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Exogenous Shocks and the Dynamics of City Growth: Evidence from New York

1. Introduction

The response of cities and regions to shocks plays a central role in our understanding of the spatial organization of firms and households, which has been shown to have important implications for economic outcomes ranging from air pollution to productivity growth. Yet because exogenous, unanticipated shocks are rarely observed, efforts to identify their effects are often hampered.

This paper empirically examines the spatial and temporal responses of the New York City economy to a large, but spatially concentrated, exogenous shock to its capital stock: the terrorist attacks of September 11, 2001. Our focus on the city's response allows us to draw inferences about how city economies work, rather than to explore the effects of terrorism on New York or other cities. We utilize data before and after 9/11 to study the response because we believe that the size, location, and timing of the shock were unanticipated, and because the shock was large enough to create substantial dislocations in the city's economy. While the actual financial losses produced by the attacks were not large relative to the size of the city's economy, a major element of the shock was the perception that the city would be in danger of future attacks.

Our analysis reveals that New York City's economy was surprisingly resilient to the 9/11 attacks and the damage they caused, but the shock was associated with significant changes, particularly in the spatial distribution of activities. Furthermore, the particular character of the city's economy and the shock it sustained played an important role in the pattern of the city's recovery. We argue that several explanations could account for this economic resilience. One is that based on previous events, private actors had already reacted to the threat of terrorism, and that the events of 9/11 were, in a meaningful sense, anticipated. A second possibility is that a repeat of the 9/11 attacks was regarded as very unlikely. A third possibility is that the destruction of the World Trade Center, while unanticipated, came amid a disequilibrium in the city's real estate markets and, by chance, happened to reinforce preexisting trends. Finally, it is possible that public pronouncements, regulation, and planning played a substantial role in the economic recovery. Perhaps most surprising is this fourth possible conclusion—that government could have a positive effect in such a setting. Yet recent work on New York City's real estate markets concludes that regulation plays an important role in economic development more generally (Glaeser, Gyourko, and Saks 2004). Such signals are perhaps particularly effective when an economy is out of equilibrium, as New York City's may have been in early 2001.

2. The Effect of 9/11 on New York City's Economy

In the late 1990s, New York City was experiencing extraordinarily strong growth for such a mature economy.

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Between 1996 and 2000, private sector employment in the city grew at a 2.6 percent annual rate, the strongest four-year run in more than four decades. In each of those years, the rate of city job growth exceeded that of the nation. Private sector wage and salary growth also exceeded the national average over this period, rising 7 percent per year in real terms (Bram 2003). This economic strength was reflected in broader measures of activity as well. In January 2000, the New York City index of coincident economic indicators (CEI), a measure of the short-run dynamics of economic activity, reached its highest level since the series began in 1965.[1] City housing values were also at very high levels in both absolute terms and relative to the nation (Bram, Haughwout, and Orr 2002). Real revenues from the city's four largest taxes reached an all-time high, despite rate reductions, in fiscal year 2000-01 (Edgerton, Haughwout, and Rosen 2004).

In the subsequent two years, the city experienced a sharp economic downturn. Private sector jobs reversed their strong growth and, for the 2001-03 period, fell at a 2.1 percent annual rate. By November 2003, the CEI had retreated nearly 10 percent from its peak value. Revenues from the city's four major taxes declined sharply in real terms during fiscal year 2002, and they had yet to recover their 1999 level by fiscal year 2003.

The sources of this reversal in the city's fortunes are not controversial: the 9/11 attacks on the World Trade Center, the decline in the stock market, and the national recession all clearly played important roles in the slowing of aggregate city economic activity.

## 2.1 Isolating the City-Specific Component of the Shock

The destruction of the World Trade Center had several potential effects on the economy of New York. First, and most horrific, the attacks took nearly 2,800 lives. In economic terms, this means that the human capital stock for the entire metropolitan region was reduced, at least in the short run. Despite the tragic consequences for the individuals and their families, the direct impact on the supply of human capital in New York City—an open economy with more than 3.5 million jobs and 8 million residents—was small.

The sixteen acres of the World Trade Center site housed approximately 13.4 million square feet of class A office space, nearly 30 percent of the Downtown total. This complex was destroyed on September 11, and several surrounding buildings were damaged when the towers fell. While some residential space was affected as well, it was reoccupied relatively quickly.

As of this writing, the World Trade Center site remains essentially vacant, although the reopened PATH station—the Lower Manhattan terminus of the Port Authority's light-rail system—occupies a small portion of the area. This persistent loss of productive capital and the potential ongoing threat of future loss of life and property caused many commentators to voice concerns about the future of the city as a highly desirable location for businesses and households.

The attacks occurred as a recession was already under way in the nation and the city. Employment in New York peaked in December 2000 and had declined by 60,000 jobs by August. Another 100,000 jobs were lost between August and October 2001 (Chart 1). The New York City CEI began falling as the local recession commenced in January 2001 and declined nearly 0.95 percent in September 2001 alone (Chart 2). This was the fourth-largest monthly decline in the history of the index. While the CEI continued to decline until August 2003, the total peak-to-trough decline totaled 8.9 percent, which was significantly less deep than those registered during the city downturns that began in 1969 and 1989. In addition, the rates of decline before September 2001 and after are approximately the same, suggesting that the ongoing national recession was an important factor in the adverse outcomes experienced by the city economy. For this reason, isolating the effect of the city-specific shock that struck New York on September 11 requires controlling, to the extent possible, for the effects of the ongoing national recession. In the analysis that follows, we accomplish this by normalizing our results by changes in the national economy. We thus seek to isolate differential New York City effects from changes in the national economy as a whole, whether attributable to 9/11 or to other factors.
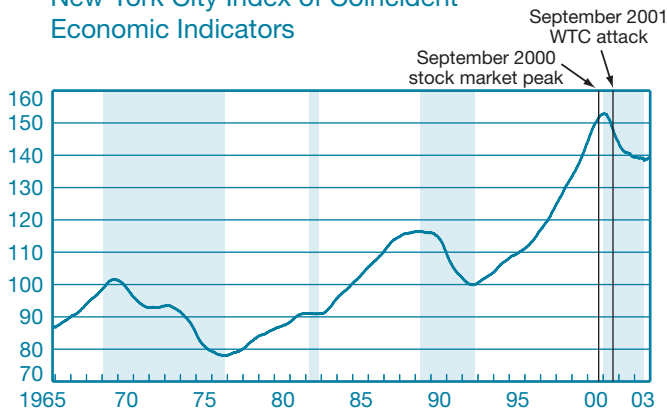
Chart 1
Employment in New York City

Millions of employees
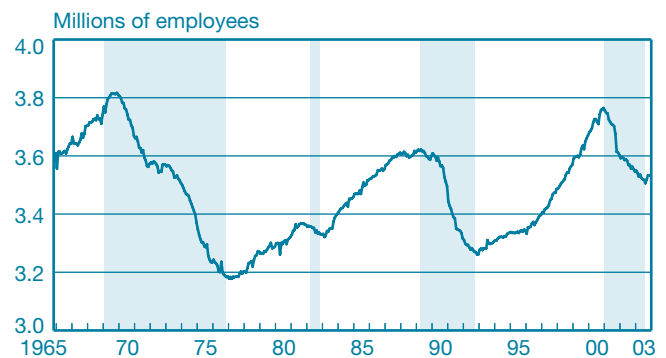
Source: U.S. Department of Labor, Bureau of Labor Statistics.

Notes: Data are seasonally adjusted. The bands indicate local recessions.

New York City Index of Coincident Economic Indicators

September 2001
WTC attack

September 2000
stock market peak

Source: Federal Reserve Bank of New York.

Note: The bands indicate local recessions.

2.2 The City's Real Estate Markets

The series depicted in Chart 3 is the quarterly Office of Federal Housing Enterprise Oversight (OFHEO) single-family home price index for the New York metropolitan area, divided by the national index. Both indexes, and the resulting series, are indexed to 100 in 1976:2, when the New York series began.

There is little evidence here that the September 11 attacks on the World Trade Center reduced the demand for residential locations in the New York metropolitan area. The chart shows

New York City Area House Prices Relative to U.S. Average

Index: 1976=100

September 2001 →
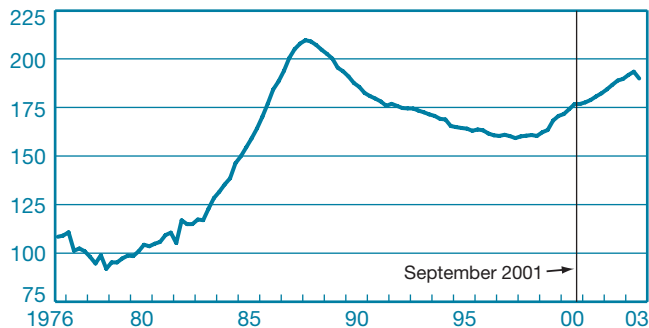
Sources: Office of Federal Housing Enterprise Oversight; Federal Reserve Bank of New York calculations.

Note: The index is based on the ratio of the repeat-sales price measure for existing single-family homes in the New York City metro area to that of the United States overall.

the date of the attacks, which occurred during 2001:3. Repeat-sale house prices in the metropolitan area were rising faster than they were in the rest of the nation both before and after the attacks, as depicted by the steady rise in the index on both sides of the September 11 point. That is to say, the New York area's residential housing market gained ground on the rest of the nation immediately after the attacks. (Statistical tests fail to reject the null hypothesis that the trend in the series is the same before and after 2001:3.) Only after two years had passed, in late 2003, was there any sign that housing prices in New York had faltered relative to the nation. Since that period, data not plotted here suggest that the New York metropolitan area housing price premium has resumed its rise. Thus, the relative demand for residential locations in the New York area market has remained strong since the attacks.

The OFHEO data cover only single-family homes, which are presumably located primarily in the suburbs. Increased demand for single-family houses may reflect reduced demand for Manhattan locations and a decentralization of population from New York City proper. Such a result, for example, is consistent with the ideas presented in Mills' (2002) early reflections on the implications of urban terrorism. To address this issue of urban form, we turn to a detailed examination of the New York City housing market before and after the attacks.

2.3 Neighborhood-Level Microdata on the City's Real Estate Markets

Our second housing market analysis is more restrictive in the sense that it focuses solely on housing units in the city of New York. However, our data source for this analysis, the New York City Housing and Vacancy Survey (HVS), allows consideration of a much broader range of housing types, from rental apartments to condominiums to single-family homes, with the mix reflecting the actual housing consumption patterns of city households.

The HVS is conducted about every three years (the coverage here is 1991, 1993, 1996, 1999, and 2002). Each survey collects information on the structural and locational characteristics of about 18,000 housing units in the city. The structural characteristics include detailed items such as the number of bedrooms, the presence of complete kitchen facilities, and the condition of exterior walls.[2] For the purposes of the survey, New York is divided into fifty-five sub-boroughs, and the sub-borough location of each unit is identified in the public data.

The HVS data, like the OFHEO data, provide a limited view of changes in housing demand. In particular, the HVS complements the OFHEO index in the sense that it allows for a detailed look at those parts of the city itself expected to have

been affected most by the terrorist attacks and the fear of future attacks.

To discern the effects of September 11 on the demand for housing in New York City, we estimate a set of regression equations of the form $V = V(t, N, H)$, where V is a measure of unit value (expected sales price for owner-occupied units or gross rent for rental apartments), t indexes time, N indexes neighborhood, and H is a vector of housing capital measures.

We interact the fifty-five sub-borough measures with a set of five survey (year) dummies. Our test consists of looking for significant negative effects on the 2002 dummies in the city as a whole or in those sub-boroughs expected to have been affected most by the attacks.[3] Our specification estimates average trait prices and looks for temporal variation in the relative value of particular neighborhoods. If variations in traits whose prices are changing are correlated with neighborhood, then we may obtain biased estimates of neighborhood effects. We leave research on this topic to future work, but note that if components of housing capital that experienced rising prices are concentrated in Lower Manhattan, then we will understate the relative depreciation (or overstate the relative appreciation) of a Lower Manhattan location per se.

We experimented with several specifications of the basic relationships, including estimating the equation in level and semi-log forms, eliminating the top and bottom 5 percent of observations based on value, eliminating top-coded units, and augmenting the equation with information about financial arrangements and move-in or lease dates. Each of these specifications leads to the same qualitative conclusions.

Results

Table 1 reports the results of two sets of regressions designed to identify the effects of the September 11 terrorist attacks on the demand for residential locations in New York City. The figures are the regression coefficients on year 2002 dummies either on their own (column 1) or interacted with dummies for a particular borough (column 2), sub-borough (column 5), or group of sub-boroughs (columns 3 and 4). If the attacks were to have broken the trend of absolute price and rental growth in the city, we would expect negative coefficients to predominate in the table. Analyzing the evidence on the city's appreciation relative to that of the rest of the nation requires another step, described below.

The first column of the table reports the overall citywide trends in prices and rents, controlling (as do all specifications reported here) for the units' structural characteristics. In addition, for owner-occupied units, we control for the year in which the owner acquired the unit or, for rental units, the year the occupant moved in. The requirement that we have information for all of these variables reduces the sample size to the approximately 51,000 reported in the table. We present results from both the level and semi-log specifications.

The results suggest that city residential prices and rents in 2002 were both higher than they were in 1999, the year of the previous survey. But when we subtract the national increase in shelter costs, 11.1 percent, only the price increase is statistically different from zero; rental increases were slightly slower in New York City than they were in the nation as a whole.[4] Note, however, that we can reject the hypotheses that absolute rents and prices in New York fell on average; all four estimates in column 1 are positive and more than twice their standard errors.

The second column of Table 1 reports the price changes in Manhattan in 2002 relative to 1999, controlling for citywide time effects. These results reveal a pattern similar to that in the citywide estimates. Although the point estimate of 12 percent rental appreciation in Manhattan slightly exceeds the national average, the standard error of the estimated coefficient does not allow for rejection of the hypothesis that the New York increase was the same as the nation's. Manhattan prices, meanwhile, grew much more rapidly than did the shelter component of the national CPIU.

Column 3 reports results for the two Lower Manhattan sub-boroughs and three Northwest Brooklyn sub-boroughs (see map). All of these areas benefit from direct accessibility to

Sub-Boroughs of Lower Manhattan and Northwest Brooklyn
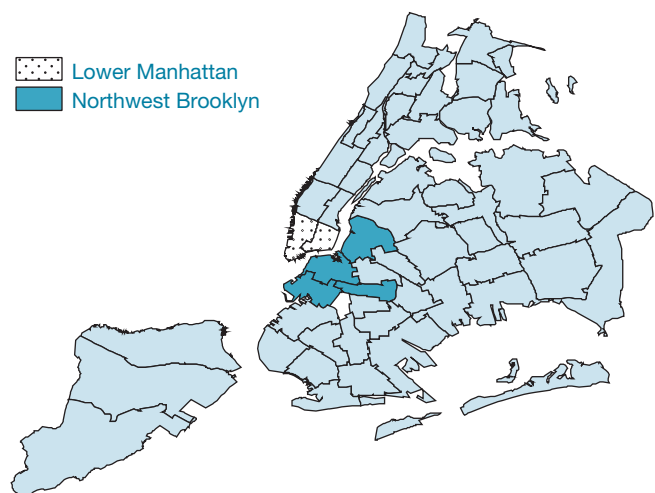
Source: U.S. Census Bureau.

the Lower Manhattan central business district, with housing units typically within a thirty-minute commute on public transportation.[5] We might thus expect residential markets in these areas to be negatively affected by the attacks. Again, the data provide little evidence to support this conjecture, although rental increases are statistically indistinguishable from zero for these areas as a whole.

Since the attacks occurred in Lower Manhattan, there is the potential that the area would endure significant reductions in demand. Columns 4 and 5 address this issue, using two definitions. In column 4, we include the area that extends as far north and east as Chinatown, while the column 5 results are limited to the Financial District and Greenwich Village. Once again, the evidence suggests price *increases* relative to the nation in all these areas as well as significant rent increases in the area most proximate to the World Trade Center.

Our tests indicate that demand for rental properties in New York was no stronger than demand in the nation, and in some areas it may have been weaker. Yet in Lower Manhattan, the area most affected by the attacks, rents grew strongly. The apparent divergence between the residential rental market in Lower Manhattan and that in the rest of the city may be partially attributable to incentives for residents to locate Downtown, part of the package of aid that the city received in the wake of the crisis. Under these programs, residents willing to make a two-year residential commitment to areas of Lower Manhattan close to the site of the attacks were eligible to receive up to $12,000 in grants. Our estimated 1999-2002 rental increase in Lower Manhattan (Table 1, column 5) less the increase in the city as a whole is about $325 per month, or approximately $7,800 over a two-year period. Unfortunately, we cannot identify which units receive the subsidy, so a direct

Table 1

2002 Price and Rent Effects in New York and Selected Subcity Areas

	Citywide (1)	Manhattan (2)	Lower Manhattan, Lower East Side, Northwest Brooklyn (3)	Lower Manhattan, Lower East Side (4)	Lower Manhattan (5)	Lower East Side (6)	Northwest Brooklyn (7)
Prices							
Dollars	**68,714**	**151,883**	**102,709**	**57,771**	**113,733**	-940	**130,467**
	(3,732)	(7,244)	(11,153)	(16,742)	(23,465)	(23,560)	(14,585)
ln	**0.77**	**1.3**	**1.03**	**1.23**	**2.01**	0.38	**0.8**
	(0.03)	(0.07)	(0.1)	(0.15)	(0.22)	(0.22)	(0.13)
Monthly rents							
Dollars	39.6	169.1	91.1	161	**365.4**	1.85	14.08
	(5.8)	(8)	(12.2)	(16.8)	(25.3)	(21.9)	(16.8)
ln	0.05	0.12	0.02	0.12	**0.37**	-0.06	-0.07
	(0.01)	(0.01)	(0.02)	(0.03)	(0.04)	(0.04)	(0.02)

Source: Authors' calculations, using data from the New York City Housing and Vacancy Survey.

Notes: The figures in bold represent increases that are significantly greater than national average increases in the shelter component of the CPIU between 1999 and June 2003 (11.1 percent). The total number of observations for prices is 16,672; the total number for monthly rents is 34,586. All regressions include controls for structural traits, survey year, rent control status, whether the unit is a condominium or cooperative (price regressions), whether the owner lives in the building (rent regressions), and year acquired (price regressions) or year the current occupant moved in (rent regressions). Rows labeled "dollars" are estimated in levels; results reported in rows labeled "ln" are from models in which the dependent variable is a natural logarithm.

For column 1, the coefficient and standard error estimates are on a dummy variable for 2002 prices, relative to 1999 prices. For column 2, the coefficient and standard error estimates are on a dummy variable for 2002 Manhattan prices, relative to 1999 Manhattan prices. For column 3, the coefficient and standard error estimates are on a dummy variable for 2002 prices in Lower Manhattan, Chinatown and the Lower East Side, and Northwest Brooklyn, relative to 1999 prices in the same areas. For column 4, the coefficient and standard error estimates are on a dummy variable for 2002 prices in Lower Manhattan and in Chinatown and the Lower East Side, relative to 1999 prices in the same areas. For column 5, the coefficient and standard error estimates are on a dummy variable for 2002 Lower Manhattan prices, relative to 1999 Lower Manhattan prices. For column 6, the coefficient and standard error estimates are on a dummy variable for 2002 Lower East Side and Chinatown prices, relative to 1999 Lower East Side and Chinatown prices. For column 7, the coefficient and standard error estimates are on a dummy variable for 2002 Northwest Brooklyn prices, relative to 1999 Northwest Brooklyn prices.

comparison of rent with the value of the subsidy is not possible. However, since the majority of the units in Lower Manhattan as we define it are eligible for smaller (or no) subsidies, it seems most likely that our estimate of the rental increase in the area incorporates demand effects above and beyond those stimulated by the subsidy.

Of course, the price of any good, including housing, is determined by both supply and demand. One potential explanation for increased rents (prices) in Lower Manhattan is reductions in the current (expected future) supply of units. Evidence of the direct effect of the attacks on the housing supply is hard to uncover. Table 2 displays the number of new housing units added to the Downtown stock from 1995 to 2004. In Downtown Manhattan, with its paucity of vacant land, office building conversions are an important source of new residences, as indicated in the table. Also important is a city tax-incentive program, adopted in 1995, that offers property tax abatements for residential conversions Downtown.

The data are difficult to interpret, as the peak year for new units was 2001—the year of the 9/11 attacks. Since the process of adding units to the stock takes time, it is reasonable to suppose that the vast majority of the 2,578 units that came on line in 2001 were planned before the attacks. Nonetheless, despite the national recession, the 2002-04 total of 4,167 units slightly exceeds the 1999-2001 total of 4,098, indicating little effect on the trajectory of the housing supply after 9/11. In addition, the 2004 total is the second highest of any year since 1995. The data, then, do not suggest a significant effect on the supply of Downtown residential units. Given that the supply of Downtown housing appears to have been changed little by the

Table 2
Downtown Residential Development, 1995-2004

Date Open	Conversions	New Developments	Total by Year
1995	8	0	8
1996	0	0	0
1997	46	0	46
1998	1,454	152	1,606
1999	102	398	500
2000	811	209	1,020
2001	2,139	439	2,578
2002	1,366	25	1,391
2003	545	449	994
2004	867	915	1,782
Totals	7,338	2,587	9,925

Sources: Alliance for Downtown New York; New York City Department of Housing Preservation and Development.

attacks, we interpret our results as strong evidence that the demand for residential locations in Lower Manhattan remained very robust in the wake of 9/11.

For the other areas potentially affected by the attacks, the signals are less clear. Rents in Northwest Brooklyn were essentially flat in nominal terms, and thus lagged the national average in the immediate aftermath of the attacks. Prices, however, remained strong, growing at a pace significantly faster than the national average. Meanwhile, on the Lower East Side, both prices and rents fell relative to the national average. This last finding complements earlier evidence that businesses in Chinatown, which is in the Lower East Side neighborhood, were affected negatively by 9/11-related disturbances in transportation and telecommunications infrastructure (Asian American Federation of New York 2002). Yet given that these were expected to be temporary phenomena—and indeed have largely been rectified in the years since 2001—the residential price effects we observe are a puzzle. Of course, long-run divergences between rents and prices may signal differences in current conditions and expectations of future conditions. The 2005 HVS, which will be released in 2006, may help answer some of these questions.

Some Caveats

We begin by noting that our analysis of the 2002 data is based on a comparison with 1999, the previous survey year. Because the 2002 survey was based on results from the 2000 decennial census, while the 1999 survey relied on the 1990 census, variations in the under- or overcount of housing units in the census could affect the results. This will only lead to biased estimates of the neighborhood effects if changes in the housing characteristics of miscounted units are correlated with neighborhood. Such a bias would likely appear as a significant change in results when sampling weights, which adjusts the sample data to match the census population characteristics. The results we describe above obtain whether the regression is estimated with or without the sampling weights, ameliorating this concern to some extent.

It is also possible that the prices and rents we observe in 2002, while higher than those in 1999, are lower than they were immediately before the attacks, a period for which less data are available. Analysis of actual transactions for which we have prices provides modest support for the contention that real prices in Manhattan were stronger in 2002 than in 2001, but the number of units in the HVS sample that sold in those two years is too small to allow any strong conclusions to be drawn from the data. We take some comfort from the fact that the analysis

of annual metropolitan statistical area trends produced conclusions broadly consistent with those advanced here.

Finally, the 2002 survey was conducted during the first half of the year, or immediately in the aftermath of the terrorist attacks of late 2001. Since very little time elapsed between the attacks and the beginning of the survey, there is potential bias in the survey responses. This bias could be in either direction: respondents might not have had time to internalize fully the negative effect of the attacks on their property values, and thus might have provided an overly optimistic view of value. However, Lower Manhattan in the first six months of 2002 was still very much in the throes of the turmoil created by the destruction of the World Trade Center and a substantial amount of city infrastructure (such as roads and subways). Indeed, the fires ignited by the attacks were extinguished only in late December 2001, and the cleanup of the site continued until late May 2002. In these circumstances, the idea that property owners would be overly optimistic about the value of their homes seems unlikely. Nonetheless, it is impossible to know for certain. Again, we take comfort from the fact that the results here are consistent with the analysis of the OFHEO price index.

2.4 Office Markets

We now examine trends in the market for office space in New York's two central business districts—Downtown and Midtown—using data from the National Real Estate Index.[6] These data are collected for class A office space in sixty markets across the nation. We focus on the two New York markets and, to control for prevailing national conditions, calculate indexes measuring appreciation in these markets relative to the nation. These indexes, which are based in 1985:4, are shown in Charts 4 and 5.

Note in these charts the trend deterioration of Downtown office prices and rents relative to Midtown. In rents, this pattern is evident immediately following the commencement of the data (Chart 4), although it is most pronounced in the price data after 1993 (Chart 5). This reduction in the relative premium for Downtown office locations is part of the long-term trend described by Glaeser and Shapiro (2002).

The September 11 attacks destroyed or rendered temporarily or permanently unusable nearly 28 million square feet of class A office space, 13.4 million of which was in the World Trade Center complex itself. If the demand for Lower Manhattan locations remained stable, we might expect to see a strong increase in office rents for the remaining Downtown office space. There is little evidence of this in Chart 4. Indeed, nominal class A office rents declined nearly 9 percent between 2001:3 and 2002:3, suggesting that demand fell at the same time as supply. A decline in demand is consistent with Glaeser and Shapiro's view that the attacks hastened the decline of Lower Manhattan as a principal site for New York City office locations. Yet this decline was matched by an 8.5 percent decline in class A rents nationwide, with the result being that both the Downtown and Midtown indexes depicted in Chart 4 remained essentially flat, with perhaps a modest downward trend.

CHART 4

Office Rent Indexes
Class A Space, Manhattan Markets Relative to National Average
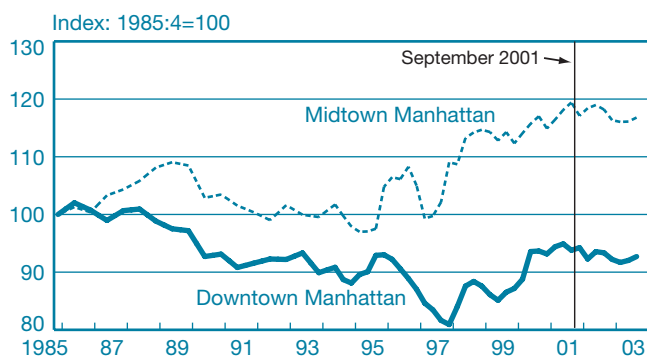
Index: 1985:4=100

Sources: Global Real Analytics, National Real Estate Index; Federal Reserve Bank of New York calculations.

Note: The indexes are based on the ratio of office rents in Manhattan to that of the United States.

CHART 5

Office Price Indexes
Class A Space, Manhattan Markets Relative to National Average
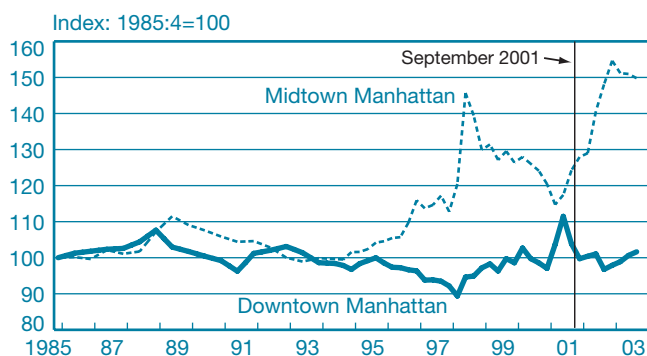
Index: 1985:4=100

Sources: Global Real Analytics, National Real Estate Index; Federal Reserve Bank of New York calculations.

Note: The indexes are based on the ratio of office prices in Manhattan to that of the United States.

Prices reveal an interesting pattern both before and after September 11, 2001 (Chart 5). Between 1985:4 and 2003:3, Downtown office building prices essentially held steady relative to the nation, while they fell relative to Midtown. Note, however, that Downtown prices reached a trough in 1998:1 (at which point, Downtown had fallen more than 10 percent relative to the nation since the end of 1985). From 1998:2 to 2001:2, the Downtown market rallied, and the relative price index stood at 111.5 on the eve of September 2001. By the close of 2001, the Downtown market had given back all its gains relative to the nation, and the index reached a low of 96.8 in 2002:3. There is modest evidence here of a rally in the Downtown market since that point, as the index rose back above the break-even point (101.6) by 2003:3.

The fact that the relative Downtown office prices remain below the peak they reached immediately prior to the September 11 attacks might be taken as evidence that the attacks themselves had a very substantial effect on office prices. There are several points to make here. First, the 2001:2 peak of the office index (111.5) was anomalous in the sense that it represented a sharply higher level than it did in the previous quarter (103.7). Second, the pre-9/11 rise in the index as we measure it was the result of a modest decline in the national index and a sharp uptick in the Downtown index.[7] That is, the chart shows a sharp increase in part because of the national office market downturn. Third, the fact that the Downtown office market stabilized in the subsequent two years provides some indication that demanders continue to find locations there attractive. By the end of the period, the relative Downtown price index was about 3 percent higher than it had been three years earlier. However, there is some evidence, as suggested by Glaeser and Shapiro (2002), of a post-attack shift in demand to Midtown, where prices have rallied strongly relative both to the nation and to Downtown since mid-2001. Statistical tests indicate that both the level and the growth rate of the ratio of Midtown to Downtown prices per square foot of office space increased significantly after 2001:3.

Overall, the evidence from the office market suggests a post-attack weakening of demand in Lower Manhattan relative to the rest of the nation, especially in light of the decline in the supply of space that accompanied the destruction of the World Trade Center. The most dramatic effects are seen in prices (Chart 5), although an unusual spike just prior to the attacks makes the data difficult to interpret. Nonetheless, it is clear that the dramatic increase in prices that occurred in Midtown has not been experienced Downtown. In rental markets, there is some sign of weakening in both Downtown and Midtown, although there was modest evidence of stabilization in both areas by the end of 2003.

These data are consistent with a fairly benign view of the attacks' effect on the demand for New York locations. As suggested by Glaeser and Shapiro (2002), it would appear that Downtown's appeal to businesses has declined relative to that of Midtown. However, Downtown demand has held up reasonably well relative to demand in the nation, especially given the temporary dislocations associated with the cleanup and redesign of the World Trade Center and surrounding areas.

We can calculate the weighted average price increase for all of Manhattan by applying the Downtown and Midtown shares of class A space as weights to the relevant price increases. That calculation yields a 12.6 percent increase in office prices across Manhattan between 2001 and 2003.

2.5 Summary

Our evidence suggests several interesting features of the 9/11 shock on the New York City economy:

- It destroyed a very significant share of the Downtown class A office stock.

- The shock exacerbated the effects of the ongoing recession, and almost certainly contributed to a sharp loss of city jobs in late 2001.

- Long-run demand for city locations relative to the rest of the nation appears to have been affected very little; modest evidence from aggregate real estate prices suggests that it may have continued to strengthen.

- Long-run demand for residential space in Lower Manhattan strengthened significantly, but demand in the short run was weaker.

- Both long- and short-run demand for office space in Lower Manhattan weakened relative to the rest of the nation, while demand for Midtown offices rose sharply.

3. INTERPRETING THE DATA

What can economic models tell us about what happens to cities over time when they experience significant shocks? Previous work on the dynamics of city economies in light of factor mobility is surprisingly limited. Wildasin (2003) describes a model in which at least one factor of production is imperfectly mobile in the short run, and explores the dynamic implications for tax competition. A key conclusion is that the effect of shocks depends on whether agents are surprised by them;

anticipated shocks have little or no effects. Glaeser and Gyourko (forthcoming) examine the implications of capital durability for paths of urban growth and decline. Both papers indicate that dynamics are very important to the behavior of actors and to the interpretation of empirical results.

A few papers provide models that explicitly incorporate shocks of the sort we examine here. Harrigan and Martin (2002) study simple equilibrium theoretical models of urban growth in the face of terrorism. In both models presented, a large shock is sufficient to reduce the long-run equilibrium size of the city, but the authors argue that large shocks of this type are unlikely to occur as a result of terrorism. They conclude that the transport cost and labor pooling advantages of urban density are likely to be broad and durable enough to absorb plausible terrorism shocks in the long run. The models that these authors adopt are not designed to examine intracity spatial or temporal dynamics, but their results are broadly consistent with the evidence from New York.

In a noneconomic approach to the effects of 9/11, Beunza and Stark (2003) report the results of an ethnographic study of a financial services firm before and after the 2001 attacks. They conclude that the organization's ability to recreate itself was the result of a complex interaction of human and technological capital. One theme that clearly emerges is the primacy of networks across firms and information sharing within the firm. These findings suggest that spatial concentration of activities is an enduring feature of advanced service economies, even in light of sophisticated technologies for transferring and storing information. These conclusions support those of Harrigan and Martin while adding some empirical detail to the advantages conferred by density. One relevant feature of Beunza and Stark's study is that it does not presume that the spatial organization of activity on September 10, 2001, was an equilibrium allocation, which implies that the dynamics of recovery will depend on the expected future configuration as well as the particular character of the shock.

The aggregate effect of shocks on the New York City economy has been empirically documented by several authors. Two kinds of shocks have drawn special attention: the 9/11 terrorism shock (Haughwout 2005) and changes in city fiscal policies (Haughwout et al. 2004). One remarkable feature of these studies is the very different responses that the city economy exhibits in response to these different kinds of shocks. Haughwout et al. find that small changes in tax rates have substantial effects on city tax bases, which are themselves determined by city economic activity, including employment. However, as we indicate, the arguably very large shock caused by the attacks of September 11 resulted in very little aggregate effect on the city economy, but it seems to have been associated

with changes in the equilibrium distribution of activities over space.

Rossi-Hansberg (2004) provides a dynamic general equilibrium analysis of the effect of a terrorist attack on a city economy. The paper reaches several conclusions. First, the long-run effect of a terrorist attack on the overall size of a city is expected to be substantial, with a benchmark simulation suggesting that a modestly sized attack would produce city output declines of between 12 and 21 percent, depending on commuting costs. Second, the new equilibrium spatial configuration features no uniform effects on business land rents, but uniformly *higher* residential land rents.

In Rossi-Hansberg's model, the long-run effect of a terrorist attack is determined by what the attack implies about ongoing risks of future destruction and the distribution of that threat over areas of the city, or what the author refers to as the "terrorism tax." Policy interventions such as subsidies to development in areas that are (incorrectly) perceived to be at elevated risk of future attacks will improve welfare only to the extent that the public sector has special (correct) information about the probability of future attacks that it cannot credibly convey to private actors.

Glaeser, Gyourko, and Saks (2004) emphasize the importance of land use regulations in influencing the level and distribution of economic activity in New York. Government's role in providing information that affects development may have been an important factor in the case of New York as well, although in a different way than those highlighted by Rossi-Hansberg and Glaeser, Gyourko, and Saks. Because government plays an important role in determining the equilibrium spatial configuration of activity in New York City, clear pronouncements about the future equilibrium configuration provided market players with information in the face of uncertainty. This information appears to have been valuable enough to more than offset the terrorism tax that 9/11 imposed on the city, allowing a relatively smooth transition toward the new equilibrium.

3.1 Understanding New York's Response to 9/11

New York's relatively rapid recovery after 9/11 is a puzzle. How could such a large shock result in so little aggregate change in the economy after just two years? One possible explanation is that while the general public did not anticipate a terrorist attack of such magnitude, relevant market actors like property developers and their insurers understood that it was a real possibility. An example of evidence supporting this argument

is that this was not the first terrorist attack on the World Trade Center, which had survived an attempt to topple the towers in 1993. Another possibility is that relevant market actors expected that the shock would never be repeated, or that the ongoing terrorism tax was very low. Yet neither notion is supported by evidence from insurance markets. In the immediate aftermath of the attacks, property insurance prices soared (Lakdawalla and Zanjani 2005), suggesting that the shock was unanticipated and that the perceived probability of further attacks had risen.

As we observe, Lower Manhattan on the eve of the 9/11 terrorist shock was already changing from a primary location of the financial services and banking industries, centered on Wall Street. As indicated in Charts 4 and 5, Manhattan office rents and prices had lagged those in Midtown for at least fifteen years. Indeed, public construction of the World Trade Center itself in the 1960s was an effort to resuscitate a lagging Downtown office market (Glaeser and Shapiro 2002). Meanwhile, throughout the 1990s, demand for Manhattan residential locations, including Downtown, was strong.

Prior to 9/11, the movement of office employment to Midtown was gradual, in part because of a shortage of accessible, developable land in Midtown; existing stocks of office capital Downtown; and heavy government regulation in both markets. Given that only the last of these can be altered in the short run, it is useful to think about the spatial allocation of activities in Manhattan prior to 9/11 as a disequilibrium.

A critical feature of this disequilibrium is the central role played by government in affecting the distribution of activities in New York. Industries and occupations that place high value on spatially defined networks dominated employment in pre-9/11 Lower Manhattan. For these firms, the geographic characteristics of places are less important than their economic and social characteristics. That is, the agglomeration of financial services firms that exists in Lower Manhattan could potentially be located anywhere within the greater New York commuting area, as long as the relevant actors are located together. As a preexisting agglomeration begins to come apart, firms lack a means of coordinating their new locations so as to remain near each other. When the public sector has important effects on location patterns, government regulators have the tools at their disposal to serve this coordination function.

In this context, the behavior of public officials in the wake of the 9/11 terrorist attacks had the potential to be a crucial determinant of the future level and distribution of activity. How did officials respond? The federal government immediately pledged $20 billion in aid to reconstruct the city, signaling that it was committed to maintaining New York as the nation's primary center of economic activity. City officials responded in several ways. In addition to proposing detailed plans for the use of the federal money, they made strong and repeated announcements about the future of Downtown Manhattan as a 24/7 mixed-use community. In addition, city officials sought to divert some of the federal resources intended for Downtown businesses to businesses located elsewhere in the city.[8] Finally, Mayor Michael Bloomberg's administration accelerated the process of developing the far West Side of Manhattan, adjacent to Midtown, as a new premium office location complete with a new football stadium.

All of these actions served to signal that the city intended to accommodate the transformation of Downtown into a residential location. This transformation included the relocation of financial services jobs from Downtown to Midtown. All of these actions, whether intentionally or not, provided valuable information to market participants in the wake of 9/11. The change from Downtown as a business location to Downtown as a residential location proceeded slowly, in part because of the existence of large amounts of sector-specific capital. The 9/11 attacks destroyed a large portion of this durable capital in a short period of time. In the market uncertainty that followed, consistent government behavior was interpreted as a clear signal that the future location for business was Midtown.

This view of the evidence is, we believe, consistent with much of the previous literature on city economies. It places appropriate weight on the importance of networks and spillovers, as emphasized by Beunza and Stark (2003). It also stresses the importance of government activities in general (Rossi-Hansberg 2004) and in New York (Glaeser, Gyourko, and Saks 2004). Finally, it provides a potential explanation for the difference between the findings in Haughwout et al. (2004) on tax shocks and the relatively small effect of the terrorism tax. What distinguishes the two is that in the latter case, government is attempting to offset an exogenous shock, while in the former, government itself is generating a "surprise," to use Wildasin's (2003) language. Combined, these results suggest that the actions of New York City government are perceived to be highly credible, both when they signal preferred patterns of land use and when they signal a redistribution of resources.

4. Conclusion

The resilience of cities to powerful shocks has been documented by many authors. In this paper, we present and interpret data on the effects of the September 11 attacks on New York City. The New York experience is consistent with a significant role for government in resolving uncertainty in the immediate aftermath of the attacks. Our results suggest that

cities' responses will depend on the size of the original shock and its expected ongoing cost (in this case, the terrorism tax), whether the preshock spatial configuration was an equilibrium, and the importance and effectiveness of public sector actors as coordinating agents.

If this conjecture is valid, then a negative shock to capital stocks in a city that is in a stable equilibrium will likely reduce activity in the short run, but absent a long-run cost, long-run levels and the spatial distribution of activity will return to the previous equilibrium. But when a city's spatial configuration is far from equilibrium, the shock will potentially exert a stronger effect on the spatial distribution of activity in the long run. In the case of New York, the fact that the city was not in equilibrium, as evidenced by the long-term trends away from Downtown as a business location, and that a very influential local government provided clear information led to marked increases in the Midtown premium for business locations and the Downtown residential premium.

In addition to emphasizing the importance of government behavior, these results suggest that analysts who study the effect of shocks on urban economies take into account the potential effects of disequilibrium on the shock's effects. The results also suggest the usefulness of modeling both the temporal and the spatial dimensions of the shock.

Endnotes

1. The New York City CEI is a broad-based, dynamic single-factor measure of economic activity, constructed according to the methodology of Stock and Watson (1989). The index is calculated from the common movements in four indicators tied to the city's labor market: payroll employment, the unemployment rate, average weekly hours worked in manufacturing, and real earnings. The CEI is described more fully in Orr, Rich, and Rosen (1999).

2. A complete description of the survey is available at <http://www.census.gov/hhes/www/housing/nychvs/2002/nychvs02.html>.

3. Because of high correlations among the measures of unit quality, the specifications reported in Table 1 exclude some variables. These exclusions have no effect on the coefficients of interest. R^2 values for the regressions range from 0.72 for the price equations to 0.85 for the rent equations. Detailed results are available upon request.

4. All prices and rents are measured in nominal terms. The shelter component of the national CPIU increased 11.1 percent between 1999 and June 2002 (Council of Economic Advisers 2005, Table B-61). Since the rental and owner's equivalent rent components grew at similar rates (12.3 percent and 11.1 percent, respectively), we use the total as our benchmark; disaggregating would not affect our conclusions. Overall CPIU inflation over this time period was 8.0 percent.

5. Average commutes in New York City outside of Manhattan average more than forty minutes, placing the four "outer boroughs" sixth, seventh, eighth, and ninth in the national ranking of longest commuting times.

6. Global Real Analytics, which produces the index, collects quarterly information on recently closed office building sales and average rents for class A office space.

7. The price for a square foot of class A office space in Lower Manhattan rose from $307 in 2001:1 to an all-time high of $328 in 2001:3, while the national average fell from $215 to $213. Comparing fourth-quarter prices, we note that Downtown prices were 4.8 percent higher in 2001 than they were in 2002.

8. See <http://www.lowermanhattan.info/construction/looking_ahead/residential_growth.asp>.

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