2009/10 than we would have expected based on their preexisting trends.

Panel B of figure 9.12 shows the same revenue streams for the least affected public schools. Their federal revenue rises modestly compared to the increases for the most affected schools. Interestingly, though, their revenue from tuition and educational activities rises modestly as well. This pattern is a muted version of what we see for the most affected public schools. Moreover, their state revenue falls by more than their federal revenue rises. Overall, their 2009/10 revenues are above what we would expect based on their preexisting trend, but they only achieve these higher revenues through the *combination* of higher tuition revenue, higher educational activity revenue, and higher federal revenue.

Panel C of figure 9.12 shows the expenditures of the public institutions most affected by stimulus-driven research funding. The first thing to observe

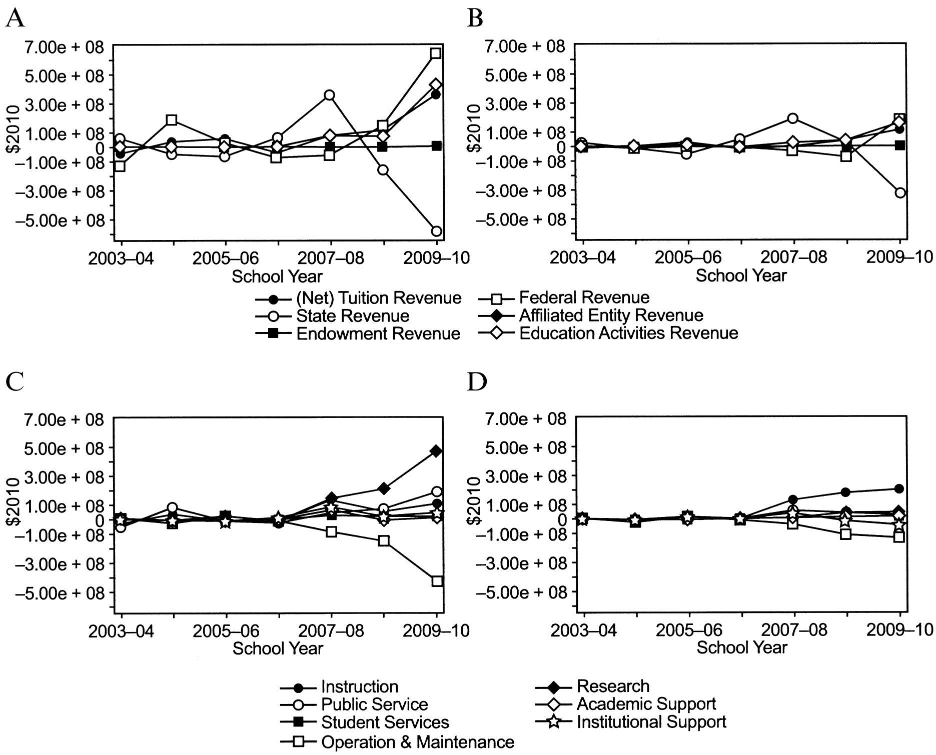

Fig. 9.12 Revenues and expenditures of the public universities most and least affected by stimulus-driven federal research funding

Notes: Panel A, revenues of public universities most affected by stimulus-driven research funding; panel B, revenues of public universities least affected by stimulus-driven research funding; panel C, expenditures of public universities most affected by stimulus-driven research funding; and panel D, expenditures of public universities least affected by stimulus-driven research funding.

is that their research expenditures rise very substantially—not by the full amount of the increase in federal funding but by an amount quite close to it (especially when we recall that not all of their federal revenue is for research). Their expenditures on instruction and public service rise modestly. Their expenditures on operations and maintenance fall very substantially. Overall, their expenditures in 2009/10 are above the preexisting trend. This, recall, is made possible by the fact that their revenue in 2009/10 is also above the preexisting trend, owing to increases in federal, tuition, and educational activity revenue.

Panel D of figure 9.12 shows the same expenditure categories for the public institutions least affected by stimulus-driven federal research funding. Their research expenditures rise just slightly—not by the full extent of their increase in federal funding (compare panels B and D). Interestingly, their expenditures on instruction rise. Their expenditures on operations and maintenance fall.

Analyzed simultaneously, panels A through D of figure 9.12 indicate a fascinating narrative (one that we confirm below). A public institution that was able to get substantial federal research funding during the stimulus period may have made a bargain with its state government in which it lost state appropriations (of an amount equal to its increase in federal revenue), but gained the ability to raise its tuition and to sell more educational activities. Since the public universities in question were setting their tuition and other prices well below what the market would bear previous to 2009/10 (especially if one looks at the tuition of competing private universities), this is plausible. Put another way, the public institutions used the crisis to move closer to the private institutions on key dimensions: market-based tuition, market-driven sales of educational activities, and the like. Of course, we need econometric analysis to confirm that these relationships are causal.

9.7 The Effect of Stimulus Funding on Universities' Revenues, Expenditures, Employment, and Other Outcomes

In this section, we use econometric analysis to show plausibly causal effects of stimulus funding on postsecondary institutions' revenues, expenditures, employment, and institutional aid to students. We also show the effects on other outcomes that the institutions themselves only influence or partially control: their endowment spending and state appropriations.

9.7.1 The First Stage of the Instrumental Variables Estimations

Before showing the effects that are our main interest, it is useful to demonstrate that our instrumental variables have considerable explanatory power and have coefficients that are in the range of what we expect, given how they are constructed. Table 9.2 shows these results. The two instruments are the Bartik-type instrument for federal research funds and the simulated instrument based on the Pell grant formula and the institution's prerecession number of students at the maximum grant. Columns (1) and (3) show the first-stage estimates for private institutions; columns (2) and (4) show the first-stage estimates for public institutions. The standard errors in the table are robust and clustered at the institution level.

Table 9.2 shows estimates from our preferred specification, in which we do not include controls for the prerecession economic characteristics of the county in which the institution is located. We prefer this specification because the prerecession economic characteristics of small counties are not published so that we must fill them in using less precise state economic characteristics. However, appendix table 9A.2 shows exactly parallel estimates based on equations in which we do include the controls, all measured in the year 2006 unless otherwise specified: the unemployment rate, per capita

Table 9.2 First-stage estimates: Regressions of federal funding variables on instruments

Dependent variable:	Dependent variable: Year-over-year change in federal research funds		Dependent variable: Year-over-year change in federal Pell funds	
Type of postsecondary institution:	Private research universities and medical schools (1)	Public research universities and medical schools (2)	Private research universities and medical schools (3)	Public research universities and medical schools (4)
Explanatory variable:				
Bartik-type instrument based on change in federal research funds	1.004***	1.103***	0.010*	0.092***
	(0.183)	(0.146)	(0.005)	(0.019)
Simulated instrument based on change in maximum Pell grant	7.421	0.067	4.134***	5.043***
	(6.555)	(0.751)	(0.750)	(0.639)
Observations	300	524	300	524
R-squared	0.403	0.483	0.219	0.464

Notes: The table shows estimates of the first-stage equations described in the text. Each column represents a regression. Robust standard errors clustered at the institution level are shown in parentheses. An observation is a postsecondary research university or medical school in a year between the 2006/7 and 2009/10 school years, inclusive. All amounts are in real dollars, adjusted for inflation using the GDP deflator. The dependent variables are the year-over-year change, in dollars, of federal research funds (columns [1] and [2]) and federal Pell grant funds (columns [3] and [4]). The Bartik instrument is constructed by applying the national rate of growth in a given federal agency's funding (national *excluding* the institution itself) to the institution's base year funding from that agency and then summing over all agencies. See equation (4) in the text. The Pell-based simulated instrument is constructed by applying the change in the maximum Pell grant to each institution's estimated number of students eligible for the maximum grant in the base year. See equation (5) in the text. Asterisks indicate p-value.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

income, a house price index, the change in the house price index from 2000 to 2006, the number of stable jobs, the number of stable hires, the average earnings in stable jobs, farm income as a share of all personal income, and population. These controls help to ensure that the Pell-based instrument is not correlated with omitted economic characteristics that might predict how the area fares in the recession.

Recall that the Bartik-type instrument for federal research funds is constructed so that no institution's own needs or research trajectory can affect the instrument. This construction should produce first-stage coefficients on the instrument that are fairly close to 1.[37] In columns (1) and (2) in table 9.2, we see coefficients of the expected magnitude: 1.0 for private institutions and 1.1 for public institutions. The relevant instrument is statistically powerful: the *t*-statistics on the coefficients are 5.5 for private institutions and 7.6 for public institutions (of which there are about twice as many as there are private institutions).

Similarly, the Pell formula-based instrument is highly statistically significant, with the relevant *t*-statistics being 5.5 for private institutions and 7.9 for public institutions. The relevant coefficients are constructed in such a way that their coefficients should be greater than 1.[38] The relevant coefficients are 4.1 for private institutions and 5.0 for public institutions—within the range that we expect.

9.7.2 How the Stimulus Affected *Private* Universities' Expenditures, Employment, and Other Outcomes

Table 9.3 presents estimates based on *private* research universities and medical schools. For these institutions, endowments are a potentially important source of income and a means of saving federal research funds. On the other hand, state appropriations are not important to these institutions. Thus, table 9.3 shows key outcomes like expenditures, employment, tuition revenue, institutional student aid, and the spending rate from endowments, but it does not show state appropriations.

37. The coefficient should not be equal to 1 because the institutions are not all of the same size.

38. The construction of the instrument merely affects the scale of the coefficient in the first stage equation: the magnitude of this coefficient does not affect the instrumental variables results. Nevertheless, to see why we expect the coefficient to be greater than 1, recall that the instrument is the number of students estimated to be eligible for the maximum Pell grant times the change in the maximum Pell grant. The first reason why the coefficient on the instrument should be greater than 1 is that we estimated the number of students at the maximum grant using prerecession changes in the maximum grant, and these changes took place several years ago when institutions enrolled fewer students. The second reason why the coefficient on the instrument should be greater than 1 is that institutions with more students at the maximum grant also have students who are Pell-eligible but below the maximum grant. These students may become eligible for additional Pell aid either because (a) the institution responds to the change in the maximum Pell grant by raising tuition, or (b) because their families become poorer as a result of the recession. We show evidence below that phenomenon (a) does occur.

Table 9.3 **The effect of stimulus-motivated federal funds on *private* research universities and medical schools**

	Dependent variable is year-over-year change (minus prerecession trend) in:							
	Total expenditure (1)	Research expenditure (2)	Instructional expenditure (3)	Number of employees (per $1,000 of funds) (4)	Total payroll (5)	Net tuition revenue (6)	Institutional grant aid (7)	Scaled spending rate from endowment (8)
Year-over-year change in federal research funds	0.094	0.231*	–0.474*	0.031	0.123	–0.032*	0.017*	–0.102*
	(0.451)	(0.136)	(0.275)	(0.041)	(0.186)	(0.017)	(0.009)	(0.057)
Year-over-year change in federal Pell funds	3.683	2.941	1.090	0.020	10.892	–0.518	0.677*	–0.010
	(3.580)	(1.976)	(1.839)	(0.406)	(9.957)	(1.197)	(0.374)	(0.463)
Dependent variable controls for the prerecession trend (per equation [3])	yes	yes	yes	yes	yes	yes	yes	yes
Prerecession economic characteristics	no	no	no	no	no	no	no	no
Instrumental variables estimates	yes	yes	yes	yes	yes	yes	yes	yes
Observations	300	300	300	300	300	255	255	296

Notes: The table shows estimates of equation (3) described in the text. Each column represents a regression. Robust standard errors clustered at the institution level are shown in parentheses. An observation is a private postsecondary research university or medical school in a year between the 2006/7 and 2009/10 school years, inclusive. All amounts are in real dollars, adjusted for inflation using the GDP deflator. The dependent variables are the year-over-year change in various expenditures and other outcomes. The units are dollars unless otherwise specified. See text and equations (4) and (5) for a description of the instrumental variables. In regressions with fewer observations, some institution did not report data. Asterisks indicate *p*-value.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Private universities' research expenditures rose by about twenty-three cents for every dollar of stimulus-motivated federal research funds. This suggests that they reallocated or saved some funds they would otherwise have spent on research for other purposes, and the other outcomes shown in table 9.3 give us some idea what those other purposes were. Their net tuition revenue fell by three cents and their institutional grant aid rose by two cents for every dollar of stimulus-motivated federal research funds they received. This suggests that they reallocated some funds to keep tuition down and aid up for their students. The point estimates for their total employees and payroll are positive but statistically insignificant—more because of large standard errors than because the point estimates are small. Thus, it is possible that some of the reallocated funds were used to protect jobs.

The spending rate variable requires a bit of explanation. We want to focus as much as possible on policy variables that the institution can control, and the spending *rate* is much more under an institution's control than total spending from the endowment (the spending rate times the base used by the institution). A typical base is something like "a running average of the last three years' market value of the endowment," and institutions change the definitions of their bases infrequently. Most of the change in the base from year to year is driven by past market performance, over which the university has no control at the time it makes spending decisions. In short, we want to focus on the spending rate and not spending from the endowment, but we must scale the spending rate in such a way that it could logically have the same relationship with a dollar of federal funds if the rate is applied to a massive base like Harvard's or a smaller base like Pace University's. Therefore, we multiply each spending rate by its base in the base year and use this "scaled spending rate." This makes the coefficient easy to interpret: a dollar increase in federal funding generates a change of X dollars in endowment spending, purely through the change in the spending rate, which is under the institution's control.

We find that spending rates from private universities' endowment fell such that endowment spending fell by ten cents for every dollar of stimulus-motivated federal research funds. This result is not surprising given the clear tension in the 2008/9 fiscal year when many private universities felt constrained to maintain spending rates that were difficult when many of their funds were underwater.[39] Thus, when stimulus-motivated funds arrived—mainly in the 2009/10 fiscal year—schools that could use them to relieve a little of the tension appear to have done so.

Interestingly, instructional spending fell by about forty-seven cents for every dollar of stimulus-motivated federal research funds. At first this result seems surprising, but at least part of it is explained by the fact that private research universities have quite a large number of people on their payroll

39. This is the authors' interpretation of comments in the NCSE surveys of 2009 and 2010.

who divide their time between instruction and research. These people appear to have shifted toward doing more research when stimulus-motivated federal funds were available but the universities' budgets were otherwise very tight. For instance, using IPEDS data, we found that stimulus-motivated federal research funds were associated with a substantial shift of graduate assistants from teaching duties (instructional spending) to research duties (research spending).[40] We found a similar shift from instruction to research among employees with faculty status who are not part of tenure system. (Many such employees are found in laboratories and medical schools.) These are only two of the fairly obvious ways in which such shifts can take place. For instance, faculty who remain primarily instructors can buy out a course or an undergraduate student who would have done an independent project (using instructional funds) can work on a research project headed by a faculty member. In short, we believe that at least some of the fall in instructional spending was a reallocation of the universities' resources toward research, and this reallocation may have enabled the universities to protect jobs and student support.

We estimated the effects of stimulus-motivated federal funds on several categories of expenditures not shown in table 9.3. These suggest that money reallocated from federal research funds was broadly distributed as small percentage increases across all other areas (student services, academic support, public service, and so on).[41] This is consistent with the highly imprecise point estimate suggesting that total expenses rose by 9.4 cents for every stimulus-motivated federal research dollar. In other words, part of the windfall research dollar was allocated to research (including the shifting of people from instruction to research), but much of the windfall dollar was probably allocated in much the same way that an unrestricted, additional dollar of revenue would be at the university in question.[42] This is what economic theory predicts would occur in a university whose prerecession allocation of revenue was approximately optimal and whose funds were somewhat but not wholly restricted.

At private universities, stimulus-motivated Pell grant receipts had no statistically significant effects except on institutional grant aid, which rose by sixty-seven cents for every dollar of Pell funds. This result is probably not a strictly causal effect but a reflection of the tendencies of private universities that have an unusually large number of Pell grant-eligible students. These universities increased their own institutional aid to students as the maximum Pell grant increased. Since the students were made better off by the increase in the maximum grant, these schools must have either given such students an even bigger increase in aid than they received through the increase in the

40. These calculations are available from the authors.

41. These results are available from the authors.

42. That is, if every institution spends the additional funds in a broad manner that is idiosyncratic, the overall estimates end up being imprecise.

grant or—more likely—given increased aid to other students whose incomes were modest but too high to qualify for the Pell grant.

The overall picture that emerges from private universities is as follows. They appear not to have reacted much to stimulus-motivated Pell funds, but they did react to stimulus-motivated federal research funds. When they received an extra dollar of such funds, they spent part of it on research but implicitly reallocated some of it to keep tuition down, keep student aid up, possibly protect some jobs, and relieve the pressure on their endowments (by allowing the spending rate to fall relative to the counterfactual).

We performed a variety of specification tests on our estimates for private universities. These are shown in appendix table 9A.3. When we add covariates for preexisting economic conditions in the county, the coefficient estimates generally exhibit the same pattern but the standard errors rise. For private universities, we consider this an important specification test only for the effect of stimulus-motivated Pell grant funds on institutional aid. This is the only effect likely to be biased by a correlation between the Pell-based instrument and preexisting economic conditions. This effect survives the addition of covariates. When we estimate the equation by ordinary least squares, the pattern of coefficients on stimulus-motivated federal research funds is very similar except that the change in instructional spending is substantially smaller. This suggests, if anything, that it was the universities that were *less* likely to shift instructors to research that received more stimulus-motivated funding for *non*exogenous reasons.

9.7.3 How the Stimulus Affected *Public* Universities' Expenditures, Employment, and Other Outcomes

The effects of stimulus-motivated federal funds turn out to be quite different for *public* research universities and medical schools. The estimates are shown in table 9.4.[43]

Public universities' research expenditure rose approximately dollar for dollar with stimulus-motivated federal research funds, and instructional spending rose by about sixty-two cents for every dollar. State appropriations fell by about twenty-nine cents for every dollar of stimulus-motivated federal research funds. The greater expenditure on instruction may have been paid for by increases in net tuition (thirty-six cents for every dollar of federal research funds) and small decreases in institutional grant aid (three cents for every dollar of federal research funds). The negative but statistically insignificant coefficients on total employees and payroll suggest that, if anything, public universities that received federal research funds cut jobs. Overall, a consistent and interesting picture arises. A public research university that

43. Table 9.4 shows state appropriations as an outcome because they are highly relevant to public universities. However, it does not show endowment-related outcomes, as these turned out to be largely irrelevant.

Table 9.4 **The effect of stimulus-motivated federal funds on *public* research universities and medical schools**

	Dependent variable is year-over-year change (minus pre-recession trend) in:							
	Total expenditure (1)	Research expenditure (2)	Instructional expenditure (3)	Number of employees (per $1,000 of funds) (4)	Total payroll (5)	Net tuition revenue (6)	Institutional grant aid (7)	State appropriations (8)
Year-over-year change in federal research funds	–0.238	1.238***	0.618**	–0.039	–0.070	0.364***	–0.030***	–0.287*
	(0.393)	(0.159)	(0.247)	(0.054)	(0.195)	(0.105)	(0.011)	(0.171)
Year-over-year change in federal Pell funds	0.125	0.238	1.341***	0.082	–0.526	1.003***	0.079*	–2.122***
	(1.121)	(0.275)	(0.375)	(0.107)	(0.538)	(0.346)	(0.043)	(0.626)
Dependent variable controls for the prerecession trend (per equation [3])	yes	yes	yes	yes	yes	yes	yes	yes
Prerecession economic characteristics	no	no	no	no	no	no	no	no
Instrumental variables estimates	yes	yes	yes	yes	yes	yes	yes	yes
Observations	515	524	524	524	524	460	460	524

Notes: The table shows estimates of equation (3) described in the text. Each column represents a regression. Robust standard errors clustered at the institution level are shown in parentheses. An observation is a public postsecondary research university or medical school in a year between the 2006/7 and 2009/10 school years, inclusive. All amounts are in real dollars, adjusted for inflation using the GDP deflator. The dependent variables are the year-over-year change in various expenditures and other outcomes. The units are dollars unless otherwise specified. See text and equations (4) and (5) for a description of the instrumental variables. Asterisks indicate p-values.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

enjoyed stimulus-motivated federal research funds reoriented itself toward research and instruction, raised tuition (by increasing in-state tuition, enrolling more out-of-state students who pay higher tuition, or both), and reduced institutional grant aid (perhaps by substituting out-of-state students for low-income in-state ones). These institutions may have been able to make these changes, which have a flavor of greater independence from state government, precisely because their ability to bring in federal research funds caused their state governments to think that they could reduce appropriations without generating chaos. Put another way, this quantitative evidence is in line with the theory in section 9.3 and with the graphical evidence of the previous section: prominent public research universities may gain independence from state governments during recessions by increasing their reliance on research funding and tuition and decreasing their reliance on state appropriations. In fact, we have heard several narratives from public university trustees who participated in making such "grand bargains." The public universities' greater independence has been (at least anecdotally) associated with greater emphasis on research and instruction, more out-of-state students, and prices that are closer to market-based pricing. We believe that our study provides the first systematic, as opposed to anecdotal, evidence of this phenomenon.

Stimulus-motivated Pell grant receipts had important effects on public universities. Their net tuition revenue rose dollar for dollar with Pell grant revenue generated by the increase in the maximum grant. Net tuition revenue excludes tuition paid by Pell grants, so this effect is *not* mechanical. Instead, this effect indicates that public universities responded logically to the incentives provided by the Pell grant formula. The formula is such that, when the maximum Pell grant rises, institutions with sufficiently low tuition have an incentive to raise their tuition to fully tap the change in the maximum grant, thereby maximizing revenue from the federal Pell program. Students who receive the maximum Pell grant before and after the tuition increase may be no worse off, but higher-income students pay (at least some of) the higher tuition from their own funds. Institutional grant aid also rose by eight cents for every dollar of stimulus-motivated Pell funds. This was probably not a strictly causal effect but—like the corresponding estimate for private universities—evidence that public universities with more Pell-eligible students also had more students with modest incomes who did not qualify for the increased grant but who needed greater aid because of the recession or the tuition increase.

Even more interesting, state governments appear to have taken *all* the increases in revenue from the stimulus-motivated changes in the maximum Pell grant and *all* the increases in revenue from the related tuition increases: state appropriations fell by about two dollars for every dollar of additional Pell funds generated by the increase in the maximum grant. State governments must have used the money they would otherwise have appropriated to universities for other programs or to prevent taxes from rising.

Finally, it is worth noting that instructional spending rose when a public university received more Pell revenue as a result of the increase in the maximum grant. We interpret this as further evidence of what public universities do when they can act more independently because they become more reliant on tuition revenue and less reliant on state appropriations.

In appendix table 9A.4, we show specification tests for our baseline public university results shown in table 9.4. Adding prerecession economic characteristics of the county does not change any of the coefficients in a meaningful way. This lack of change is especially important for the coefficients on stimulus-motivated Pell funds since it was the Pell-based instrument that we thought might be correlated with area's economic characteristics. Appendix table 9A.4 also shows that OLS results are generally very similar to the section 9.4 results.[44]

All in all, the picture that emerges from the public universities is as follows. Federal stimulus-motivated research and Pell funds made public universities less reliant on state appropriations and more reliant on tuition revenue (as well as on the federal funds themselves). The consequence was apparently a reorientation toward research and instruction. The reorientation toward research is not at all surprising given that many federal funds were intended for research. The reorientation toward instruction is probably a sign that public research universities were moving toward a tuition-dependent model of finance, in which attracting out-of-state students and other high-ability-to-pay students is important.

9.7.4 A Note on "Adding Up"

All revenue is either spent or saved, so one might expect that, when an additional dollar of federal funds arrived at a university, it would be easy to see how the changes in (a) spending, (b) saving, and (c) other sources of revenue sum to one. The numbers do sum to one for each institution, but it is difficult to present regression estimates that demonstrate this in a transparent way. The reason is twofold. First, outside of the major, generic categories like research and instructional, many spending categories are highly institution-specific. For instance, institutions with independent operations or medical schools have idiosyncratic spending patterns. Second, institutions have many ways to save and dissave: endowments; debt; additions to and subtractions from land, infrastructure, buildings, equipment, and art and library collections; changes in capital leases; and changes in construction schedules. We found that we had two alternatives, neither of which was informative. We could sum up all of the idiosyncratic categories into motley aggregates that would mechanically satisfy the sum-to-one rule, but

44. We examined the effects of more detailed categories of expenditure and employment. These enrich but do not change the picture that emerges from the results already described. In particular, stimulus-motivated federal research funds raised spending on research salaries (fifteen cents for every dollar), academic support services, and student services. We also examined the public universities' receipt of State Fiscal Stabilization Funds, which were part of ARRA. These appear as appropriations in section 9.2. As anticipated (see table 9.1), we found that these funds made such small contributions to the revenues of major public research universities that their effects, if any, could not be discerned.

these did not admit of coherent interpretation. Alternatively, we could show regressions for fairly disaggregated categories, but these required so much interpretation (for instance, knowing which institutions had independent operations) that they were far from transparent. These problems were aggravated by the fact that, when universities fall on temporary hard times, they often employ their budgetary ingenuity in exactly the areas that were most idiosyncratic in the first place. Suffice it to say that adding up does occur for each institution and that a good share of the reconciliation occurred in areas that are not highly salient.

9.8 The Effect of Stimulus Funding on Areas Where Universities Are Located

Some commentators on universities sanguinely predicted that stimulus funds would prop up the local economies surrounding universities. In this section, we investigate this possibility. However, our results in the previous section lead us to expect less than dramatic results, especially for public universities where a good share, if not the majority, of stimulus funds made their way into the hands of nonuniversity beneficiaries of state spending and possibly of state taxpayers. These people may have spent the stimulus money to prop up aggregate demand, but there is little reason to think that they spent it in the immediate vicinity of the universities themselves. Stimulus funds that found their way into students' hands would presumably be spent around the universities, but the federal funds provoked tuition increases at public universities so that many students would presumably feel poorer, not richer. Research spending rose, but the lack of increase in university employment suggests that employees were moved around within universities with little net increase in universities' local employment.

Table 9.5 shows estimates of how federal stimulus funding affected employment and payroll in counties in which universities are located. The outcomes are based on the QWI, and the estimates are from section 9.4 regressions. The left-hand side of the table shows results for counties in which private universities are located, and the right-hand side of the table shows results for counties in which public universities are located.

We observe no statistically significant effect of stimulus-motivated Pell funds on the employment or payrolls of counties in which private institutions are located. We also observe no statistically significant effect of stimulus-motivated federal aid funds on employment or payroll in counties where public universities are located. We observe a small but statistically significant *negative* effect of stimulus-motivated federal research funds on employment in counties where public universities are located: the estimates suggest that a dollar of stimulus-motivated research funds reduces employment in the county by 0.0001 jobs. When we examine more detailed subcategories of employment, the last of these results is not clarified. It is also

Table 9.5 **The effect of stimulus-motivated federal funds on the economies of counties in which research universities and medical schools are located**

	Dependent variable is year-over-year change (minus prerecession trend in control counties) of counties containing:			
	At least 1 private research university or medical school		Only public research universities or medical schools	
	Employment (1)	Total payroll (2)	Employment (3)	Total payroll (4)
Year-over-year change in federal research funds	–0.0004	–51.209	–0.0001*	–5.993
	(0.0004)	(33.398)	(0.00005)	(4.377)
Year-over-year change in federal Pell funds	0.0002	–27.201	–0.0004	–31.121
	(0.0010)	(90.864)	(0.0004)	(24.672)
Dependent variable controls for the prerecession trend (per equation [3])	yes	yes	yes	yes
Synthetic control counties included to establish time effects (see text)	yes	yes	yes	yes
Prerecession economic characteristics of the county	yes	yes	yes	yes
Instrumental variables estimates	yes	yes	yes	yes
Observations				

Notes: The table shows estimates of equation (3) described in the text. Each column represents a regression. Robust standard errors clustered at the county level are shown in parentheses. An observation is a county in a year between the 2006/7 and 2009/10 school years, inclusive. All monetary amounts are in real dollars, adjusted for inflation using the GDP deflator. The dependent variables are the year-over-year change in employment and payroll. The units are dollars unless otherwise specified. See text and equations (4) and (5) for a description of the instrumental variables. Asterisks indicate *p*-values.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

not sensitive to our including or excluding prerecession county economic characteristics. Since the result does not carry over to the payroll (jobs may have been lost but no payroll was), we are inclined to think that the negative effect on employment is spurious.

In any case, we find no evidence that federal stimulus funds directed to universities propped up employment or payroll in the counties immediately surrounding them.

Even the most generous interpretation of the QWI results suggests that there is no local multiplier.

9.9 Discussion and Conclusions

There are two ways to evaluate the stimulus provided to universities. First, we could evaluate whether universities served as an effective means to prop up aggregate demand quickly—by getting money into the hands of (university and individual) consumers who would spend it right away rather than save it, thereby creating a multiplier as envisioned by Keynesian logic. Second, we could evaluate whether universities spent stimulus funds in a manner that was likely to be productive for society, with a large share of the benefits likely arising in the mid- to long term owing to the fact that human capital and research investments do not pay off immediately even if they are superbly made. Ambivalence about the manner in which the stimulus for universities should be evaluated shows up clearly in commentators' and analysts' anecdotal reports. Some of them tout universities for creating jobs and propping up aggregate demand in "university towns." Others say that universities used stimulus funds to keep students in school (raising human capital in the mid- to long run), to invent technology that would ultimately increase economic growth, or to conduct research that would otherwise help society (through better medical care, for example).[45]

We conclude that there is little evidence in this chapter that universities

45. We found many examples of both types of arguments on the ScienceWorksForUs website, which features reports and commentary by numerous university leaders and researchers. As examples of the first type of argument, consider that the University of California claimed that $837 million in ARRA research funds created over 1,400 jobs at its schools. The University of Chicago claimed that its $75 million in ARRA funding "preserv[ed] and creat[ed], on average, close to 100 jobs." As an example of the other type of argument, consider Stanford's statement that "SLAC National Accelerator Laboratory, a facility that serves 3,000 visiting scientists and students each year, has received $90.2 million for infrastructure improvements, accelerator research support and cutting-edge instrumentation for advanced X-ray studies." This appears to be a claim about long-run benefits to research, not job creation. Some universities' statements contain a mixture of both arguments. For instance, the University of Vermont stated that "In Vermont to date, over $20 million in ARRA funds have advanced research and created or leveraged more than fifty paid positions at UVM and throughout the state." See http://www.scienceworksforus.org/images/stories/PDFs/uc%20arra%20brochure.pdf; http://www.scienceworksforus.org/press-releases/universities-highlight-benefits-of-stimulus-research-funding; http://www.scienceworksforus.org/images/stories/PDFs/university%20leaders%20comment%20on%20benefits%20of%20recovery%20act%20final.pdf.

were an effective route for stimulus funds if the only goal was propping up local aggregate demand. While our estimates have standard errors that do not allow us to rule this out as a possibility, there are many pieces of evidence that run counter to this idea. Most obviously, there is at best very weak evidence that universities created jobs or increased their payrolls as a result of stimulus funding. There is certainly no evidence for a multiplier. Also, state governments essentially took all of the stimulus funding directed to public universities—albeit by indirect means. While the states might have allocated these funds in such a way that they stimulated the state's—as opposed to the local—economy, it would surely have been more in keeping with Keynesian logic to give state governments the funds in the first place and mandate that they spend them quickly. Giving the funds to universities and subsequently renegotiating the implicit bargain between state governments and universities must have slowed down stimulus spending. Similarly, it appears that some of the stimulus funds for private universities ended up in the hands of the families whose students were enrolled. While these families may well have consumed more in consequence, the Keynesian stimulus effect might have been greater if the money was simply sent to them in the first place (perhaps through a tax credit) rather than make its way to them in a roundabout and necessarily slow manner. Private universities appear to have saved a small share of their federal research funds for future use. This policy is not one that boosts aggregate demand immediately. Finally, public universities seem to have used the stimulus funds to set their tuition higher, as part of their gaining independence from state governments. The higher tuition probably depressed the consumption of middle- to upper-income students.

So far as we know, there is no plausibly causal evidence that contradicts our conclusion that federal stimulus funds did little to prop up aggregate demand. Universities' own claims about jobs created or preserved were purely formulaic. They simply divided their extra federal funds by their average salary or some similar number.[46] None, so far as we know, analyzed its payroll in a plausibly causal way. There is at least one simulation based on input-output tables: Ash and Palacio (2012). However, this method is also formulaic: it does not attempt to identify exogenous variation in federal funds or to construct credible counterfactuals.

In contrast to the lack of evidence for the stimulus funds propping up aggregate demand, an array of evidence indicates that universities used stimulus funds to increase their investments in research and instruction.

Private universities used the federal research funds to do additional research, presumably thereby complying with the terms of their research grants and contracts. They shifted some graduate students and other employees from teaching to research to fulfill their greater research needs, to support their students, and to protect jobs. They reallocated some funds that

46. See Kelderman (2009).

they would otherwise have spent on research and used them to keep tuition down, increase institutional grant aid, and—possibly—maintain jobs that they would otherwise have had to eliminate. They saved some funds for the future by slightly reducing the spending rate on the endowment. Private universities passed the entirety of the stimulus-motivated increase in the maximum Pell grant to students. This lack of reaction may have been due to their having such high initial tuition that the Pell formula contains no incentive to raise it. Their lack of reaction may also be because Pell grant funds are not terribly important to them, as shown in section 9.2.

In short, private research universities and medical schools undoubtedly care about research, but they also appear to feel impelled to maintain implicit or explicit commitments to keep tuition from accelerating quickly, to provide aid, to support graduate students, to maintain employment, and to protect their endowments for future use. In fact, private universities appear to have used stimulus-motivated federal funds as economic theory suggests they would if (a) they were attempting to maximize the same objectives both before and after receiving the federal windfall, (b) these objectives require them to spend on a broad array of activities, and (c) restrictions on the uses of funds made it efficient (cheaper) to use a disproportionate share of the windfall funds in the areas for which they were formally intended. That is, private universities are roughly described by panel C of figure 9.8.

Public universities apparently used the stimulus to gain independence from state legislatures, increase tuition for students who could afford it, and reorient their activities into greater alignment with the market. Both federal research and federal Pell grant funds induced substantial reductions in state appropriations that were offset by tuition increases. This suggests that some combination of the following is true:

1. During recessions, state governments have different priorities than maintaining their appropriations to postsecondary institutions.

2. State governments and/or public universities conclude that a sufficiently large number of prospective students can actually afford higher tuition that it can be raised during recessions without causing enrollments to fall so much that the universities' finances get worse instead of better. Some of this ability-to-afford is mechanical because low-income students receive increased Pell grants, but much of it is not mechanical.

3. State governments and/or public universities are willing to accept the trade-off of lower appropriations in return for greater independence (to set tuition, enroll out-of-state students, and allocate resources within the university).

4. When they are more reliant on tuition and federal funds and less on state appropriations, public research universities spend more on research and instruction and less on other categories of spending.

In short, if we evaluate the stimulus directed to universities based on the second criteria—Did they use it to benefit society?—our evidence is about as positive as could be expected for short-run evidence.[47] Only a longer-term study—something in the manner of Aghion et al. (2010)—could investigate whether the research and human capital investments made by universities during the stimulus period actually paid off by raising economic growth, patentable inventions, and the like.

Overall, we conclude that the stimulus for universities probably did not work well if the goal was quickly propping up aggregate demand, especially in the areas surrounding the schools. However, we also conclude that universities used stimulus funds in a manner that was consistent with an intention to benefit society in the mid- to long term. We must leave an evaluation of these benefits to future investigators.

47. Even raising public university tuition likely benefits society. This is because highly subsidized tuition at public universities can distort human capital investment choices in a manner that is likely to reduce social welfare relative to more individuated solutions to the human capital investment problem, such as student loans or individual-specific financial aid. Peltzman (1973) and Hansen and Weisbrod (1969) drew economists' attention to these distortions long ago.

Appendix

Table 9A.1 **Federal funds directed to postsecondary institutions by category of funds and type of institution, 2006/7**

Institution type:	Grants & contracts as % of total revenue excluding auxiliary, hospital, independent operations	Appropriations as % of total revenue excluding auxiliary, hospital, independent operations	Aid as % of total revenue excluding auxiliary, hospital, independent operations	Grants & contracts as % of total revenue including auxiliary, hospital, independent operations	Appropriations as % of total revenue including auxiliary, hospital, independent operations	Aid as % of total revenue including auxiliary, hospital, independent operations
Private ext. research	15.17	0.36	0.71	11.15	0.27	0.52
Public ext. research	20.04	0.21	2.50	13.93	0.15	1.74
Private int. research	7.39	0.01	1.82	6.14	0.00	1.51
Public int. research	17.65	0.16	3.89	12.91	0.11	2.85
Private medical	26.48	0.45	0.21	13.20	0.22	0.11
Public medical	20.92	0.00	0.28	10.22	0.00	0.14
Private engineering	0.00	0.00	0.00	0.00	0.00	0.00
Public engineering	20.74	0.00	2.30	18.57	0.00	2.06
Private other Health	2.39	0.00	2.45	1.86	0.00	1.91
Public other Health	15.63	0.00	0.09	12.26	0.00	0.07
Private BA/MA	2.45	0.34	4.01	2.07	0.29	3.39
Public BA/MA	6.46	0.03	7.33	5.41	0.03	6.14
Private associate	4.23	0.30	13.93	3.54	0.25	11.67
Public associate	5.98	0.27	10.86	5.47	0.25	9.93

Notes: The table shows federal funds directed to postsecondary institutions in the 2006/7 school year as a share of total revenue defined in two different ways. Related statistics are shown in table 9.1. Federal funds come in three basic forms: (a) grants and contracts, (b) appropriations, and (c) student aid. These categories are defined further in the text. Institutions are grouped by their 2000 Carnegie classification (Carnegie Foundation for the Advancement of Teaching 2001).

Table 9A.2 First-stage estimates: Regressions of federal funding variables on instruments and prerecession economic characteristics of counties in which postsecondary institutions are located

Dependent variable:	Dependent variable: Year-over-year change in federal research funds		Dependent variable: Year-over-year change in federal Pell funds	
Type of postsecondary institution:	Private research universities and medical schools (1)	Public research universities and medical schools (2)	Private research universities and medical schools (3)	Public research universities and medical schools (4)
Explanatory variable:				
Bartik-type instrument based on change in federal research funds	1.165***	1.112***	0.013*	0.088***
	(0.128)	(0.163)	(0.006)	(0.023)
Simulated instrument based on change in maximum Pell grant	6.717	0.359	4.103***	4.806***
	(4.931)	(0.745)	(0.616)	(0.679)
Prerecession economic characteristics of county	yes, see notes	yes, see notes	yes, see notes	yes, see notes
Observations	264	496	264	496
R-squared	0.430	0.495	0.291	0.477

Notes: The table shows estimates of the first-stage equations described in the text. Each column represents a regression. Robust standard errors clustered at the institution level are shown in parentheses. An observation is a postsecondary research university or medical school in a year between the 2006/7 and 2009/10 school years, inclusive. All amounts are in real dollars, adjusted for inflation using the GDP deflator. The dependent variables are the year-over-year change, in dollars, of federal research funds (columns [1] and [2]) and federal Pell grant funds (columns [3] and [4]). The Bartik instrument is constructed by applying the national rate of growth in a given federal agency's funding (national *excluding* the institution itself) to the institution's base year funding from that agency and then summing over all agencies. See equation (4) in the text. The Pell-based simulated instrument is constructed by applying the change in the maximum Pell grant to each institution's estimated number of students eligible for the maximum grant in the base year. See equation (5) in the text. The prerecession economic characteristics of the county are the following, all for the 2006 year unless otherwise noted: the unemployment rate, per capita income, a house price index, the change in the house price index from 2000 to 2006, the number of stable jobs, the number of stable hires, the average earnings in stable jobs, farm income as a share of all personal income, and population. Asterisks indicate p-value.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 9A.3 Specification checks for the effect of stimulus-motivated federal funds on *private* research universities and medical schools

	Dependent variable is year-over-year change (minus prerecession trend) in:						
	Total expenditure	Research expenditure	Instructional expenditure	Number of employees (per $1,000 of funds)	Total payroll	Net tuition revenue	Institutional grant aid
Instrumental variables estimates with prerecession economic characteristics							
Year-over-year change in federal research funds	0.407	0.098	–0.267	0.069	0.193	–0.063	0.016
	(0.466)	(0.162)	(0.243)	(0.048)	(0.213)	(0.087)	(0.014)
Year-over-year change in federal Pell funds	4.018	2.547	0.031	–0.310	12.291	–1.198	0.482*
	(3.663)	(1.877)	(2.955)	(0.268)	(10.107)	(1.049)	(0.290)
Ordinary least squares estimates							
Year-over-year change in federal research funds	0.166	0.268**	–0.151**	0.019	0.181	–0.073*	0.027***
	(0.129)	(0.107)	(0.069)	(0.013)	(0.137)	(0.041)	(0.008)
Year-over-year change in federal Pell funds	1.434	1.026	0.654	0.103	2.605	0.791	0.078
	(2.878)	(0.618)	(1.216)	(0.190)	(2.543)	(0.585)	(0.112)

Notes: The table shows estimates of equation (3) that are alternatives to the estimates shown in table 9.3. The notes for that table apply, except that the bottom panel of this table reports ordinary least squares estimates and the top panel reports regressions that include the prerecession economic characteristics of the county in which the institution is located. These are: the unemployment rate, per capita income, a house price index, the change in the house price index from 2000 to 2006, the number of stable jobs, the number of stable hires, the average earnings in stable jobs, farm income as a share of all personal income, and population.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 9A.4 **Specification checks for the effect of stimulus-motivated federal funds on *public* research universities and medical schools**

	Dependent variable is year-over-year change (minus prerecession trend) in:							
	Total expenditure	Research expenditure	Instructional expenditure	Number of employees (per $1,000 of funds)	Total payroll	Net tuition revenue	Institutional grant aid	State appropriations
	Instrumental variables estimates with prerecession economic characteristics							
Year-over-year change in federal research funds	–0.385	1.205***	0.616**	–0.061	–0.180	0.381***	–0.026**	–0.318*
	(0.359)	(0.170)	(0.272)	(0.060)	(0.196)	(0.111)	(0.012)	(0.161)
Year-over-year change in federal Pell funds	–0.045	0.405	1.224***	0.153	–0.530	0.972***	0.085*	–2.326***
	(1.400)	(0.311)	(0.414)	(0.140)	(0.664)	(0.342)	(0.046)	(0.684)
	Ordinary least squares estimates							
Year-over-year change in federal research funds	–0.335	0.852***	0.320**	–0.007	–0.121	0.220***	–0.005	–0.205*
	(0.283)	(0.084)	(0.127)	(0.026)	(0.130)	(0.056)	(0.008)	(0.120)
Year-over-year change in federal Pell funds	0.049	0.526**	1.374***	0.010	–0.618	0.950***	0.022	–1.617***
	(0.548)	(0.209)	(0.267)	(0.060)	(0.427)	(0.185)	(0.023)	(0.341)

Notes: The table shows estimates of equation (3) that are alternatives to the estimates shown in table 9.4. The notes for that table apply, except that the bottom panel of this table reports ordinary least squares estimates and the top panel reports regressions that include the prerecession economic characteristics of the county in which the institution is located. These are: the unemployment rate, per capita income, a house price index, the change in the house price index from 2000 to 2006, the number of stable jobs, the number of stable hires, the average earnings in stable jobs, farm income as a share of all personal income, and population.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Data Appendix

Data Sources

The NASA data was obtained from Research.gov. We use data where the recipient's name includes "Univ.," "College," "Polytech," or both "Institute" and "Tech."[48]

The data for NIH transfers to universities was obtained from the Research Portfolio Online Reporting Tool (RePORT). Since we have data on all transfers made by NIH (not only to universities), we only use data for which the recipient's name includes the words "Univ.," "College," "Polytech," both "Institute" and "Tech," or both "School" and "Medicine." We keep university affiliated hospitals by looking for names with "Hospital," "Medical," "Health," or "Cancer."

Our main source of NSF data is the NSF itself. We use data where the recipient's name includes "Univ.," "College," "Polytech," or both "Institute" and "Tech." We use this data set for fiscal years 2000 to 2009 and supplement it with extracts from Research.gov. Regarding the latter, we only kept grants where the organization type was university or college.

We are confident that, in searching the aforementioned databases, we have not missed any research universities, medical schools, or important "other health" institutions. This is because we can compare the data we gather to that gathered by the NSF in its *Higher Education Research and Development Survey* (NSF 2013). What we gather is a superset of what is gathered in that survey, apparently because the survey respondents fail to report or aggregate some research funds we observe. We use that survey for data on federal research funds received by each postsecondary institution from agencies *other* than NASA, the NIH, and NSF. The most important such agencies are Agriculture, Defense, and Energy.

Financial aid data were downloaded from the Federal Student Aid Gateway. For years prior to 2006/7 we have yearly, not quarterly, data.

IPEDS Data were downloaded from the public Data Center at http://nces.ed.gov/ipeds/datacenter/DataFiles.aspx. Delta Cost Project data were downloaded from http://nces.ed.gov/ipeds/deltacostproject/. QWI data were downloaded from http://www.vrdc.cornell.edu/qwipu/.

Associating Grants and Contracts with the Universities That Received Them

Grants and contracts must be matched to the appropriate university. Standardized school codes are included in the Pell and IPEDS data. For other

48. Research.gov says data on NASA grants is really only reliable for fiscal year 2007 onward. However, we also use data from 2006 and before.

grants, we start by using the zip code associated with the grant to find a school with the same zip code. We verify all potential matches manually by comparing the grant's institution name to the school we have matched it to. Among remaining grants, we then look for schools with a zip code whose first three digits match the first three digits of the grant's zip code. Again, we verify all potential matches manually. Finally, for remaining grants we have not matched, we match them by examining the name of the school. Of our matched grants, 73 percent are matched by the zip code, 23 percent are matched by the zip code's first three digits, and 4 percent are matched only by name.

We take care to include research grants to university-affiliated hospitals and independent operations. Grants hosted by the National Bureau of Economic Research are matched to the university(ies) of the principal investigator(s).

Special Grants

Several types of grants might be prone to double counting, and thus we take measures to avoid accidentally including them twice. These grants are forward funding and grant transfers. Forward funding can occur if an agency doles out the full grant in annual increments (a "continuing grant"), but at some point in the grant's life the agency gives the institution the rest of the grant's balance all at once. This forward funding can appear in the data as a separate entry from the original grant. Grant transfers might occur if a principal investigator (PI) switches universities. The amount left on a continuing grant will then be forwarded to the new institution and appear as a new grant.

We identify forward funding as grants having the same PIs, title, and university but different grant numbers and amounts. If the earlier grant is for a larger amount, then we subtract the second grant amount from the first.

We identify grant transfers as grants having the same PIs, dates, and title but different universities, grant numbers, and amounts. If the earlier grant is for a larger amount, then we subtract the second grant amount from the first.

Grant Disbursement Timing

For Pell grants in fiscal year (FY) 2007 or later, our data are quarterly and thus identify which quarter the money was disbursed. Prior to FY2007, we only know yearly disbursements, so we need to spread the disbursement out across that fiscal year's quarters. To do so, we take the quarterly distribution of disbursements for FY2007 and assume the same distribution for previous years. Thus, if FY2007 Quarter (Q) 1 had 20 percent of the total disbursement in FY2007, we assign 20 percent of the FY2006 total to FY2006Q1.

For the NASA, NIH, and NSF grants, we allocate funding to the relevant university uniformly by month starting with the project's budget start date and ending with the budget end date. We use the project start and end dates if budget start and end dates are unavailable. We can thus aggregate the disbursements by year or by quarter, as necessary.

Outcome Variables

We use a number of variables from IPEDS. For number of employees, we used "all employees total'' in the "Employees by Assigned Position" form or—equivalently—"ftall1" + "ptall1" in the Delta Cost Project data.

For institutional grant aid, we used "IGRNT_T," the "total amount of institutional grant aid received by full-time, first-time undergraduates." This variable comes from the "Student Financial Aid and Net Price" form. It is the variable known as "institutional_grant_aid" in the Delta Cost Project data.

The rest of the variables come from the IPEDS "Finance" forms. Private institutions (as well as some public institutions) file the FASB form while other public institutions file the GASB form. Therefore, we combine variables from the two forms.

We get total expenditure from "F2B02" ("total expenses") in the FASB and "F1D02" ("total expenses and other deductions") in the GASB. This variable is "total01" in the Delta Cost Project data. We get research expenditure from "F2E021" ("research-total amount") in the FASB and "F1C021" ("research-current year total") in the GASB. This variable is "research01" in the Delta Cost Project data. We get instructional expenditure from "F2E011" ("instruction-total amount") in the FASB and "F1C011" ("instruction-current year total") in the GASB. This variable is "instruction01" in the Delta Cost Project data. We get state appropriations from "F2D03" ("state appropriations-total") in the FASB and "F1B11" ("state appropriations") in the GASB. This variable is "state03" in the Delta Cost Project data. We get total payroll from "F2E132" ("total expenses-salaries and wages") in the FASB and "F1C192" ("total expenses deductions-salaries and wages") in the GASB. This variable is "total02" in the Delta Cost Project data. Finally, we use the net tuition revenue from students not including Pell grants from the Delta Cost Project data: "net_student_tuition."

For the QWI data, we use two main variables: "emp" ("employment: counts") and "payroll" ("total quarterly payroll: sum").

Pell Grant Instrument

To construct our Pell grant instrument, we need to estimate the number of students at the maximum Pell grant in the base year, for each institution. This number is not reported in the Federal Student Aid Gateway database. Therefore, we estimate the number by analyzing how a prior change in the maximum Pell grant affected schools' aid funds.

For the prior change, we use the change between FY2007 and FY2008. The maximum Pell grant increased from $4,050 to $4,310. As a check, we also run our regressions using the change between FY2001 and FY2002 (maximum increased from \$3,330 to \$3,750). Results are very similar to the results using the FY2008 change.

For school i and year t, we estimate the percentage (p_{it}) of Pell recipients at a school who receive maximum funding. Let m_{2007} and m_{2008} be the maximum grants in the two years. Let a_{it} be the average amount received by students not at the maximum. Let $y_{i,2007}$ and $y_{i,2008}$ be the average Pell funding for all recipients.

We observe the yearly maximum amounts, m_{2007} and m_{2008}, and the total yearly disbursement for each school, $y_{i,2007}$ and $y_{i,2008}$. We do not observe the average amount received by students not at the maximum, but we assume that the amounts are the same in the two years. Thus, we assume $a_{i,2007} = a_{i,2008} = a_i$. We also assume that the percentage of Pell recipients at a school who receive maximum funding is stable across the two years: $p_{i,2007} = p_{i,2008} = p_i$.

For each year we have the following equation:

$$m_{2007}p_i + a_i(1 - p_i) = y_{i2007}$$

$$m_{2008}p_i + a_i(1 - p_i) = y_{i2008.}$$

Thus when we combine them we can estimate p:

$$\hat{p}_i = (y_{i2008} - y_{i2007})/(m_{2008} - m_{2007}).$$

We bound $\hat{p}_i$ between 0 and 1.

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