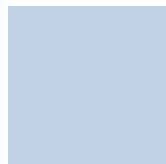
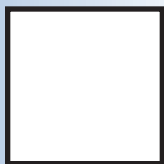


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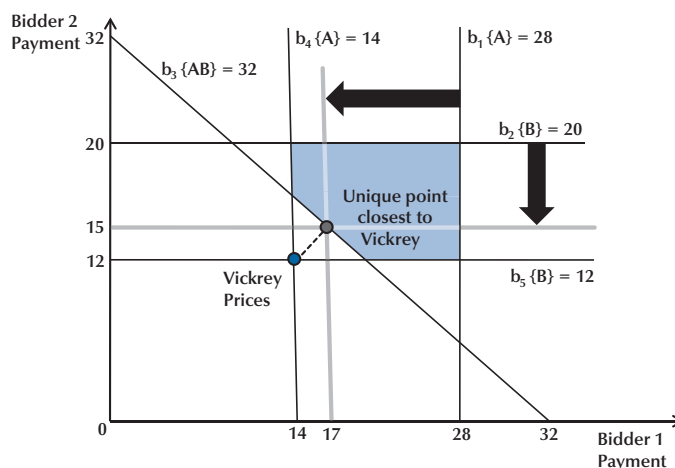
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Erratum

The article “Auctions as a Vehicle to Reduce Airport Delays and Achieve Value Capture,” by Jeffrey P. Cohen, Cletus C. Coughlin, and Lesli S. Ott, published in the November/December 2009 issue of the *Review*, contained an error: Figure 6, from page 582, appears below in its correct form, showing the combination of bids closest to Vickrey prices as 17 (bidder 1) and 15 (bidder 2). The original figure mislabeled those points as 19 and 13. The authors thank H. Martin Weingartner, Currey Professor of Finance (Emeritus), Vanderbilt University, for pointing out the error.



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The Effects of Recessions Across Demographic Groups

Kristie M. Engemann and [Howard J. Wall](#)

The burdens of a recession are not spread evenly across demographic groups. As the public and media noticed, from the start of the current recession in December 2007 through June 2009 men accounted for more than three-quarters of net job losses. Other differences have garnered less attention but are just as interesting. During the same period, the employment of single people fell at more than twice the rate that it did for married people and the decline for black workers was one and a half times that for white workers. To provide a more complete understanding of the effect of recessions, this paper examines the different effects of this and previous recessions across a range of demographic categories: sex, marital status, race, age, and education level. (JEL E32, J20, R12)

Federal Reserve Bank of St. Louis *Review*, January/February 2010, 92(1), pp. 1-26.

Since the U.S. economy entered its current recession in December 2007, most demographic groups and industries have seen steep job losses. By standard measures of overall labor-market performance, the news has been dire: Between 2007:Q4 and 2009:Q3, U.S. nonfarm employment fell by about 6.8 million jobs while the national unemployment rate rose from 4.8 percent to 9.6 percent.

Although the picture has been bleak overall, the recession's ill effects have not been distributed evenly across demographic groups. The difference in job losses between men and women has garnered the most attention; by 2009:Q2, men accounted for 76 percent of net job losses despite having only a slim majority (51 percent) of nonfarm employment at the start of the recession. In light of the disproportionate effects on men, some commentators in the press and elsewhere have labeled the current recession a "man-cession" or even the "Great Man-Cession."

This paper takes the different effects on men and women as a starting point and examines the

employment experiences across a range of other demographic categories—marital status, race, age, and education. The purpose is to understand more about what recessions mean for people. Such information will, hopefully, give us an idea of what needs to be done to help policymakers address the effects of the current recession and better prepare for future ones.

WHY LOOK AT DEMOGRAPHIC DIFFERENCES?

The dominant explanation for the current man-cession is that it follows from differences in the severity of the recession across industries. According to Hoff Sommers (2009), men "are bearing the brunt of the current economic crisis because they predominate in manufacturing and construction, the hardest-hit sectors" and that women "are a majority in recession-resistant fields, such as education and health care." Greg Mankiw (2009) echoes this in his blog: "[A] large part of the explanation is the sectoral mix of this

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particular downturn in economic activity, including a significant slump in residential construction.”

Job losses have indeed been steepest in the goods-producing industries—natural resources and mining, construction, and manufacturing—which accounted for about half of total losses from 2007:Q4 to 2009:Q3. Job losses have not been the rule across all industries, however, as the education and health services sector actually saw an increase of 768,000 and the government sector added 115,000 jobs.

Despite the current interest in the phenomenon, the large difference in the relative effects of the recession on the employment of men and women is not unusual. Men always bear the brunt of job losses during recessions; and, compared with previous recessions, men have actually been bearing a smaller proportion during this one. During the five recessions between 1969 and 1991, male employment fell by an average of 3.1 percent per recession, whereas female employment actually tended to rise by 0.3 percent per recession.¹ Women have a much larger presence in the workforce now than between 1969 and 1991, however, so a more relevant comparison is to the 2001 recession. In that recession, employment peaked in 2001:Q1 and bottomed out in 2003:Q3, with a total loss of a little over 2.6 million jobs. Men accounted for 78 percent of those job losses, similar to the 76 percent in the current recession.² So, in terms of job losses, the current recession has hit men in roughly the same proportion as did the previous recession, but by a much smaller proportion than in earlier recessions.

The difference in employment between the sexes is only one of the interesting and significant differences across demographic groups. Nonfarm (or payroll) employment data are not broken down by demographic categories other than sex, however. Fortunately, the Bureau of Labor Statistics (BLS) also conducts a separate monthly “household” survey that includes several demographic categories. Employment measures from the payroll and household surveys differ in that they

cover different types of employment. For example, payroll employment does not include farm employment or self-employment. Nevertheless, the two employment measures capture the same broad patterns in male-female employment. In fact, by fortunate coincidence, the household survey indicates the same 76/24 split in the male/female employment losses between 2007:Q4 and 2009:Q2 that appeared in the nonfarm employment data discussed above. From this point forward, the data we refer to come from this household survey.

The differences in household employment by sex, marital status, and race from 2007:Q4 to 2009:Q3 are illustrated by Figure 1. Whereas total employment losses amounted to 4.7 percent, male employment fell by 6.4 percent and female employment fell by 2.9 percent. Similarly, large differences in employment losses have occurred according to marital status and race: Employment of single adults fell at nearly twice the rate as it did for married adults, and white employment fell by only about two-thirds as much as black employment.

Figure 2 shows employment changes by age groups, indicating much larger-than-average employment losses for those 16 to 19, 20 to 24, and 35 to 44 years of age. In contrast, employment among those 55 years and older actually rose by 4 percent. Unsurprisingly, changes in employment across education levels also have been significant. For example, Figure 3 shows that employment of those without a high school diploma fell by 7.5 percent while employment for those with at least a bachelor’s degree actually rose by 0.4 percent.

What accounts for the variation in the employment changes across these demographic groups? The oft-cited reason for the difference between the sexes is that it is a reflection of what has happened to industries. As discussed below, this is not a terribly satisfying explanation, but it does make some sense. Analogous explanations are not likely to fit the other demographic categories, however.

For example, perhaps single people are more heavily concentrated in industries hit hardest by the recession, but it is difficult to imagine why this would be so. It is much easier to imagine instead

¹ See Goodman, Antczak, and Freeman (1993).

² Note that data splitting nonfarm employment by sex were available only up through 2009:Q2 at the time this paper was prepared.

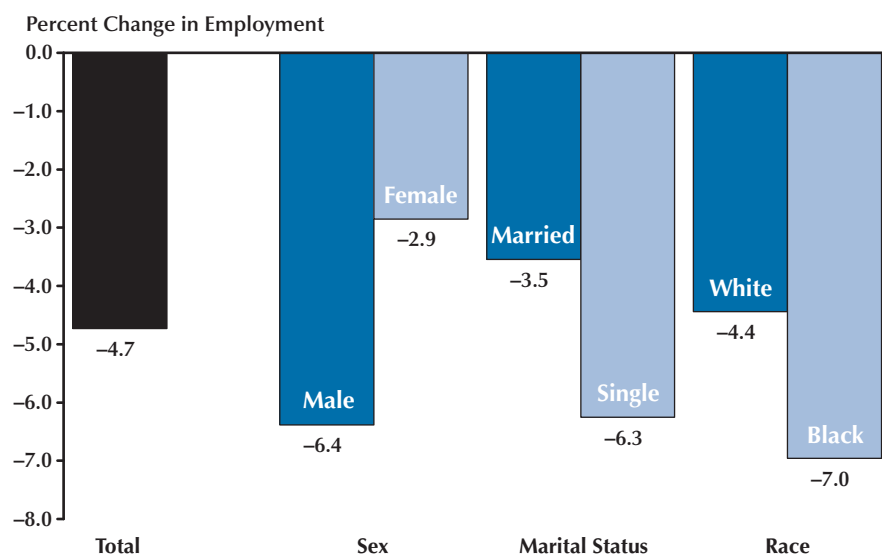
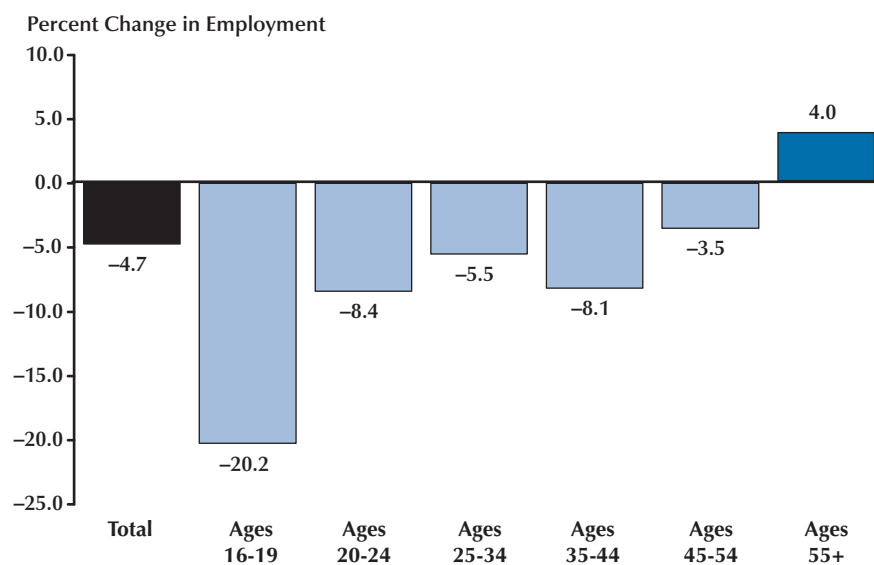
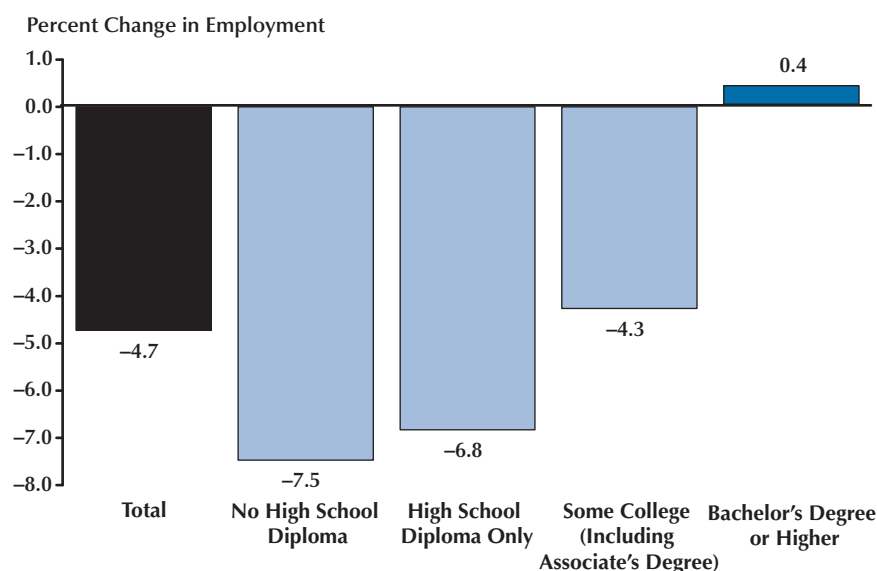
Figure 1**Employment Changes by Selected Demographic Categories (2007:Q4–2009:Q3)****Figure 2****Employment Changes by Age Groups (2007:Q4–2009:Q3)**

Figure 3**Employment Changes by Education Levels (2007:Q4–2009:Q3)**

that single people might have lost proportionally more jobs because the average single person is younger and, therefore, less experienced and less educated than the average married person. Because of these differences, we would expect that, within a given industry, single people would bear disproportionate job losses.

The industry story might not even be a good causal explanation for the differences between sexes. As discussed by Wall (2009), because men have tended to be affected disproportionately across all industries, the man-cession cannot be explained by industry mix alone but must have some relation to demographic differences. For example, men are less likely than women to have finished high school, a fact that is consistent with their relative job losses.

More generally, it is not a simple matter to separate the role of industry from the role of demographics. For example, is the decrease in employment larger for manufacturing than for other industries because it experienced a larger external shock? Or was the shock the same across sectors, but job losses in manufacturing were greater

because its workers, on average, have lower education levels than do workers in other sectors? Put another way, would there have been fewer job losses in manufacturing if workers in the sector had higher education levels? There are no simple answers to these questions because there is no proximate cause for what happened in manufacturing that was different from, say, professional and business services. The recession experience may have differed between the two sectors because they experienced different external shocks; or perhaps they experienced the same external shock, but the demographic differences of their workforce led to different outcomes. Most likely, some combination of the two explanations accounts for the different employment outcomes.

The questions can be turned around to refer to demographic groups: Are the different impacts of the recession across demographic groups attributable to the industries in which the groups are employed or to the differences in the groups' characteristics? Again, the most likely explanation is some combination of the two.

WHAT ARE THE EMPLOYMENT EFFECTS OF A RECESSION?

When the word “recession” is used to describe specific periods of economic weakness, it refers most often to the official recession dates determined by the business cycle–dating committee of the National Bureau of Economic Research (NBER). When weighing their decisions whether to label a period a recession, NBER committee members take into account a wide variety of economic indicators. As a result, NBER dates for recessions tend to coincide most closely with periods in which the broadest measure of economic activity, real gross domestic product (GDP), is contracting. It used to be that NBER recession periods coincided with periods of falling employment. Beginning with the 1990-91 recession, however, this link was broken, and the economy experienced a prolonged period of job losses well after the end of the official recession. Such a so-called jobless recovery also occurred in the wake of the 2001 recession.

This disconnect between official recessions and falling employment means that it is not possible to use NBER recession dates to compare the effects of recent recessions with earlier ones. For pre-1990 recessions, one could measure the change in employment from the beginning to the end of an official recession and obtain a reasonably complete picture of the recession’s employment effects. For post-1990 recessions, however, the full effects of a recession on employment were not realized until after the recession ended, and at times even began before the onset of the official recession.

Therefore, an alternative metric is needed to determine the period during which recessions affected employment. Keep in mind that using this different metric means that estimates of the effects of the current recession on the various demographic groups will differ somewhat from those in Figures 1 through 3. Nonetheless, the scale of the effects and the comparisons across categories within demographic groups are the same with either set of numbers.

Fortunately, there is a fairly straightforward statistical method for determining the timing of recessions: a Markov-switching model. Briefly,

the model takes any data series, which in our case is household employment, and estimates growth rates that are typical for expansionary and recessionary phases. At the same time, the model decides for each data point the phase that best describes that period, taking into account the periods immediately prior. For example, positive employment growth that has persisted for many periods will be called an expansionary period, while negative growth that has persisted for many periods will be called a recessionary period. The tougher job is deciding on the more ambiguous periods—such as when growth is positive for one period following several periods of negative growth or when a period has middling growth—so that it is not obvious if the period should be labeled part of a recession. We will leave it to the model to decide these tough questions so that there will be a consistent application across recessions.³

Appendix A provides the estimated periods for which household employment was in recession surrounding each of the six official recessions since 1974. Figure A1 compares the growth rate of household employment with the official NBER recession dates, showing that employment growth first dipped below zero in early 2007, months before the start of the official recession, and remained weak thereafter. As a consequence, the last three quarters of 2007 are classified as recessionary, meaning that household employment was in recession three quarters earlier than the start of the official recession.⁴

TOTAL EFFECTS OF RECESSIONS ON TOTAL EMPLOYMENT

Once the timing of official recessions is disentangled from the periods during which they are

³ See Owyang, Piger, and Wall (2008) for a technical description of the statistical methodology and for results using aggregate payroll employment. A quarter is designated as recessionary if the probability of recession exceeds 50 percent.

⁴ Note that the disjoint between official recessions and household employment recessions is not as severe as might have been expected. This is because household employment tends to recover earlier than payroll employment, which is the measure most often used in discussions of jobless recoveries.

Table 1**Total Percent Effects of Recessions on Employment**

Recession	Employment Change	Forgone Employment	Total Effect
1974-75	-2.0	-1.9	-3.9
1980	-1.0	-1.3	-2.2
1981-82	-1.7	-4.4	-6.0
1990-91	-1.2	-2.3	-3.5
2001	-1.2	-1.3	-2.5
2007-09	-4.6	-3.3	-7.9
Average	-1.9	-2.4	-4.3

NOTE: The recession dates and the employment data are for the household employment series produced by the BLS.

affecting employment, the total employment changes related to the current recession can be calculated and compared with those of earlier recessions. The percent changes in total employment during each of the estimated recession periods are provided in the second column of Table 1. The most notable result in the column is that the 4.6 percent employment loss from the current recession dwarfs those of the other five, which were in the 1 to 2 percent range.

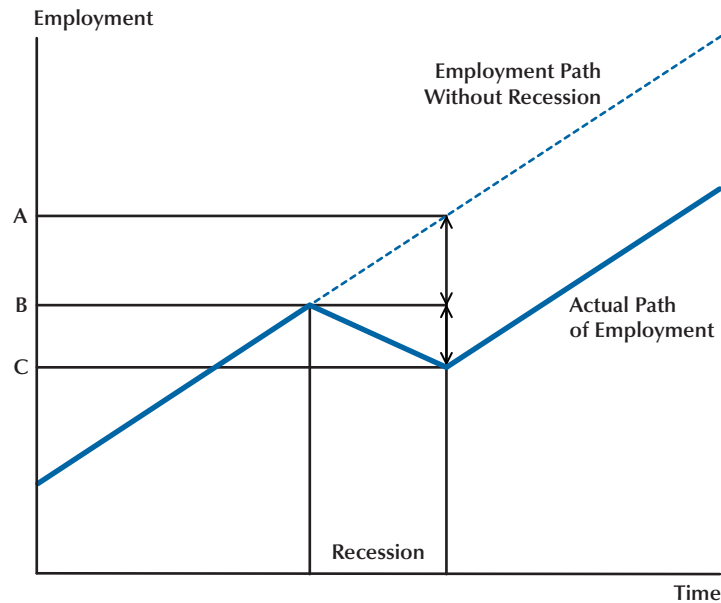
Typically, the effects of a recession on employment are seen as simply the difference between the levels of employment at the start and end of a recessionary period, as in the second column of Table 1. This assumes, though, that there would have been zero employment growth even if there had been no recession. However, a recession not only causes a drop in employment from the pre-recession level, it also prevents employment growth that would have occurred. This “forgone” employment is also an effect of the recession and needs to be accounted for in an analysis of the recession’s total effects on employment. Figure 4 provides a diagrammatic explanation of the total costs of the recession on employment.

In the figure, the solid line is the actual path that employment followed over time, including a recession with falling employment. The dotted line is the path that employment would have followed if the recession had not occurred. This is an extremely stylized diagram that assumes that employment growth is constant and positive dur-

ing expansionary periods and constant and negative during recessions. The direct change in the level of employment is C-B, the difference between the levels of employment at the end and at the beginning of the recession. If the recession had not occurred, the level of employment would have continued to rise and would have reached level A when the recession ended. Thus, the total effect of the recession on employment is C-A, which includes forgone employment (B-A) and the change in employment (C-B).

The most straightforward way to account for forgone employment is to assume that employment would have grown at some typical rate if the recession had not occurred. We also must account for differences in growth rates before and after the mid-1980s, when the so-called Great Moderation meant significantly less variability in the growth of a wide range of economic variables. Specifically, we assume as relevant that, during a recession, employment would have grown at its median growth rate for the periods 1972-84 and 1985-2009.

The third column of Table 1 shows estimates of the employment growth that was forgone during each of the six recessions, which for the current recession is not particularly onerous. Although forgone employment has been above average, it is much smaller than it was for the 1981-82 recession, primarily because median employment growth before 1985 was higher than after 1985. Nonetheless, by combining forgone employment with the employment decline, the total effect of

Figure 4**The Two Effects of Recession on Employment**

the current recession is the highest among the six recessions, with only the 1981-82 recession coming close.

In the subsequent section, a similar exercise is performed for a variety of demographic categories. Specifically, the exercise shows the effects of the current recession by sex and compares them with previous recessions. It then does this, in turn, for marital status, race, and age, with extra attention paid to the differences between men and women for each category.

RECESSIONS ACROSS DEMOGRAPHIC CATEGORIES

When calculating forgone employment, one must also consider the sometimes large differences in typical growth across demographic categories. For reference, the different employment trends are summarized in Appendix B, which provides employment-to-population ratios for 1972-2009 for the demographic categories examined below. As with total employment in the previous section,

we assume, as relevant, that, during a recession employment for each demographic category would have grown at its median growth rate for the periods 1972-84 and 1985-2009 (see Appendix C).⁵

Sex

As already mentioned, men always bear the brunt of employment losses during recessions, and the current recession has been no different. This is true whether one looks at payroll employment, as earlier studies have, or at household employment, as this study does. As reported in Table 2, male household employment has fallen 2.46 times the rate that female employment has (–6.4 percent vs. –2.6 percent) during the current recession. Looking at earlier recessions, it is clear that the current one is actually in the lower half in terms of the relative effects on men. During the two recessions in the 1980s, male and female

⁵ This breakpoint will also take account of the significant decrease in female employment growth that occurred after 1990 as the rapid increases in female labor-force participation wound down.

Table 2**Percent Effects of Recessions on Employment**

Recession	Men	Women	Men/Women
1974-75	-2.8	-0.9	3.10
1980	-1.7	0.0	-58.12
1981-82	-3.3	0.5	-6.76
1990-91	-2.0	-0.3	6.90
2001	-1.2	-1.1	1.13
2007-09	-6.4	-2.6	2.46
Average	-2.9	-0.7	3.99

NOTE: The recession dates and the employment data are for the household employment series produced by the BLS.

employment moved in opposite directions, while during the 1990-91 recession, male employment fell nearly seven times the rate that female employment did. The 1974-75 recession was somewhat comparable to the current recession in the relative employment loss for men, but the 2001 recession saw male employment fall only slightly more than female employment.

The story of the current recession changes a great deal when forgone employment is considered. As reported in Figure 5, male forgone employment has been only 62 percent that of women. This is because employment growth for women has tended to be higher than that for men during the entire sample period—meaning that, for every quarter of recession, more female than male employment is forgone. Adding the two effects together reveals that men as a whole have still borne a much larger effect of the recession, but it is 1.33 times the effect for women rather than 2.46 times, as suggested by the employment changes alone.

Now that we know the total employment effects of the current recession, how does it compare with earlier ones? Has it been the Great Man-Cession? Figure 6 shows the total effects of the six recessions since 1974 on male and female employment, along with the relative effect for men and women. For both sexes, this has been the most costly recession in terms of employment. Male employment is 8.9 percent lower than it would have been without a recession, which is rivaled

only by the total effect of the 1981-82 recession. For women, the current recession is somewhat similar to the 1981-82 recession, when female employment actually rose (recall Table 2). However, because female employment growth was much higher before than after 1985, they experienced a comparatively higher percentage of forgone employment during the 1981-82 recession.⁶

The male-to-female ratio for the current recession, 1.33, is surpassed only by the 1980 recession and is much higher than for all other recessions. So, even though it's not quite the Great Man-Cession, it's still been relatively more severe for men than is usual. Interestingly, the estimates also indicate that the total effects of the 2001 recession were actually higher for women than for men. Recall from Table 2 that employment losses for men and women did not differ by much, so the higher forgone employment for women means a higher total effect.

Marital Status

Over the course of the current recession, the employment of married people has fallen at 76 percent of the rate that employment of single people has fallen (Figure 7). Married employment fell by 4 percent while single employment fell by 5.3 percent. Because single employment has

⁶ A recent paper by DiCecio et al. (2008) reviews changes in labor-force participation, separating trends from the changes due to economic conditions.

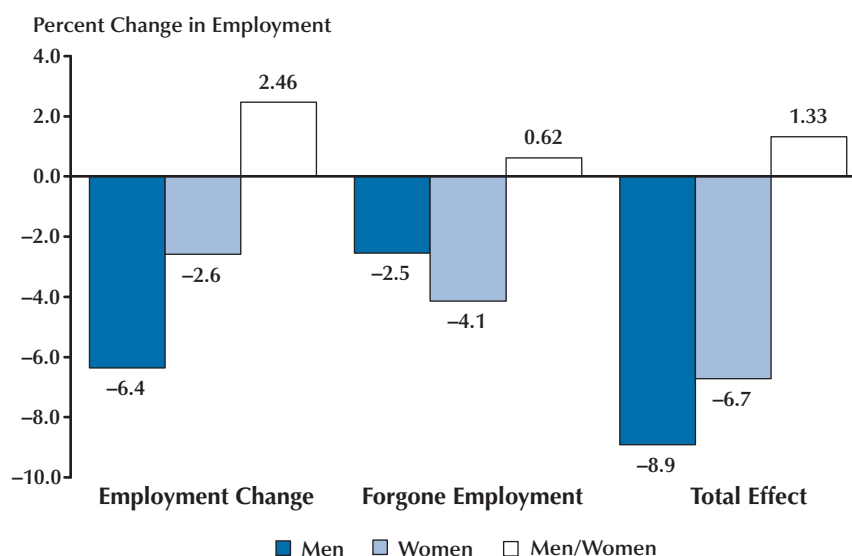
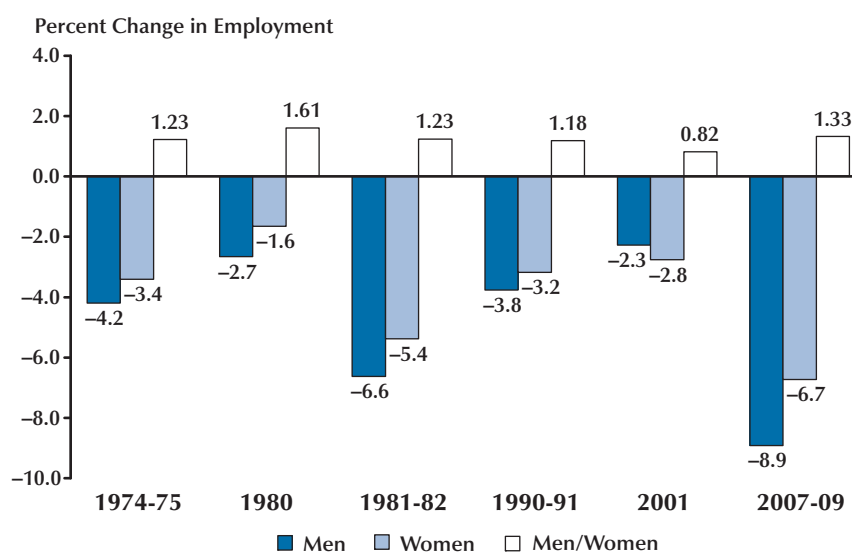
Figure 5**Total Effects of 2007-09 Recession: Men versus Women****Figure 6****Total Effects of Recessions: Men versus Women**

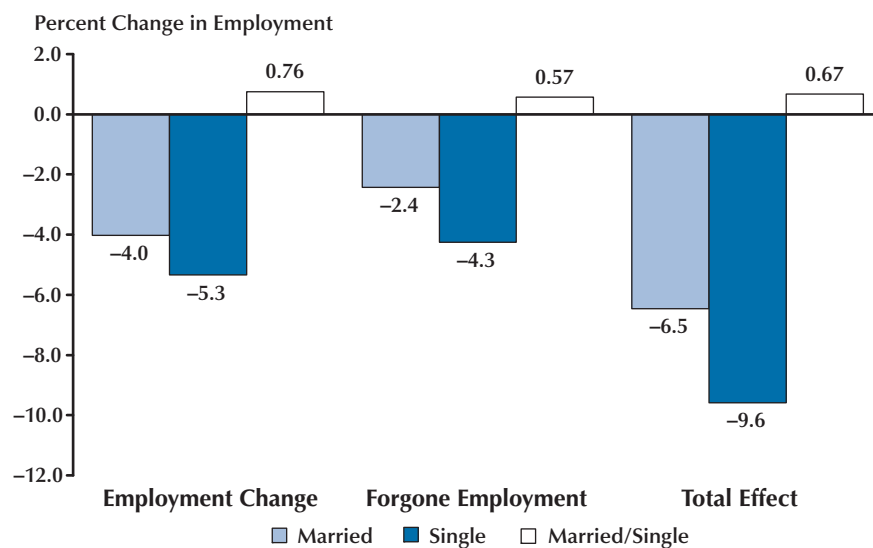
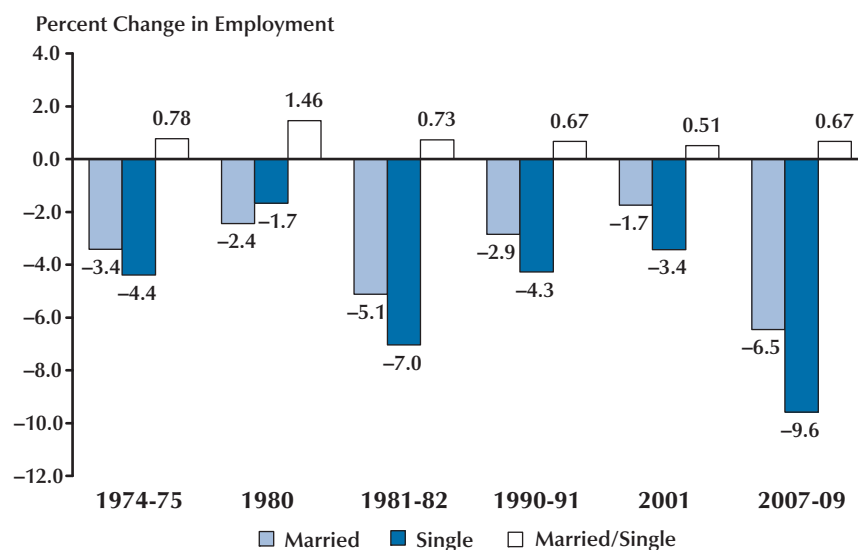
Figure 7**Total Effects of 2007-09 Recession: Married versus Single****Figure 8****Total Effects of Recessions: Married versus Single**

Figure 9**Total Effects of 2007-09 Recession: Marital Status and Men versus Women**

tended to grow much faster than married employment since 1985, the forgone employment for singles during the recession has been much larger. Adding up the two effects, the total effect of the recession for married people has been 67 percent as large as the total effect for single people.

The relative effects of this recession on married and single workers are typical of those for the previous five recessions (Figure 8). Single people have almost always borne a greater total effect, although, because the median employment growth for singles is lower than it was before 1985, the forgone employment for singles was relatively less important for the past two recessions. With the exception of the 1980 recession, married people bore between 50 and 80 percent of the total effect that single people did. For the 1980 recession, employment for singles, particularly single women, was higher at the end of the recession than at the beginning. As we have seen, that recession was really one that hit men the hardest relative to other categories.

An interesting difference is found in the comparison of men and women in the married and single categories (Figure 9). In the current recession,

married men and women saw smaller job losses than did their single counterparts, meaning that married women saw the smallest reduction in employment of the four groups. In part, this can be explained by what has been called the “added-worker effect.”⁷ According to this effect, some married women enter the labor force during recessions following their husbands’ job losses. The added-worker effect can account for the fact that the number of women in the labor force, either employed or looking for employment, has actually risen during the current recession, whereas the male labor force has fallen.

Another explanation for the difference between married and single people is that married people are more likely to have children to support and are, therefore, more likely to take a new job at lower pay after they lose a job. Also, many of the differences for marital status are reflections of other demographic differences that make them more likely to be affected by a recession: Compared with married people, single people tend to

⁷ See, for example, Stephens (2002). DeRiviere (2008) has estimated the size of a related effect called the “pin-money” hypothesis.

be younger (i.e., have less work experience) and have lower education levels.

White and Black

As with all demographic groups, the differences across racial categories are intertwined with differences across other categories as well. For example, black men, for whom average education is lower than for black women or whites, saw the largest decrease in employment. Black women, on the other hand, have seen the most forgone employment of any of these sex-race categories. Underlying these differences is the long-term trend of women, especially black women, becoming more likely to be employed (see Appendices B and C).

The white-black employment effects of the current recession are illustrated by Figure 10, which indicates that white employment has fallen at 58 percent of the rate that black employment has (−4.4 percent vs. −7.5 percent). Because black employment has tended to grow faster than white employment, white forgone employment has been only 79 percent of that for blacks.

Figure 11 shows the relative total effects of the past six recessions on black and white employment. Recent recessions have actually tended to affect black employment relatively more than they used to, even as blacks have become more successful in the labor market. For the past three recessions, the ratio of white-to-black total effects has been between 0.65 and 0.74, after it had been above 1 for the two recessions of the 1980s, indicating that white employment had been more adversely affected. In part, this change over time is because the gap between white and black employment growth has reversed.

It is worth breaking out the two employment effects (employment change and forgone employment) for all six recessions to see how the white-to-black ratios have changed over time (Figure 12). Before 1985, white employment grew at a median rate of 2.5 percent per year, whereas the analogous number for black employment was 2.1 percent. Thus, there was more forgone white employment for each quarter of recession. Since 1985, however, median white employment growth has fallen by

half, whereas median black employment growth has fallen by only one quarter. The ratio of direct employment changes has also fallen over time, meaning that the direct employment change used to be relatively smaller for blacks than it has become. (The 1974-75 recession, however, hit black employment much harder than white employment.) As a consequence, blacks tend to bear a relatively larger burden during recessions now than they used to.

In a sense, the recent success in labor markets has made the total effects of recessions on blacks greater than in the past. As already discussed, black employment has been growing faster than white employment, so each quarter of recession means a greater loss of employment for blacks. Also, because blacks now have higher participation in the labor market than in the past and their education and work experience still lags those of whites, more blacks are vulnerable to the effects of recession than had been the case earlier.

We have alluded to white/black differences in the relative effects of recessions on men and women. This is illustrated for the current recession by Figure 13, which shows that the total effect on white men and women is smaller than that on black men and women, respectively. Also, the total effect on white men is 59 percent greater than that on white women, while the total effect on black men is 18 percent higher than that on black women. This difference is because black women have seen a much larger decline in employment than have white women (−5.3 percent vs. −2.3 percent) while also seeing more forgone employment because black women's median growth rate is nearly twice that of white women. Just as described for black employment overall, this story is really a side effect of the labor market success of black women, who have seen rapid employment growth relative to black men and white women.

White and Other

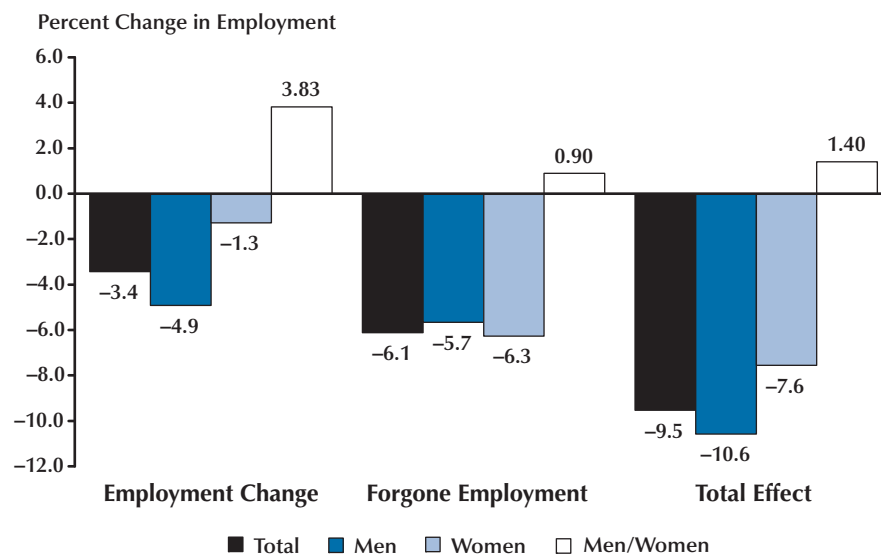
The race category “Other” captures all who are neither white nor black and has become an increasingly important category in the labor market: In 1972, the Other category accounted for 1.2 percent of total employment, but by 2009:Q3

TOTAL EFFECTS OF 2007-09 RECESSION: HISPANICS

Over the course of the current recession, Hispanic employment has not fallen by as much as overall employment (−3.4 percent vs. −4.6 percent), and, for both men and women, Hispanic employment has fallen by at least 1 percentage point less than has overall employment. On the other hand, because Hispanic employment has tended to grow at almost twice the rate of overall employment, these simple employment changes do not capture the whole story. Specifically, whereas overall forgone employment has been 3.3 percent, Hispanic forgone employment has been 6.1 percent, with similar numbers for men and women. In total, the recession has hit Hispanic employment relatively hard, resulting in employment that is 9.5 percent lower than it would have been if the recession had not occurred. As with overall employment, the effects of the recession have been more severe for Hispanic men, who have borne about a 40 percent larger total effect than have Hispanic women. For Hispanics, however, the difference between men and women comes from the employment change rather than forgone employment.¹

Figure

Total Effects of 2007-09 Recession: Hispanics



¹ Note that it is not possible to do simple comparisons of the Hispanic experience across recessions because the data have been subject to extremely large spikes following new estimates of the Hispanic population.

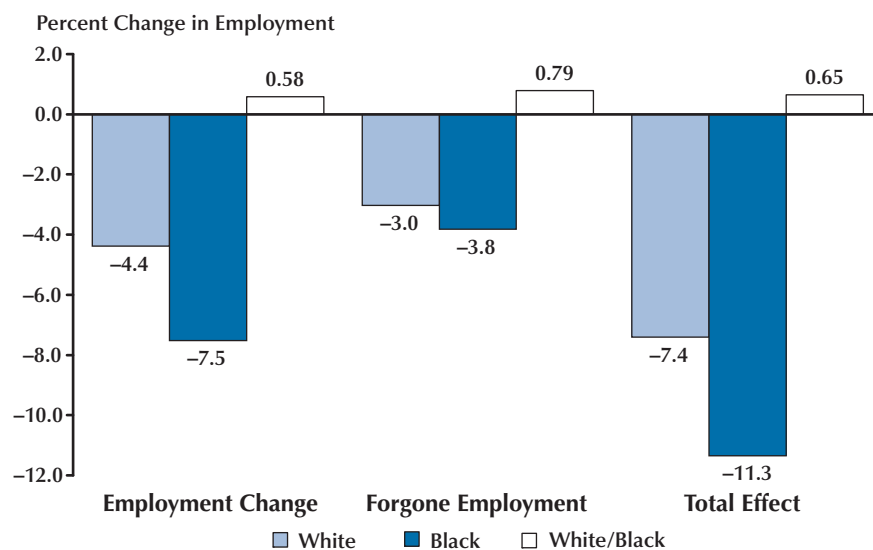
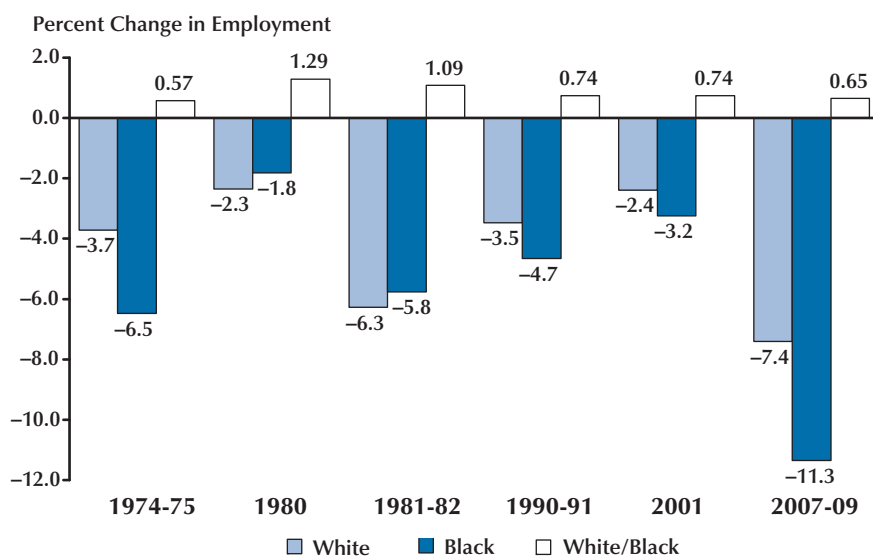
Figure 10**Total Effects of 2007-09 Recession: White versus Black****Figure 11****Total Effects of Recessions: White versus Black**

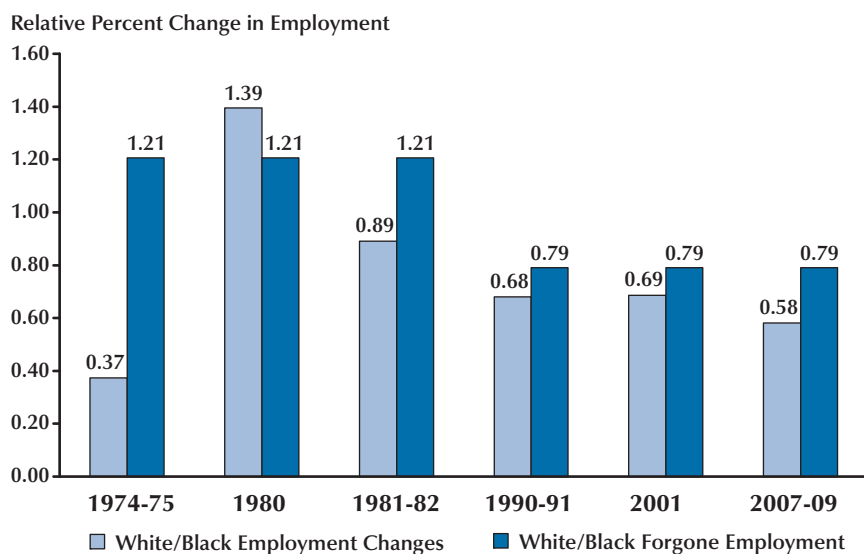
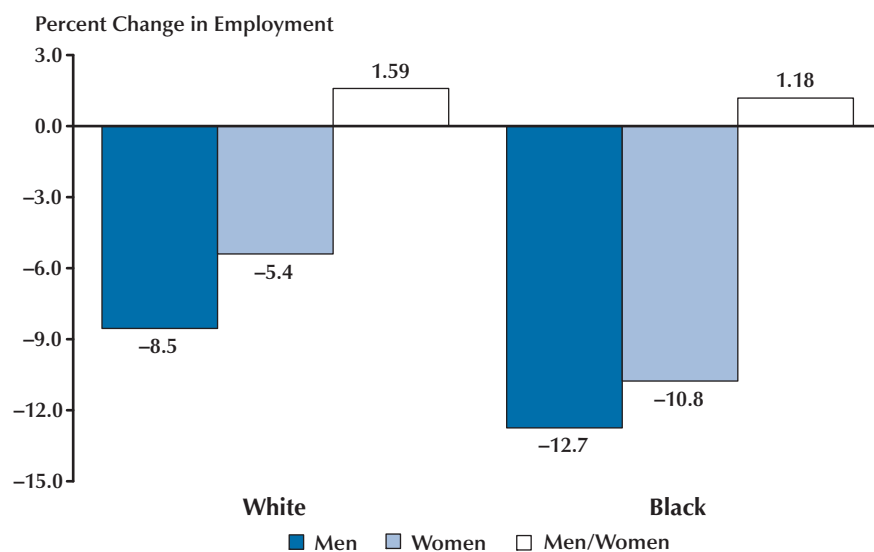
Figure 12**The Two Employment Effects of Recessions: White versus Black****Figure 13****Total Effects of 2007-09 Recession: White and Black and Men versus Women**

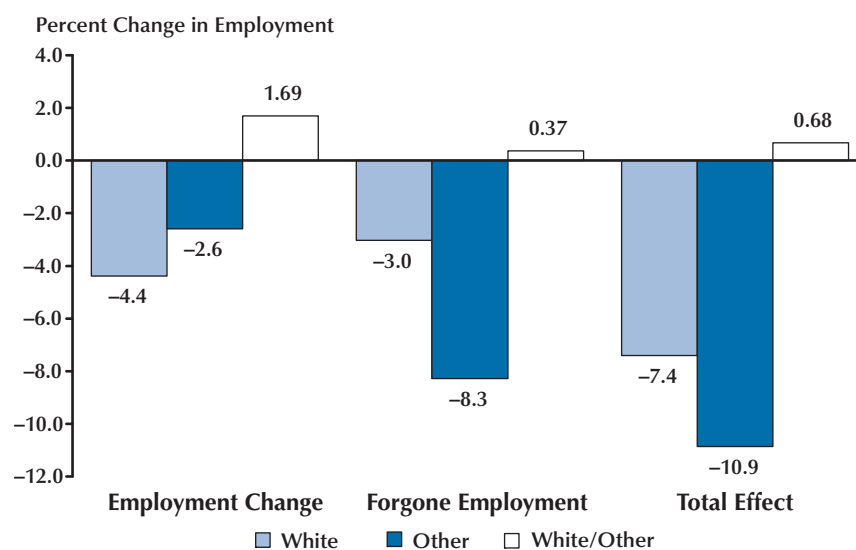
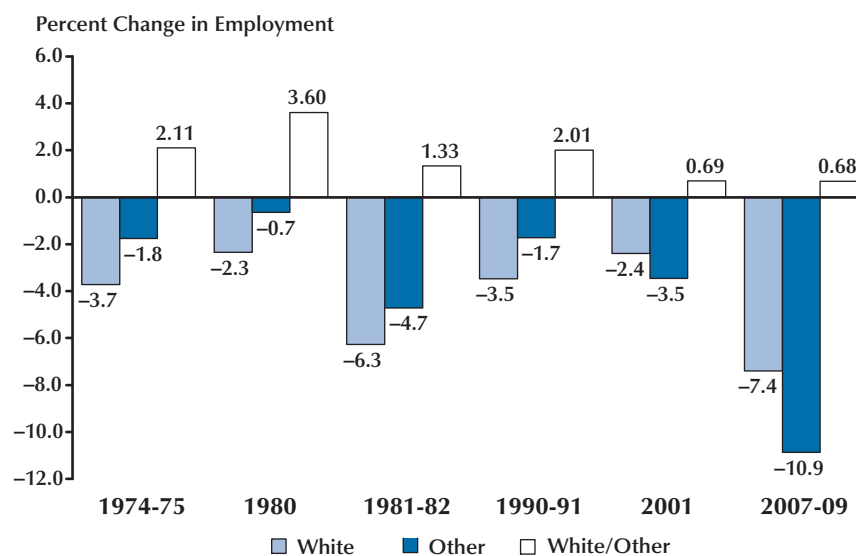
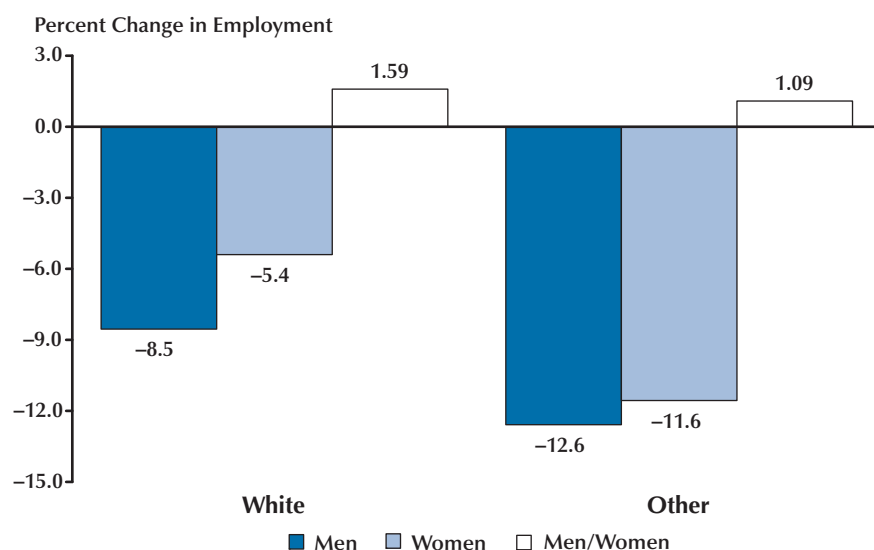
Figure 14**Total Effects of 2007-09 Recession: White versus Other****Figure 15****Total Effects of Recessions: White versus Other**

Figure 16**Total Effects of 2007-09 Recession: White and Other and Men versus Women**

it had risen to 7 percent.⁸ Over that period, the composition of the category changed a great deal, reflecting large influxes of immigrants from China, India, and other Asian countries. In 2007, the average education level of the group was much higher than for the population as a whole, which is reflected in the group's employment performance during the recession.

As depicted by Figure 14, the Other group has seen a drop in employment about half that of whites. On the other hand, because median employment growth for the group is nearly three times that of whites, the group's forgone employment during the current recession has been almost triple that of whites. In total then, employment for the group is estimated to be 10.9 percent lower than if the recession had not occurred. This effect is of roughly the same magnitude as for blacks, but for very different reasons. The bulk of the effect for blacks was from a drop in employment, whereas for people in the Other category the bulk

of the effect was from forgone employment.

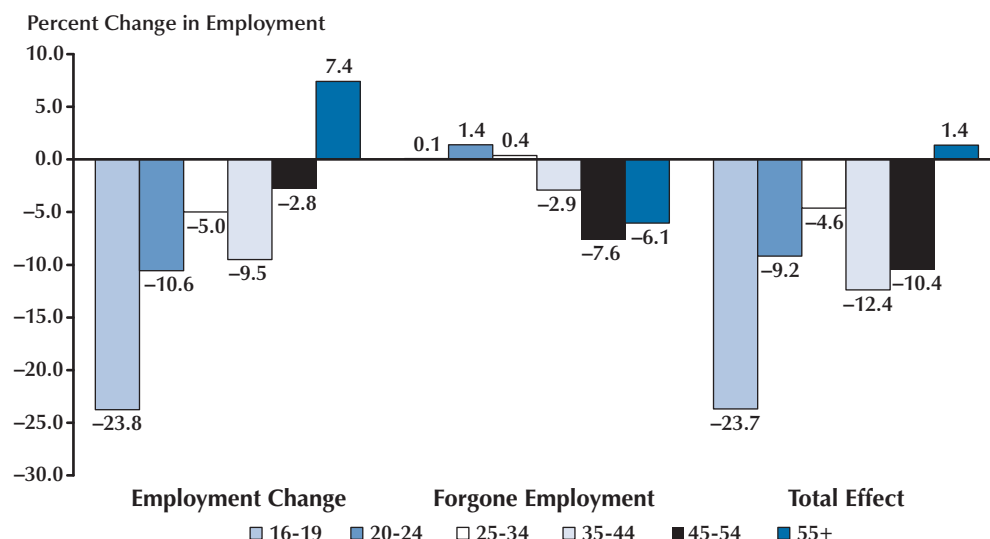
It has only been in the past two recessions that the Other category experienced a larger total effect than did whites (Figure 15). During the four earlier recessions, employment of this group rose by between 3.3 percent and 9.3 percent, whereas negative employment changes are the current norm. So, despite large forgone employment during recessions, the total effects of recessions on the group used to be relatively small.

Unlike the other two race categories, men and women in the Other category have seen similar total effects from the current recession (Figure 16). Just as with the total effects over time, this equality of the sexes is a recent phenomenon. For example, for the earliest three recessions in our sample period, men saw much larger negative total effects during recessions.

Age Groups

The different effects of the current recession are stark when they are broken down by age groups. Teen employment has fallen by 23.8 percent during the recession, whereas employment of those 55 years and older has risen by 7.4 percent

⁸ At the start of 1972, the white and black shares of employment were 89.4 percent and 9.4 percent, respectively. By 2009:Q3 the shares were 82.3 percent and 10.7 percent, respectively.

Figure 17**Total Effects of 2007-09 Recession: Age Groups**

(Figure 17). The 20- to 24-year and 35- to 44-year age groups also have experienced significant employment declines, while the employment drop for the 45- to 54-year age group has been relatively minor.

One reason the 55-plus age group has seen increased employment during the current recession is the effect of the recession on the decision to retire. A dominant feature of the recession has been a significant collapse of stock prices and the resulting devaluation of many people's retirement savings. So, instead of retiring, large numbers of this age group have elected to remain employed, thereby suppressing the normal effect that the recession would have had. In fact, employment of this age group was higher than it would have been without a recession: It grew by 7.4 percent during the recession, but, without a recession, it would have grown by 6.1 percent. This leaves a total effect of an increase in employment of 1.4 percent. From these numbers, it is not possible to determine the number of people who were pushed into employment because of the collapse of retirement savings. The push effect is something greater than 1.4 percent because that number is the push

effect minus the decrease in the demand for these workers that resulted from the recession.

At the other end of the age spectrum, the total effect on employment for the 16- to 19-year group was the same as its employment change. Forgone employment was almost zero because effectively there has been no trend employment growth for this age group. The share of the population of this group that is employed has been falling steadily over time, even when the economy was not in recession (see Appendix B).

As the group with the lowest average education and the least experience, it is not surprising that teenagers have borne a much bigger-than-average burden of the recession. We need to be careful, however, before attributing the entire change in employment to the recession. The federal minimum wage rose in the middle of the recession in 2008 and would have had its largest negative employment impacts on the two youngest age groups. A majority of those working at or below the minimum wage in 2008 were younger than 25 years, and almost half of those were teenagers.

The age breakdown also provides interesting insights into the nature of the relatively large effect

Figure 18**Total Effects of 2007-09 Recession: Age Groups and Men versus Women**

that the recession has had on men. The three oldest groups saw relatively similar effects on men and women (Figure 18). For the 25- to 34-year age group, on the other hand, the total effect on men has been 2.46 times the total effect on women. Therefore, any explanation of the man-cession must include a discussion of the role of age.

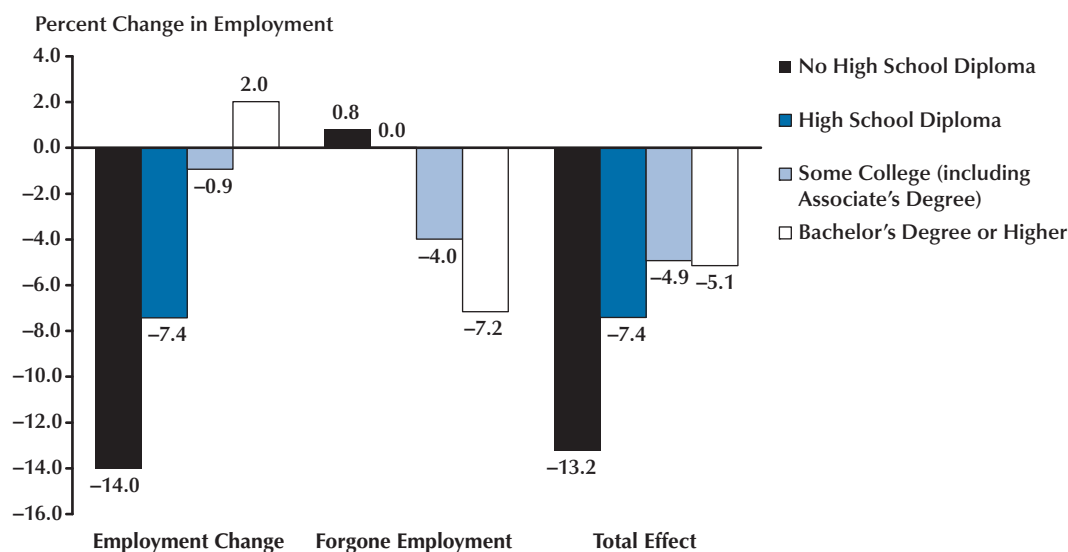
THE ROLE OF EDUCATIONAL ATTAINMENT

The final demographic category is educational attainment, which, because of its importance as a causal factor in the results across all other categories, warrants its own section. Figure 19 breaks down the effect of the current recession according to educational attainment. Keep in mind that the employment data by educational attainment include only those aged 25 and older. This gives a better idea of the employment effects once people achieve their highest education level.

The employment change during the recession has been greatest for those without a high school diploma, followed by those who have completed high school but have not attended any college.

Employment for those with some college fell slightly, while employment for those with a bachelor's degree actually rose during the recession. Because trends across these groups differ a great deal, so do the estimates of their forgone employment. Specifically, employment for those without a high school diploma has been trending down for many years, so part of the decrease in employment during the recession would have occurred anyway. Correcting for this, the total effect of the recession on the employment of those without a high school diploma has been a drop of 13.2 percent. Above-average effects have also been experienced by those with a high school diploma but no college. The total effect on those with at least a bachelor's degree has also been higher than average because forgone employment for this group was the highest among the four categories.

Using Figure 20, it is possible to map the results for educational attainment onto the results across other demographic groups. Specifically, recall that the effect of the current recession on men has been 1.33 times its effect on women. Figure 20 shows that men are less likely to have completed high school, whereas women are much more likely to have some college (particularly an

Figure 19**Total Effects of 2007-09 Recession: Education Level**

associate's degree in the nearly recession-proof nursing profession). Recall also that the effect of the recession on single people has been much greater than it has been on married people. From Figure 20, we can see that single people 25 years and older are much more likely to not have a high school diploma or to have only a high school diploma. They are also much less likely to have a bachelor's degree.

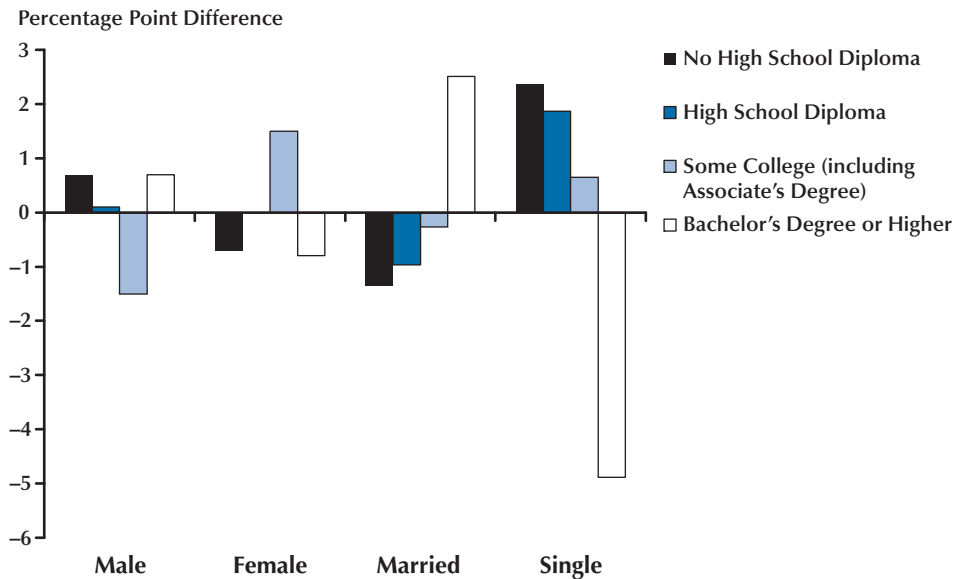
Educational attainment across racial categories maps just as easily onto the employment effects described in previous sections. Relative to white employment, the effect of the current recession on black employment is larger primarily because of larger direct decreases in employment. In contrast, the effect on the employment of those in the Other category is also larger than for whites, but this is primarily because of higher forgone

employment. Relative to whites, blacks are much less likely to have a bachelor's degree and more likely to have a high school diploma or less (Figure 21). For those in the Other category, those 25 years and older are much more likely to have a bachelor's degree or higher.

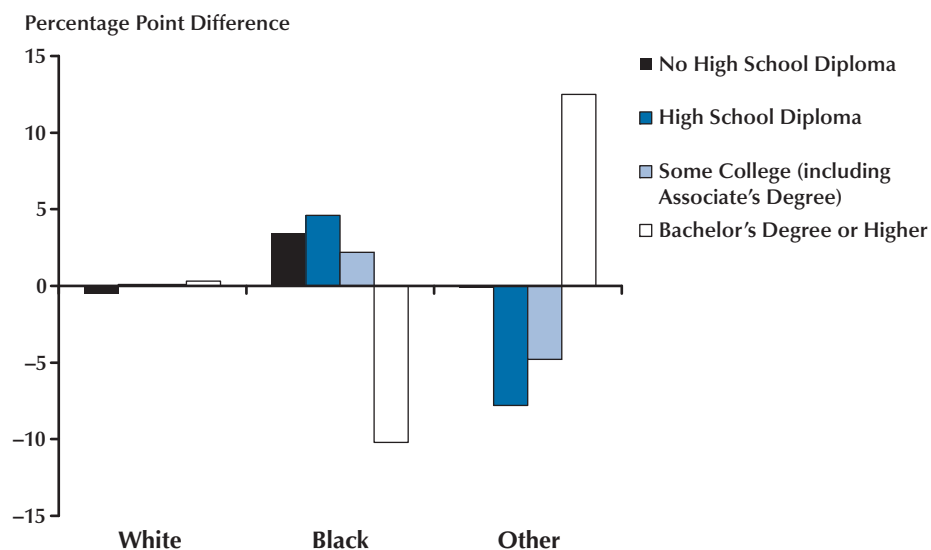
It is not possible to conclude from the analysis here that educational attainment is the primary determinant of the extent to which a recession affects employment across demographic groups. Other factors—such as the industries in which people tend to be employed, job experience, cultural differences, etc.—clearly matter, also. Nevertheless, any discussion of the effects of a recession across demographic groups should have educational attainment as one of the first, if not the first, factor that is considered.

Figure 20

Educational Attainment, 25 Years and Older: 2007 (Difference from the Total: Sex and Marital Status)

**Figure 21**

Educational Attainment, 25 Years and Older: 2007 (Difference from the Total: Race)



REFERENCES

- DeRiviere, Linda. "Have We Come a Long Way? Using the Survey of Labour and Income Dynamics to Revisit the 'Pin Money' Theory." *Journal of Socio-Economics*, December 2008, 37(6), pp. 2340-67.
- DiCecio, Riccardo; Engemann, Kristie M.; Owyang, Michael T. and Wheeler, Christopher H. "Changing Trends in the Labor Force: A Survey." Federal Reserve Bank of St. Louis *Review*, January/February 2008, 90(1), pp. 47-62; <http://research.stlouisfed.org/publications/review/08/01/DiCecio.pdf>.
- Goodman, William; Antczak, Stephen and Freeman, Laura. "Women and Jobs in Recessions: 1969-92." *Monthly Labor Review*, July 1993, 116(7), pp. 26-35.
- Hoff Sommers, Christina. "No Country for Burly Men." *The Weekly Standard*, June 29, 2009, 14(39); www.weeklystandard.com/Content/Public/Articles/000/000/016/659dkrod.asp.
- Mankiw, Greg. "This Recession's Gender Gap." June 7, 2009; <http://gregmankiw.blogspot.com>.
- Owyang, Michael T.; Piger, Jeremy and Wall, Howard J. "A State-Level Analysis of the Great Moderation." *Regional Science and Urban Economics*, November 2008, 38(6), pp. 578-89.
- Stephens, Melvin Jr. "Worker Displacement and the Added Worker Effect." *Journal of Labor Economics*, July 2002, 20(3), pp. 504-37.
- Wall, Howard J. "The 'Man-Cession' of 2008-09: It's Big, but It's Not Great." Federal Reserve Bank of St. Louis *The Regional Economist*, October 2009, pp. 4-9; <http://research.stlouisfed.org/publications/regional/09/10/mancession.pdf>.

APPENDIX A

Table A1

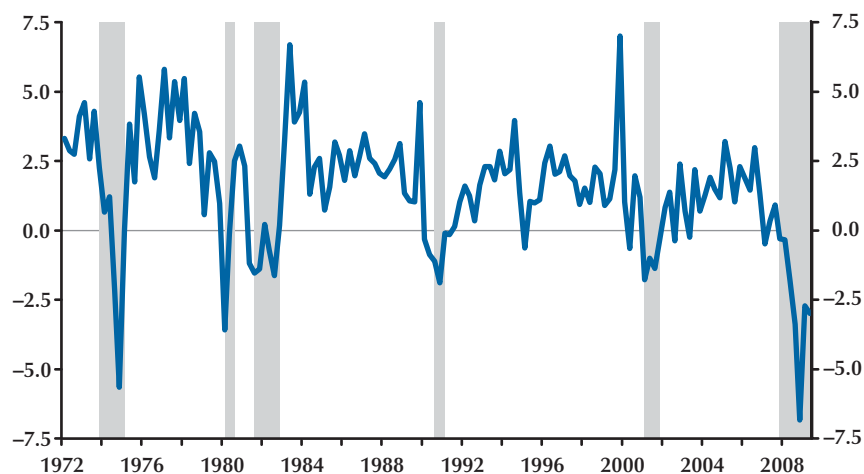
The Timing of Official Recessions and Employment Recessions

Recession	NBER Dates	Household Employment Dates
1974-75	1974:Q1–1975:Q1	1974:Q4–1975:Q2
1980	1980:Q2–1980:Q3	1980:Q2–1980:Q3
1981-82	1981:Q4–1982:Q4	1981:Q3–1983:Q1
1990-91	1990:Q4–1991:Q1	1990:Q2–1991:Q4
2001	2001:Q2–2001:Q4	2001:Q2–2002:Q1
2007-09	2008:Q1–?	2007:Q2–?

NOTE: The official recession dates are determined by the NBER. The dates for household employment recessions are estimated with a Markov-switching model.

Figure A1

Household Employment Growth Rate (1972-2009) Quarterly, Seasonally Adjusted



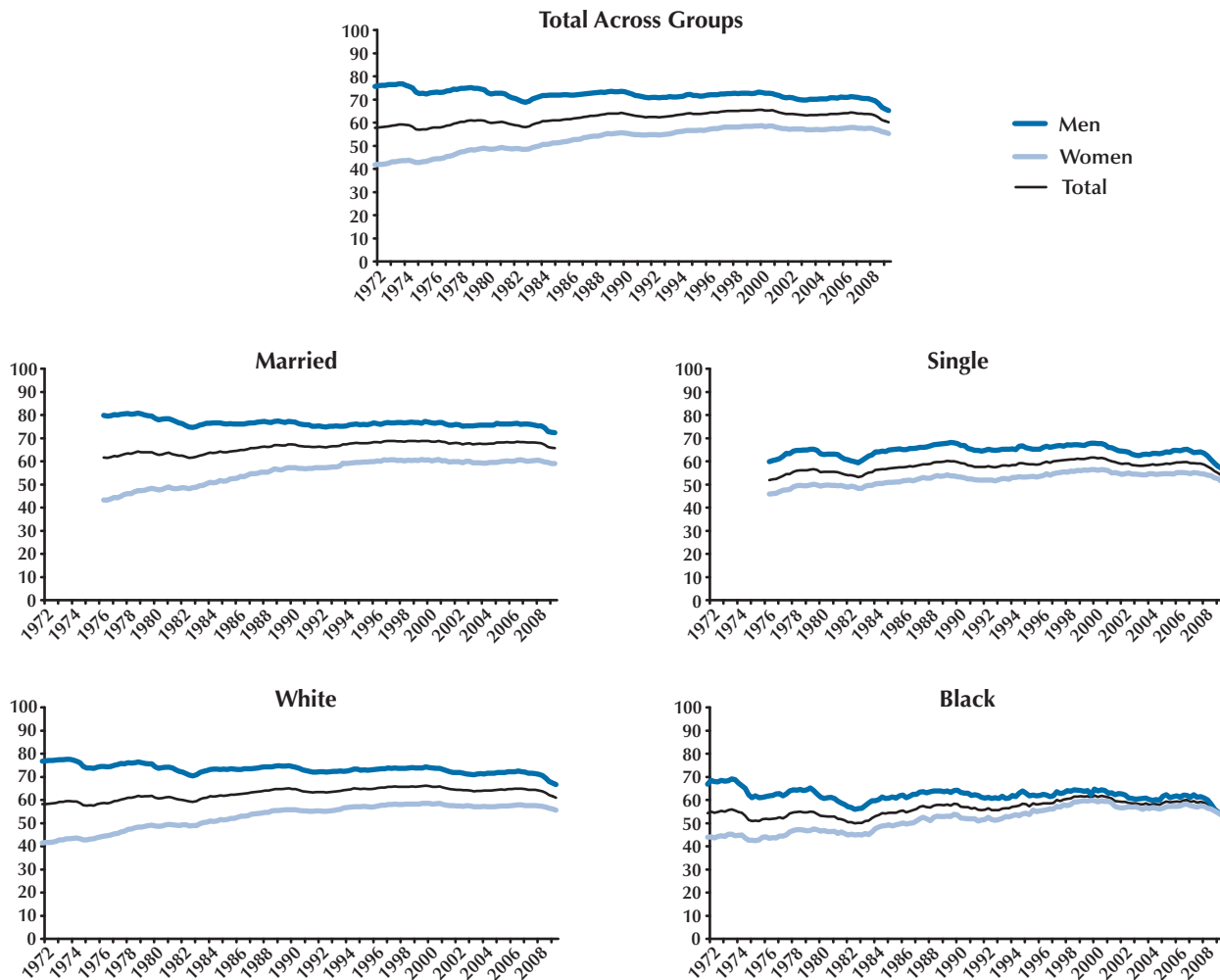
NOTE: Gray bars indicate official NBER recessions.

SOURCE: BLS/Haver Analytics.

APPENDIX B

Figure B1

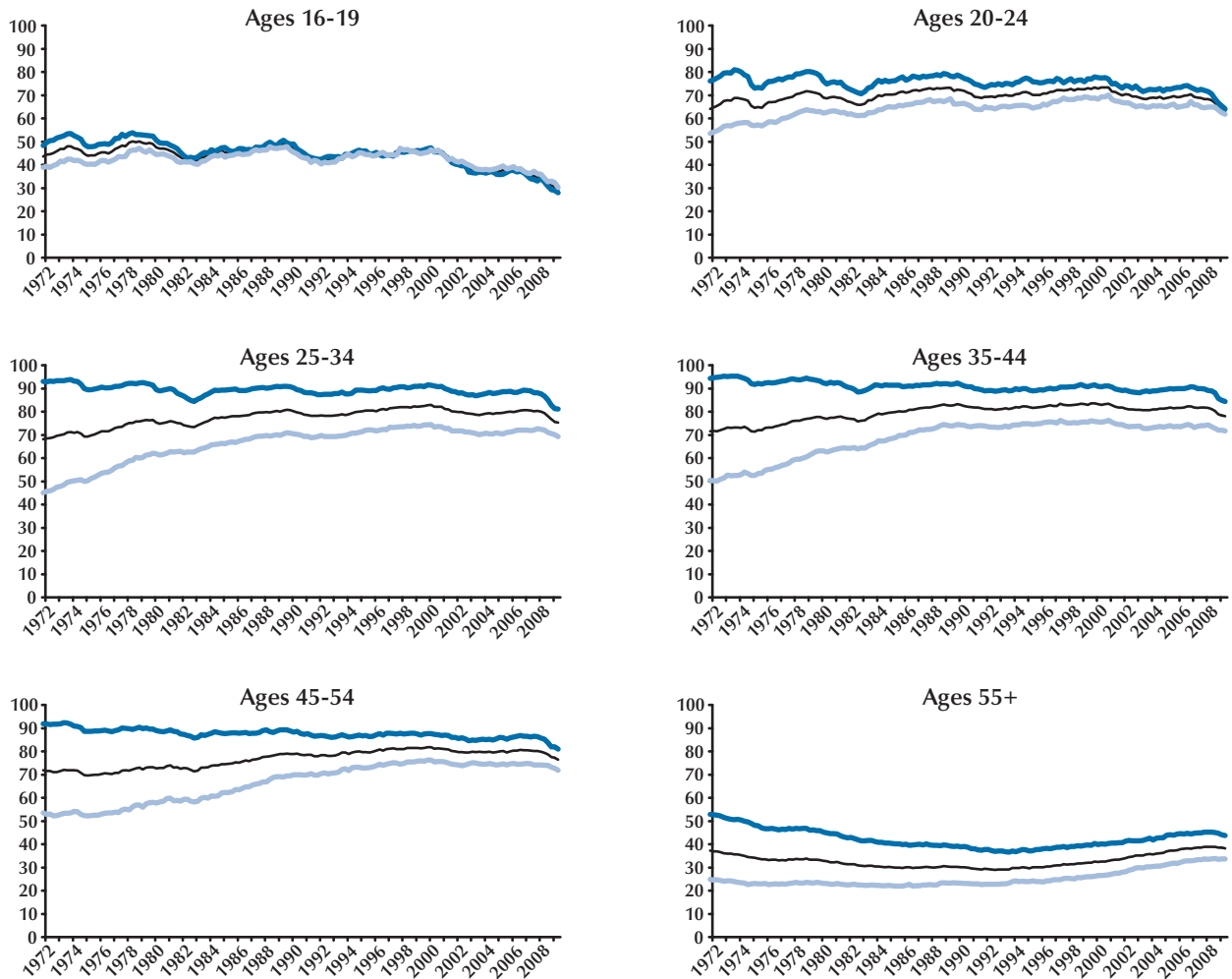
Employment-to-Population Ratio for the Sexes (1972-2009) Overall, by Marital Status, Race, and Age



APPENDIX B

Figure B1, cont'd

Employment-to-Population Ratio for the Sexes (1972-2009) Overall, by Marital Status, Race, and Age



APPENDIX C

Table C1

Median Employment Growth Rates (Annual)

A. Aggregate and by marital status

	Aggregate		Married		Single	
	1972-84	1985-2009	1972-84	1985-2009	1972-84	1985-2009
Total	2.5	1.3	1.6	1.0	3.7	1.7
Men	1.9	1.0	0.7	0.7	4.7	1.6
Women	3.4	1.7	3.4	0.9	3.7	1.4

B. By race

	White		Black		Other	
	1972-84	1985-2009	1972-84	1985-2009	1972-84	1985-2009
Total	2.5	1.2	2.1	1.5	8.0	3.3
Men	1.7	1.0	2.0	1.0	9.0	3.3
Women	3.1	1.2	3.0	2.2	4.6	4.4

C. By age group

	16-19 Years		20-24 Years		25-34 Years		35-44 Years		45-54 Years		55+ Years	
	1972-84	1985-2009	1972-84	1985-2009	1972-84	1985-2009	1972-84	1985-2009	1972-84	1985-2009	1972-84	1985-2009
Total	-0.4	0.0	2.4	-0.6	5.3	-0.2	3.6	1.2	0.1	3.1	-0.1	2.4
Men	-0.4	-0.5	2.2	-0.8	4.1	-0.4	2.5	1.1	-0.4	2.5	-0.6	2.0
Women	-0.2	-0.8	2.6	-0.3	5.9	0.1	5.0	1.7	0.7	3.2	0.4	2.8



Community Colleges and Economic Mobility

[Natalia A. Kolesnikova](#)

This paper examines the role of community colleges in the U.S. higher education system and their advantages and shortcomings. In particular, it discusses the population of community college students and economic returns to community college education for various demographic groups. It offers new evidence on the returns to an associate's degree. Furthermore, the paper uses data from the National Survey of College Graduates to compare educational objectives, progress, and labor market outcomes of individuals who start their postsecondary education at community colleges with those who start at four-year colleges. Particular attention is paid to the Federal Reserve's Eighth District, the geographic area served by the Federal Reserve Bank of St. Louis. (JEL I20, I21, J30)

Federal Reserve Bank of St. Louis *Review*, January/February 2010, 92(1), 27-53.

Joliet Junior College (Joliet, Illinois), the oldest community college in the nation, was founded in 1901. Since then, community colleges have become increasingly important for the U.S. education and training system. Today, 11.5 million students (6.5 million of whom are studying for college credits) are enrolled in almost 1,200 community colleges, according to the American Association of Community Colleges. Community college students constitute a remarkable 46 percent of all U.S. undergraduates.

The term “junior college” originally referred to any two-year, postsecondary school. Over the last few decades, the term “community college” became more popular to describe public two-year institutions as it better conveys the mission of these colleges to serve their local communities. This distinction was not prevalent before the 1980s and the two terms are still often used interchangeably. However, in 1992 the American

Association of *Junior* Colleges did change its name to the American Association of *Community* Colleges.

The original goal of two-year colleges was to prepare students, through an associate's degree (AD) program, to transfer to a four-year college. Over time, the purpose evolved to include workforce training programs, schooling toward certification in areas such as nursing and other professions, and adult continuing education classes. A more recent development is that some community colleges now offer bachelor's degrees in a number of fields.

However, there are big differences across states in how the community college system is used. Rouse (1998) found evidence suggesting that states tend to focus their resources on either a community college or a four-year college system. California has the largest network of the former; 66 percent of the state's current undergraduates attend community colleges. In contrast, only 16

Natalia A. Kolesnikova is an economist at the Federal Reserve Bank in St. Louis. Luke Shimek and Yang Liu provided research assistance. Portions of this paper previously appeared in *The Regional Economist* (Kolesnikova and Shimek, 2008, and Kolesnikova, 2009a) and as a Federal Reserve Bank of St. Louis Community Development Research Report (Kolesnikova, 2009b).

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Table 1**College Enrollment Statistics for the Federal Reserve Eighth District**

Region/State	Enrollment in community college (Fall 2005)	Percent of all undergraduates (Fall 2005)
United States	6,184,000	41
Eighth District states		
Arkansas	47,771	37
Illinois	352,824	51
Indiana	59,969	19
Kentucky	84,669	39
Mississippi	66,298	50
Missouri	86,742	28
Tennessee	74,829	31

SOURCE: U.S. Department of Education, National Center for Education Statistics.

percent of undergraduates in Nevada and Vermont are enrolled in community colleges.¹

Among the states within the Federal Reserve System's Eighth District (which consists of all of Arkansas and parts of Missouri, Mississippi, Illinois, Indiana, Tennessee, and Kentucky) Illinois and Mississippi have the largest proportion of undergraduates—about half—in community colleges. Indiana has the lowest percentage—19 percent. Table 1 summarizes enrollment statistics for the Eighth District states.

For many individuals, community colleges represent a unique opportunity to receive a postsecondary education and improve their economic status. Community colleges thus serve as a path to upward economic mobility for a large part of the population. Given the significant role community colleges in U.S. higher education, it is important to have as much information as possible about community college students, their goals, educational choices, and outcomes. This paper concentrates on several of these topics and attempts to present a comprehensive picture of community college education. In particular, it addresses the following questions:

- What are the advantages of community colleges compared with traditional four-year colleges?
- Do students attending community colleges differ from students at traditional four-year colleges?
- What are the economic returns of attending a community college?
- What are the intentions of community college students with regard to their educational objectives?
- Does starting postsecondary education at a community college affect a person's chances of obtaining a bachelor's degree and postgraduate education?
- Do students who attended a community college and received an AD before obtaining a bachelor's degree have different educational and labor market outcomes than those who did not have an AD before obtaining a bachelor's degree?

The paper reviews the existing literature on community college education. In addition, it offers new evidence on the returns to attaining an AD and uses the National Survey of College Graduates (NSCG) to carefully analyze the differences in a variety of educational and economic

¹ These are the 2005 state-level statistics from the National Center for Education (U.S. Department of Education), the latest information available when this paper was written.

Table 2**Comparisons of College Tuition and Fees for the Federal Reserve Eighth District**

Region/State	Average tuition and required fees (2006-07)		
	Four-year public college (in-state) (\$)	Four-year private college (\$)	Two-year community college (\$)
United States	5,685	20,492	2,017
Eighth District states			
Arkansas	4,937	13,396	1,890
Illinois	8,038	20,181	2,252
Indiana	6,284	22,060	2,713
Kentucky	5,821	14,739	2,633
Mississippi	4,457	12,300	1,709
Missouri	6,320	16,539	2,284
Tennessee	5,009	17,576	2,474

SOURCE: U.S. Department of Education, National Center for Education Statistics.

outcomes between individuals who started their postsecondary education at community colleges and those who started at four-year institutions.²

ADVANTAGES OF COMMUNITY COLLEGES

Compared with a traditional four-year college, a community college has several important advantages for students. To begin, the open admission policy makes it easier for students to enroll regardless of their prior academic record.

Attending community colleges costs less because of lower tuition and other fees than those at four-year colleges. Community college students on average paid \$2,017 in tuition and fees for the 2006-07 academic year, which is less than half the amount for students in public four-year universities (\$5,685) and only about one-tenth of the tuition and fees for students in private four-year universities (\$20,492), according to the U.S. Department of Education.

Table 2 presents a comparison of tuition costs and other fees for the Federal Reserve's Eighth

District. Mississippi has the lowest tuition among the states of the Eighth District. Attending a four-year private college in Mississippi costs \$12,300 per year on average. Attending a four-year public college costs significantly less: \$4,457 per year. Community college tuition in Mississippi is \$1,709 per year. Even the state with the highest community college tuition in the District, Indiana, charges only \$2,713 per year. In comparison, tuition at a private four-year college in Indiana costs on average \$22,060 per year. Illinois has the highest tuition for four-year public universities in the District (\$8,038).

In addition, most community college students live at home, thus saving the added room and board expenses incurred by students at other institutions. Finally, community colleges offer a more flexible curriculum, and their schedules include evening and weekend classes, which gives students an opportunity to attend college while working full-time.

Community College Students

The population of community college students is diverse and differs from the typical population at four-year colleges. Community college populations have 60 percent white, 15 percent black,

² The latest available data are used throughout the paper, which means that time periods may vary between different sections of the paper.

and 14 percent Hispanic students.³ Forty-one percent of community college students are males. In comparison, students attending four-year colleges are more likely to be white (70 percent) and male (45 percent).

Because of the flexibility they offer and the relatively low monetary and time costs of attending, community colleges have more so-called nontraditional students than four-year colleges. Community college students are more likely to be older: 35 percent are 30 years old or older compared with 16 percent in four-year colleges. The average community college student is 28 years old, with a median age of 24. The corresponding ages for students in four-year colleges are 24 and 21 years.

Only 31 percent of community college students are enrolled full-time, in part because students attending community colleges are more likely to also be working. In contrast, 63 percent of students at four-year colleges are enrolled full-time. Only 21.4 percent of all community college students do not work, compared with 30.5 percent at four-year colleges. Furthermore, 40.8 percent of community college students work full-time, compared with 22.8 percent of their four-year college counterparts.

More students in community colleges are first-generation college students than are students attending four-year colleges. More than 40 percent of the former have parents with only a high school education or less. In contrast, only 27 percent of four-year college students have parents with a high school education or less.

Not surprisingly, most community college students attend an institution close to their home. They live on average 40 miles away from the college they attend. In comparison, students at four-year institutions attend colleges on average 230 miles away from their home. More than 95 percent of community college students attend colleges in their home states compared with 83 percent of students at four-year colleges.

³ Unless noted otherwise, the data in this section are from the Center for Education Statistics, U.S. Department of Education, 2003-04 as presented in Horn and Nevill (2006).

LABOR MARKET RETURNS

What is the economic payoff to attending community college? The answer to this question is rather complicated, partly because of the lack of available data. Until 1990, the U.S. Census Bureau recorded only the number of years of education, making it impossible to identify individuals attending community college specifically. In the 1990 and 2000 U.S. censuses, the highest educational attainment was recorded instead of years of education. This makes it possible to focus on individuals with a completed AD. Still, this information does not make it possible to identify an institution students attended if they did not complete a degree.

Several available studies use different longitudinal survey data instead. Most of the surveys record data on various characteristics of respondents, starting with their teenage years and following them through the years.⁴ One limitation of these studies is that, given the timeline of surveys, they include only students who enrolled in community college soon after graduating from high school.

Most studies found that students who attended community college, but did not complete a degree, earn 9 to 13 percent more than those with only a high school diploma. The estimation technique usually attempts to control for differences in academic preparation between the two groups as measured by test scores and class rank. Furthermore, researchers found an increase in annual earnings of 5 percent to 8 percent associated with each year of education at a community college. This finding is particularly interesting because it is similar to the return to a year of schooling in a four-year college.

Jacobson, LaLonde, and Sullivan (2005) looked at a very different group—older, high-tenure, displaced workers. Most retraining efforts for this group take place at community colleges. These researchers found that one year of community college schooling increases the long-term earnings of displaced workers by about 9 percent for men and about 13 percent for women com-

⁴ See Kane and Rouse (1999) for a survey of these studies and a more detailed description of data.

pared with earnings for similar workers who did not attend community college. Another important fact reported by these authors is that technically oriented and math and science courses lead to a higher earnings payoff—about 14 percent for men and 29 percent for women—but less technically oriented courses yield very low and possibly zero returns.

RETURNS TO AN ASSOCIATE'S DEGREE

Another way to assess the value of a community college education is to determine how much more a person with an AD earns compared with a similar person with only a high school diploma. Separate studies by Kane and Rouse (1995) and Leigh and Gill (1997) estimated the labor market return to an AD is about 16 to 27 percent.

The much-larger dataset from the U.S. 2000 Census⁵ affords answers to more detailed questions. For instance, are there differences in labor market returns to an AD between different demographic groups? Are the returns the same across different cities? Data also allow looking at the differentials in hourly wages rather than annual earnings.

The sample consists of men and women 25 to 55 years of age with an AD or a high school diploma who live either in the 20 largest metropolitan areas of the United States (including St. Louis) or in large metropolitan areas of the Eighth District (Memphis, Little Rock, and Louisville).

A simple matching estimator was used to calculate, for each metropolitan area j , the rate of return to an AD. Intuitively, people who have an AD were matched with those who do not but who have otherwise similar demographic characteristics. We can ask, then, how their wages differ. It is assumed that productivity, which translates into wages, is a function of education and age, since older workers tend to have more work experience.

More precisely, for an individual with age $x = X$ in metropolitan area j , we would like to estimate the causal effect of an AD ($AD = 1$),

$$\Delta(X, j) = E(y_1 | x = X, AD = 1, j) - E(y_0 | x = X, AD = 1, j),$$

the difference between the wage of an individual with an AD and his or her potential wage if formal education stopped at the high school level. Here, y_1 is the logarithm of the worker's wage if the individual has an AD, and y_0 is the logarithm of the worker's wage if the individual stops his or her education at high school. Of course, we cannot directly observe the second term in the above equation; we never observe what a person with an AD would have earned with only a high school education.

If, however, we are willing to eliminate selection problems by assumption (including the issue of ability bias that has received close attention in the literature), we have

$$E(y_0 | x = X, AD = 1, j) = E(y_0 | x = X, AD = 0, j),$$

This equation simply means that the wages of a person with an AD, if he or she did not receive it, would have been the same as the wages of a similar person with a high school diploma. Thus, the mean return to an AD in a particular metropolitan area j , denoted as $\Delta(j)$, is

$$\Delta(j) = \int \Delta(x|j) dF(x|j),$$

where $dF(x|j)$ is the distribution of x in the metropolitan area.

In principle, $\Delta(j)$ might vary across cities simply because of differences in the age distributions in these cities. Such differences would be of little interest, so to “standardize” the estimates, I use the national cumulative distribution function of x and calculate

$$\Delta_n(j) = \int \Delta(x|j) dF_n(x),$$

where $dF_n(x)$ is derived from the national data.⁶

⁵ Data are from 2000 Public Use Micro Sample of the U.S. Census (see Ruggles et al., 2004).

⁶ For more on this approach to a nonparametric estimation of returns to schooling, see Black, Kolesnikova, and Taylor (2009).

Table 3**Labor Market Returns* to Associate's Degree (Relative to High School) for Women by Race**

Region/City	White	Black	Hispanic
United States	0.29	0.30	0.29
20 largest metropolitan areas			
Atlanta	0.27	0.29	0.53
Baltimore	0.28	0.28	0.20
Boston	0.29	0.33	0.31
Chicago	0.25	0.23	0.21
Dallas	0.30	0.27	0.24
Detroit	0.32	0.19	0.25
Houston	0.24	0.45	0.20
Los Angeles	0.20	0.26	0.30
Miami	0.25	0.30	0.33
Minneapolis	0.23	0.28	0.24
New York	0.26	0.35	0.28
Philadelphia	0.28	0.24	0.38
Phoenix	0.24	0.33	0.18
Pittsburgh	0.29	0.19	—
Riverside-San Bernardino	0.31	0.40	0.36
San Diego	0.23	0.21	0.28
San Francisco	0.26	0.21	0.30
Seattle	0.25	0.29	0.39
St. Louis	0.24	0.43	—
Washington	0.23	0.26	0.37
Eighth District large metropolitan areas			
Memphis	0.23	0.31	—
Little Rock	0.37	—	—
Louisville	0.32	0.32	—

NOTE: *The numbers can be interpreted as percentage increases in wages. (See footnote 7 for more information.)

SOURCE: Author's calculations. Data are from 2000 Public Use Micro Sample (PUMS) of the U.S. Census. Results are missing if data were insufficient because of small sample size.

This estimation is performed separately for men and women and for different racial groups.

One immediate feature of the results is that, though the estimated average returns to an AD are consistent with other researchers' findings, there are significant differences among demographic groups (Tables 3 and 4). Women of all races have higher returns to an AD than men do, which might be due to the fact that women are more likely to major in nursing and related

health fields. The return to an AD also varies among racial groups. Hourly wages of white men with an AD are 18 percent higher than wages of white men who stopped their formal education at high school.⁷ The same returns are much

⁷ Tables 3 and 4 report differences in mean log wages between holders of ADs and high school graduates. Differences in mean log wages, called log points differences, approximate percentage differences.

Table 4**Labor Market Returns* to Associate's Degree (Relative to High School) for Men by Race**

Region/City	White	Black	Hispanic
United States	0.18	0.25	0.27
20 largest metropolitan areas			
Atlanta	0.21	0.26	0.39
Baltimore	0.15	0.26	0.19
Boston	0.17	0.06	0.25
Chicago	0.10	0.21	0.19
Dallas	0.24	0.28	0.29
Detroit	0.21	0.22	0.34
Houston	0.19	0.21	0.27
Los Angeles	0.16	0.35	0.30
Miami	0.30	0.25	0.30
Minneapolis	0.17	0.27	0.32
New York	0.11	0.24	0.21
Philadelphia	0.15	0.17	0.32
Phoenix	0.18	0.42	0.24
Pittsburgh	0.16	0.17	—
Riverside-San Bernardino	0.20	0.15	0.24
San Diego	0.15	0.36	0.24
San Francisco	0.12	0.48	0.23
Seattle	0.04	0.22	0.17
St. Louis	0.11	0.13	—
Washington	0.18	0.22	0.16
Eighth District large metropolitan areas			
Memphis	0.16	0.22	—
Little Rock	0.22	—	—
Louisville	0.18	0.17	—

NOTE: *The numbers can be interpreted as percentage increases in wages. (See footnote 7 for more information.)

SOURCE: Author's calculations. Data are from 2000 Public Use Micro Sample (PUMS) of the U.S. Census. Results are missing if data were insufficient because of small sample size.

higher for black and Hispanic men—25 and 27 percent higher, respectively.

Furthermore, the return to an AD is not the same across different cities in the United States. For example, white men with ADs are paid only 4 percent more than white high school graduates in Seattle but as much as 30 percent more in Miami. For Hispanic men, the return to an AD is 16 percent in Washington, D.C., but it is more than twice as much—39 percent—in Atlanta. Cross-city dif-

ferentials for white women are not as large, but they are significant for minority women.

Tables 3 and 4 also present estimated returns to an AD in four large metropolitan areas of the Eighth District. White men with an AD earn on average 11 percent more in St. Louis, 16 percent more in Memphis, 22 percent more in Little Rock, and 18 percent more in Louisville than similar men with only a high school diploma. For black men, returns to an AD are 13 percent in St. Louis,

22 percent in Memphis, and 17 percent in Louisville. Consistent with the rest of the country, women's returns are higher than men's. For example, black women in St. Louis with an AD earn 43 percent more than black women with only a high school education.

Why is there such a large variation in returns to an AD across cities? Although no formal research has been done on this topic, possible explanations might be locational differences in labor market conditions and industrial composition.

DIFFERENT EDUCATIONAL PATHS

Community college students have various educational goals and intentions when they enter college. Although many plan to obtain an AD, some students enroll to take just a few classes to improve their skills or to become certified in a certain field. Some intend to transfer to a four-year institution without any formal community college credentials.

This ability of community colleges to offer students many options provides a unique opportunity to obtain postsecondary education for many students who would not have it otherwise. On the other hand, because the educational objectives of students—and, thus, their paths—are so different, it is difficult to track their progress through college and to assess the effect of community college education on their educational attainment and labor market outcomes. The fact that most students attend community colleges part-time and take longer to complete their program makes the task even more complicated.

Critics of the community college system often point out that a significant proportion of community college students earn relatively few college credits. Kane and Rouse (1999) calculated that the majority of community college students complete one year or less and 35 percent complete only one semester of study or less. The study also showed that fewer than half of community college students complete any degrees. In particular, about 15 percent receive a certificate, 16 percent complete an AD, and another 16 percent eventually receive a bachelor's degree or higher. Kane and Rouse (1999) point out that, unlike their

community college counterparts, almost 60 percent of four-year college entrants receive at least a bachelor's degree.

Does this mean that enrolling in a two-year college somehow reduces an individual's educational attainment? One view is that easy access to community college sidetracks students from a four-year college, where they are more likely to obtain a bachelor's degree. On the other hand, many nontraditional students who attend community college would not attend four-year colleges. For them, community colleges provide a chance for a postsecondary education they would not have had otherwise. Therefore, researchers argue, even if attending a community college instead of a four-year college might lower educational attainment for some students, more students have access to higher education, which raises overall educational attainment in society.

To better answer questions about the effect of community colleges on educational attainment, it is necessary to consider students' intentions toward their educational objectives together with their outcomes. The problem is a lack of reliable data that measure students' goals and preparation.

The U.S. Department of Education has attempted to study educational outcomes of community college students. Its report used data from several sources, including those tracking students over time (Hoachlande et al., 2003). The study found that about 90 percent of students entering community college intended to obtain a formal credential or to transfer to a four-year college. One could argue that it is more reasonable to consider completion rates only for those who intended to obtain a degree in the first place. The report estimated that, depending on the data used, between 51 percent and 63 percent of these students had fulfilled their expectations within six to eight years after initial enrollment. In particular, about 11 percent had earned a certificate, 17 percent to 18 percent had earned an AD, 11 percent to 28 percent (depending on the data used) had attained a bachelor's degree or higher, and 12 percent to 13 percent had transferred to a four-year college without attaining a formal degree.

Keeping in mind that a primary goal of two-year colleges is to prepare students to continue

their studies at four-year institutions, it is particularly important to evaluate their transfer rates. The U.S. Department of Education (Hoachlande et al., 2003) report indicated that, overall, about 29 percent of community college students had transferred to four-year colleges. Interestingly, 51 percent of those who intended to complete a bachelor's degree when they first started had transferred. At the time data were collected, 80 percent of those who transferred either obtained a bachelor's degree or were still working toward it.

What about the students who left community college without any formal credential? This amounts to more than half of those who started classes. According to the report, about one-third of this group said that postsecondary education improved their salary. For 47 percent, attending community college led to increased job opportunities. About 43 percent reported improvement in job performance, and 47 percent said they had more job responsibilities.

Students who did receive a certificate or a degree were more likely to be satisfied with their outcomes. About 80 percent of them said their salaries had increased. Almost 85 percent reported having a better job or more responsibilities.

FROM A COMMUNITY COLLEGE TO A BACHELOR'S DEGREE

As discussed previously, even though community colleges initially were introduced to help prepare students for four-year colleges, fewer than a third of community college students transfer to four-year colleges. Still, it is important to compare the outcomes of students who transfer to a four-year institution with the outcomes of their counterparts who began at a four-year institution.

A recent study by Long and Kurlaender (2008) evaluates whether there is what the authors term a "community college penalty." The study uses a unique longitudinal dataset that includes everyone who entered Ohio public institutions of higher education in the fall of 1998 with follow-up over the next nine years. It provides information on students' high school preparation, entrance examinations, degree intentions, family background,

college performance and, finally, degree completion. As long as students transfer between Ohio's public colleges and universities, they remain in the dataset. This makes it possible to track most students' progress from starting postsecondary education at a community college to receiving a bachelor's degree from a four-year college.

The study finds that there is indeed a "penalty" resulting from beginning postsecondary education at a community college. The rates of dropping out or "stopping out" without a degree are much higher for those who start at community colleges than for those who start at four-year institutions. For example, community college students were 36 percent less likely to obtain a bachelor's degree than similar students who started at four-year colleges.

One possible explanation for this result is that four-year college students start with an intention to graduate while community college students have different educational objectives. The study finds, however, that even community college students who expressed an intention to obtain a four-year bachelor's degree are significantly less likely to do so within nine years of starting their postsecondary studies. Only 26 percent of this group have a bachelor's degree nine years after starting their postsecondary education. To put it in perspective, 50 percent and 73 percent of those who start at nonselective and selective four-year institutions, respectively, obtain a bachelor's degree. In addition, students who start at community colleges have fewer total earned credits than students who start at four-year colleges.

The observed differences in educational outcomes may occur because of the differences between the students at two-year and four-year institutions. Demographic, family, and other characteristics of students who begin at community colleges differ from those of students who begin at four-year institutions. Such differences might lead to a selection bias of the estimates. However, the negative effect of starting postsecondary education at a community college remains even after adjusting for selection bias by controlling for students' race, gender, age, ability (measured by ACT scores), and family income. The authors find "a persistent community college

Table 5**Proportion of Bachelor's Degree Holders with Associate's Degrees by Region of Residence**

Region	Proportion of bachelor's degree holders	
	With AD (%)	Who attended community college (%)
New England	14	31
Middle Atlantic	15	34
East North Central	15	42
West North Central	15	44
South Atlantic	18	45
East South Central	17	43
West South Central	15	48
Mountain	15	50
Pacific	20	58

SOURCE: Author's calculations. Data are from NSCG (2003).

penalty," but they suggest that "it is worth comparing the size of the penalty to the difference in costs at two-year versus four-year institutions."

LONG-TERM EDUCATIONAL OUTCOMES

Few community college students go on to receive a bachelor's degree. Still, some successfully transfer to four-year colleges and obtain a bachelor's degree or higher. This section compares these individuals with those who start postsecondary education at traditional four-year colleges and analyzes their long-term educational outcomes.

The NSCG is a joint project of the U.S Census Bureau and the National Science Foundation. The 2003 survey included a sample of respondents to the 2000 Decennial Census long form who indicated they have a bachelor's degree or higher in any field of study. The survey collected detailed information about their education, current and past employment, current salary, and demographic characteristics. In particular, the dataset reports educational background characteristics, such as type of college attended, major field of study, number of degrees, and the highest degree received. Most importantly, for my purposes, it identifies respondents who have an AD or attended a com-

munity college. One shortcoming of these data, however, is a lack of family background information and ability measures.

Among people who have at least a bachelor's degree, 17 percent report having received an AD. (I assume here that they started their postsecondary education at a community college and, after receiving an AD, continued their education at a four-year college.) The rest of this section compares this group with the rest of the respondents with at least a bachelor's degree.⁸ I start the comparison of the two groups by presenting some descriptive statistics.

Table 5 reports the proportion of respondents with a bachelor's degree who either attended a community college or have an AD; this group is classified according to region of residence.⁹ Between 14 and 20 percent of four-year college graduates have an AD, depending on the region. Bachelor's degree holders in the Pacific and South Atlantic regions are most likely to have an AD

⁸ The dataset also identifies individuals who attended a community college but does not identify what they were studying. It is impossible to know whether a person took classes for credit in preparation for college or not. Because of this limitation, I ignore these individuals' community college experience.

⁹ The definition of the region in this context is provided in Appendix A. "Region" is the smallest geographic unit of analysis available in the NSCG dataset.

Table 6**Proportion of Bachelor's Degree Holders with Associate's Degree by Region of Birth**

Region	Proportion of bachelor's degree holders	
	With AD (%)	Who attended community college (%)
New England	15	34
Middle Atlantic	16	38
East North Central	15	44
West North Central	16	44
South Atlantic	18	47
East South Central	16	42
West South Central	15	48
Mountain	18	48
Pacific	24	60

SOURCE: Author's calculations. Data are from NSCG (2003).

(20 percent and 18 percent, respectively), while New England residents with a bachelor's degree are least likely to have an AD (14 percent). As many as 58 percent of bachelor's degree holders attended a community college at some point in the Pacific region, but only 31 percent did in New England.

Table 6 reports similar statistics by region of birth. People with a bachelor's degree who were born in the Pacific region are significantly more likely to attend community college (60 percent) or have an AD (24 percent) than people who were born in other regions. This is not surprising given that the Pacific region includes California, the state with the highest community college enrollment.

Figure 1 presents a distribution of parental education. Consistent with other studies, I find that AD holders are much more likely to be first-generation college students than those who do not have an AD. They are also more likely to have parents with a level of education less than a college degree.

Next, I examine whether there are differences in educational choices between those who obtained an AD before enrolling in a four-year college and those who did not. Table 7 summarizes the types of four-year institutions that respondents attended. The Carnegie Foundation Classification of Insti-

tutions of Higher Education is used to categorize universities as Research Universities (I and II), Doctorate Granting (I and II), Master's Granting (I and II), Liberal Arts (I and II), and Associates of Art Colleges that include community colleges.¹⁰

While direct comparison of the quality of education provided by different universities is difficult, traditionally research and doctorate-granting universities are perceived as being more selective and having better resources than master's-granting and liberal arts colleges.

Table 7 shows that people with a prior AD were significantly less likely to attend Research I universities (18 percent vs. 26 percent) and slightly less likely to attend Doctorate-Granting universities (6 percent vs. 7 percent). On the other hand, a much higher proportion attended Master's-Granting universities (36 percent vs. 27 percent). It also seems that people with a prior AD were much less likely to attend more selective Liberal Arts I colleges than their counterparts (1 percent vs. 6 percent). To sum up, it appears that AD recipients attended less-selective (and perhaps less-expensive) institutions for their bachelor's studies. Figure 2 shows that students with an AD are also more likely to be enrolled in public

¹⁰ See Appendix B for definitions of the Carnegie Foundation Classification of Institutions of Higher Education categories.

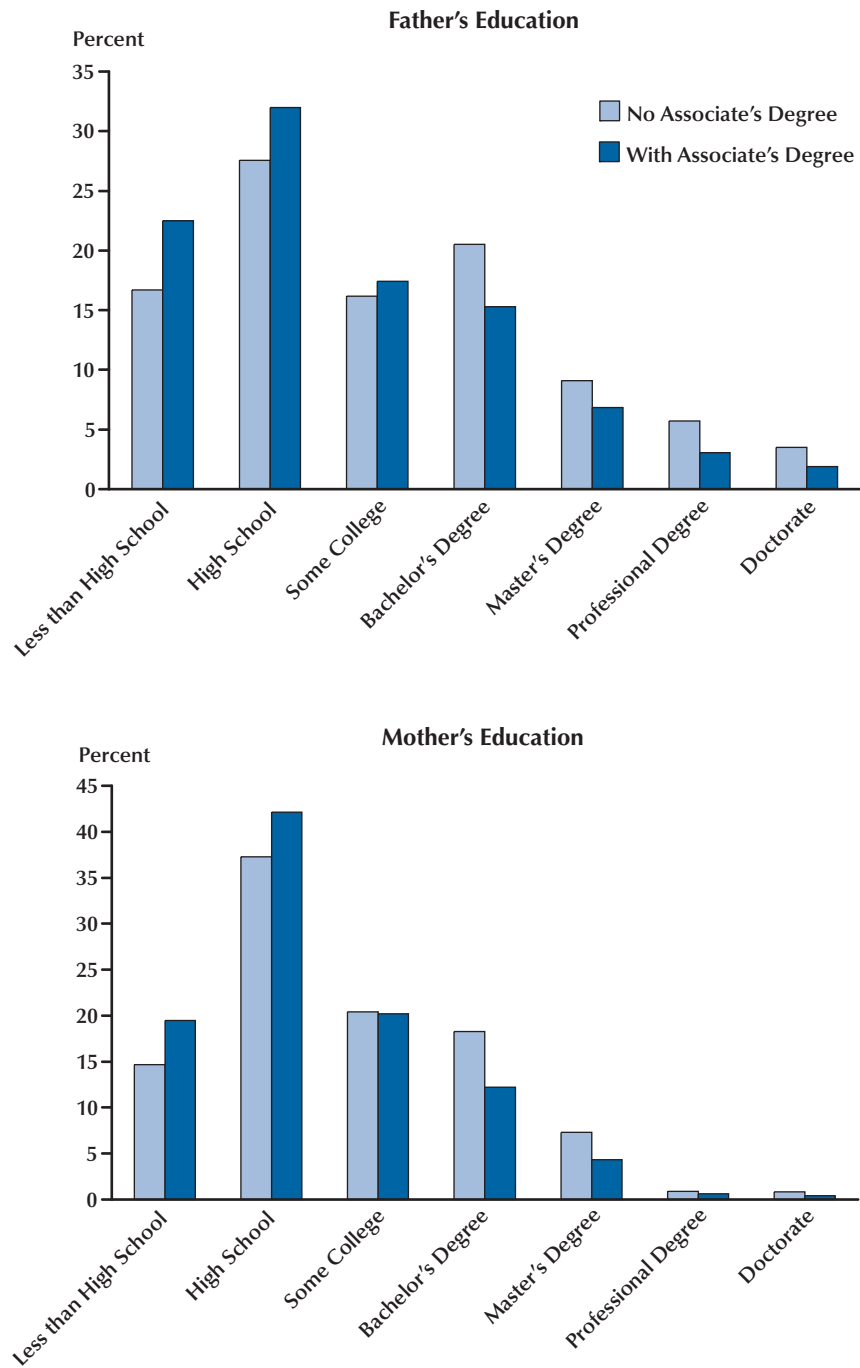
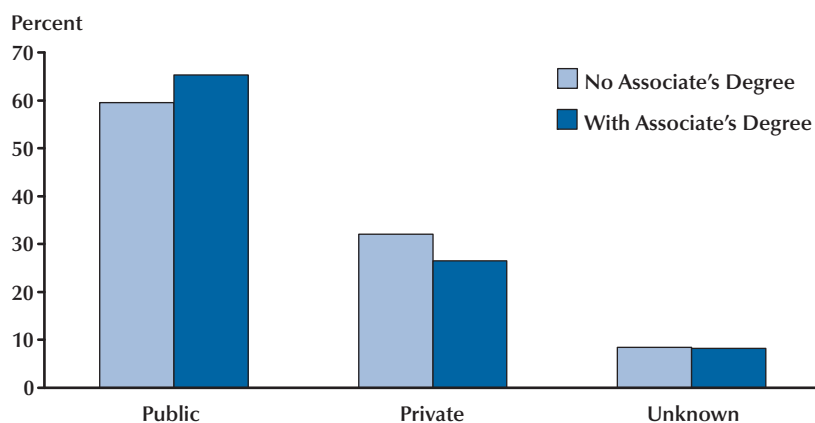
Figure 1**Parents' Education**

Figure 2**Public or Private Institution of Bachelor's Degree****Table 7****Institution Awarding First Bachelor's Degree**

Carnegie Classification of Institution	All bachelor's degree holders (%)	No AD (%)	With AD (%)
Research University I	24.57	25.88	18.29
Research University II	7.39	7.52	6.74
Doctorate-Granting I	6.68	6.89	5.72
Doctorate-Granting II	5.78	5.57	6.79
Master's I	28.5	26.95	36.02
Master's II	2.24	2.03	3.23
Baccalaureate (Liberal Arts) I	5.08	5.86	1.32
Baccalaureate (Liberal Arts) II	7.62	7.51	8.18
Associate of Art Colleges	0.27	0.15	0.84
Other	2.62	2.49	3.35
Missing information	9.23	9.17	9.54

NOTE: See Appendix B for descriptions of the classifications.

SOURCE: Author's calculations. Data are from NSCG (2003).

Table 8**Distribution of Major Fields of Study of First Bachelor's Degree**

Major field of study	All bachelor's degree holders (%)	No AD (%)	With AD (%)
Computer and math sciences	3.86	3.87	3.82
Computer and information sciences	1.99	1.86	2.66
Mathematics and statistics	1.87	2.01	1.16
Biological, agricultural, environmental	6.2	6.48	4.87
Agricultural and food sciences	0.8	0.83	0.69
Biological sciences	4.97	5.27	3.54
Environmental life sciences	0.43	0.38	0.64
Physical and related sciences	2.9	3.14	1.71
Chemistry, except biochemistry	1.51	1.67	0.73
Earth, atmospheric, and ocean sciences	0.57	0.59	0.46
Physics and astronomy	0.62	0.68	0.32
Other physical sciences	0.2	0.2	0.2
Social and related sciences	14	14.27	12.69
Economics	2.16	2.4	1.04
Political and related sciences	3.11	3.34	2.01
Psychology	4.61	4.55	4.9
Sociology and anthropology	2.76	2.64	3.32
Other social sciences	1.36	1.34	1.42
Engineering	7.7	7.99	6.35
Aerospace, aeronautical, and astronautical	0.29	0.31	0.22
Chemical engineering	0.6	0.68	0.22
Civil and architectural engineering	1.16	1.19	1.02
Electrical and computer engineering	2.39	2.43	2.2
Industrial engineering	0.48	0.5	0.41
Mechanical engineering	1.76	1.81	1.48
Other engineering	1.02	1.07	0.8
Health, science education, technology	9.57	9.46	10.21
Health	6.6	6.51	7.08
Science and mathematics teacher education	1.15	1.19	0.97
Technology and technical fields	1	0.88	1.62
Other science- and education-related fields	0.82	0.88	0.54
Business, management, art	55.75	54.79	60.32
Management and administration fields	17.61	16.6	22.45
Education, except science and math teacher education	13.51	13.39	14.08
Social service and related fields	2.28	2.19	2.71
Sales and marketing fields	2.61	2.56	2.86
Art and humanities fields	12.69	13.22	10.15
Other non-science and education fields	7.05	6.83	8.07

SOURCE: Author's calculations. Data are from NSCG (2003).

Table 9**Proportion of Males by Major Field of Study**

Major field of study	All bachelor's degree holders (%)	No AD (%)	With AD (%)
Computer and math sciences	64	64	64
Computer and information sciences	67	69	61
Mathematics and statistics	60	59	71
Biological, agricultural, environmental	57	57	59
Agricultural and food sciences	68	66	76
Biological sciences	54	54	53
Environmental life sciences	71	70	75
Physical and related sciences	74	74	73
Chemistry, except biochemistry	68	68	64
Earth, atmospheric, and ocean sciences	81	80	86
Physics and astronomy	84	84	81
Other physical sciences	64	64	65
Social and related sciences	48	49	46
Economics	72	73	67
Political and related sciences	63	63	62
Psychology	33	33	32
Sociology and anthropology	37	34	46
Other social sciences	52	53	51
Engineering	89	89	89
Aerospace, aeronautical, and astronautical	92	93	83
Chemical engineering	80	80	67
Civil and architectural engineering	89	88	91
Electrical and computer engineering	90	89	91
Industrial engineering	85	84	91
Mechanical engineering	93	93	92
Other engineering	88	89	83
Health, science education, technology	37	37	37
Health	22	23	21
Science and mathematics teacher education	51	51	51
Technology and technical fields	86	86	87
Other science- and education-related fields	75	74	76
Business, management, art	45	45	47
Management and administration fields	63	64	61
Education, except science and math teacher education	22	22	25
Social service and related fields	48	49	45
Sales and marketing fields	57	59	51
Art and humanities fields	42	42	41
Other non-science and education fields	44	42	51

SOURCE: Author's calculations. Data are from NSCG (2003).

Table 10**Age at Attaining Degrees**

	All	No AD	With AD
Age at first bachelor's degree (years)			
Mean	26.8	26.2	29.5
Standard deviation (SD)	5.3	4.6	7.3
Minimum	15	15	16
Maximum	74	71	74
10 percent	23	22	23
25 percent	24	24	25
Median	25	25	27
75 percent	28	27	32
90 percent	32	30	40
Age at highest degree (years)			
Mean	29.7	29.3	31.7
SD	7.2	6.8	8.3
Minimum	15	15	16
Maximum	77	77	73
10 percent	23	23	24
25 percent	25	25	26
Median	27	27	29
75 percent	32	31	36
90 percent	40	38	44

SOURCE: Author's calculations. Data are from NSCG (2003).

colleges than students who do not have an AD and less likely to attend private colleges.

Are there differences in major fields of study between the two groups? One of the main objectives of community colleges is to prepare students for four-year college studies. Do students who have taken classes at a community college choose different fields of study than students who did not go to community college before attending a four-year institution?

Fortunately, NSCG data provide detailed information on respondents' degree majors. As shown in Table 8, fewer people with an AD major in sciences and engineering than people with no AD. Instead, people with an AD are more likely to major in health, technology, and management than their counterparts. Preference for the health

and technology fields is expected, given that community colleges often focus more on these disciplines. It is somewhat surprising that so many more AD holders choose to major in management than people without an AD (22 percent vs. 17 percent).

Interestingly, there is little difference in gender distribution across major fields of study between the two groups (Table 9). There are some exceptions, however. More women with ADs choose to major in computer and information sciences, economics, aerospace engineering, chemical engineering, and marketing than women without an AD; and more men with ADs choose to major in mathematics and statistics, agriculture, environmental and earth sciences, sociology, and industrial engineering than men without an AD. It is hard to know whether this is a result of stu-

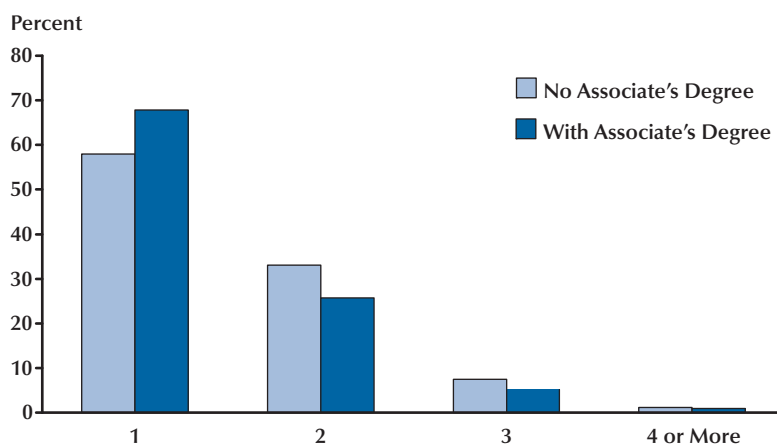
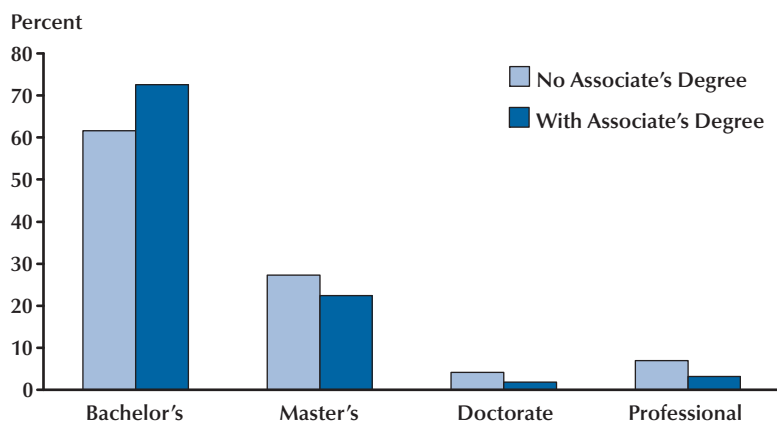
Figure 3**Number of Degrees (Bachelor's and Higher)****Figure 4****Highest Degree Attained**

Table 11**Years from Bachelor's Degree to Advanced Degree**

	All	No AD	With AD
Years from bachelor's degree to master's degree			
Mean	7.8	7.9	7.4
Standard deviation (SD)	6.8	6.9	6.6
Years from bachelor's degree to doctorate			
Mean	11.1	10.9	12.8
SD	7.0	6.9	8.5
Years from bachelor's degree to professional degree			
Mean	5.4	5.4	5.3
SD	4.4	4.4	4.8

SOURCE: Author's calculations. Data are from NSCG (2003).

Table 12**Proportion of Associate's Degree Holders by Highest Degree**

Highest degree	With AD (%)
Bachelor's degree	20.7
Master's degree	14.3
Doctorate	5.8
Professional	9.5

SOURCE: Author's calculations. Data are from NSCG (2003).

dents' exposure to some subjects before entering a four-year institution or other effects on some students' choice of a major field of study.

Not surprisingly, AD holders are older on average when they obtain a bachelor's degree. Their mean age is 29.5 years, compared with the mean age of 26.2 years of those who obtain a bachelor's degree without an AD (Table 10).

Almost 70 percent of bachelor's degree holders with an AD do not continue their education beyond their first bachelor's degree. This contrasts with the fewer than 60 percent of their counterparts without an AD (Figure 3). A higher proportion of people with no AD go on to receive a master's degree, a doctorate, or a professional degree (e.g., J.D. or M.D.) (Figure 4). Table 11

shows that, for those who continued beyond a bachelor's degree, it took slightly less time on average to obtain a master's or a professional degree if a person had an AD but longer to finish a Ph.D. program.

Table 12 presents another way to compare the highest education levels of people with and without an AD. Among people with only a bachelor's degree, about 21 percent have a prior AD. Among those who received a master's degree, only 14.3 percent have an AD. The proportion of people with an AD is even smaller among those with a doctorate or a professional degree (5.8 and 9.5 percent, respectively).

LONG-TERM LABOR MARKET OUTCOMES

This section compares labor market outcomes of people with an AD who proceeded to receive a bachelor's degree or higher and the labor market outcomes of their counterparts with no AD. In particular, it concentrates on one measure of labor market outcome—annual salary.

This analysis considers only individuals of prime age (23 to 55 years old) who are employed. Since salaries are top-coded in the NSCG dataset, those above the 95th percentile of salary distribution are omitted from the sample, as are those

Table 13**Salaries (in US\$) by Education Level**

	All	No AD	With AD
A. All			
Mean	57,686	58,559	53,696
Standard deviation (SD)	29,660	30,218	26,597
B. Bachelor's degree			
Mean	54,126	54,667	52,022
SD	28,319	28,855	26,029
C. Master's degree			
Mean	60,676	61,323	56,997
SD	28,663	29,030	26,185
D. Doctorate			
Mean	70,711	71,246	62,906
SD	29,837	29,832	28,851
E. Professional degree			
Mean	78,705	79,491	70,349
SD	36,711	36,793	34,799

SOURCE: Author's calculations. Data are from NSCG (2003).

below the 5th percentile, to maintain distribution symmetry. Thus, individuals who earn less than \$10,000 or more than \$150,000 per year are not included.

Table 13 shows the average annual salary by education level for the full sample and then separately for individuals with and without an AD. As expected and well documented in many other studies, people with a higher level of education have, on average, higher earnings. Bachelor's degree holders earn \$54,126 per year; people with master's degrees earn \$60,676 per year; people with a doctorate earn \$70,711 per year, and people with professional degrees earn \$78,705 per year, on average. Remarkably, annual salaries for individuals with an AD differ from those without an AD for all education levels. Regardless of the highest degree, people who started their postsecondary education with an AD earn less on average than those who started at a four-year college. The difference is particularly large for those with a doctorate or a professional degree.

A regression analysis can be used to better understand this phenomenon. In particular, I estimate the following equation:

$$S = \beta_0 + \beta_1 * X + \beta_1 * I_{AD} + \varepsilon,$$

where S is an individual's annual salary in dollars, X is a vector of various characteristics that will be defined shortly, and I_{AD} is an indicator of whether a person has an AD, in which case it is equal to 1; otherwise, it is 0. The goal is to compare individuals with the same characteristics X but different values of an indicator I_{AD} , 0 or 1. The question is how an AD affects one's salary. Relevant characteristics include age, gender, race, major field of study, and highest degree attained.

The estimation results of the above equation are reported in Table 14, panel A. The dependent variable is salary S . The results indicate that an annual salary increases by about \$542 per year as people age and accumulate more work experience. Women, on average, earn \$12,137 per year less than men with similar characteristics. Minority groups earn less compared with whites. The

Table 14**Regression Analysis: Effects of Various Factors on Salary**

	Coefficient	Standard error	t-Statistic
A. All			
Age	541.9	13.7	39.6
Woman	-12136.5	233.5	-52.0
Black	-4943.0	410.5	-12.0
Hispanic	-5768.8	460.1	-12.5
Asian	-2558.6	416.9	-6.1
Associate's degree	-3854.1	283.1	-13.6
Controls			
Major field of study	Yes		
Highest degree	Yes		
Number of observations	59,346		
Adjusted R^2	0.22		
B. Bachelor's degree			
Age	487.6	17.6	27.73
Woman	-12724.9	300.1	-42.4
Black	-6017.6	522.7	-11.5
Hispanic	-6807.9	577.8	-11.8
Asian	-3267.3	565.7	-5.78
Associate's degree	-3620.8	346.0	-10.46
Controls: Major field of study	Yes		
Number of observations	34,067		
Adjusted R^2	0.19		
C. Master's degree			
Age	574.1	24.3	23.6
Woman	-11460.2	421.3	-27.2
Black	-2198.1	716.5	-3.1
Hispanic	-3549.5	865.6	-4.1
Asian	-980.5	707.4	-1.4
Associate's degree	-3379.1	536.7	-6.3
Controls: Major field of study	Yes		
Number of observations	17,803		
Adjusted R^2	0.23		

Table 14, cont'd**Regression Analysis: Effects of Various Factors on Salary**

	Coefficient	Standard error	t-Statistic
D. Doctorate			
Age	1078.1	58.4	18.5
Woman	-8176.1	884.1	-9.3
Black	-7725.4	1839.1	-4.2
Hispanic	-3055.8	1937.8	-1.6
Asian	-3544.6	1116.6	-3.17
Associate's degree	-9565.3	1679.5	-5.7
Controls: Major field of study	Yes		
Number of observations	4,521		
Adjusted R^2	0.21		
E. Professional degree			
Age	984.4	81.7	12.1
Woman	-7949.2	1349.9	-5.9
Black	-2325.0	2921.2	-0.8
Hispanic	-3006.2	2775.5	-1.1
Asian	-2473.6	2393.2	-1.0
Associate's degree	-9423.2	2416.5	-3.9
Controls: Major field of study	Yes		
Number of observations	2,955		
Adjusted R^2	0.08		

annual salary of blacks is \$4,943 lower on average than that of comparable whites. The corresponding difference for Hispanics is \$5,769, and it is \$2,559 for Asians. These facts are well documented in the economics literature. The most striking finding, however, is that even when other factors are controlled, people with an AD earn \$3,854 less per year than their counterparts with no AD. All coefficients are statistically significant at a 5 percent level or better.

The same equation is also estimated separately for each education-level group: bachelor's degree, master's degree, doctoral degree, and professional degree. Panels B through E of Table 14 show the results of the estimations. The same pattern is observed for each education-level group: Older workers earn more; women and minorities earn less. More importantly, those who earn an AD and then a more-advanced degree have lower earnings than those who earn a bachelor's degree or higher

but no AD. For example, bachelor's degree holders earn \$3,621 less per year when they have a prior AD. Strikingly, earning gaps are observed even for those community college students who receive a doctorate or a professional degree. Their salaries are \$9,565 and \$9,423 lower, respectively, than salaries of their counterparts who started at a traditional four-year college.

One possible explanation for the salary disparity is that the quality of education differs for the two groups. For example, labor markets might assign an additional premium for a degree from an elite college. Controls were included for the type of institution awarding a bachelor's degree to test this possibility. Results remain virtually unchanged, which allows rejection of this explanation.¹¹

¹¹ These results are not reported here but are available from the author upon request.

Table 15**Regression Analysis: Effects of Work Experience**

	Coefficient	Standard error	t-Statistic
A. All			
Experience	605.2	13.4	45.2
Woman	-12100.4	232.5	-52.0
Black	-4342.6	409.1	-10.6
Hispanic	-5412.6	458.6	-11.8
Asian	-3018.7	414.9	-7.3
Associate's degree	-2426.1	281.2	-8.6
Controls			
Major field of study	Yes		
Highest degree	Yes		
Number of observations	59,346		
Adjusted R^2	0.23		
B. Bachelor's degree			
Experience	574.8	17.2	33.4
Woman	12681.1	298.6	-42.5
Black	-5583.1	520.2	-10.7
Hispanic	-6345.7	575.4	-11.0
Asian	-3627.2	562.9	-6.4
Associate's degree	-2268.7	342.8	-6.6
Controls: Major field of study	Yes		
Number of observations	34,067		
Adjusted R^2	0.20		
C. Master's degree			
Experience	532.9	23.7	22.5
Woman	-11671.3	421.2	-27.7
Black	-1349.4	718.7	-1.9
Hispanic	-3534.4	866.9	-4.1
Asian	-1836.0	705.9	-2.6
Associate's degree	-2117.2	537.3	-3.9
Controls: Major field of study	Yes		
Number of observations	17,803		
Adjusted R^2	0.23		

Table 15, cont'd**Regression Analysis: Effects of Work Experience**

	Coefficient	Standard error	t-Statistic
D. Doctorate			
Experience	1374.1	55.5	24.8
Woman	-7583.2	860.7	-8.8
Black	-6014.6	1791.7	-3.4
Hispanic	-2556.2	1885.4	-1.4
Asian	-3012.9	1086.6	-2.8
Associate's degree	-6883.8	1625.8	-4.2
Controls: Major field of study	Yes		
Number of observations	4,521		
Adjusted R^2	0.25		
E. Professional degree			
Experience	1185.5	81.5	14.6
Woman	-7061.9	1340.0	-5.3
Black	-2025.1	2890.2	-0.7
Hispanic	-2899.1	2745.9	-1.1
Asian	-2455.6	2362.8	-1.0
Associate's degree	-7767.6	2392.3	-3.3
Controls: Major field of study	Yes		
Number of observations	2,955		
Adjusted R^2	0.10		

One might also be concerned that when we compare people of the same age with and without an AD, we in fact compare people with different levels of experience. People who start at a community college take longer, on average, to graduate with a bachelor's degree, so they have less work experience after receiving a bachelor's degree. It could be argued, however, that these people are accumulating work experience while in school if they study part-time and continue to work. Still, to check the robustness of the results, I replaced the age variable in the analysis with the experience variable. "Experience" is defined as the number of years from the time a person received the highest degree until the time of the survey. It is assumed that a person has been working continuously.

The results that control for work experience are presented in Table 15, panels A through E. When work experience is measured more care-

fully, the estimated negative effect of having an AD is somewhat smaller. Overall, people with an AD earn \$2,426 less per year than people with the same highest degree who have no AD. The earnings gap is smaller for bachelor's and master's degree holders (\$2,269 and \$2,117, respectively) and larger for people with doctorates and professional degrees (\$6,884 and \$7,768, respectively). Note that gender and race effects remain almost unchanged compared with Table 14, panels A through E.

Why does the observed salary gap persist between people with and without a prior AD even among the highly educated? Data available from the NSCG survey are not sufficient to answer this question. An important caveat of the above analysis is the lack of ability and school performance measures and data on family characteristics, such as family income. One hypothesis is that

because community college students are more likely to come from families with lower incomes and education, they are also more likely to attend lower-performing elementary and secondary schools. It is possible that they fall far behind even before entering the postsecondary education system. The results seem to suggest that this disadvantage affects educational and labor market outcomes throughout their lives—as a group they never catch up with their peers.

CONCLUSION

Community colleges play a significant role in U.S. higher education, enrolling 46 percent of current U.S. undergraduates. They offer the opportunity to receive a postsecondary education to many students who would not attend college otherwise: first-generation college students, students from low-income families, and older students who continue to work as they attend classes part-time. Attending a community college even without completing a degree results in economic payoffs—in particular, annual earnings increase by 5 to 8 percent for each year of community college education—and better job opportunities. Today, the number of U.S. undergraduates is at an all-time high as more people understand the necessity of higher education in our technology-intensive world. In addition, historically, college enrollments in general increase during economic downturns. Community colleges are important in helping to absorb this increasing number of students. Currently, community colleges have additional appeal because tuition and fees at four-

year colleges continue to increase while financial aid and student loans are harder to obtain.

Despite all the benefits of community colleges, there are downsides as well. The original goal of community colleges was to prepare students to transfer to four-year colleges. Associate's degree programs were intended to accomplish that goal. However, only about 29 percent of community college students transfer to four-year institutions, and only about 16 percent eventually receive a bachelor's degree or higher. Even among those who start their postsecondary education intending to receive a bachelor's degree, only 26 percent accomplish it. They are also much less likely to pursue postgraduate studies.

In addition, the salary gap persists between those with a bachelor's degree or higher and a prior AD and similar individuals without an AD, even among the highly educated. This gap remains even for people of the same gender, race, education, experience level, field of study, and type of college they attended.

Still, for many students, community colleges offer the best chance to obtain a college education. It is important, however, for individuals to know both the benefits and the disadvantages of attending a community college when making decisions about higher education.

This paper attempts to present a comprehensive overview of how community colleges improve the economic mobility of a significant subset of the U.S. population. A better understanding of all aspects of this complicated subject should be an important priority for researchers and policymakers.

REFERENCES

- Black, Dan; Kolesnikova, Natalia and Taylor, Lowell. "Earnings Functions When Wages and Prices Vary by Location." *Journal of Labor Economics*, January 2009, 27(1), pp. 21-47.
- Hoachlande, Gary; Sikora, Anna C.; Horn, Laura and Carroll, C. Dennis. "Community College Students: Goals, Academic Preparation, and Outcomes." NCES Report 2003-164, National Center for Education Statistics, June 2003; <http://nces.ed.gov/pubs2003/2003164.pdf>.
- Horn, Laura and Nevill, Stephanie. "Profile of Undergraduates in U.S. Postsecondary Education Institutions: 2003-04, With a Special Analysis of Community College Students." NCES Report 2006-184, National Center for Education Statistics, June 2006; http://nces.ed.gov/pubs2006/2006184_rev.pdf.
- Jacobson, Louis S.; LaLonde, Robert J. and Sullivan, Daniel G. "Estimating the Returns to Community College Schooling for Displaced Workers." *Journal of Econometrics*, March/April 2005, 125(1-2), pp. 271-304.
- Kane, Thomas J. and Rouse, Cecilia Elena. "Labor Market Returns to Two- and Four-Year College." *American Economic Review*, June 1995, 85(3), pp. 600-14.
- Kane, Thomas J. and Rouse, Cecilia E. "The Community College: Educating Students at the Margin Between College and Work." *Journal of Economic Perspectives*, Winter 1999, 13(1), pp. 63-84.
- Kolesnikova, Natalia A. and Shimek, Luke. "Community Colleges: Not So Junior Anymore." Federal Reserve Bank of St. Louis *The Regional Economist*, October 2008, pp. 6-11; http://stlouisfed.org/publications/pub_assets/pdf/re/2008/d/colleges.pdf.
- Kolesnikova, Natalia A. "From Community College to a Bachelor's Degree and Beyond: How Smooth Is the Road?" Federal Reserve Bank of St. Louis *The Regional Economist*, July 2009a, pp. 10-11; http://stlouisfed.org/publications/pub_assets/pdf/re/2009/c/community_college.pdf.
- Kolesnikova, Natalia A. "Community Colleges: A Route of Upward Mobility." Federal Reserve Bank of St. Louis Community Development Research Report, March 2009b, pp. 1-28; http://stlouisfed.org/community_development/assets/pdf/CommunityColleges.pdf.
- Leigh, Duane E. and Gill, Andrew M. "Labor Market Returns to Community Colleges: Evidence for Returning Adults." *Journal of Human Resources*, Spring 1997, 32(2), pp. 334-53.
- Long, Bridget Terry and Kurlaender, Michal. "Do Community Colleges Provide a Viable Pathway to a Baccalaureate Degree?" NBER Working Paper No. 14367, National Bureau of Economic Research, September 2008; <http://papers.nber.org/papers/w14367.pdf>.
- Rouse, Cecilia E. "Do Two-Year Colleges Increase Overall Educational Attainment? Evidence from the States." *Journal of Policy Analysis and Management*, Fall 1998, 17(4), pp. 595-620.
- Ruggles, Steven; Sobek, Matthew; Alexander, Trent; Fitch, Catherine; Goeken, Ronald; Hall, Patricia; King, Miriam and Ronnander, Chad. "2000 Public Use Micro Sample of the U.S. Census," in Integrated Public Use Microdata Series. Minneapolis, MN: Minnesota Population Center [producer and distributor], 2004; <http://usa.ipums.org/usa/>.

APPENDIX A

Table A1

Census Bureau–Designated Regions

	West		Midwest		Northeast			South		
	Pacific	North Central	East	North Central	West	New England	Mid-Atlantic	South Atlantic	East	West
Mountain										
Idaho	Alaska	Wisconsin		North Dakota	North Dakota	Maine	New York	Delaware	Kentucky	Oklahoma
Montana	Washington	Michigan		South Dakota	South Dakota	New Hampshire	Pennsylvania	Maryland	Tennessee	Texas
Wyoming	Oregon	Illinois		Nebraska	Nebraska	Vermont	New Jersey	District of Columbia	Mississippi	Arkansas
Nevada	California	Indiana		Kansas	Kansas	Massachusetts		Virginia	Alabama	Louisiana
Utah	Hawaii	Ohio		Minnesota	Minnesota	Rhode Island		West Virginia		
Colorado				Iowa	Iowa	Connecticut		North Carolina		
Arizona				Missouri	Missouri			South Carolina		
New Mexico								Georgia		
								Florida		

APPENDIX B

Category Definitions of Carnegie Foundation Classification of Institutions of Higher Education

The 1994 Carnegie Classification includes all colleges and universities in the United States that are degree-granting and accredited by an agency recognized by the U.S. Secretary of Education.

Research Universities I: These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees¹ each year. In addition, they receive annually \$40 million or more in federal support.²

Research Universities II: These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees¹ each year. In addition, they receive annually between \$15.5 million and \$40 million in federal support.²

Doctoral Universities I: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the doctorate. They award at least 40 doctoral degrees¹ annually in five or more disciplines.³

Doctoral Universities II: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the doctorate. They award annually at least 10 doctoral degrees—in three or more disciplines—or 20 or more doctoral degrees in one or more disciplines.³

Master's (Comprehensive) Universities and Colleges I: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the master's degree. They award 40 or more master's degrees annually in three or more disciplines.³

Master's (Comprehensive) Universities and Colleges II: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the master's degree. They award 20 or more master's degrees annually in one or more disciplines.³

Baccalaureate (Liberal Arts) Colleges I: These institutions are primarily undergraduate colleges with major emphasis on baccalaureate degree programs. They award 40 percent or more of their baccalaureate degrees in liberal arts fields⁴ and are restrictive in admissions.

Baccalaureate Colleges II: These institutions are primarily undergraduate colleges with major emphasis on baccalaureate degree programs. They award less than 40 percent of their baccalaureate degrees in liberal arts fields⁴ or are less restrictive in admissions.

Associate of Arts Colleges: These institutions offer associate of arts certificate or degree programs and, with few exceptions, offer no baccalaureate degrees.⁵

¹ Doctoral degrees include Doctor of Education, Doctor of Juridical Science, Doctor of Public Health, and the Ph.D. in any field.

² Total federal obligation figures are available from the National Science Foundation's annual report, called Federal Support to Universities, Colleges, and Nonprofit Institutions. The years used in averaging total federal obligations are 1989, 1990, and 1991.

³ Distinct disciplines are determined by the U.S. Department of Education's Classification of Instructional Programs 4-digit series.

⁴ The liberal arts disciplines include English language and literature, foreign languages, letters, liberal and general studies, life sciences, mathematics, philosophy and religion, physical sciences, psychology, social sciences, the visual and performing arts, area and ethnic studies, and multi- and interdisciplinary studies. The occupational and technical disciplines include agriculture, allied health, architecture, business and management, communications, conservation and natural resources, education, engineering, health sciences, home economics, law and legal studies, library and archival sciences, marketing and distribution, military sciences, protective services, public administration and services, and theology.

⁵ This group includes community, junior, and technical colleges.

SOURCE: This information is from *A Classification of Institutions of Higher Education*. Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching Carnegie Foundation, 1994, pp. xix-xxi. Used with permission.



Alt-A: The Forgotten Segment of the Mortgage Market

[Rajdeep Sengupta](#)

This study presents a brief overview of the Alt-A mortgage market with the goal of outlining broad trends in the different borrower and mortgage characteristics of Alt-A market originations between 2000 and 2006. The paper also documents the default patterns of Alt-A mortgages in terms of the various borrower and mortgage characteristics over this period. (JEL G1, G21)

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High default rates on subprime mortgages marked the onset of the current financial crisis. Not surprisingly, both academic research and policy studies have focused their attention on the boom and subsequent collapse of the subprime mortgage market. However, the high incidence of defaults was not limited to subprime mortgages only; defaults have also risen rapidly in the other segments of the mortgage market—for example, the market for Alt-A (or Alternative-A) mortgages. But our knowledge of the Alt-A market is significantly less than our knowledge of subprime mortgages.

This paper aims to fill this void. This study presents a brief overview of Alt-A mortgage originations with the goal of outlining broad trends in the different borrower and mortgage characteristics of Alt-A originations between 2000 and 2006. The paper also documents the default patterns of Alt-A mortgages in terms of the various borrower and mortgage characteristics over this period. We begin with a broad overview of the different segments of the overall U.S. mortgage market and their evolution over this period, with a special emphasis on the Alt-A mortgage segment.¹

Since the 1970s, the principal structural change in the mortgage market has been the use of securitization. Prior to this, mortgages were

retained by banks in their portfolios until they matured or were paid off. Securitization is a process by which mortgages (typically a large pool of mortgages) are used as collateral to issue securities, also known as mortgage-backed securities (MBS). Some mortgage securities are backed implicitly or explicitly by the U.S. government and are commonly called *agency* MBS. Such origination of mortgages and issuance of MBS is dominated by loans to *prime* borrowers conforming to underwriting standards set by the government-sponsored agencies. Non-agency MBS issuance can be split into three broad categories—jumbo, Alt-A, and subprime. “Loosely speaking, the Jumbo asset class includes loans to prime borrowers with an original principal balance larger than the conforming limits² imposed on the agencies

¹ See Lehnert (2009) and Quigley (2006) for a more detailed overview.

² Conforming mortgages satisfy balance limits and are typically securitized either with some form of explicit government guarantees (Federal Housing Administration/Veterans Administration [FHA/VA] mortgages securitized by the Government National Mortgage Association [Ginnie Mae]) or with implicit government guarantees (conventional mortgages securitized by the Federal National Mortgage Association [Fannie Mae] and Federal Home Loan Mortgage Corporation [Freddie Mac]). In contrast, the private-label market securitizes nonconforming mortgages, which include the jumbo prime, subprime, and Alt-A markets (for more details, see Fabozzi, 2006).

Rajdeep Sengupta is an economist at the Federal Reserve Bank of St. Louis. The author thanks Geetesh Bhardwaj, Dan Thornton, and Dave Wheelock for comments on a previous draft of this article. Yu Man Tam provided research assistance.

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by Congress; the Alt-A asset class involves loans to borrowers with good credit but includes more aggressive underwriting than the conforming or Jumbo classes (i.e., no documentation of income, high leverage); and the Subprime asset class involves loans to borrowers with poor credit history.”³ Both agency and non-agency jumbo mortgages constitute the prime mortgage market of high-credit-quality borrowers, while the non-prime segment comprises subprime and Alt-A mortgages.

At the outset, it is important to mention that the guidelines for selecting mortgages into subprime and Alt-A pools vary by arranger of the MBS. Typically, Alt-A mortgages are underwritten to borrowers of good credit quality—that is, those who would otherwise qualify for a prime loan in terms of their credit history. However, Alt-A borrowers do not satisfy the underwriting rules for prime loans because they are unwilling or unable to provide full documentation on their mortgage application.⁴ Their inability to provide this information is largely due to the fact that such borrowers are in professions characterized by variable incomes or are self-employed borrowers operating cash businesses. On the other hand, subprime originations are primarily to borrowers with incomplete or impaired credit histories. Therefore, while the criterion for selection into a particular pool is not consistent across lenders, the credit quality for Alt-A pools is characteristically better than that for subprime pools.

Historically, the Alt-A market has been the preserve of highly specialized lenders with expertise in underwriting such loans. Over the years, this market has grown significantly and evolved with an increased level of investor sponsorship. Figure 1 shows the evolution of mortgage originations by market segment in the United States between 2001 and 2006.⁵ A significant decline in prime mortgage interest rates between 2000 and 2003 aided a refinance boom and the

increase in agency mortgages was a major factor behind the growth in total mortgage originations over this period (see Figure 1). However, with the rise in mortgage interest rates, prime originations declined sharply after 2003. Meanwhile, the growth of non-prime originations continued unabated. The growth rates in annual originations for the agency, subprime, and Alt-A segments from 2001 through 2003 were 95 percent, 94 percent, and 54 percent, respectively, but annual agency originations declined by 60 percent from 2003 to 2006. In contrast, the comparable growth rates between 2003 and 2006 for the subprime and Alt-A segments were 94 and 340 percent, respectively. The higher levels of originations after 2003 were largely sustained by the growth of the non-prime (both the subprime and Alt-A) segment of the mortgage market.

This paper uses the loan-level data on securitized Alt-A originations from 1998 through 2007 published by LoanPerformance (LP).⁶ The data contain details on individual securitized Alt-A loans, and a loan is classified as subprime or Alt-A depending on whether it is securitized in a subprime or Alt-A pool.⁷ The details include mortgage attributes of the loan, such as the product type, the interest rate, the loan purpose (purchase or refinance), documentation (full-doc or low-doc), loan-to-value (LTV) ratio, and borrower characteristics such as credit scores (FICO⁸ at the time of origination). The next section outlines the broad trends in the underwriting standards for Alt-A mortgages in terms of these attributes. We then outline the performance of Alt-A loans in terms of the borrower and mortgage characteristics mentioned previously.

³ Ashcraft and Schuermann (2008).

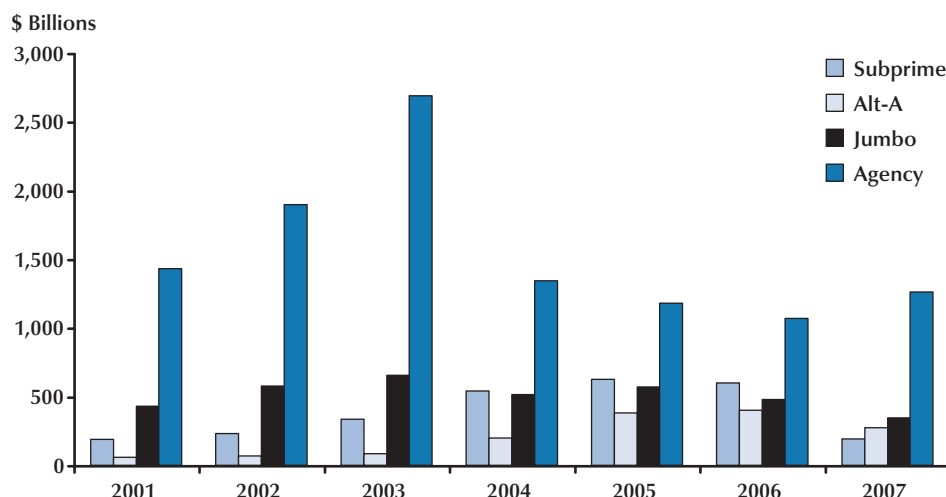
⁴ Generally this documentation is regarding their income. In limited or no-documentation programs, applicants typically state their income and assets to the loan officer but are not required to show detailed proof of that information for the lender's files. They are often termed *stated income* mortgages.

⁵ This figure is updated from Sengupta and Tam (2008).

⁶ For details on the coverage of the LP data and the relation to other available mortgage databases, see Mayer and Pence (2008). According to Mayer and Pence (2008), LP captures “around 90 percent of the subprime securitized market from 1999 to 2002 and nearly all the market from 2003 to 2005.”

⁷ As mentioned earlier, different arrangers use different criteria for this selection. Therefore, it is possible that what is considered to be subprime by a particular arranger may be classified as Alt-A by a different arranger.

⁸ Borrower credit score at the time of loan origination is denoted by FICO (an industry standard developed by the *Fair Isaac Corporation*) with a number in the range 300 to 850. The score increases with the creditworthiness of the borrower.

Figure 1**Origination and Issue of Mortgage Loans by Market Segment**

NOTE: The figure shows the evolution of mortgage originations by market segment in the United States between 2001 and 2007.

SOURCE: Insider Mortgage Finance Publications, Inc.

SUMMARY: TRENDS FOR ALT-A MORTGAGES

We begin this section by studying the characteristics of Alt-A mortgages originated between 1998 through 2007. The shares of product types originated in the Alt-A markets by vintage (year of origination) are given in Table 1. Table 1 shows that before 2004, the majority of Alt-A mortgages were fixed-rate mortgages (FRMs). Interestingly, the share of FRMs as a proportion of total originations fell by half in a single year, from 2003 to 2004. This decline was accompanied by a rise in the fraction of loans that were adjustable-rate mortgages (ARMs).

Table 1 also shows the growth of hybrid-ARM products over this period.⁹ We define ARM_q as the hybrid-ARM where the first reset occurs after *q* years. Typically, the mortgage rate on an ARM loan resets once every 6 months or a year into an *indexed rate* (like the 6-month LIBOR) plus a *margin*. Therefore the ARM₁ is just the standard ARM product that resets after the first year, while the ARM₂, ARM₃, and ARM₅ categories include

the more specialized products, such as the 2/28, the 3/27, and the 5/25 mortgage products, respectively.¹⁰

Table 2 presents a similar table for subprime mortgages. The data show a gradual rise in ARM₂ and ARM₃ products in the subprime market from around 30 percent of the market in 1998 to more than 70 percent of the market between 2004 and 2006. However, with the exception of 2004-05, ARM₂ and ARM₃ products were never more than 10 percent of the Alt-A market. Among hybrid-ARM Alt-A originations, the ARM₅ product has the largest share of the market, growing from less

⁹ Hybrid-ARM products are specialized products that include an initial period over which the repayment schedule on the mortgage resembles that of an FRM and a subsequent period over which the mortgage product acts like an ARM. During the fixed-leg of the hybrid-ARM, the mortgagee pays a lower introductory closing rate called the *teaser rate*. The teaser rate remains in effect until the reset date, after which the repayment schedule on the hybrid-ARM resembles an ARM. The reset date, market index rate used, and the margin are decided at the closing date.

¹⁰ Therefore, the 2/28 and the 3/27 products are 30-year mortgages with teaser rates for two and three years, respectively. The rationale for adopting the ARM_q terminology over the traditional 2/28 or 3/27 is that this terminology is inclusive of mortgage products that have amortization terms of more than 30 years.

Table 1**Evolution of Alt-A Securitized Mortgages (Percent Market Share by Product Type)**

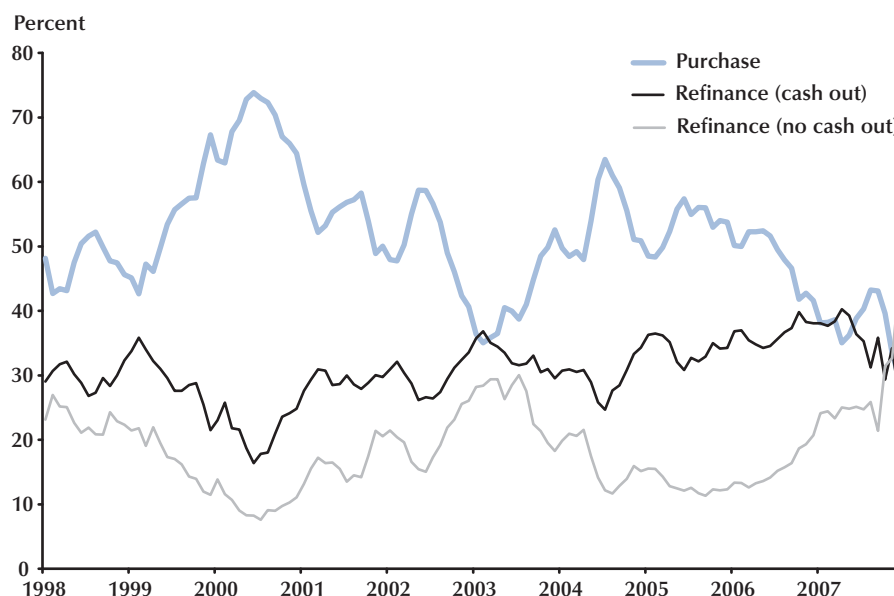
Vintage	Mortgage type						Share of total
	FRM	ARM1	ARM2	ARM3	ARM5	Other	
1998	98.97	0.41	0.09	0.02	0.11	0.41	2.7
1999	93.27	1.50	2.64	0.79	0.94	0.87	1.7
2000	85.04	9.15	1.13	0.94	1.88	1.87	1.5
2001	79.36	6.20	5.09	1.50	5.34	2.52	2.6
2002	75.52	9.98	3.68	1.86	7.33	1.64	4.4
2003	71.21	5.88	4.92	4.38	12.90	0.70	8.3
2004	35.72	21.70	8.03	14.07	20.37	0.11	17.4
2005	38.52	31.57	5.24	6.37	18.24	0.05	27.5
2006	37.01	34.40	1.77	3.05	22.90	0.87	25.5
2007	41.56	22.51	0.18	0.91	33.90	0.94	8.4
Share of total	46.5	24.4	4.1	5.6	18.8	0.6	100

NOTE: The table shows the share (percentage) of Alt-A product types by vintage (year of origination). FRM, fixed-rate mortgages; ARMq mortgages are defined as the hybrid-ARM where the first reset occurs after q years. Remaining mortgage types are classified as Other.

Table 2**Evolution of Subprime Securitized Mortgages (Percent Market Share by Product Type)**

Vintage	Mortgage type						Share of total
	FRM	ARM1	ARM2	ARM3	ARM5	Other	
1998	51.33	8.20	26.53	4.52	0.25	9.17	2.6
1999	38.88	2.26	29.34	19.21	0.50	9.81	3.8
2000	32.58	1.20	43.29	14.78	0.56	7.59	4.1
2001	31.70	0.51	48.69	12.44	0.54	6.13	5.1
2002	28.37	0.60	54.84	12.62	1.16	2.42	7.7
2003	33.57	0.45	52.60	11.37	1.20	0.81	12.9
2004	23.81	0.35	59.73	14.64	1.30	0.17	19.5
2005	18.66	0.54	65.48	13.22	1.57	0.53	23.0
2006	19.98	0.82	62.56	10.86	1.35	3.44	18.1
2007	27.59	0.45	50.23	9.92	5.87	5.94	3.4
Share of total	25.7	0.8	56.7	12.7	1.6	2.5	100

NOTE: The table shows the share (percentage) of subprime product types by vintage (year of origination). FRM, fixed-rate mortgages; ARMq mortgages are defined as the hybrid-ARM where the first reset occurs after q years. Remaining mortgage types are classified as Other.

Figure 2**Percentage Share by Total Alt-A Origination by Purpose**

NOTE: The figure shows the monthly trends of share Alt-A originations by purpose in percentages between 1998 and 2007.

than 1 percent of the total in 1998-99 to 33 percent of the total by 2007. Further research is needed to determine the causes behind the sudden switch from FRMs to ARMs after 2003 and the increase in share of hybrid ARMs in the 2004 and 2005 vintages. This paper presents data on only Alt-A mortgages, which are then compared with the trends in subprime originations over the same period.¹¹

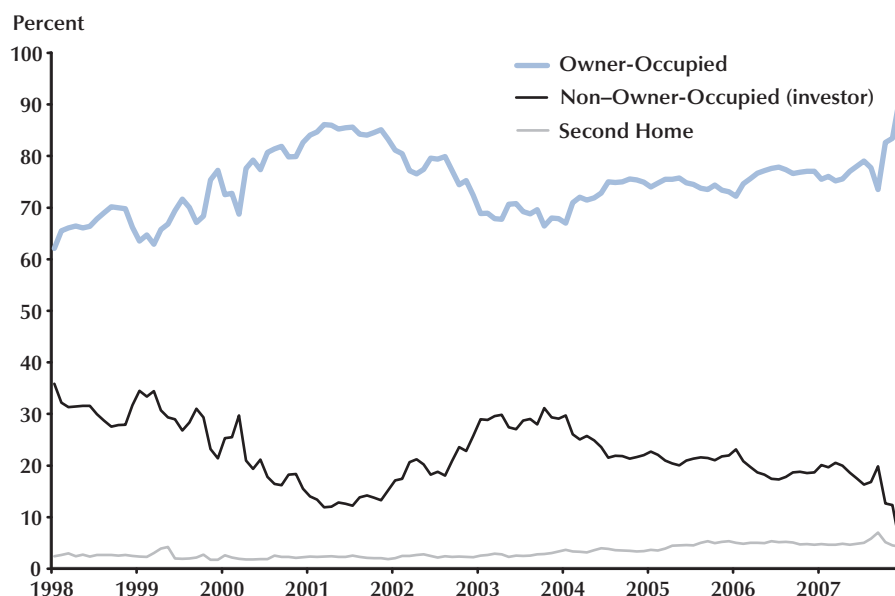
It is important to point out that most hybrid-ARM Alt-A originations are ARM5 products that originated after 2003. Therefore, most reset dates for surviving mortgages in this pool have not yet arrived at the time of this writing. In contrast, the majority of subprime hybrid-ARM originations were ARM2 and ARM3 products, which are currently past their reset dates. Therefore, unless these products are refinanced earlier, rate resets can adversely affect repayment behavior and increase future delinquency rates on surviving Alt-A originations.

Figure 2 shows the monthly trends in share of Alt-A originations by purpose (purchase or refinance). Purchases make the largest category of Alt-A originations, but their proportion fluctuates over the months in our sample period. At their peak in June 2000, purchases accounted for 74 percent of Alt-A originations. However, their fraction drops to 34 percent in February 2003. This movement might be explained by the refinancing behavior of households. From 2000 to 2004, the Federal Reserve adopted an expansionary monetary policy. To the extent this translated to lower mortgage rates on Alt-A products, households would choose to refinance existing mortgages for lower rates.¹²

While fluctuations in the proportion of no-cash-out refinances and purchases might be explained in terms of mortgage rates, this pattern does not hold for cash-out refinances. Perhaps the

¹¹ Data on the summary trends on subprime mortgages are not presented here but are available on request.

¹² Indeed, prime mortgage rates fell from 8.29 percent in June 2000 to 5.84 percent in March 2004. Individual mortgage rates on Alt-A loans are tailored to specific borrower and loan attributes. To the best of our knowledge, there is no known universal contract rate for Alt-A mortgages.

Figure 3**Percentage Share by Total Alt-A Origination by Occupancy**

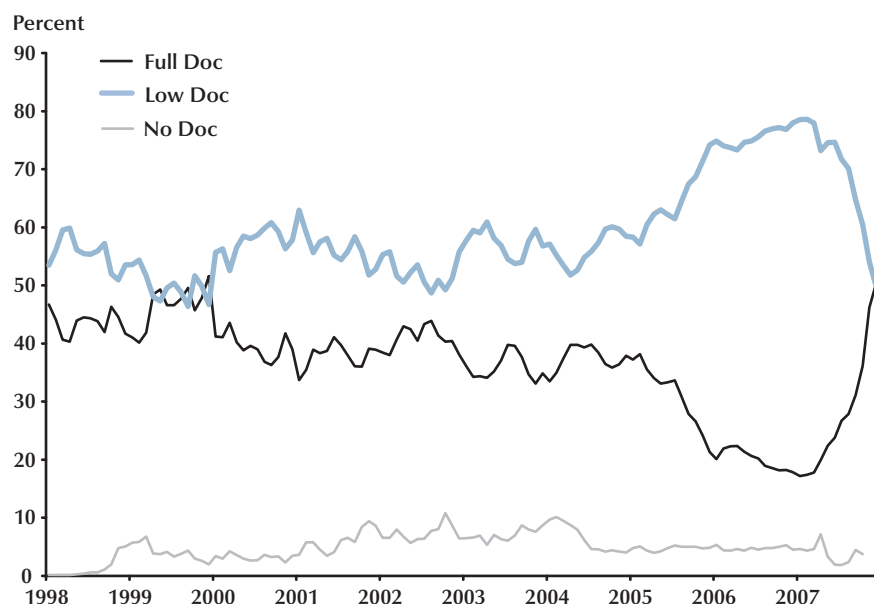
NOTE: The figure shows the monthly trends of share Alt-A originations by occupancy in percentages between 1998 and 2007.

more remarkable trend in Figure 2 is an increase in the share of cash-out refinances since 2000. A similar pattern is observed for subprime mortgages as well. In short, the growth in non-prime mortgages after 2000 has been fueled largely by households seeking to extract home equity during a period of appreciating home prices. With the decline in home prices and the onset of the mortgage crisis, the Fed lowered rates after the second quarter of 2007. At the same time, the share of both cash-out refinances and purchases fell sharply, while that for no-cash-out refinances increased.

In terms of occupancy, most Alt-A originations were for owner-occupied properties as shown in Figure 3. The share of owner-occupied housing increased from a little over 60 percent at the beginning of our sample period to more than 80 percent toward the end of the sample period. During the same time, the share of Alt-A second-home originations fell by half: from nearly 35 percent in 1998 to around 17 percent by the end of 2006. The fraction of non-owner-occupied housing has been

small throughout the sample period. The broad pattern of shares in each occupancy category has been similar to that for subprime mortgages. For example, owner-occupied houses have accounted for the significant majority (more than 90 percent) of subprime originations for most of our sample period. Consequently, the share of second homes in the subprime category has been much smaller than that for Alt-A.

Figure 4 shows a sharp increase in the share of low-doc loans in post-2004 Alt-A originations. Barring a few exceptions, the share of low-doc originations has always ranged between 50 and 60 percent of originations until 2004. To the casual observer this figure may seem very high. But this is precisely the rationale behind the creation of the Alt-A market: borrowers of good credit quality unwilling or unable to provide full documentation for a prime loan. In any case, the share of low-doc loans rose from 52 percent in April 2004 to 78 percent by the end of 2006. A similar trend toward low-doc originations was witnessed for

Figure 4**Percentage Share by Total Alt-A Origination by Documentation**

NOTE: The figure shows the monthly trends of share Alt-A originations by documentation in percentages between 1998 and 2007.

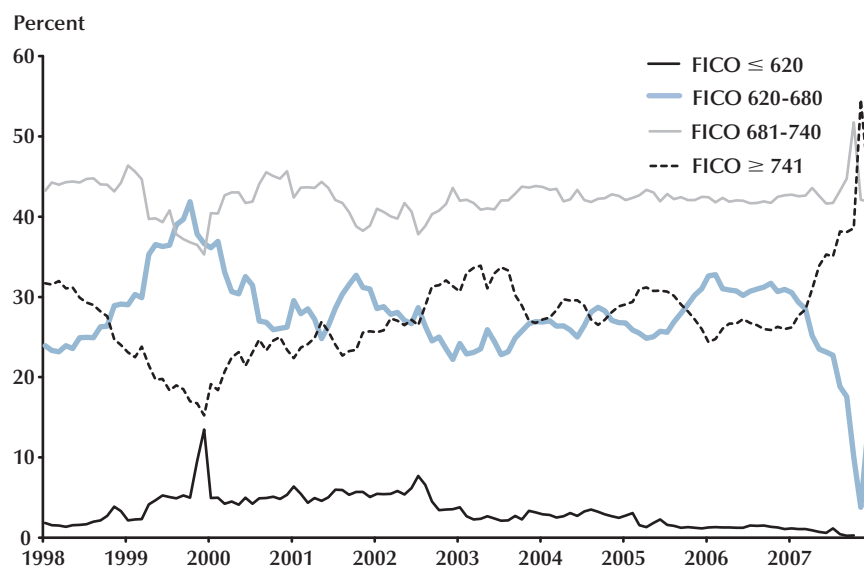
subprime originations, although the increase there was moderate and gradual compared with that of Alt-A. It is unclear what prompted this sharp increase in low-doc originations in the non-prime market segment. More recently, the share of low-doc mortgages dropped sharply from its peak of 78 percent at the beginning of 2007 to 50 percent at the end of 2007.

An important measure of underwriting is the credit quality on the originations as represented by the credit (FICO) scores of borrowers at the time of origination. The majority of borrowers who originate Alt-A mortgages have FICO scores in excess of 680 (Figure 5). This is a major distinguishing characteristic between the subprime and Alt-A mortgage pools. The average credit quality of Alt-A pools is significantly higher than that for subprime pools. It needs to be mentioned here that this is not the *only* distinguishing characteristic; it is often possible to identify a mortgage that belongs to the subprime pool but has a FICO score above 700. The reason a mortgage with a

high FICO score could be characterized as subprime (and not Alt-A) is possibly because the mortgage fails to qualify as Alt-A (or even prime) on one or more criteria other than credit score such as documentation, lien type, and LTV ratio.¹³

Figure 5 shows that, for the most part, the shares of originations with FICO scores in the 621-680 range and the 740 or higher range have been similar. The share of originations with FICO scores above 740 fell for a period between October 1998 and December 1999; this was accompanied by a rise in the share of originations in the 621-680 range. More recently, the onset of defaults in non-prime mortgages tightened lending standards in this market, leading to a sharp increase in the percentage of originations with FICO scores in excess of 740 from around 26 percent in December 2006 to 54 percent in November 2007. To sum up, Figure 5 shows that, except for the two periods mentioned above, the share of originations across

¹³ The choice of a non-prime mortgage between Alt-A and subprime typically varies with the arrangement of the security.

Figure 5**Percentage Share by Total Alt-A Origination by Credit Quality (FICO Score)**

NOTE: The figure shows the monthly trends of share Alt-A originations by credit quality in percentages between 1998 and 2007.

the various FICO score categories are fairly stable over the years in our sample period.

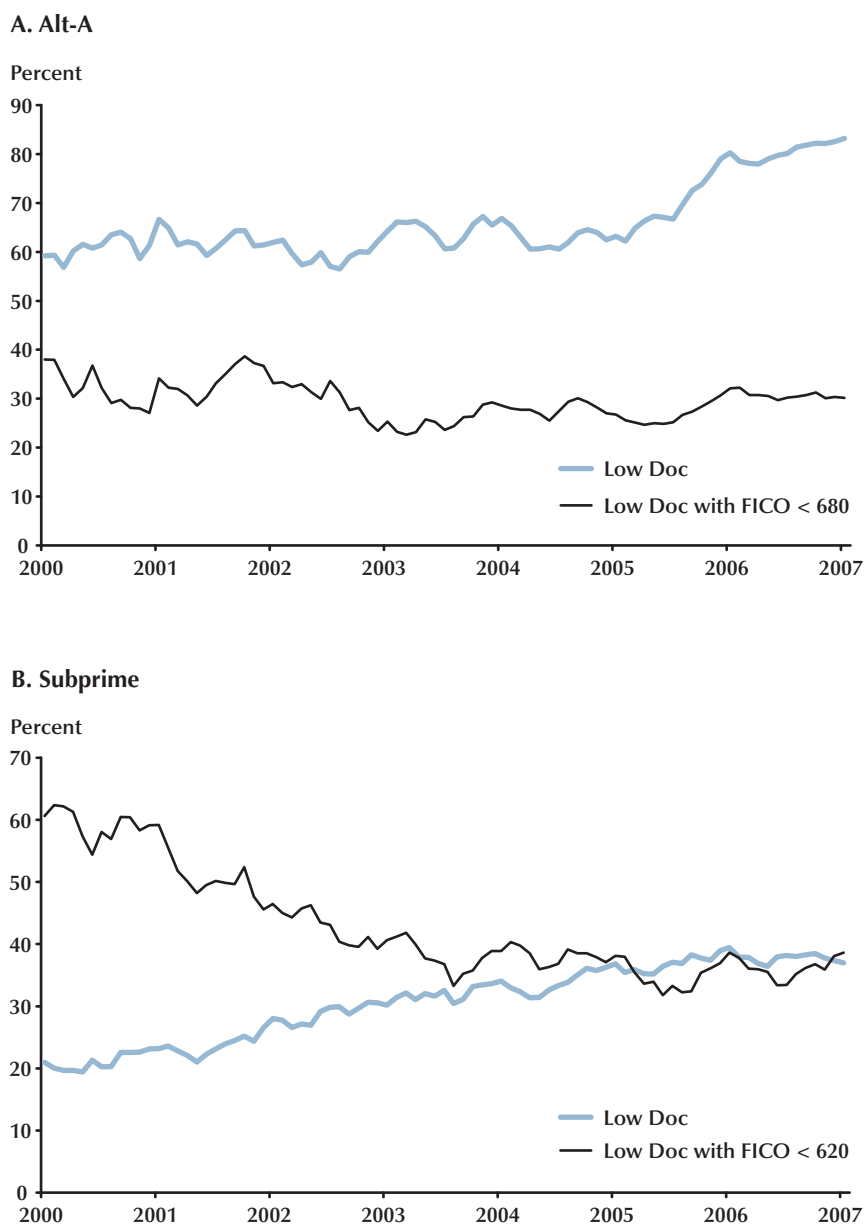
At this point, it is important to highlight the difference between the originations of subprime and Alt-A loans between 2000 and 2007 with regard to documentation and credit scores. In both cases, the share of low-doc loans increased over the years, as shown in Figure 6. However, in the case of the subprime market, there is evidence that average credit scores on originations with lower documentation increased. This is shown in Figure 6B as the decline in the proportion of low-doc originations with FICO scores less than 620. This feature of underwriting suggests that lenders' emphasis on FICO score was not only an adequate indicator of credit risk, but also a means to adjust for other riskier attributes on the origination. On the other hand, there does not appear to be such a trend toward higher FICO scores for loans with low documentation in the case of the Alt-A mortgage market. The proportion of low-doc loans with FICO scores less than 680 remains roughly the same over the years in our

sample period (Figure 6A).¹⁴ This pattern seems to point to secular deterioration in the underwriting for Alt-A mortgages, unlike that observed for subprime originations.

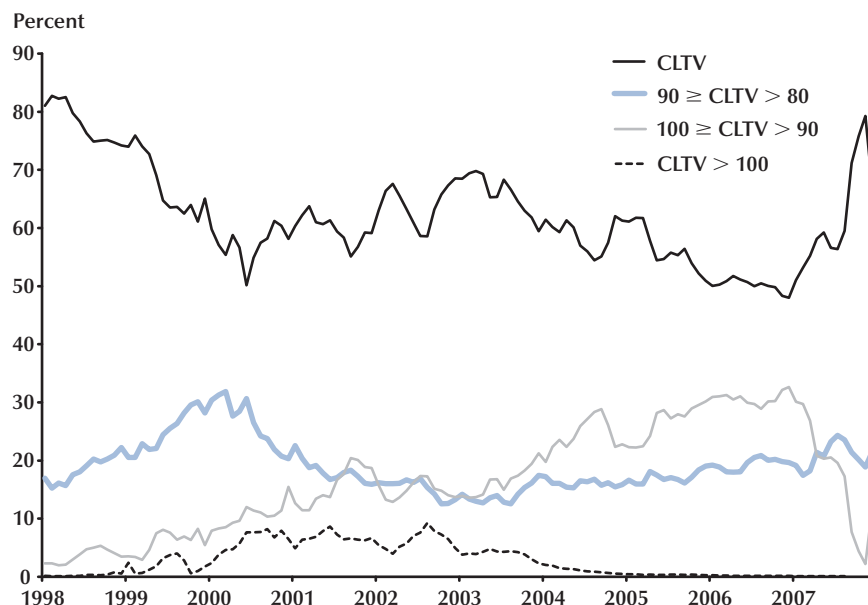
A final measure of underwriting on Alt-A originations in our dataset is the LTV ratio on the mortgage (Figure 7).¹⁵ The majority of Alt-A originations have LTV ratios that are less than 80 percent, and it is important to note that the LTV threshold of 80 percent is one of the requirements on prime mortgages. Figure 7 shows that the share of originations with LTVs less than or equal to 80 percent has declined over the years in our sample period. This is accompanied by an increase in the

¹⁴ The FICO scores chosen are higher for Alt-A because on average Alt-A credit scores are higher than subprime. The weighted average of FICO scores for the Alt-A market is presumably higher, but we have chosen our cutoff conservatively.

¹⁵ The LTV ratio is calculated as the *closing balance/value of the property*, and where available we have used the cumulative loan-to-value (CLTV) ratio because it provides a better measure of the home equity of the borrower. The CLTV ratio is the proportion of loans (secured by the property) on all liens in relation to the property's value.

Figure 6**Evidence on Underwriting: Documentation and FICO Score**

NOTE: The figure shows the monthly trends of share Alt-A (subprime) originations with low documentation, and among those, with FICO scores less than 680 (620) in percentages between 2000 and 2007.

Figure 7**Percentage Share by Total Alt-A Origination by LTV Ratios**

NOTE: The figure shows the monthly trends of share Alt-A originations by loan-to-value ratios in percentages between 1998 and 2007.

share of Alt-A originations with LTV in the (90, 100] range. The share in this category increased from a low of 2 percent of total originations from the beginning of our sample period to about 32 percent by the end of 2006. Meanwhile, the share of originations with LTV in the intermediate range of (80, 90] has remained fairly stable except for a period between 1999 and 2001 when this share increased.

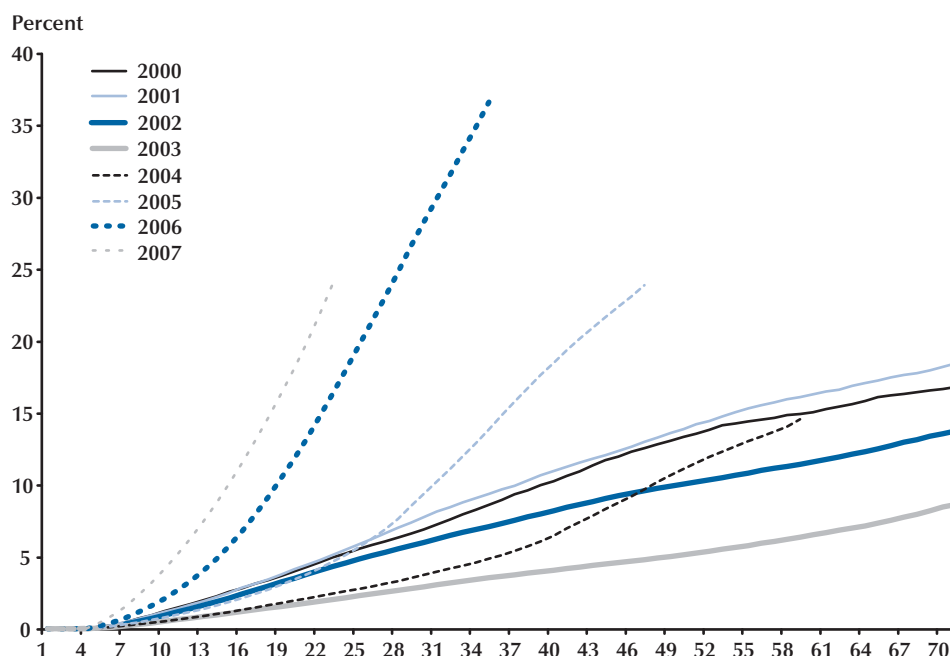
In summary, Alt-A mortgages are typically originated to borrowers of moderate to high credit quality with a lack of willingness or ability to provide documentation in support of their loan application. First, most Alt-A originations have FICO scores above 680. At the same time, the share of low-doc originations in this market has almost never been below 50 percent. While this has been the principal characteristic of Alt-A loans, the market witnessed a significant relaxing of credit standards both in terms of a greater share of low-documentation loans and high-LTV originations between 2000 and 2006. Perhaps more signifi-

cantly, the share of borrowers using Alt-A products to extract equity in their homes has almost doubled between 2000 and 2006. In the next section, we study the performance of these mortgages in terms of the attributes on the originations.

Loan Performance of Alt-A Mortgages

The LP data allow for tracking repayment behavior on mortgages on a monthly basis. Therefore, we can determine the nature (30-day, 60-day, 90-day, or foreclosure) and timing (month) of the delinquency event. Following industry conventions, we define a mortgage to be in default (or in serious delinquency) if it records a 90-day delinquency event at any point in its repayment history.¹⁶ The nonparametric default probabilities presented in this paper are calculated using the Kaplan-Meier product limit estimator (see the appendix for details on this methodology).

¹⁶ Although we use 90-day delinquencies throughout the paper, the results for 60-day delinquencies and foreclosures are qualitatively similar and are available on request.

Figure 8**Default Rate on Alt-A Originations by Vintage**

NOTE: The plot shows the Kaplan-Meier default probabilities by loan age for securitized Alt-A mortgages. The graph presents the default probabilities by years of origination (vintage). Each line shows the performance of originations of the same vintage.

Figure 8 presents the overall performance of Alt-A mortgages by showing estimated default probabilities for each *vintage* (year of origination) by age of the loan. The broad trends in Figure 8 show that defaults started to rise sharply in 2006 and 2007, primarily for originations after 2003. To give an example, about 10 percent of mortgages originated in 2001 were in serious delinquency after the third calendar year (at the beginning of 2003), whereas the same proportion of defaults for 2006 originations occurred after the first one-and-a-half calendar years (middle of calendar year 2007).¹⁷

The rise in sharp defaults for later vintages is best viewed by comparing the default rates on originations of 2003 and 2004 vintages with that

of originations of 2005 and 2006 vintages. Table 3 shows the default rates on originations of 2003 and 2004 vintages at the end of the second calendar year were 2.03 percent and 2.47 percent, respectively. In contrast, originations of 2006 vintage had a default rate of 16.36 percent by the end of the second calendar year. To summarize, defaults rise sharply around 2006 and this is largely concentrated on originations after 2003. Perhaps the most striking feature of this trend is that a significant proportion of the mortgages defaulted very early. This is also true for subprime mortgages, and the literature on subprime has focused on explaining such high early defaults.

An interesting piece of anecdotal evidence is revealed in the significantly lower default rates on 2003 vintages. Indeed, 2003 is the best-performing vintage for Alt-A mortgages and this is true for subprime mortgages as well. For subprime originations, the anomalous behavior for originations

¹⁷ The year of origination is counted as the first year of evaluation of loan performance. In the interest of clarity, the performance plots for 1998 and 1999 vintages are omitted from Figure 8.

Table 3**Performance of 2003-2006 Alt-A Vintages for the First Three Calendar Years**

Calendar date	Default rate (%) per year of origination			
	2003	2004	2005	2006
End of 2003	0.64	—	—	—
End of 2004	2.03	0.63	—	—
End of 2005	3.55	2.45	0.97	—
End of 2006	—	4.86	4.67	2.66
End of 2007	—	—	13.84	16.36
End of 2008	—	—	—	36.60

The table shows the default rates on Alt-A mortgages originated between 2003 and 2006 at the end of the first three calendar years.

Table 4**90-Day Delinquent Alt-A Mortgages (Percent by Attributes on Origination)**

	All	Product type			Purpose			Occupancy		
		FRM	ARM	ARM5	Purchase	Refinance (cash-out)	Refinance (no cash-out)	Owner	Second home	Non-owner (investor)
A. Percent delinquent after first 18 calendar months										
2000	3.1	3.5	0.4	0.7	3.3	2.6	3.1	3.3	1.5	2.6
2001	3.1	3.1	2.7	1.2	3.9	2.3	2.0	3.0	1.8	3.9
2002	2.7	2.7	2.4	1.5	3.4	2.2	1.5	2.8	2.1	2.2
2003	1.3	1.2	1.7	1.0	1.9	1.1	0.7	1.6	1.0	0.7
2004	1.5	1.4	1.5	1.0	1.7	1.2	1.3	1.6	0.9	1.3
2005	2.4	1.9	2.8	3.2	2.9	1.7	2.2	2.4	1.8	2.6
2006	7.9	5.6	9.3	12.9	9.5	5.3	9.0	8.0	6.7	7.8
2007	13.1	8.4	16.6	18.8	16.6	8.9	14.1	13.3	13.9	11.8
B. Percent delinquent after two calendar years										
2000	5.0	5.5	1.1	2.2	5.1	4.1	5.1	4.8	2.7	4.4
2001	5.1	5.2	4.3	2.3	6.3	3.9	3.5	4.7	3.1	5.9
2002	4.3	4.5	3.4	2.3	5.4	3.7	2.6	4.3	3.2	3.5
2003	2.0	1.8	2.5	1.5	2.9	1.7	1.1	2.3	1.4	1.2
2004	2.4	2.3	2.6	1.8	2.7	2.1	2.3	2.4	1.5	2.2
2005	4.7	3.3	5.7	5.9	5.5	3.5	4.3	4.2	3.8	4.9
2006	16.4	10.7	19.9	24.2	18.5	12.4	18.8	15.0	14.8	15.6
2007	24.0	15.7	30.3	33.0	28.6	18.2	26.0	22.4	24.0	22.0

The table shows the percentage of originations of a given vintage that are in default within a given time period across various attributes on the origination, including product types, purpose, and occupancy.

Table 5**90-day Delinquent Alt-A Mortgages (Percent by Attributes on Origination)**

	All	Documentation		Credit score			CLTV ratio			
		Full	Low	621-680	681-740	740+	<70	[70, 80)	(80,90]	(90,100]
A. Percent delinquent after first 18 calendar months										
2000	3.1	2.4	3.6	5.1	2.1	1.2	1.3	2.5	5.1	4.2
2001	3.1	1.9	3.9	5.5	2.0	1.1	1.3	2.4	5.5	5.2
2002	2.7	1.9	3.3	4.9	1.8	0.8	0.9	2.2	4.4	5.1
2003	1.3	0.9	1.6	2.8	0.9	0.4	0.4	0.9	2.3	3.1
2004	1.5	1.1	1.7	2.7	1.2	0.5	0.5	1.0	2.2	2.7
2005	2.4	1.6	2.8	4.3	2.2	0.9	0.7	1.5	2.8	4.8
2006	7.9	3.6	9.1	12.1	7.8	3.4	1.7	4.8	9.5	14.1
2007	13.1	5.8	14.9	19.3	14.0	6.4	3.0	9.3	18.1	23.6
B. Percent delinquent after two calendar years										
2000	5.0	4.1	5.5	7.8	3.6	2.0	2.2	4.1	7.9	6.4
2001	5.1	3.4	6.3	8.7	3.5	1.8	2.2	4.0	8.5	8.7
2002	4.3	3.3	5.1	8.0	3.0	1.2	1.5	3.6	6.9	8.1
2003	2.0	1.5	2.3	4.3	1.5	0.6	0.6	1.5	3.6	4.6
2004	2.4	1.9	2.8	4.5	2.0	0.9	1.0	1.7	3.6	4.2
2005	4.7	2.9	5.5	8.2	4.4	1.8	1.4	3.1	6.1	8.7
2006	16.4	7.7	18.7	23.6	16.5	7.7	4.2	11.5	21.7	25.4
2007	24.0	11.5	27.0	34.2	25.6	12.3	7.1	19.2	33.3	37.9

The table shows the percentage of originations of a given vintage that are in default within a given time period across various attributes on the origination, including documentation, credit score, and CLTV ratio.

of 2003 vintage has been explained in terms of the high prepayment rates on subprime mortgages. As many as 83 percent of surviving subprime hybrid-ARMs that were originated in 2003 were prepaid by the end of 2007 (see Bhardwaj and Sengupta, 2009b). This is not surprising for subprime mortgages, given that prepayment is an integral part of the mortgage design for hybrid-ARM products (see Gorton, 2008, for details). However, hybrid-ARMs are not a significantly large part of the Alt-A pool. Therefore, it would be interesting to explore whether the low default rates on 2003 Alt-A products were also driven by high prepayments. In what follows, we show that this broad trend of a significant increase in the default rates on post-2004 originations can be seen across various mortgage attributes such as product type, purpose, occupancy, and documentation. These

trends show a high degree of correlation between default rates and some origination attributes. Of course, the standard caveat applies to interpreting these correlations as causation.

Tables 4 and 5 show the percentage of originations of a given vintage that are in default within a given time period, by various attributes of the origination. Panel A presents the default rates for the first 18 calendar months since the year of origination, whereas Panel B reports the same for the first two years since the year of origination. These choices of time periods are driven by two reasons. First, we have only the first two years of data for every origination vintage from 2000 through 2007, allowing for a comparison across all vintages. Second, as demonstrated earlier, the crisis in the mortgage markets was characterized by high early defaults.

For most years in our sample period, ARMs have registered higher default rates than FRMs, but the difference was much greater for originations between 2005 and 2007 (columns 3 through 5 in Table 4). For 2003, however, the performance of ARMs is similar to that of FRMs. The lower default rates on ARMs for earlier vintages might be explained by the low interest rate environment during the early part of this decade. However, as the Federal Reserve tightened monetary policy after the second half of 2004, the burden of interest payments on ARMs would have increased significantly. Also, the share of ARMs in total originations for earlier vintages was low compared with the share for later vintages. Therefore, it is difficult to interpret the default patterns as being reflective of the risk underlying each product type. Evidently, the default rates on ARM5 products¹⁸ are even higher than those on ARM products overall. This is interesting, given that the loan maturity period under consideration is well before the reset dates on the ARM5 products. These results seem to suggest that the defaults on Alt-A products have little to do with interest rate resets on hybrid-ARM products.

Next, we study the default patterns by purpose of origination (columns 6 through 8 in Table 4). Purchase originations show significantly higher rates of default over the years in our sample period. This may be attributed to greater adverse selection problems for first-time buyers than for refinances, where the borrower is likely to have had a recorded history of mortgage payments, presumably with the same lender. Here, too, default rates rise significantly for originations after 2005.

Under occupancy, we find that non-owner-occupied homes have the highest default rates, followed by second homes, while owner-occupied homes have the lowest default rates (columns 9 through 11 in Table 4). Anecdotal evidence often points to the role of investors using non-prime mortgage products to speculate on residential property after 2004. This has been claimed as a proximate cause of the mortgage crisis in the United States. Of course, this would also explain

the deterioration of lending standards and the high early default rates on originations after 2004. However, the summary data presented above show little evidence in support of this hypothesis. The proportion of second homes had been declining over the sample period. Moreover, non-owner-occupied properties were a small fraction of the loans throughout the sample period.

Not surprisingly, low-doc originations show a higher rate of default than full-doc loans (columns 3 and 4 in Table 5). Given the higher default rates on such loans, even for the earlier vintages, it is surprising to see the increasing share of Alt-A originations after 2004 that do not provide full documentation. To most observers this would bring into question the wisdom of originators who increased the proportion of low-doc loans in their mortgage pools. However, as noted previously, Alt-A mortgages are originated in an effort to capture borrowers who have good credit but are otherwise unable to provide documentation on their loans. Moreover, it is difficult to interpret the lack of documentation on loans as the principal cause behind the high default rates in the Alt-A market. For example, more than half of the originations in 2003 were loans without full documentation. However, the difference in the default rates on full-doc and low-doc loans for this vintage was less than 1 percentage point even after three calendar years.¹⁹

Next, we turn our attention to default rates in terms of credit quality as measured by borrower FICO at the time of origination (columns 5 through 7 in Table 5). A number of observers have pointed to higher default rates on a given FICO score as an indication of the poor performance of FICO. However, one needs to approach this argument with caution. For instance, if some exogenous factor were driving defaults in the mortgage market, one is likely to see poor performance for the said vintages across all FICO score groups. This is precisely what we observe in the data. A more relevant test of the effectiveness of FICO would

¹⁸ The choice of ARM5 is motivated by the fact that, among Alt-A originations with hybrid products, the ARM5 product has the largest market share.

¹⁹ Among originations of 2003 vintage, the default rate after three calendar years on full-doc loans was 2.82 percent, whereas the default rate on low-doc loans was 3.79 percent. The comparable figures for originations of 2006 vintage were 19.03 and 39.18 percent, respectively.

be a comparison across the different FICO score groups for a given vintage. The three panels show the performance of Alt-A by FICO score groups of 621-680, 681-740, and higher than 740.²⁰ Within each FICO score group, the later vintages (post-2004 originations) show higher default rates. More importantly, across the various score groups, the default rates for the same vintage are higher as one moves from a higher FICO score group to a lower FICO group.

Lastly, we study the effect of LTV on the summary measures of default (columns 8 through 11 in Table 5). Default probabilities increase when one moves from originations with lower LTV ratios to those with higher LTV ratios. Note that the loan performance for the 80 to 90 percent and the 90 to 100 percent LTV ratio categories are somewhat similar, especially for the early vintages.²¹ However, the gap in the default rates widens on later vintages.

In summary, Tables 4 and 5 confirm our a priori knowledge on underwriting. First, riskier attributes such as lower documentation, lower FICO scores, and higher LTV ratios perform poorly. Second, the differences in default probabilities between a more-risky attribute and that of a less-risky attribute increase for originations after 2004. Third, there is no monotonic trend over the years in the default rates across these attributes, however. Default rates have typically fallen for 2003 and 2004 originations, but risen sharply for later vintages. Finally, even for the later vintages, the defaults have risen across all attributes, irrespective of ex ante risk on the attribute. These summary results emphasize that one must exert caution when interpreting the riskier attributes on the origination as proximate causes of high early defaults on Alt-A mortgages in 2006 and 2007.

CONCLUSION

This paper provides a preliminary overview of Alt-A mortgages that were originated in the United States from 1998 through 2007. First, the summary data indicate a shift of Alt-A originations toward a greater share of owner-occupied properties, adjustable-rate products, and cash-out refinances. This is accompanied by a deterioration of underwriting standards for a greater proportion of mortgages with lower documentation and higher loan-to-value ratios. Serious delinquencies on Alt-A originations rose sharply in 2006 and 2007, primarily for originations after 2003. Even for originations of a later vintage, the defaults have risen across all attributes, irrespective of ex ante risk on the attribute.

A final comment addresses the following question: How does one reconcile the secular deterioration of underwriting for Alt-A mortgages with the lack of this evidence in the case of subprime mortgages (see Bhardwaj and Sengupta, 2009a)? In their handbook chapter on Alt-A mortgages, Bhattacharya, Berliner, and Liber (2006, p. 189) remark that “the demarcation between Alt-A and subprime loans has been blurred. Over time Alt-A has expanded to include loans with progressively less documentation and lower borrower credit scores. At the same time, subprime loans have, on average experienced a slow but steady rise in average credit scores. A result of this convergence has been the creation of the so-called Alt-B sector, where loans using this nomenclature were securitized in 2004.”

²⁰ We do not report default rates for the FICO score group less than 620, as their share throughout has been small and declining. In fact, fewer than 1 percent of post-2004 originations in the Alt-A market have FICO scores less than 620.

²¹ Again, since they form a small share of the total market, the plots for Alt-A originations with LTV in excess of 100 are not reported here.

REFERENCES

- Ashcraft, Adam B. and Schuermann, Til. "Understanding the Securitization of Subprime Mortgage Credit." Staff Reports No. 318, Federal Reserve Bank of New York, March 2008; www.newyorkfed.org/research/staff_reports/sr318.pdf.
- Bhardwaj, Geetesh and Sengupta, Rajdeep. "Where's the Smoking Gun? A Study of Underwriting Standards for US Subprime Mortgages." Working Paper 2008-036C, Federal Reserve Bank of St. Louis, October 1, 2009a; <http://research.stlouisfed.org/wp/2008/2008-036.pdf>.
- Bhardwaj, Geetesh and Sengupta, Rajdeep. "Did Prepayments Sustain the Subprime Market?" Working Paper 2008-039B, Federal Reserve Bank of St. Louis, May 2009b; <http://research.stlouisfed.org/wp/2008/2008-039.pdf>.
- Bhattacharya, Anand K.; Berliner, William S. and Lieber, Jonathan. "Alt-A Mortgages and MBS," in Fabozzi, Frank, ed., *The Handbook of Mortgage-Backed Securities*. Sixth edition. New York: McGraw-Hill, 2006, pp. 187-206.
- Fabozzi, Frank J., ed. *The Handbook of Mortgage-Backed Securities*. Sixth edition. New York: McGraw-Hill, 2006.
- Gorton, Gary. "The Panic of 2007." Manuscript prepared for the Federal Reserve Bank of Kansas City, Jackson Hole Conference, August 4, 2008; www.kc.frb.org/publicat/sympos/2008/gorton.08.04.08.pdf.
- Kaplan, E. and Meier, P. "Nonparametric Estimation from Incomplete Observations." *Journal of the American Statistical Association*, 1958, 53(282), pp. 457-81.
- Lehnert, Andreas. "Residential Mortgages," in Allen Berger, Phillip Molyneux, and John Wilson, eds., *Oxford Handbook of Banking*. Oxford, UK: Oxford University Press, 2009.
- Mayer, Christopher K. and Pence, Karen. "Subprime Mortgages: What, Where, and to Whom?" Working Paper No. W14083, National Bureau of Economic Research, June 2008; <http://papers.nber.org/papers/w14083.pdf>.
- Quigley, John M. "Federal Credit and Insurance Programs: Housing." Federal Reserve Bank of St. Louis *Review*, July/August 2006, 88(4), pp. 281-309; <http://research.stlouisfed.org/publications/review/06/07/Quigley.pdf>.
- Sengupta, Rajdeep and Tam, Yu Man. "Mortgage Originations: 2000-2006." Federal Reserve Bank of St. Louis *Economic Synopses*, 2008, No. 18; <http://research.stlouisfed.org/publications/es/08/ES0818.pdf>.

APPENDIX

Default rates and the probability of surviving a delinquency are calculated by using the Kaplan and Meier (1958) product limit estimator. We begin this nonparametric approach to survival and hazard function estimation by formalizing it in the current context of mortgage repayment behavior.

Following Kaplan and Meier (1958), the delinquency rate $D(t)$ at month t (the age of the mortgage in months) is defined as

$$D(t) = 1 - P(T > t),$$

where T is the age in months for the delinquency event (60-day, 90-day, or foreclosure) of a randomly selected mortgage and $S(t) \equiv P(T > t)$ is the survivor function or the probability of surviving the delinquency event beyond age t . Let $t_{(1)} < t_{(2)} < \dots < t_{(k)}$ represent the ordered age in months at the time of the delinquency event. For all these months, let $n_{(i)}$ be the number of surviving mortgages just prior to month $t_{(i)}$. Surviving mortgages exclude not only the ones that have been delinquent, but also the ones that have been refinanced prior to age $t_{(i)}$. If $d_{(i)}$ is the number of mortgages that become delinquent at age $t_{(i)}$, then the Kaplan-Meier estimator of surviving the event of delinquency is defined as

$$\hat{P}(T > t) = \prod_{i=1}^k \left(1 - \frac{d_i}{n_i} \right).$$



The Relationship Between the Daily and Policy-Relevant Liquidity Effects

[Daniel L. Thornton](#)

The phrase “liquidity effect” was introduced by Milton Friedman (1969) to describe the first of three effects on interest rates caused by an exogenous change in the money supply. The lack of empirical support for the liquidity effect using monthly and quarterly monetary and reserve aggregates data led Hamilton (1997) to suggest that more convincing evidence of the liquidity effect could be obtained with daily data—the daily liquidity effect. This paper investigates the implications of the daily liquidity effect for Friedman’s liquidity effect using a more comprehensive model of the Federal Reserve’s daily operating procedure than has been previously used in the literature. The evidence indicates that it is no easier to find convincing evidence of a Friedman liquidity effect using daily data than it has been with lower-frequency monthly and quarterly data. (JEL E40, E52)

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The phrase “liquidity effect” (LE) was first used by Milton Friedman (1969) to describe the first of three effects on interest rates caused by an exogenous change in the supply of money.¹ Despite its prominent role in conventional theories of the monetary policy transmission mechanism, there has been little evidence of a statistically significant or economically meaningful LE.² Suggesting that previous attempts to identify the LE have been unsuccessful because low-frequency data mix the effects of policy on economic variables with the effects of economic variables on policy, Hamilton (1997) sought to develop a “more con-

vincing measure of the liquidity effect” by estimating the response of the federal funds rate to exogenous reserve supply shocks using daily data. This is referred to as the “daily liquidity effect” (DLE). Thornton (2001a) showed that (i) Hamilton’s estimates of the DLE were the consequence of a few extreme observations and (ii) there was no evidence of a DLE using Hamilton’s model and methodology for his sample period and for sample periods before or after that period. Recently, however, Carpenter and Demiralp (2006) report evidence of a DLE using a more complete model of the operating procedure of the Trading Desk of the Federal Reserve Bank of New York (hereafter, the Desk) than that used by Hamilton. They also use a reserve supply shock measure that more adequately reflects reserve supply shocks that the Desk creates each day in the conduct of open market operations.

Carpenter and Demiralp (2006) and Hamilton (1997) claim that estimates of the DLE provide

¹ The other two effects are the “income” and “price expectation” or “inflation expectation” effects (e.g., Friedman, 1969; and Gibson, 1970a,b). These effects have roots in classical economics (e.g., Humphrey, 1983a,b). Because of the inflation expectation effect, an exogenous change in money growth eventually leads to higher, rather than lower, equilibrium nominal interest rates.

² The empirical literature on the LE dates back at least to Cagan and Gandolfi (1969) and Gibson (1970a,b).

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evidence of the existence of the Friedman LE. I argue that evidence of a DLE need not provide evidence of the existence of Friedman's LE. Specifically, I analyze the relationship between the DLE and Friedman's policy-relevant LE. The analysis shows that because of specific features in the Fed's operating procedure, its system of reserve requirements, and other factors, the relationship between the DLE and Friedman's LE is neither simple nor direct. In particular, statistically significant estimates of the former do not necessarily imply the existence of the latter. In so doing, I estimate the DLE using (i) Carpenter and Demiralp's (2006) reserve shock measure and (ii) a more complete model of the Fed's daily operating procedure than that used by either Hamilton (1997) or Carpenter and Demiralp. The empirical evidence indicates that it is no easier to find convincing evidence of Friedman's LE using high-frequency daily data than it has been using monetary and reserve aggregates at monthly or quarterly frequencies.

The remainder of the paper is divided into three sections. The upcoming section investigates the relationship between the DLE and Friedman's LE using a detailed model of the Desk's operating procedure. Following the literature, in the next section I develop estimates of an exponential autoregressive conditional heteroskedasticity (EGARCH) model of the DLE based on the model. The empirical model uses Carpenter and Demiralp's (2006) reserve supply shock measure.

THE POLICY-RELEVANT AND DAILY LIQUIDITY EFFECTS

Milton Friedman (1969) termed the first of three effects of an exogenous change in the supply of money on nominal interest rates the "liquidity effect." Friedman's LE is relevant for monetary policy. Consequently, Friedman's LE is called the "policy-relevant liquidity effect" (hereafter, LE). To understand why the DLE need not imply the existence of the LE, it is important to understand the mechanism that links the DLE to the LE. In this regard, it is important to note that the LE stems from the demand for money; that is,

$$(1) \quad M_t^d = f(i_t, y_t),$$

where M_t^d denotes the demand for money, which, for purposes of illustrating the relationship between the DLE and LE, is assumed to be a simple function of a nominal interest rate, i , and nominal income, y_t . Because individuals tend to economize their holding of money when interest rates rise, $\partial f / \partial i < 0$.

Equilibrium requires that the supply of money, M_t^s (which, for simplicity, is assumed to be exogenously controlled by the Fed), equals demand; that is,

$$(2) \quad M_t^s = M_t^d.$$

The LE is the initial effect of an exogenous change in the money supply on the interest rates and is given by

$$(3) \quad di_t / dM^s = (\partial f / \partial i)^{-1},$$

where it is assumed that neither nominal income nor inflation expectations respond immediately to the Fed's actions. Friedman (1969) called equation (3) the "liquidity effect."

Considerable empirical evidence indicates that the demand for money is negatively related to the interest rate and interest inelastic. The interest inelasticity of money demand implies that a small exogenous change in the supply of money should cause a relatively large response in interest rates—a relatively large LE. Consequently, the inability of researchers to find a statistically significant and economically meaningful LE is referred to as the "liquidity puzzle."³

The failure to find the LE using low-frequency monetary and reserve aggregates has been attributed to several factors, such as the response of nominal income or inflation expectations to money supply shocks and the inability to isolate exogenous monetary shocks. Researchers have attempted to overcome these problems using, among other things, structural vector autoregressions (SVARs). The recursive SVAR, or RSVAR, has been particularly popular in this literature. SVAR models have been estimated using a vari-

³ See Strongin (1995).

ety of monetary and reserve aggregates. Pagan and Robertson (1995) show that it is difficult to find convincing evidence of the LE with these models.⁴

The inability of researchers to find evidence of the LE using monthly or quarterly data led Hamilton (1997) to suggest that the failure of the RSVAR approach likely stemmed from the fact that changes in Fed policy are frequently due to information about “current or future values of output, inflation, exchanges rates, or other magnitudes,” so that “the correlation between such a ‘policy innovation’ and the future level of output of necessity mixes together the effect of policy on output with the effect of output forecasts on policy.”⁵ He suggested that the LE could be more easily identified by estimating the response of the funds rate to reserve supply shocks measured at the daily frequency. Specifically, he estimated reserve supply shocks from a simple time-series model of the Treasury’s daily deposits at the Fed. Assuming that the errors from this model proxy the reserve supply shocks that the Desk makes in conducting daily open market operations, Hamilton (1997) estimated the response of the federal funds rate to his estimated reserve supply shocks; that is, he estimated the DLE. He suggested that his estimates of a DLE implied the existence of the LE.

The Relationship Between the Policy-Relevant and Daily Liquidity Effects

The relationship between the DLE and the LE is a result of the Fed’s imposition of reserve requirements on some components of money. This creates a direct link between the demand for money—the source of LE—and the demand

for reserves—the source of the DLE. This relationship can be illustrated by assuming that the demand for reserves is given by

$$(4) \quad R_t^d = RR(M_t^d),$$

where R_t^d denotes the demand for reserves and $RR(M_t^d)$ denotes the Federal Reserve-imposed system of reserve requirements, which depend on the demand for money. Equation (4) shows that the demand for reserves is derived from the demand for money. Hence, in principle, it is possible to estimate the LE by estimating the response of interest rates to an exogenous change in the supply of reserves; that is, by estimating the DLE. The advantage of using daily data is that measures of reserve supply shocks at this frequency cannot be contaminated by the endogenous behavior of the Fed as Hamilton (1997) noted. Moreover, since the response will be identical whether the shock to reserves is due to an error the Desk makes in conducting daily open market operations or is a monetary policy-induced exogenous shock to reserves, there is no identification problem as there is when higher-frequency monetary and reserve aggregates are used. It is sufficient to identify a reserve supply shock from any source.

The strength of this relationship, however, depends both on the Desk’s daily operating procedure, which has remained essentially the same since at least the early 1970s, and the Fed’s system of reserve requirements, which has not.

The Desk’s Operating Procedure. The analysis begins with a model of the Desk’s operating procedure. Each day the Desk estimates the quantity of reserves that banks will demand over a maintenance period ending every other Wednesday, called “settlement Wednesday.”⁶ The Desk also estimates the quantity of reserves that will be supplied if the Desk conducts no open market

⁴ The exception is using a RSVAR with nonborrowed reserves as the monetary aggregate. Coleman, Gilles, and Labadie (1996) pointed out, however, that evidence of an LE using nonborrowed reserves may be a consequence of the Desk’s efforts to offset the effect of changes in discount window borrowing. Thornton (2001b) confirmed this by showing that the estimated LE using nonborrowed reserves is a consequence of the interest sensitivity of discount window borrowing and the Desk’s operating procedure under either monetary aggregate or funds rate targeting. He shows that this “liquidity effect” using nonborrowed reserves vanishes in the early 1980s when borrowing declined dramatically and became relatively interest-insensitive.

⁵ Hamilton (1997), p. 80.

⁶ Until October 1979 the estimate of demand was conditional on the objective or target for the federal funds rate. From October 1979 to September 1982, the estimate was conditional on the objective for the growth rate of the M1 monetary aggregate. Beginning in September 1982, the Fed claimed that the estimate was conditional on an objective for borrowed reserves; however, Thornton (2006) provides evidence from Federal Open Market Committee (FOMC) transcripts suggesting that the real objective was the federal funds rate. Today the objective is unquestionably the federal funds rate.

operations that day.⁷ If the former estimate exceeds the latter, the operating procedure suggests that the Desk add reserves through an open market purchase. If the former is smaller than the latter, the procedure suggests that reserves be drained through an open market sale.

Specifically, the Desk estimates the demand for total reserves:

$$(5) \quad E_{t-1}TR_t^d = E_{t-1}RR(f(i_t, y_t)) + E_{t-1}ER_t^d,$$

where TR_t^d denotes the demand for total reserves, ER_t^d denotes depository institutions' demand for excess reserves, and E_{t-1} denotes the expectation operator conditional on information available before that day's open market operation.

The supply of reserves available each day is given by

$$(6) \quad TR_t^s = B_t + BR_t + F_t + OMO_t,$$

where B_t denotes the Fed's holding of government debt before that day's open market operation, BR_t denotes bank borrowing at the discount window, F_t denotes autonomous factors that affect reserve supply—currency in circulation, the Treasury's balance at the Fed, the float, and so on—and OMO_t denotes the amount of open market purchases or sales conducted by the Desk that day.⁸

Each day the Desk estimates the supply of reserves that will be available if the Desk conducts *no* open market operations: $OMO_t = 0$. The Desk essentially knows the magnitude of B_t , but it must estimate F_t . The Desk does not estimate borrowing, but rather applies the Federal Open Market Committee (FOMC)–determined borrowing assumption, called the initial borrowing assumption (IBA_t).⁹ The estimate of reserve supply if the Desk conducts no open market operations is

$$(7) \quad E_{t-1}TR_t^s = B_t + E_{t-1}F_t + IBA_t,$$

where $E_{t-1}F_t$ denotes the Desk's estimate of autonomous factors. The amount of the open market operations suggested by the Desk's operating procedure, which I call the operating procedure–determined open market operation ($OPDOMO_t$), is given by

$$(8) \quad OPDOMO_t = (E_{t-1}RR(f(i_t, y_t)) + E_{t-1}ER_t^d) - (B_t + E_{t-1}F_t + IBA_t).$$

If $OPDOMO_t$ is positive, the procedure directs the Desk to purchase securities; if it is negative, the procedure indicates that securities should be sold.

If the Desk follows its operating procedure exactly, $OMO_t = OPDOMO_t$. The operating procedure is intended only to provide the Desk guidance, however. Judgment is used to conduct each day's open market operation. Indeed, over most of the period examined here, the Desk almost never followed the operating procedure exactly (e.g., Thornton, 2007). To allow for this fact, let

$$(9) \quad OMO_t = OPDOMO_t + k_t,$$

where k_t denotes the amount by which actual open market operation differs from that recommended by the operating procedure.

Reserve market equilibrium requires that the demand for reserves equals the supply; that is,

$$(10) \quad RR(f(i_t, y_t)) + ER_t^d = B_t + F_t + BR_t + OMO_t.$$

Substituting equations (8) and (9) into equation (10) yields

$$(11) \quad RR(f(i_t, y_t)) = E_{t-1}RR(f(i_t, y_t)) - (ER_t^d - E_{t-1}ER_t^d) - (F_t - E_{t-1}F_t) - (BR_t - IBA_t) + k_t.$$

The interest rate that equates the reserve market is the federal funds rate, ff_t . Thornton (2006) shows that the FOMC has been targeting the funds rate to some extent since 1982.¹⁰ Consequently, the

⁷ A more detailed analysis of the Desk's operating procedure can be found in Feinman (1993) and Thornton (2001b, 2007).

⁸ Borrowing (and later the initial borrowing assumption) refers to seasonal plus adjustment borrowing. Extended credit borrowing is treated separately as one of the autonomous factors affecting reserve supply.

⁹ The initial borrowing assumption was changed relatively infrequently and, most often, when the funds rate target was changed. Thornton (2006) shows that the initial borrowing assumption was last mentioned in discussing monetary policy during a conference call on January 9, 1991. However, it remained part of the Desk's formal operating procedure until at least 1996.

¹⁰ See Thornton (1988, 2006) for the relevant evidence.

Desk's expectation of reserve demand is conditional on the FOMC's target for the funds rate.¹¹ Consequently, equation (11) can be rewritten as

(12)

$$RR(f(i_t, y_t)) = RR(E_{t-1}f(\bar{f}_t^*, y_t)) - (ER_t^d - E_{t-1}ER_t^d) - (F_t - E_{t-1}F_t) - (BR_t - IBA_t) + k_t.$$

If the reserve supply shock is given by $(F_t - E_{t-1}F_t)$, the DLE is given by

$$(13) \quad \frac{\partial \bar{f}_t}{\partial (F_t - E_{t-1}F_t)} = \frac{1}{RR'(\partial f / \partial \bar{f}_t)} < 0,$$

where $RR' > 0$. Equation (13) shows that the relationship between the DLE and the LE depends on the Fed's system of reserve requirements, $RR(\cdot)$.

The Role of Reserve Requirements

Several aspects of the Fed's system of reserve requirements affect the relationship between the DLE and the LE. Important among these is the fact that reserve requirements are not imposed on all components of money. For example, there are no reserve requirements on the currency, and the percentage reserve requirements are different for various components of money.

Also, reserve requirements have changed over time, both exogenously and endogenously. The Fed made two major exogenous reductions in reserve requirements during the past two decades—in December 1990 and April 1992.¹² In addition, an important endogenous reduction in effective reserve requirements began in 1994 when banks started “sweeping” their retail transactions deposit accounts to reduce their effective percentage reserve requirement (e.g., Anderson

and Rasche, 2001). The result was a significant reduction in effective reserve requirements and a significant rise in the number of “nonbound” banks—banks that satisfy their reserve requirements with vault cash.¹³ This change has important consequences for the relationship between the DLE and the LE in that it severs the contemporaneous link between money demand and reserve demand for nonbound banks.

Importantly, the Fed reintroduced lagged reserve accounting in July 1998. Beginning with the maintenance period that began on July 30, 1998, there is a full two-maintenance-period (four-week) lag in the reserve accounting system. Reserve requirements for the current maintenance period now are determined by deposit balances held during the 14-day period two maintenance periods before the current one. This system of lagged reserve accounting severs the contemporaneous link between money demand and reserve demand for all banks, not simply nonbound banks. Hence, there is no contemporaneous relationship between the DLE and the LE after July 1998. Consequently, statistically significant estimates of the DLE after this date (e.g., Carpenter and Demiralp, 2006; and Judson and Klee, 2009) provide no evidence of the LE. The statistically significant negative relationship between the funds rate and reserve supply shocks merely reflects the fact that banks have an incentive to economize on their holdings of non-interest-bearing reserves. This incentive exists even if the demand for money does not depend on the interest rate, because reserve demand is interest sensitive for reasons other than the interest sensitivity of the demand for money.

Finally, Thornton (2001a) has noted a two-day lag in the Fed's prior reserve accounting system from March 1984 to July 1998.¹⁴ Specifically, a bank's maintenance-period reserve requirement was based on deposit balances held two days before the end of the maintenance period. The lack of a contemporaneous relationship between

¹¹ For a more detailed explanation, see Thornton (2001b).

¹² Effective December 13, 1990, the 3 percent reserve requirement on non-transaction liabilities was reduced to 1.5 percent for weekly reporters; effective December 27, 1990, the 1.5 percent reserve requirement on non-transaction liabilities was reduced to zero for weekly reporters. The combined effect of these actions reduced required reserves by an estimated \$13.2 billion. Although not reported here, these changes appear to have had no important effect on the estimates of the DLE reported in the next text section. There have been numerous other changes in the Fed's percentage reserve requirements over the years; however, these were relatively small and of little consequence.

¹³ See Anderson and Rasche (2001) for more details on the effects of retail sweep programs.

¹⁴ From 1968 to March 1984 there was a one-maintenance-period lag in the Fed's system of reserve accounting.

money demand and reserve demand on those days means that evidence of a DLE on the last two days of the maintenance period need not imply anything about the existence of the LE.

Analyses by Clouse and Dow (2002) and Bartolini, Bertola, and Prati (2002), however, show that reserve demand may be related to money demand on the last two days of the maintenance period if individual banks behave optimally with respect to the reserve carryover provision.¹⁵ These models do not include the costs of operating such procedures, however, and these costs could be large relative to the cost of satisfying a reserve shortfall at the end of the maintenance period through the discount window or in the federal funds market.¹⁶ Consequently, it is not clear whether such intense reserve management—though technically feasible—is economically viable.¹⁷ In any event, even if banks behave optimally, the relationship between the DLE and the LE would be affected by the fact that reserve demand on these days is due to the carryover provision. Consequently, the extent to which estimates of the response of the funds rate to a reserve supply shock on the last two days of the maintenance period provide evidence of the LE is uncertain.

ESTIMATING THE DAILY LIQUIDITY EFFECT

Hamilton (1997) and Carpenter and Demiralp (2006) estimate the DLE using a model based on a simpler version of equation (12). Estimating the DLE requires several additional assumptions. First, it requires an assumption about the Fed's system of reserve requirements. Effectively, Hamilton (1997) and Carpenter and Demiralp (2006) assume that the Fed's system of reserve

requirements applies to *all* components of the money supply; for example,

$$(14) \quad RR(M) = rrM,$$

where rr denotes a proportionate reserve requirement, say 0.10. This assumption is crude because (i) reserve requirements do not apply equally to all components of the money supply, (ii) rr may differ for various components of alternative definitions of money, (iii) rr has changed over time both exogenously and endogenously, and (iv) rr is effectively zero with the introduction of lagged reserve accounting in 1998 and during the last two days of the maintenance period before the adoption of lagged reserve accounting. Despite these problems, to maintain comparability with the previous literature, equation (14) is assumed.

Second, following Hamilton (1997) we assume that money demand is a linear function of the federal funds rate; that is,

$$(15) \quad f(\bar{f}, y_t) = \beta \bar{f}_t + \alpha y_t + \eta_t,$$

where α and β are positive fixed parameters and η_t denotes an i.i.d. random disturbance with a mean of zero and a constant variance.¹⁸ With these assumptions, equation (12) can be rewritten as

$$(16) \quad \bar{f}_t = -(1/rr\beta) \begin{bmatrix} -rr\tilde{\beta}\bar{f}_t^* + (F_t + E_{t-1}F_t) \\ + (BR_t - IBA_t) - (rr\alpha y_t - rr\tilde{\alpha}y_t) \\ - (ER_t - E_{t-1}ER_t^d) + k_t - \eta_t \end{bmatrix},$$

where \sim denotes the Desk's estimate of the corresponding parameter or variable.

Thornton (2001a) has shown that estimates of the DLE can give misleading indications about the LE on days with large idiosyncratic shocks to the funds rate. In particular, the distortion can be large on settlement Wednesdays. Hence, special care is taken in estimating the DLE on days with large idiosyncratic shocks to the funds rate.

¹⁵ I thank Jim Hamilton for pointing out this possibility to me.

¹⁶ For example, the one-day cost of paying a 1 percentage point premium on a \$100 million dollar reserve shortfall is \$2,739.73.

¹⁷ There is also no direct evidence that banks actually implement such procedures. Indeed, anecdotal evidence from reserve account managers of two very large New York banks in the late 1990s suggests that these banks did not rely on such procedures to manage their reserves.

¹⁸ Equation (15) assumes that the funds rate is a reasonable proxy for the interest rate in the money demand function. However, this need not be the case. The literature on monetary demand has debated whether a long-term or short-term rate should be in the money demand function and, if it is a short-term rate, which short-term rate it should be.

Finally, Hamilton (1997) and Carpenter and Demiralp (2006) note that a necessary condition for obtaining unbiased estimates of the DLE is that reserve supply shocks be uncorrelated with shocks to money demand, η_t . However, equation (16) shows that the measure of reserve supply shocks that they use (i.e., a measure of $F_t - E_{t-1}F_t$) must also be uncorrelated with $BR_t - IBA_t$, k_t , $ER_t^d - E_{t-1}ER_t^d$, and $rr\alpha y_t - rr\tilde{\alpha}\tilde{y}_t$ —variables not included in Hamilton's (1997) or Carpenter and Demiralp's (2006) models.

Following the literature the DLE is estimated using an EGARCH model based on equation (16). The EGARCH model is in the class of autoregressive conditional heteroskedastic (ARCH) models developed by Engle (1982) and was introduced by Nelson (1991). The specification takes the general form

$$(17) \quad ff_t = X_t\beta + \varepsilon_t, \quad t = 1, 2, \dots, T,$$

where X_t denotes a 1-by- l vector of l regressors and β denotes the corresponding l -by-1 vector of coefficients. The errors, ε_t , are assumed to be conditionally heteroskedastic. Specifically,

$$(18) \quad \log \sigma_t^2 = \xi + \gamma \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \psi \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \zeta \log \sigma_{t-1}^2 + Z_t\delta + \omega_t,$$

where Z_t is a 1-by- m vector of observable variables that determine the evolution of the variance and δ is a corresponding m -by-1 vector of coefficients. The coefficient ψ allows for the possibility of asymmetry in the response of shocks to the funds rate. Because ARCH models account for heteroskedasticity, they produce estimates of β that are generally more efficient than ordinary least squares.¹⁹

Figure 1 presents ff_t and ff_t^* over the period January 2, 1986, through January 20, 2004. It shows a number of volatility clusters typical of ARCH. Some of these are associated with well-defined events, such as the marked increases in

volatility associated with the 1987 stock market crash (bracketed by the first two vertical lines) and the surprise reduction in reserve requirements in 1990 (bracketed by the third and fourth vertical lines). There is also a marked decline in volatility that appears to begin in early 2000 (denoted by the fifth vertical line), which may be associated with changes in the FOMC's disclosure procedures. Moreover, it shows a relatively large number of volatility spikes—days when the funds rate changed by a relatively large amount only to return to essentially its previous-day's level the next day. These spikes are often unique to the funds rate. Some are associated with well-known events (e.g., settlement Wednesday and the first and last days of the year or quarter); others are not.

Hamilton (1996) found that a number of dummy variables were useful in modeling the behavior of the federal funds rate. Following Hamilton (1997) and Carpenter and Demiralp (2006), dummy variables are included for (i) each of the 10 maintenance-period days (D_i , $i = 1, 2, \dots, 10$); (ii) the first and last days of the month, quarter, and year (*bom*, *eom*, *boq*, *eoq*, *eoy*); (iii) the 15th day of the month (*mom*); (iv) the day before and after holidays (*bh* and *dh*, respectively); (v) the day before and after changes in the funds rate target (*btar* and *atar*, respectively); (vi) the month of December (*dec*); and (vii) the first and second week of the maintenance period (*w1*, *w2*).²⁰ Dummy variables are also included for the period of the 1987 stock market crash (*d1987*) and the surprise change in reserve requirements (*d1990*).²¹

The error made by the staff of the Board of Governors each day in forecasting F_t is the reserve supply shock and is denoted *miss*.²² Separate

²⁰ If the 15th falls on a weekend or a holiday, *mom* takes on the value of 1 on the business day closest to the middle of the month.

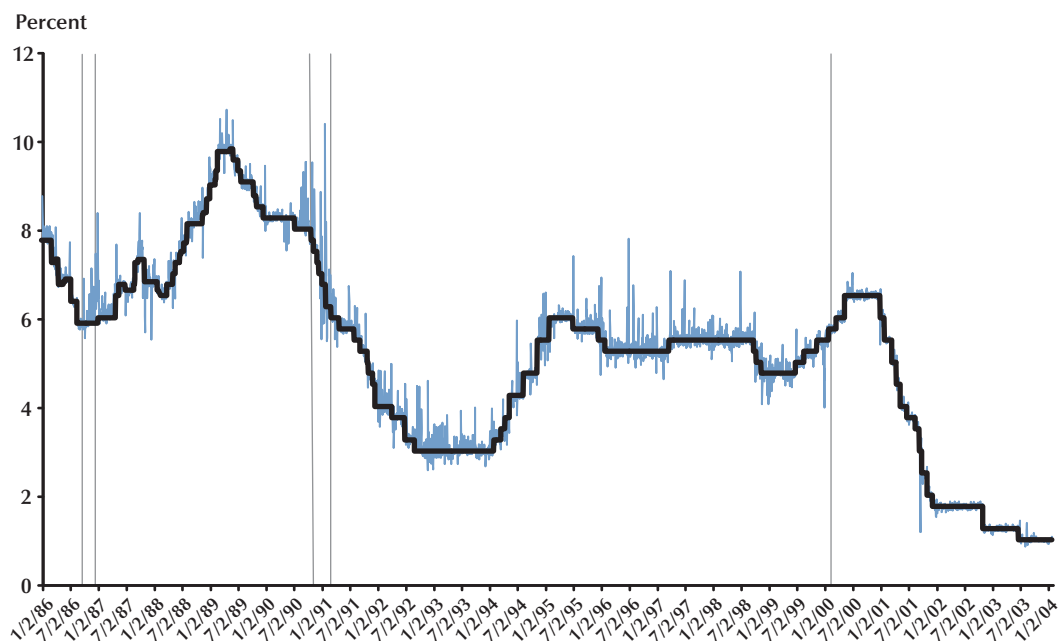
²¹ *d1987* takes on the value of 1 from the first day of the stock market crash, October 19, 1987, through December 31, 1987, and zero elsewhere. *d1990* is 1.0 from the first settlement Wednesday affected by the changes, December 13, 1990, through February 28, 1991, and zero elsewhere.

²² The Board staff's estimate is a proxy because, in reality, the staffs of the Board and the New York Fed make independent estimates of the autonomous factors. The Treasury makes an independent estimate of one of the factors, namely, its balance at the Fed. Exactly how these estimates are combined each day in conducting open market operations is unclear. See Thornton (2004) for further details.

¹⁹ However, because the EGARCH specification is not an integral part of the model, the basic equation was also estimated with ordinary least squares to determine whether the qualitative conclusions are affected by using the EGARCH model. The results indicated that the qualitative conclusions are robust to the use of the EGARCH model.

Figure 1

**The Effective Federal Funds Rate and the FOMC's Funds Rate Target
(January 2, 1986–January 20, 2004)**



estimates of the demands for required and excess reserves are made by the staffs of the Federal Reserve Bank of New York and the Board of Governors; however, the Board's estimates are used here.

Because of the introduction of sweep accounting in January 1994, initially the model is estimated over sample period January 2, 1986, though December 31, 1993. Carpenter and Demiralp (2006) found the DLE to be nonlinear and statistically significant for large shocks (shocks $> \$1$ billion) but not for small shocks (shocks $\leq \$1$ billion). Hence, for some specifications, *miss* is partitioned into large shocks (*miss_t^{lg}*) and small shocks (*miss_tsm*) using their criterion. Because of the two-day lag in the Fed's system of reserve requirements during this period, settlement days are partitioned into the last two days of the maintenance period (*l2d*) and all other days (*nl2d*).²³ Also, because the effect of reserve supply shocks on the funds rate differs on days when the funds rate target is changed, dummy variables for days

when the target was changed (*dΔff_t^{*}*) and other days (*dnΔff_t^{*}*) are included. Finally, the Student *t*-distribution, rather than the normal distribution, is used to account for the thick tails in the distribution of the funds rate.

The results in Table 1 are for three specifications, which differ by the variables included in the model. The coefficient estimates are presented in three sections. Table 1A reports the estimates of β for the parameters that are relevant for evaluating the DLE and the LE. Table 1B reports estimates of coefficients on the dummy variables that are included to account for various characteristics of the data. Table 1C reports the estimates of the variance parameters (equation 18) and the relevant summary statistics.

²³ Carpenter and Demiralp (2006) partition *miss* by each day of the maintenance period. However, save the last two days of the maintenance period, there is no particular reason to believe that the slope of the money demand curve should be systematically distinct on different days of the maintenance period. Consequently, this is not done here.

Table 1A**Estimates of the Reserve Market Model (January 2, 1986–December 31, 1993)**

Variable	Specification 1		Specification 2		Specification 3	
ff_t^*	0.5555	0.0000	0.5523	0.0000	0.5580	0.0000
Δff_t^*	0.0003	0.3820	0.0004	0.3238	0.0004	0.3320
$miss_t^{sm} \times d\Delta ff_t^*$	0.0104	0.5593	0.0109	0.1679	0.0106	0.1763
$miss_t^{sm} \times dn\Delta ff_t^* \times l2d$	-0.0047	0.8203				
$miss_t^{sm} \times dn\Delta ff_t^* \times nl2d$	-0.0083	0.0219				
$miss_t \times dn\Delta ff_t^* \times l2d$			-0.0327	0.0000		
$miss_t \times dn\Delta ff_t^* \times nl2d$			-0.0109	0.0000		
$miss_t \times dn\Delta ff_t^* \times l2d \times O$					-0.2181	0.0000
$miss_t \times dn\Delta ff_t^* \times l2d \times NO$					-0.0275	0.0001
$miss_t \times dn\Delta ff_t^* \times nl2d \times O$					-0.1195	0.0049
$miss_t \times dn\Delta ff_t^* \times nl2d \times NO$					-0.0108	0.0000
$miss_t^{lg} \times d\Delta ff_t^*$	0.0113	0.1887				
$miss_t^{lg} \times dn\Delta ff_t^* \times l2d$	-0.0323	0.0000				
$miss_t^{lg} \times dn\Delta ff_t^* \times nl2d$	-0.0114	0.0000				
$BR_t - IBA_t$	0.0243	0.0000	0.0239	0.0000	0.0239	0.0000
err_t^D	0.0088	0.0000	0.0089	0.0000	0.0088	0.0000
k_t	-0.0048	0.0003	-0.0046	0.0005	-0.0047	0.0004

Consistent with the model given by equation (16), the dependent variable is ff_t and not $ff_t - ff_t^*$, as in Carpenter and Demiralp (2006), or Δff_t , as in Hamilton (1997). Note that $ff_t - ff_t^*$ would be the appropriate dependent variable if and only if the Desk correctly estimated the interest elasticity of money demand—that is, $\tilde{\beta} = \beta$.²⁴

Specification 1 most closely resembles Carpenter and Demiralp's (2006) model. Specifically, $miss_t$ is partitioned into large and small misses using their criteria, and the response of the funds rate is allowed to differ depending on whether (i) the target changed that day, (ii) the miss occurred on the last two days of the mainte-

nance period, or (iii) it occurred on one of the other eight days. The estimates of the variance parameters for this specification presented in Table 1C show that the variance increased significantly during the periods immediately following the 1987 stock market crash and the 1990 surprise reduction in reserve requirements. Also, consistent with the thick-tailed distributions, characteristic of interest rates, the estimate of the degrees of freedom (dof) parameter is small, 3.77, and statistically significant, indicating the appropriateness of using the Student t -distribution.

All but a few of the estimates of the coefficients on the various dummy variables presented in Table 1B are statistically significant. Not surprisingly, in most cases, the estimated responses are as one would expect: The funds rate tends to be higher on settlement Wednesdays, higher at the end of the quarter, the first and last days of the month, and so on.

Table 1A reports the estimates relevant for the DLE and the LE. As expected, reserve supply shocks that occur on days when the FOMC

²⁴ The federal funds rate is very persistent and, hence, close to a unit root process. Hamilton's dependent variable is the change in the funds rate, while Carpenter and Demiralp's is the spread between the funds rate and the funds rate, both of which are stationary. The funds rate is used here because it is consistent with the model given by equation (16). However, to make sure that the qualitative conclusions reported here are not due solely to the near nonstationarity of the funds rate, the specifications reported in Table 1 were also estimated imposing the restriction $\tilde{\beta} = \beta$. While the numerical values of the parameter estimates change, the important qualitative conclusions were the same.

Table 1B**Estimates of the Reserve Market Model (January 2, 1986–December 31, 1993)**

Variable	Specification 1		Specification 2		Specification 3	
$ff_{t-1} \times w1$	0.4472	0.0000	0.4504	0.0000	0.4447	0.0000
$ff_{t-1} \times w2$	0.4461	0.0000	0.4494	0.0000	0.4436	0.0000
D1	−0.0132	0.2335	−0.0126	0.2555	−0.0130	0.2425
D2	−0.0556	0.0000	−0.0691	0.0000	−0.0683	0.0000
D3	0.0468	0.0000	0.0340	0.0001	0.0342	0.0001
D4	−0.0287	0.0015	−0.0414	0.0000	−0.0413	0.0000
D5	−0.0351	0.0001	−0.0482	0.0000	−0.0482	0.0000
D6	0.0053	0.6869	−0.0085	0.2980	−0.0077	0.3445
D7	−0.0514	0.0001	−0.0649	0.0000	−0.0640	0.0000
D8	0.0542	0.0006	0.0398	0.0006	0.0403	0.0004
D9	−0.0399	0.0224	−0.0537	0.0001	−0.0524	0.0002
D10	0.0817	0.0000	0.0678	0.0000	0.0690	0.0000
eom	0.0871	0.0000	0.0861	0.0000	0.0881	0.0000
bom	0.0572	0.0000	0.0573	0.0000	0.0570	0.0000
eoq	0.2125	0.0032	0.2159	0.0028	0.2000	0.0035
boq	−0.1152	0.0070	−0.1176	0.0056	−0.1202	0.0035
eoy	−0.3804	0.0003	−0.3810	0.0003	−0.3675	0.0004
boy	0.4270	0.0006	0.4301	0.0005	0.4351	0.0005
mom	0.0899	0.0000	0.0904	0.0000	0.0903	0.0000
bh	−0.0169	0.0329	−0.0163	0.0398	−0.0173	0.0297
ah	0.1097	0.0000	0.1094	0.0000	0.1095	0.0000

changed the funds rate target are not statistically significant, regardless of whether the shocks are large or small. Also, consistent with Carpenter and Demiralp (2006), the response of the funds rate to small shocks on all but the last two days of the maintenance period is statistically significant and smaller than the response to large shocks. However, the magnitude of the difference between the response to large and small shocks is relatively small. Indeed, the likelihood ratio test statistic for equality of the response is 0.464, which is not statistically significant at any reasonable significance level. Contrary to Carpenter and Demiralp's (2006) results, there is no evidence of nonlinearity.

Given the absence of nonlinearity, the model is estimated without partitioning the reserve supply shocks into large and small shocks. Estimates of this specification are presented as speci-

fication 2 of Table 1. Again, there is no statistically significant response of the funds rate to reserve supply shocks that occur on days when the target is changed. Also, consistent with Hamilton (1997) and Thornton (2001a), the response of the funds rate on the last two days of the maintenance period is about three times larger than the response on the other eight days, and it is statistically significant.

As expected, the coefficients on $BR_t - IBA_t$, k_t , and err_t^D are all statistically significant. The coefficient on $BR_t - IBA_t$ is positive, suggesting that borrowing above the FOMC's assumed level is associated with the funds rate above the target. The sign of the coefficient is inconsistent with a supply shock interpretation, but it is consistent with the evidence that borrowing responds endogenously to the funds rate (e.g., Thornton, 2001b). The coefficients on k_t and err_t^D have the

Table 1C**Estimates of the Reserve Market Model (January 2, 1986–December 31, 1993)**

Variable	Specification 1		Specification 2		Specification 3	
Constant	−3.0817	0.0000	−3.0848	0.0000	−3.0208	0.0000
$ \varepsilon_{t-1}/\sigma_{t-1} $	0.7053	0.0000	0.7043	0.0000	0.6821	0.0000
$\varepsilon_{t-1}/\sigma_{t-1}$	0.0559	0.2237	0.0585	0.2058	0.0638	0.1507
$\log \sigma_{t-1}^2$	0.5387	0.0000	0.5374	0.0000	0.5466	0.0000
$D1 + D2 + D3$	1.5364	0.0000	1.5356	0.0000	1.5135	0.0000
<i>btar</i>	0.6902	0.0085	0.6768	0.0086	0.6660	0.0097
<i>ah</i>	1.1983	0.0000	1.2091	0.0000	1.1562	0.0000
<i>eom</i>	0.9886	0.0000	−1.8576	0.0096	−1.6951	0.0161
<i>eoq</i>	2.4000	0.0000	2.4184	0.0000	2.3238	0.0000
<i>eoy</i>	−1.8168	0.0108	0.9883	0.0000	0.9508	0.0000
<i>mom</i>	0.6470	0.0028	0.6558	0.0024	0.6322	0.0033
<i>d1987</i>	0.4993	0.0239	0.4942	0.0251	1.3252	0.0000
<i>d1990</i>	1.3196	0.0000	1.3238	0.0000	0.5740	0.0099
Degrees of freedom	3.7653	0.0000	3.7529	0.0000	3.7440	0.0000
No. of observations	1,966		1,966		1,966	
\bar{R}^2	0.9887		0.9885		0.9892	
SE	0.2234		0.2244		0.2180	
Log likelihood	1477.061		1475.596		1479.130	

anticipated signs. The estimated coefficient on k_t suggests that the funds rate tends to be significantly lower on days when the Desk engages in more open market operations than the operating procedure suggests. Likewise, if the Desk underestimates the demand for reserves, the funds rate is somewhat higher.

Equation (16) suggests that the absolute magnitude of the response of the funds rate to *miss*, err_t^D , $BR_t - IBA_t$, and k_t should be equal; however, this restriction was not imposed.²⁵ Nevertheless, it is interesting to note that the estimated coefficients on err_t^D and *miss* on days other than the last two of the maintenance period are similar in magnitude but opposite in sign as suggested by

equation (16). The likelihood ratio statistic for the hypothesis that the responses are equal but opposite in sign is 0.79.

Thornton (2001a) showed that Hamilton's (1997) results were sensitive to days with large shocks to the funds rate. Hence, I investigate the sensitivity of the estimates of the DLE to unusually large and idiosyncratic shocks to the funds rate. This is important because the response of the funds rate to supply shocks on such days is not necessarily evidence of an LE. Specifically, *miss* is partitioned by days with large and idiosyncratic shocks to the funds rate: outliers (O) and days with no outliers (NO). Days with idiosyncratic shocks to the funds rate are obtained by regressing the federal funds rate on a constant and the 3-month Treasury bill rate over the sample period. The residuals from this equation are daily changes in the funds rate that are not associated with changes in the 3-month T-bill rate: idiosyncratic shocks to the federal funds rate. Idiosyncratic

²⁵ Given that borrowing is endogenous, it is unlikely that the restriction would hold for borrowing. Also given that the Desk is free to deviate from the procedure as it sees fit, it seems unlikely that it would hold for k_t as well. Indeed, a test that the absolute values of the coefficients on *miss*, err_t^D , and k_t are equal is rejected at the 5 percent significance level or lower.

Table 2**Estimates of the Reserve Market Model
(January 3, 1994–December 31, 1996)**

Variable	Coefficient	Significance level
ff_t^*	0.769	0.000
Δff_t^*	−0.000	0.820
$miss_t^{sm} \times d\Delta ff_t^*$	0.769	0.000
$miss_t \times dn\Delta ff_t^* \times l2d \times O$	0.000	0.820
$miss_t \times dn\Delta ff_t^* \times l2d \times NO$	−0.008	0.881
$miss_t \times dn\Delta ff_t^* \times nl2d \times O$	−0.011	0.281
$miss_t \times dn\Delta ff_t^* \times nl2d \times NO$	−0.004	0.051
$BR_t - IBA_t$	0.198	0.000
err_t^D	0.004	0.006
k_t	0.000	0.770
No. of observations	754	
\bar{R}^2	0.946	
SE	0.197	
Log likelihood	789.248	

shocks to the funds are considered large when they are more than 80 basis points (roughly two standard errors [SEs] of the idiosyncratic shocks to the funds rate).²⁶ There are 62 days when there were large, idiosyncratic shocks to the funds rate during the sample period (slightly more than 3 percent of the days), 33 of which occurred on a settlement Tuesday or Wednesday.

The results are reported in specification 3 of Table 1. As anticipated, estimates of the DLE are sensitive to large idiosyncratic shocks to the funds rate. On days with large idiosyncratic shocks to the funds rate, the estimated DLE is about 10 times larger than on days without such shocks. Consistent with the results of Thornton (2001a), estimates of the DLE appear to be significantly overestimated on days with large idiosyncratic shocks to the funds rate. Nevertheless, the estimate on days other than the last two of the maintenance period reported in specification 2 is nearly

identical to the estimate when there are no outliers in specification 3. Hence, the effect of large, idiosyncratic shocks to the funds rate is reflected mostly in estimates on settlement Tuesday and Wednesday.²⁷

Post-1993 Estimates of the Daily Liquidity Effect

The introduction of sweep accounts in January 1994 dramatically reduced reserve requirements for banks over time. Anderson and Rasche (2001) suggest that by the end of 1999, “the willingness of bank regulators to permit use of deposit-sweeping software has made statutory reserve requirements a ‘voluntary constraint’ for most banks” (p. 71). To investigate the effect of sweep accounts on the estimate of the DLE, the model is estimated over the period from January 3, 1994, through December 31, 1996. To conserve space, only estimates of the parameters that are relevant for the LE are reported in Table 2. All estimated coefficients on the various partitions of *miss* are much smaller in absolute value than those reported in Table 1. Moreover, none is statistically significant at the 5 percent significance level. The estimate is statistically significant at slightly higher than the 5 percent significance level when *miss* is partitioned by *nl2d* and *NO*. The estimate is only about half as large as that for the pre-1994 period. The smaller estimate is inconsistent with the fact that sweeps effectively reduce reserve requirements. Other things the same, lower effective reserve requirements should have resulted in a larger coefficient estimate. One possible explanation is that the effective elimination of mandatory reserve requirements for nonbound banks significantly altered the interest sensitivity of reserve demand independent of money demand. It is interesting to note that the estimated coefficient on *miss* for these days is again equal but opposite in sign to that of reserve demand shocks.

²⁶ As a robustness check on the qualitative results, values of 40, 50, and 60 basis points were also used. The qualitative conclusion about the coefficient *miss* on *NO* days is invariant to the value used.

²⁷ Given the close relationship between the funds rate and the funds rate target, the model was also estimated using $ff_t - ff_t^*$ as the dependent variable. While the coefficient estimates changed somewhat, the qualitative conclusions are not sensitive to whether ff_t or $ff_t - ff_t^*$ is the dependent variable. The quantitative and qualitative results are very sensitive to excluding $BR_t - IBA_t$, err_t^D , and k_t , however. The correlations between *miss* and $BR_t - IBA_t$, err_t^D , and k_t over this sample period are −0.058, 0.352, and −0.013, respectively.

Post-1998 Estimates of the Daily Liquidity Effect

Finally, the model was estimated over the period August 3, 1998, through January 30, 2004, to determine whether such evidence has no implication for the LE. Data on $BR_t - IBA_t$, err_t^D , and k_t are not available over this period, so the estimates are likely to be biased. The estimate of the DLE for days other than the last two of the maintenance period when there were no outliers is small, -0.007 , but statistically significant. This shows that the demand for reserves is interest sensitive apart from the interest sensitivity of the demand for money. Given the interest sensitivity of reserve demand, caution is necessary in concluding that there is a statistically significant and economically relevant LE based on statistically significant estimates of the DLE.

CONCLUSION

The DLE was first estimated by Hamilton (1997) in an attempt to find evidence of Friedman's (1969) policy-relevant LE, which had escaped detection using lower-frequency (monthly and quarterly) data. Unfortunately, Hamilton and subsequent researchers did not investigate the linkage between the DLE and the LE. This article fills this gap in the literature by showing that the DLE is directly linked to the LE by Federal Reserve-imposed reserve requirements. The relationship between the DLE and the LE is then analyzed and investigated using a more comprehensive model of the Desk's operating procedure than has been used in the literature. The analysis shows that the relationship between the DLE and the LE depends on the Desk's operating procedure, the

Fed's system of reserve requirements, and other factors. Importantly, the analysis shows that there is no relationship between these LEs after July 1998 when the Fed reinstated lagged reserve accounting.

Estimates of the DLE before 1994 suggest that there may have been a statistically significant policy-relevant LE before 1994. The estimated DLE is small, however. The estimate suggests that a \$10 billion reserve supply shock generates about a 20-basis-point change in the funds rate. If one assumes that the average effective reserve requirement during the sample period is 10 percent, this would be equivalent to about a \$100 billion shock to the money supply—much larger than any shock during this sample period.

More problematic is the finding of a statistically significant DLE after July 1998, when the Fed established lagged reserve accounting. The existence of a DLE over this period is due to the fact that banks have an incentive to economize on their holdings of reserves, independent of the interest sensitivity of money demand. The fact that there is a statistically significant DLE during a period when estimates of the DLE can have no implication for the LE raises a question of the extent to which estimates of the DLE have implications for the LE during other periods. It could be that all estimates of the DLE reflect the interest sensitivity of reserve demand independent of the interest sensitivity of money demand. In any event, the results presented here indicate that it is no easier to find convincing evidence of a statistically significant and economically important policy-relevant LE using high-frequency daily data than it has been using lower-frequency (monthly and quarterly) data. A resolution of the liquidity puzzle remains elusive.

REFERENCES

- Anderson, Richard G. and Rasche, Robert H. "Retail Sweep Programs and Bank Reserves, 1994-1999." Federal Reserve Bank of St. Louis *Review*, January/February 2001, 83(1), pp. 51-72;
<http://research.stlouisfed.org/publications/review/01/0101ra.pdf>.
- Bartolini, Leonardo; Bertola, Giuseppe and Prati, Alessandro. "Day-to-Day Monetary Policy and the Volatility of the Federal Funds Interest Rate." *Journal of Money, Credit, and Banking*, February 2002, 34(1), pp. 137-59.

Thornton

- Cagan, Phillip and Gandolfi, Arthur. "The Lag in Monetary Policy as Implied by the Time Pattern of Monetary Effects on Interest Rates." *American Economic Review*, May 1969, 59(2), pp. 277-84.
- Carpenter, Seth and Demiralp, Selva. "The Liquidity Effect in the Federal Funds Market: Evidence from Daily Open Market Operations." *Journal of Money, Credit, and Banking*, June 2006, 38(4), pp. 901-20.
- Clouse, James A. and Dow, James P. Jr. "A Computational Model of Banks' Optimal Reserve Management Policy." *Journal of Economic Dynamics and Control*, September 2002, 26(11), pp. 1787-814.
- Coleman, Wilbur John II; Gilles, Christian and Labadie, Pamela A. "A Model of the Federal Funds Market." *Economic Theory*, February 1996, 7(2), pp. 337-57.
- Engle, Robert F. "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation." *Econometrica*, July 1982, 50(4), pp. 987-1007.
- Feinman, Joshua N. "Estimating the Open Market Desk's Daily Reaction Function." *Journal of Money, Credit, and Banking*, May 1993, 25(2), 231-47.
- Friedman, M. "Factors Affecting the Level of Interest Rates," in *Proceedings of the 1968 Conference on Saving and Residential Financing*. Chicago: United States Saving and Loan League, 1969, pp. 11-27. Reprinted in Thomas M. Havrilesky and John T. Boorman, eds., *Current Issues in Monetary Theory and Policy*. Arlington Heights, IL: AHM Publishing, 1976, pp. 362-78.
- Gibson, William E. "Interest Rates and Monetary Policy." *Journal of Political Economy*, May/June 1970a, 78(3), pp. 431-55.
- Gibson, William E. "The Lag in the Effect of Monetary Policy on Income and Interest Rates." *Quarterly Journal of Economics*, May 1970b, 84(2), pp. 288-300.
- Hamilton, James D. "The Daily Market for Federal Funds." *Journal of Political Economy*, February 1996, 104(1), pp. 26-56.
- Hamilton, James D. "Measuring the Liquidity Effect." *American Economic Review*, March 1997, 87(1), pp. 80-97.
- Humphrey, Thomas M. "The Early History of the Real/Nominal Interest Rate Relationship." Federal Reserve Bank of Richmond *Economic Review*, May/June 1983a, 69(3), pp. 2-10; www.richmondfed.org/publications/research/economic_review/1983/pdf/er690301.pdf.
- Humphrey, Thomas M. "Can the Central Bank Peg Real Interest Rates? A Survey of Classical and Neoclassical Opinion." Federal Reserve Bank of Richmond *Economic Review*, September/October 1983b, 69(5), pp. 12-21; http://www.richmondfed.org/publications/research/economic_review/1983/pdf/er690502.pdf.
- Judson, Ruth and Klee, Elizabeth. "Whither the Liquidity Effect: The Impact of Federal Reserve Open Market Operations in Recent Years." Finance and Economics Discussion Series Working Paper 2009-25, Board of Governors of the Federal Reserve System; www.federalreserve.gov/pubs/feds/2009/200925/200925pap.pdf.
- Nelson, Daniel B. "Conditional Heteroskedasticity in Asset Returns: A New Approach." *Econometrica*, March 1991, 59(2), pp. 347-70.
- Pagan, Adrian R. and Robertson, John C. "Resolving the Liquidity Effect." Federal Reserve Bank of St. Louis *Review*, May/June 1995, 77(3), pp. 33-54; http://research.stlouisfed.org/publications/review/95/05/Resolving_May_June1995.pdf.
- Strongin, Steven. "The Identification of Monetary Policy Disturbances: Explaining the Liquidity Puzzle." *Journal of Monetary Economics*, June 1995, 35(3), pp. 463-97.
- Thornton, Daniel L. "The Borrowed-Reserves Operating Procedure: Theory and Evidence." Federal Reserve Bank of St. Louis *Review*, January/February 1988, 70(1), pp. 30-54; http://research.stlouisfed.org/publications/review/88/01/Borrowed_Jan_Feb1988.pdf.

Thornton, Daniel L. "Identifying the Liquidity Effect at the Daily Frequency." *Federal Reserve Bank of St. Louis Review*, July/August 2001a, 83(4), pp. 59-78;

<http://research.stlouisfed.org/publications/review/01/05/59-78Thornton.qxd.pdf>.

Thornton, Daniel L. "The Federal Reserve's Operating Procedure, Nonborrowed Reserves, Borrowed Reserves and the Liquidity Effect." *Journal of Banking and Finance*, September 2001b, 25(9), pp. 1717-39.

Thornton, Daniel L. "Forecasting the Treasury's Balance at the Fed." *Journal of Forecasting*, August 2004, 23(5), pp. 357-71.

Thornton, Daniel L. "When Did the FOMC Begin Targeting the Federal Funds Rate? What the Verbatim Transcripts Tell Us." *Journal of Money, Credit, and Banking*, December 2006, 38(8), pp. 2039-71.

Thornton, Daniel L. "Open Market Operations and the Federal Funds Rate," in David G. Mayes and Jan Toporowski, eds., *Open Market Operations and the Financial Markets*. Oxford, UK: Routledge, 2007; pp. 178-205.

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<http://research.stlouisfed.org/publications/review/07/11/Thornton.pdf>.



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