Risking House and Home:
Disasters, Cities, Public Policy

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Editors

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Cover: Loma Prieta Earthquake, October 17, 1989. San Francisco, California. Collapsed and burned buildings at Beach and Divisadero streets in the city's Marina District.
Photograph: C. E. Meyer, US Geological Survey

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The terrorist attacks of September 11, 2001 exacted a terrible human toll on New York City, and early estimates suggested that the city's economy suffered a severe negative shock. We provide evidence that, while the short-run effect of the attack was substantial, the city's economy demonstrated substantial resilience over the longer run. This resilience was anticipated by market actors and reflected in strong prices for the city's stock of assets - land and structures. Nonetheless, the short-run impact on local government revenue led to a serious, albeit transitory, fiscal problem for the city. At the same time, the importance of the city economy to New York state revenue, and institutional peculiarities of the state's personal income tax, meant that the state faced a serious revenue shortfall. In the end, the city dealt with its fiscal problems with little cash from the state, relying instead on its own tax base and federal aid. We use these observations to discuss the problem of fiscal policymaking in a federation subject to geographically concentrated shocks.

I. Introduction

The destruction of the World Trade Center ("WTC") on the morning of September 11, 2001 took place in a city that was in the midst of both short- and long-run change. In the short run, the New York economy was experiencing a sharp turnaround in its cyclical fortunes: between 1996 and 2000, the city had registered what was arguably its strongest performance in the postwar period

The authors are grateful to George Sweeting, Ami Glazer and participants at the Berkeley Symposium on Real Estate, Catastrophic Risk, and Public Policy, March 22-23, 2006 for comments on an earlier draft. The authors would also like to thank Robert Inman for suggesting the analytical framework for measuring the fiscal costs of 9/11. The views presented here are those of the authors, and do not necessarily reflect those of the Federal Reserve Bank of New York or the Federal Reserve System.

(Haughwout and Rabin, 2005). We argue that the attack exacerbated the decline in the city's economy in the short run, but that the strength of the city as a location for businesses and households was unaffected. New York's management of short-run fiscal stress in an economy with a bright long-run outlook is the subject of our paper.

We begin with a review of the effects of the attack on the city's economy in both the short and long runs. This effort is complicated by the fact that the attack took place in the midst of a national and local recession. We then turn to analysis of the local fiscal impact of the attack and conclude with a discussion of the design of fiscal institutions in a world with geographically concentrated shocks.

II. How Did 9/11 Affect New York City's Economy?

The destruction of the WTC held the potential to create several kinds of effects on the New York economy. First, and most horrific, the attack cost nearly 2,800 lives. In economic terms, this means that the human capital stock for the entire metropolitan region was reduced in the short run. In spite of the tragic consequences for the individuals and their families, however, the direct impact on the long-run supply of human capital in New York City, an open economy with over 3.5 million jobs and eight million residents, is small.

The sixteen acres of the WTC site housed approximately 13.4 million square feet of class A office space, nearly thirty percent of the downtown total.[1] This complex was destroyed on September 11th, and several surrounding buildings were damaged or essentially destroyed when the towers fell. While some residential space was also damaged, it was reoccupied relatively quickly. As of this writing, the WTC site remains essentially vacant, although a temporary public transportation station occupies a small portion of the area. This persistent loss of productive business land and capital was a potentially substantial cost to the city's economy over the short and medium terms. In addition, for several months following the attack, movement in Lower Manhattan was severely restricted, raising the cost of doing business in the area.[2]

The attack provided information to market players about the potential for future loss of life and property to international terrorism. It was this feature of September 11th that caused many commentators to voice significant concerns about the future of New York, and indeed cities in general, over the long run (see, for example, Mills, 2002).

To assess the short-run economic impact of the 9/11 shock, we rely on changes in real economic variables, especially employment and overall activity, as

[1] We are grateful to M. Myers Mermel of Tenantwise.com for providing these data in private communication.

[2] The restrictions included the temporary loss of several public transportation stations and, in the days immediately following the attack, prohibitions on vehicular traffic and limits on the movement of people south of Chambers Street.

well as changes in the rental rates of private capital. Long-run effects are examined by looking for changes in the prices paid for the stock of city assets. In the case of a city facing an imperfectly elastic supply of land, we believe that land prices offer the best measure of changes in demand for city locations. In all cases, we take care to control for the effects of the ongoing national recession, which itself had important effects on conditions in New York City.

A. Short-Run Effects of 9/11

Our short-run analysis focuses on pre- and post-attack changes in five measures: employment, income, overall economic activity levels, vacancy rates and monthly rents.

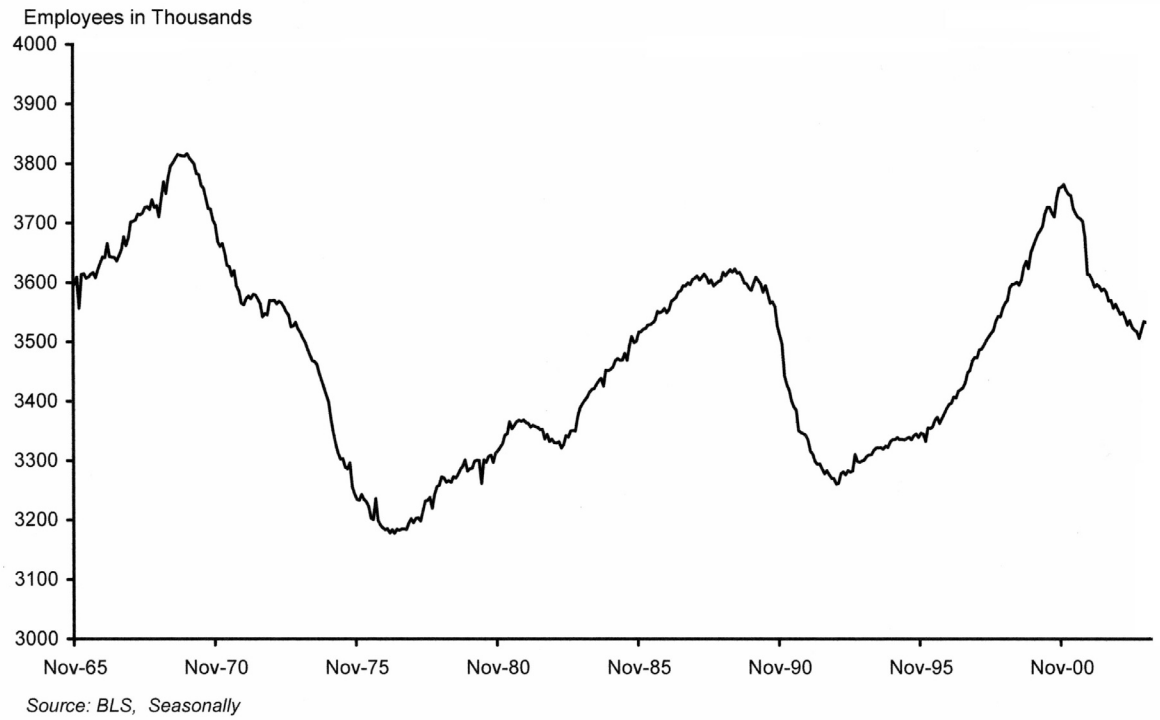
Employment, Income and Economic Activity

Employment in New York peaked in December 2000, and declined by 60,000 jobs by August 2001. About another 100,000 jobs were lost between August and October, 2001, as shown in Figure 8.1. A preliminary estimate by Bram, Orr and Rapaport (2002) indicated that the losses attributable to the attack itself peaked in February 2002 at between 49,000 and 71,000 jobs, accompanied by wage and salary shortfalls in the range of $3.6 billion to $6.4 billion by June 2002. Later analyses (Bram, 2003) adjusted the estimated attack-related job loss to about 60,000, with income losses presumably toward the center of the earlier estimate's range, or around $5 billion.

The New York City Index of Coincident Economic Indicators (NYC-CEI), a broad-based measure of economic activity in New York City, began falling as the local recession commenced in January 2001. That index declined nearly 0.95% in September 2001 alone, as shown in Figure 8.2.[3] This was the fourth largest monthly decline in the history of the index, since it was first tracked in 1965. While the NYC-CEI continued to decline until August 2003, the total decline for the full 2001-2003 downturn totaled 8.9%, significantly less deep than the recession-induced drops that began in 1969 and 1989. In addition, the rates of decline before and after September 2001 are approximately the same, suggesting that the ongoing national recession was an important factor producing the adverse outcomes in the city's economy. Nonetheless, the fact that the national economy began to grow sometime in late 2001 or early 2002, while the city's continued to

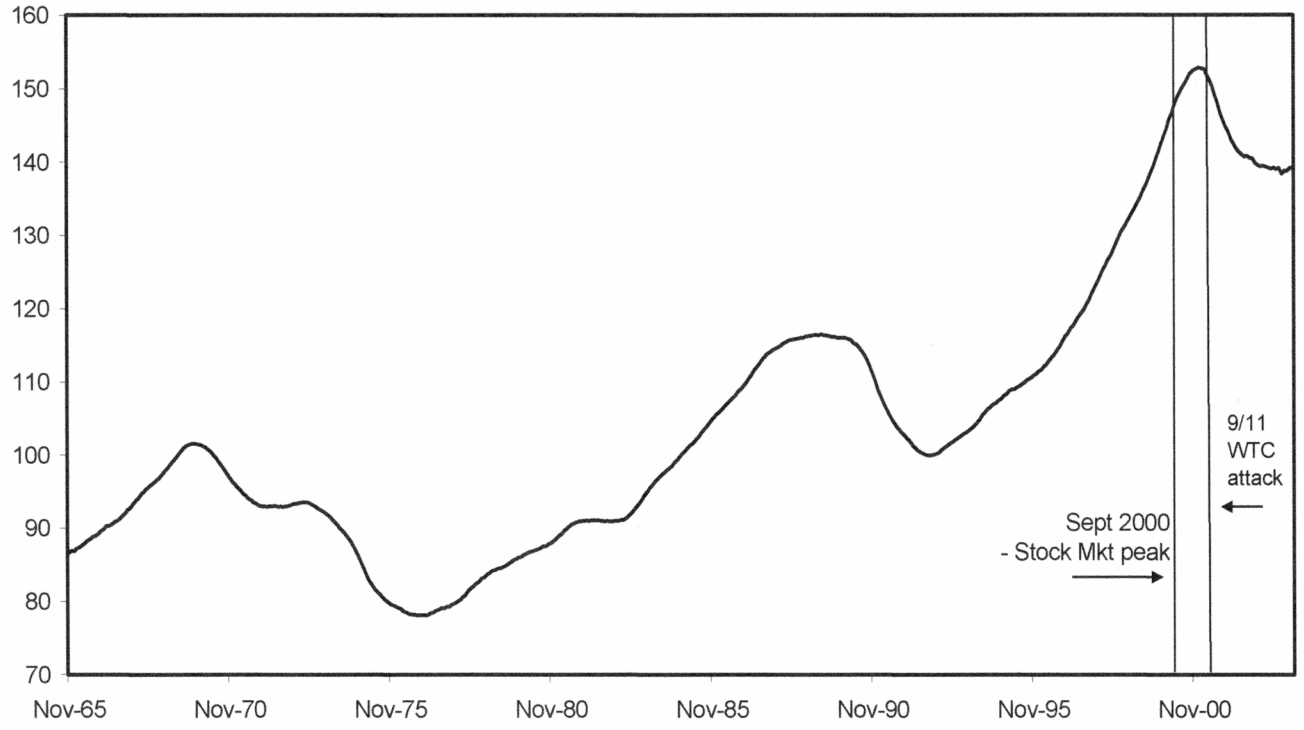
[3] NYC-CEI is a dynamic single-factor measure, now constructed following the methodology of Stock and Watson (1989). The index is calculated from the common movements in four indicators tied to the city's labor market: payroll employment, the unemployment rate, average weekly hours worked in manufacturing, and real earnings. The NYC-CEI is described more fully by Orr, Rich and Rosen (1999).

Figure 8.1. Employment in New York City



Source: BLS, Seasonally

Figure 8.2: New York City Index of Coincident Economic Indicators



Source: Federal Reserve Bank of New York

decline for twenty more months, suggests that the attack had a significant negative effect on the short-run performance of the overall local economy.

Rental Housing Markets

Additional evidence of short-run effects of the attack may be found in the city's real estate markets. The figures in Table 8.1 are the regression coefficients on calendar-year 2002 dummies, either on their own or interacted with dummies for particular definitions of the area most likely to be affected by the attack. The data for these regressions are from the New York City Housing and Vacancy Survey ("HVS"), a triennial survey of housing units in the city similar in design to the American Housing Survey. The dependent variable for the regression reported in panel A of Table 8.1 is monthly contract rent for non-owner-occupied housing units, and the regressions include controls for the structural characteristics of the units as well as their status in New York City's rent stabilization system. We present results from both the levels and semi-log specifications. Boldface entries in Table 8.1 indicate that 1999-2002 neighborhood rental growth exceeded the national increase in shelter costs, or 11.1%. If the attack were to have broken the trend of rental growth in the city, we would expect negative coefficients to predominate in panel A. Instead, the data indicate that apartment rentals in most of New York were essentially flat relative to the nation.[4] Since the HVS measures existing stock of rental agreements, rather than the most recent contracts, it is expected to understate marginal changes in the rent commanded by units newly on the market.

A remarkable exception to the general softness of apartment rents is the downtown market, which strengthened both in absolute terms and relative to the nation. The apparent divergence between rental markets in Lower Manhattan and the rest of the city may be partially attributable to incentives for residents to stay or relocate in this area, part of the package of aid that the city received in the wake of the crisis (see discussion below). Under these programs, residents willing to make a two-year residential commitment to areas of Lower Manhattan close to the site of the attack were eligible to receive up to $12,000 grants. Our estimated 1999-2002 rental increase in Lower Manhattan (see Column 5 of Table 8.1) less that in the city as a whole is about $325 per month, or about $7,800 over a two-year period. Unfortunately, we cannot identify which units receive the subsidy, so a direct comparison of rental effects with the value of the subsidy is not possible in these terms. However, the majority of units in Lower Manhattan as we define it were eligible for smaller (or zero) subsidies, leading to the tentative conclusion that the rents rose, even net of the value of these subsidies.

[4] Haughwout (2005) describes the calculations underlying these figures in detail.

Table 8.1: 2002 Price and Rent Effects in New York and Selected Sub-City Areas*

	Citywide (1)	Manhattan (2)	Lower Manhattan, LES, NW Brooklyn (3)	Lower Manhattan, LES (4)	Lower Manhattan (5)
a. Monthly Rents (N=34,586)					
Monthly Rents ($)	39.6 (5.8)	169.1 (8.0)	91.1 (12.2)	161.0 (6.8)	**365.4** **(25.3)**
Logarithm of Monthly Rents	0.05 (0.01)	0.12 (0.01)	0.02 (0.02)	0.12 (0.03)	**0.37** **(0.04)**
b. Prices (N=16,672)					
Prices ($)	**68,714** **(3,732)**	**151,883** **(7,244)**	**102,709** **(11,153)**	**57,771** **(16,742)**	**113,733** **(23,465)**
Logarithm of Prices	**0.78** **(0.02)**	**1.30** **(0.07)**	**1.03** **(0.10)**	**1.23** **(0.15)**	**2.01** **(0.22)**

Notes to Table 8.1:

* Figures in bold represent increases that are significantly greater than national average increases in the shelter component of the CPI between 1999 and June 2002 (11.1%).

All regressions include controls for structural traits, survey year, rent control status, whether 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).

(1) Coefficient and standard error estimates on a dummy variable for 2002 prices, relative to 1999 prices.

(2) Coefficient and standard error estimates on a dummy variable for 2002 Manhattan prices, relative to 1999 Manhattan prices.

(3) Coefficient and standard error estimates on a dummy variable for 2002 prices in Lower Manhattan, Chinatown and Lower East Side and Western Brooklyn, relative to 1999 prices in the same areas.

(4) Coefficient and standard error estimates on a dummy variable for 2002 prices in Lower Manhattan, Chinatown and Lower East Side relative to 1999 prices in the same areas.

(5) Coefficient and standard error estimates on a dummy variable for 2002 Lower Manhattan prices, relative to 1999 Lower Manhattan prices.

Rental Office Space

The attack destroyed or rendered temporarily or permanently unusable nearly twenty-eight million square feet of Class A office space, 13.4 million of which was in the WTC complex itself. In spite of these losses, the office vacancy rate in Manhattan rose in late 2001, led by a sharp increase (from 6.4% to 9.5%) in the downtown market (Bram, Orr, and Rapaport, 2002). The exodus of jobs from Lower Manhattan would thus appear to have exceeded those directly displaced from unusable space. However, there is some evidence that firms economized on space by reducing their allocations of space per employee, and that significant amounts of "shadow space" - available space that was not measured as vacant - served to absorb some of the employees displaced from downtown (Fuerst, 2005).

We examine trends in the rental price of office space in New York's two central business districts, downtown and midtown, using data from the National Real Estate Index ("NREI").[5] These data are collected for Class A office space in sixty markets across the nation. To control for national conditions, appreciation indices are calculated relative to the nation as a whole. The rental market, displayed in Figure 8.3, is our measure of the short-run effects of the attack on business location decisions. If the demand for Lower Manhattan locations had 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 Figure 8.3. Indeed, nominal Class A office rents declined nearly nine percent between the third quarter of 2001 and the same quarter in 2002, suggesting that demand fell at the same time as supply. A decline in demand is consistent with Glaeser and Shapiro's (2002) view that the attack hastened the existing decline of Lower Manhattan as a principal site for New York City office locations. Yet this decline was matched by an 8.5% decline in Class A rents nationwide, with the result that both the downtown and midtown indexes depicted in Figure 8.3 remained essentially flat, with perhaps a modest downward trend.[6] We conclude that both midtown and downtown commercial rents softened significantly in the wake of the 9/11 attack.

We thus detect evidence of significant dislocations to the short-run trajectory of New York City's overall activity levels - and particularly in its labor and real estate markets - that can reasonably be attributed to the 9/11 attacks. We turn next to the evidence of the effects of the "terror tax" on expectations for New York City's long-run future.

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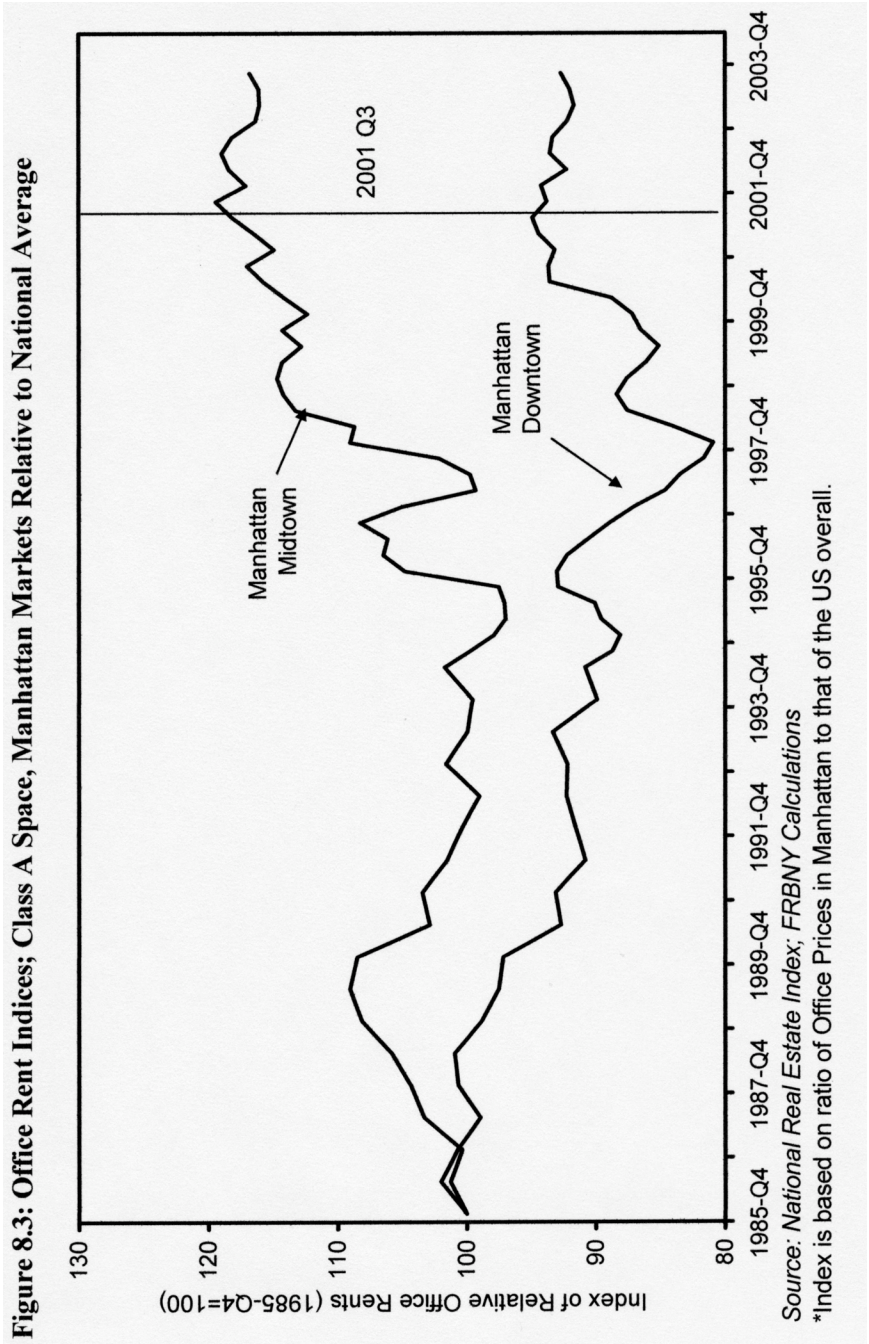
[5] Global Real Analytics, which produces the NREI, collects quarterly information on recently closed office-building sales and average rents for Class A office space.

[6] Like the HVS, the NREI measures average prices of the existing stock of rental agreements and, in a rapidly changing market, may underestimate changes in rents at the margin.

Figure 8.3: Office Rent Indices; Class A Space, Manhattan Markets Relative to National Average



Source: National Real Estate Index; FRBNY Calculations

*Index is based on ratio of Office Prices in Manhattan to that of the US overall.

B. Long-Run Effects of 9/11

We focus on building prices as an indication of changes in demand for New York City locations. Overall, we detect little evidence of permanent effects from any ongoing "terror tax" on either urban or suburban land markets, whether the land is currently occupied by businesses or households. We do, however, note some weakness in the expected future of the downtown office market.

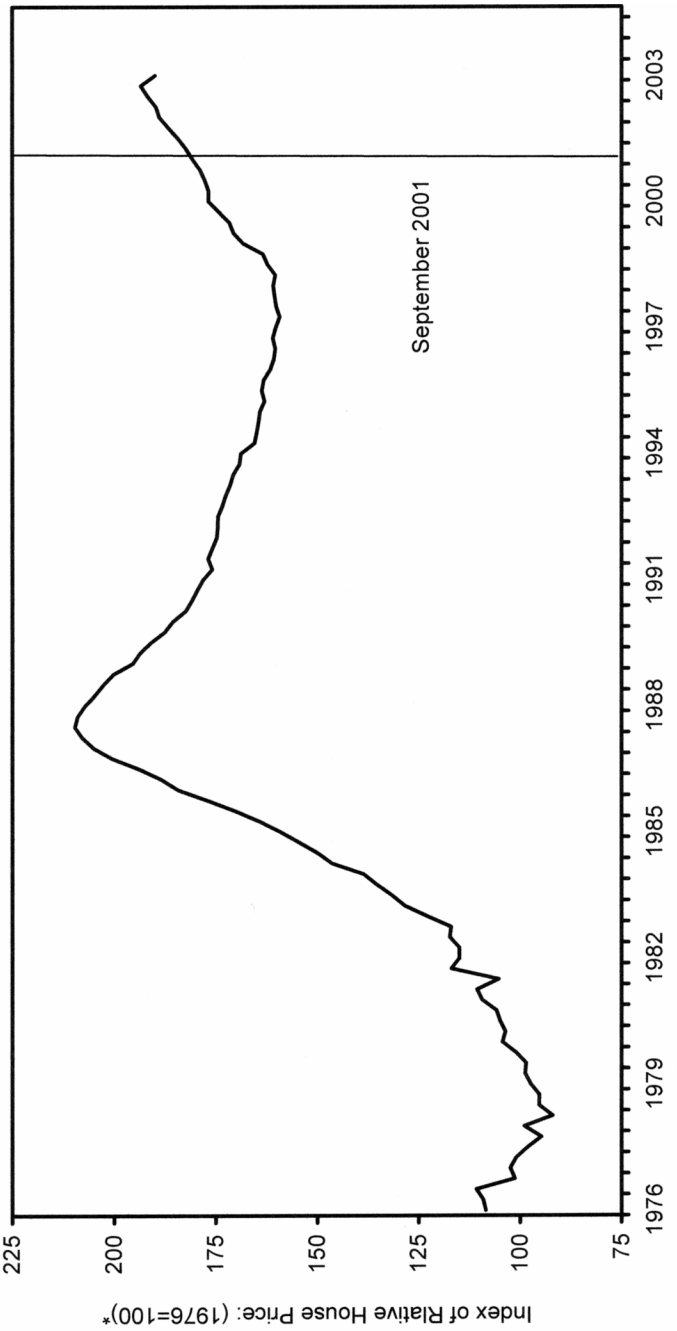
Housing Markets

Figure 8.4 shows the quarterly single-family home price index published for the New York metropolitan area by the US Office of Federal Housing Enterprise Oversight ("OFHEO"), divided by the OFHEO national index. The relative index is set to one hundred for the second quarter of 1976, when the New York series began. There is little evidence here that the 9/11 attack on the WTC reduced the long-run demand for residential locations in the surrounding metropolitan area. Repeat-sale house prices in the New York area were rising faster than in the rest of the nation both before and after the attack, as shown by the steady rise in the index on both sides of the 9/11 point. That is to say, the New York area's residential housing market *gained* ground on the rest of the nation immediately after the attack. The OFHEO data cover only single-family homes, which are presumably located primarily in the suburbs. Increased demand for single-family houses could reflect *reduced* demand for Manhattan locations, and a decentralization of population from New York City proper (Mills 2002).

Yet analysis of owner-occupied units in New York City indicates a similar pattern. Our data source, the HVS, allows consideration of rental apartments and condominiums as well as single-family homes, with the mix reflecting the actual housing consumption patterns of city households. Panel B of Table 8.1 shows that, unlike rents in Panel A, housing prices in all the areas covered grew significantly more rapidly than the shelter component of the national Consumer Price Index (U-series). Table 8.2 provides evidence of substantial increases in the supply of residential units downtown, indicating that price increases probably understate the increase in demand.

Taken as a whole, there is no evidence here of any declines in prices for residential property that could be attributed to the September 11th terrorist attack. Indeed, given that the supply of downtown (and citywide) housing appears to have been little changed by the attack, we interpret these results as strong evidence that the demand for residential locations in Lower Manhattan and elsewhere in New York remained very robust in the immediate wake of the 9/11 attack.

Figure 8.4: NYC-Area House Prices Relative to US Average



Source: Office of Federal Housing Enterprise Oversight; FRBNY Calculations
*Index is based on ratio of repeat-sales price measure for existing single-family homes in the NYC metro area to that of the US overall.

Table 8.2. Downtown Residential Development, 1995–2004

Date Open	Conversion	New Development	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

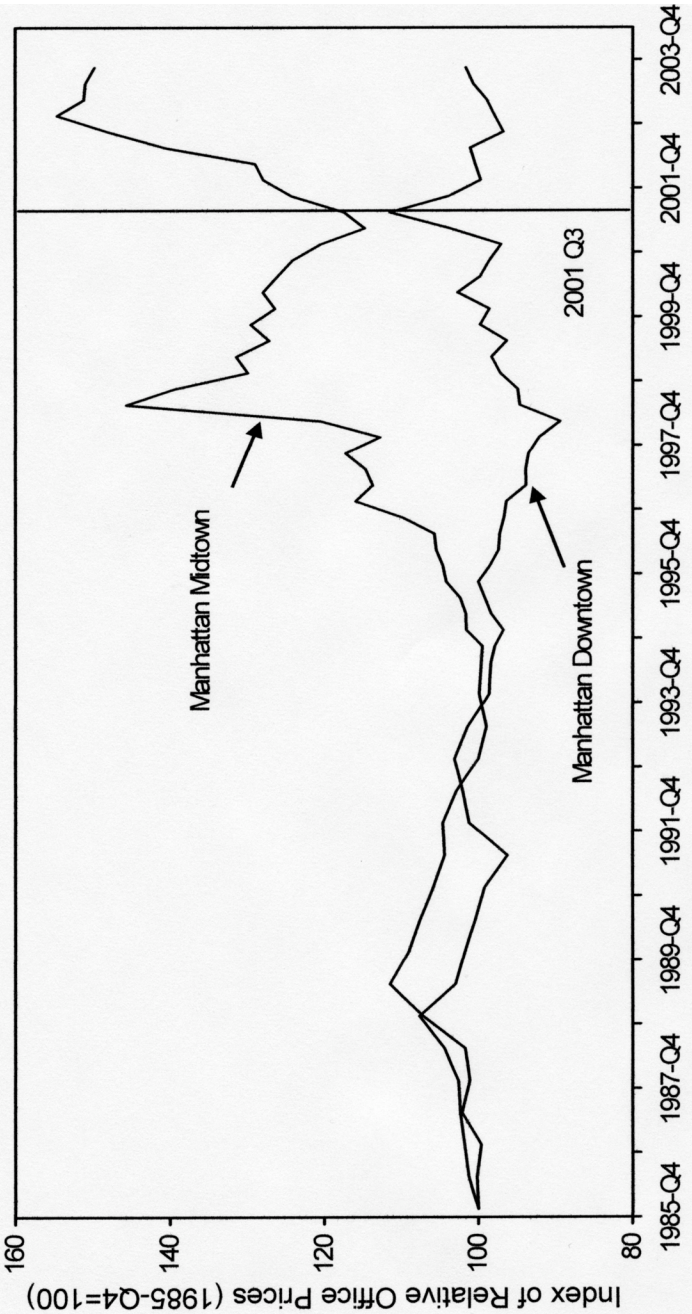
Source: Alliance for Downtown New York; New York City Department of Housing Preservation and Development.

The Market for Office Buildings

The relative sales price of office buildings depicted in Figure 8.5 reveals an interesting pattern both before and after September 11th. While holding essentially steady relative to the nation between 1985 and 2003, the downtown office market rallied from a trough in 1998. The relative price index stood at 111.5 in early 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 recent low of 96.8 in the third quarter of 2002. There is modest evidence of a rally in the downtown market since that point, as the index rose back above the breakeven point (at 101.6) by the third quarter of 2003.

The fact that relative downtown office prices remain below the peak they reached immediately prior to the attack might be taken as evidence that the attack itself had a very substantial effect on office prices. However, the peak of the office index in the second quarter of 2001 (111.5) was anomalous, in the sense that it represented a sharply higher level than the previous quarter (103.7). 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 three percent higher than it had been three years earlier. On the other hand, there is some evidence, as suggested by Glaeser and Shapiro (2002), of a post-attack

Figure 8.5: Office Price Indexes; Class A Space, Manhattan Markets Relative to National Average



Source: National Real Estate Index; FRBNY Calculations

*Index is based on ratio of Office Prices in Manhattan to that of the US overall.

shift in demand to midtown, where prices have rallied strongly relative to both the nation and to downtown since mid-2001.

Overall, the evidence from the office market suggests a modest post-attack weakening of demand in Lower Manhattan relative to the rest of the nation, especially in light of the decline in supply, and a dramatic increase in office prices in midtown. Given the dislocations associated with the cleanup and redesign of the WTC and surrounding areas, downtown demand has held up reasonably well relative to the nation. For Manhattan as a whole, the weighted average price increase shows an impressive 12.6% *increase* in relative office building prices between 2001 and 2003.

The challenge facing the city in the wake of 9/11 can therefore be characterized as a need to offset the effects of a large but temporary shock to the private economy. How the city managed its own finances is the subject of the next section.

III. The Fiscal Effects of 9/11[7]

The combination of national recession, the bursting of the high-tech bubble, and the 9/11 attack led to a severe deterioration in the fiscal condition of New York City. The city's *de facto* rainy-day fund was quickly exhausted.[8] To address the immediate problem, balanced-budget accounting rules were temporarily waived, allowing the city to issue an additional $2.1 billion in long-term debt in FY02, at an annual cost of between $150 million and $180 million. To deal with projected budget deficits of $1.1 billion in 2003 and $6.4 billion in 2004 (fourteen percent of total expenditures that year), the city cut expenditures, raised taxes, and substituted federal for local spending. In this section, we estimate the public-sector costs imposed on the city by the 9/11 attack and compare those costs to the level of federal compensation.

A. Analytical Approach

Though our goal in this section is to assess the fiscal costs of 9/11, our approach is based on changes in the welfare of the residents of the city. The government's function is to provide the services demanded by its residents and collect sufficient revenues to pay for those services. Economic well-being is assumed to depend on after-tax income and the level of public services. The loss suffered by New York residents due to the 9/11 attack can be separated into the loss in pretax

[7] This section draws heavily on Chernick (2005).

[8] By using at least partially anticipated surpluses in any given year to prepay debt service and public-authority expenditures in the next year, New York City has been able to smooth out variations between its relatively cyclical revenue structure and its expenditure requirements.

income and the loss through the public sector. The loss through the public sector is equal to the increased tax rate required to offset the loss in tax base from the disaster and pay for any increase in service costs in its wake. Assuming public service levels are unchanged, tax rates must rise in order to offset the loss in tax base. An increase in transfers helps to offset the loss in income, but must be partly financed from local sources. The analytical approach for measuring public sector costs is presented in the appendix to this chapter.

B. Measurement of Losses

In this section, we provide estimates of the components of the public-sector loss, as described in equation (8) in the appendix, and federal compensation, as described in appendix-equation (10). Cost flows of more than one year are discounted at a social discount rate of 3.5 percent (Moore et al., 2004). Results are summarized in Table 8.3. The expenditure costs are based on estimates reported by the city comptroller (Comptroller, City of New York, 2002, 2004), while the tax losses are drawn from New York City Office of Management and Budget (2004). It should be stressed that most of these figures are approximations, depending as they do on educated guesses about what would have happened to tax revenues or Medicaid enrollment had there been no 9/11 attack.

Changes in Transfer Payments and the Disaster Relief Medicaid Program[9]

As shown in Figure 8.6, New York City's public-assistance and food-stamp caseloads were little changed after 9/11. By contrast, Medicaid caseloads grew dramatically. From September 2001 to May 2002, the number of Medicaid recipients grew by twenty-five percent, from 1,617,000 to slightly more than two million. A major reason for this increase was the temporary relaxation of eligibility requirements after 9/11 under a program called Disaster Relief Medicaid ("DRM"). Some 380,000 individuals signed up for DRM. Once the four-month period for DRM eligibility was over, another 138,000 enrolled in regular Medicaid.

The increase in Medicaid eligibility imposed a direct fiscal obligation of $130 million in annual city-funded Medicaid expenditures in FY02.[10] Counties in New York pay twenty-five percent of regular expenditures under Medicaid. Hence, the total increase in transfers, is equal to $520 million, four times the local contribution. City residents in their dual capacity as state taxpayers must also bear a proportionate share of the twenty-five percent of Medicaid costs borne by the state.

[9] Most of the information on Disaster Relief Medicaid was obtained in communications with Rachelle Celebrezze of the New York City Independent Budget Office.

[10] The 2002 estimate was that 9/11 would lead to additional spending of $130 million for an unspecified number of future years. This prediction was based on the assumption that one-half of the DRM recipients would transition into regular Medicaid (Comptroller, City of New York, 2002).

Table 8.3 Fiscal Costs of 9/11 Over Various Periods*

Present Value of	Time Period	Aggregate	Per Resident
Net Cost (Gain) from Increase in Medicaid Transfers	2002	-$331M[a]	-$41
Increase in Required Expenditures	2002-2003 2002-2006	$898.6M $1.09B	$111 $135
Tax Loss	2002-2003 2002-2010	$2.47B $3.95B	$330 $488
NYC Loss	2002-2003 2002-2010	$3.04B $4.71B	$400 $582
Total Cost	2002-2003 2002-2010	$3.72B[b] $5.19B[c]	$459 $641
Federal Budgetary Compensation	2002-2004	$1.31B[d]	$162
Net Cost	2002-2003 2002-2010	$2.41B[e] $3.88B[e]	$297 (0.8%)[f] $479 (1.4%)[f]

*See text for detailed discussion.
[a] Calculated as $520M (increase in medicaid spending) minus $130M (city matching contribution) minus $58.5M (city share of state match-ing contribution).
[b] Calculated as $3.04B (NYC loss, 2002-2003) plus $477.9M (NYC share of NYS tax loss from 9/11).
[c] Calculated as $4.71B (NYC loss, 2002-2010) plus $477.9M (NYC share of NYS tax loss from 9/11).
[d] Equal to $762M (unrestricted) plus $550M (interest savings on special refinancing of municipal bonds).
[e] Calculated as sum of transfers plus expenditures plus tax loss.
[f] Share of NYC 2002 per resident personal income.

We estimate the net local benefits to New York City residents from increased Medicaid transfers under DRM to be approximately forty-one dollars per capita.[11]

[11] We calculate the net per capita DRM benefit by subtracting the local Medicaid share (25%) and the city's proportion of the statewide share (together equaling $189 million) from the total transfer increase of $520 million, and dividing the result by the city's population of 8.1 million. The sum of the local share and city-proportion of the statewide share is $[1 - m_f - (1-\alpha)m_s]$, where m_f and m_s are the federal and state shares, respectively,

Expenditure Increases

Other than Medicaid, the main reasons for increased city expenditures from 9/11 have been greater overtime and security costs. The city also faces higher pension costs and heightened exposure to claims. The City has had to add additional security measures on an ongoing basis, assigning as many as 1,400 officers a day to security patrols. The present discounted value of overtime is estimated to be $379 million. City liability for claims is estimated at $350 million, although there is considerable uncertainty about future claims from those who worked on the cleanup of the WTC site.

Extra pension expenses include $64.6 million for city employees who died in the attacks and potential expenses in the future from increased disability rates. Estimates of additional pension expenses are about $39 million per year from FY03 through FY06.[12] Additional capital costs to replace damaged or destroyed equipment and buildings are estimated at $171 million from FY02 through FY06. Adding all the costs, the net present discounted value ("PDV") of the change in required expenditures for 2002 and 2003 is $898.6 million, or $111 per capita. Between 2002 and 2006, the estimate of increased expenditures is $1.09 billion, or $135 per capita.

Taxes

Revenue Loss. Conceptually, the loss in tax revenues due to 9/11 is equal to

$$\Delta Tax_{9/11} = \tau \Delta B_{attack} = \Delta Tax_{actual} - \Delta Tax_{recession} + \Delta Tax_{policy}$$

where τ is the average tax rate prior to 9/11, ΔB_{attack} is the decline in the tax base due to 9/11, ΔTax_{actual} is the observed revenue change, $\Delta Tax_{recession}$ is the decline in tax collections that would have occurred anyway due to the economic slowdown, and ΔTax_{policy} is the increase in revenues due to higher rates applied to the 9/11-reduced tax base. The actual loss of tax revenue from 2001 to 2002 was $1.5 billion, or 6.4 percent.

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and α is the share of state revenues paid by city residents. We assume that none of the additional Medicaid spending was for nursing-home care, hence m_s is twenty-five percent. The federal share is set at fifty percent, though it was raised by to 52.95 percent from April 2003 through June 2004. City residents' share of state income-tax payments was slightly less than forty percent in 2002, but the city's share of personal income was about forty-five percent. We use the higher figure. Hence, the direct plus indirect cost to city residents from the increased Medicaid spending is the change in the real local fiscal cost of the transfers, or [1 - 0.50 - (1 - 0.45)(0.25)] = 36.25% of the total transfer increase of $520 million, or $189 million.

[12] Large amounts of overtime raised the salaries of many police and firefighters by substantial amounts. The inclusion of this extra pay in the pension calculation provided a strong incentive for many police and fire department members to retire after just twenty years on the force. In addition, the trauma of the attack itself has led to increased retirements.

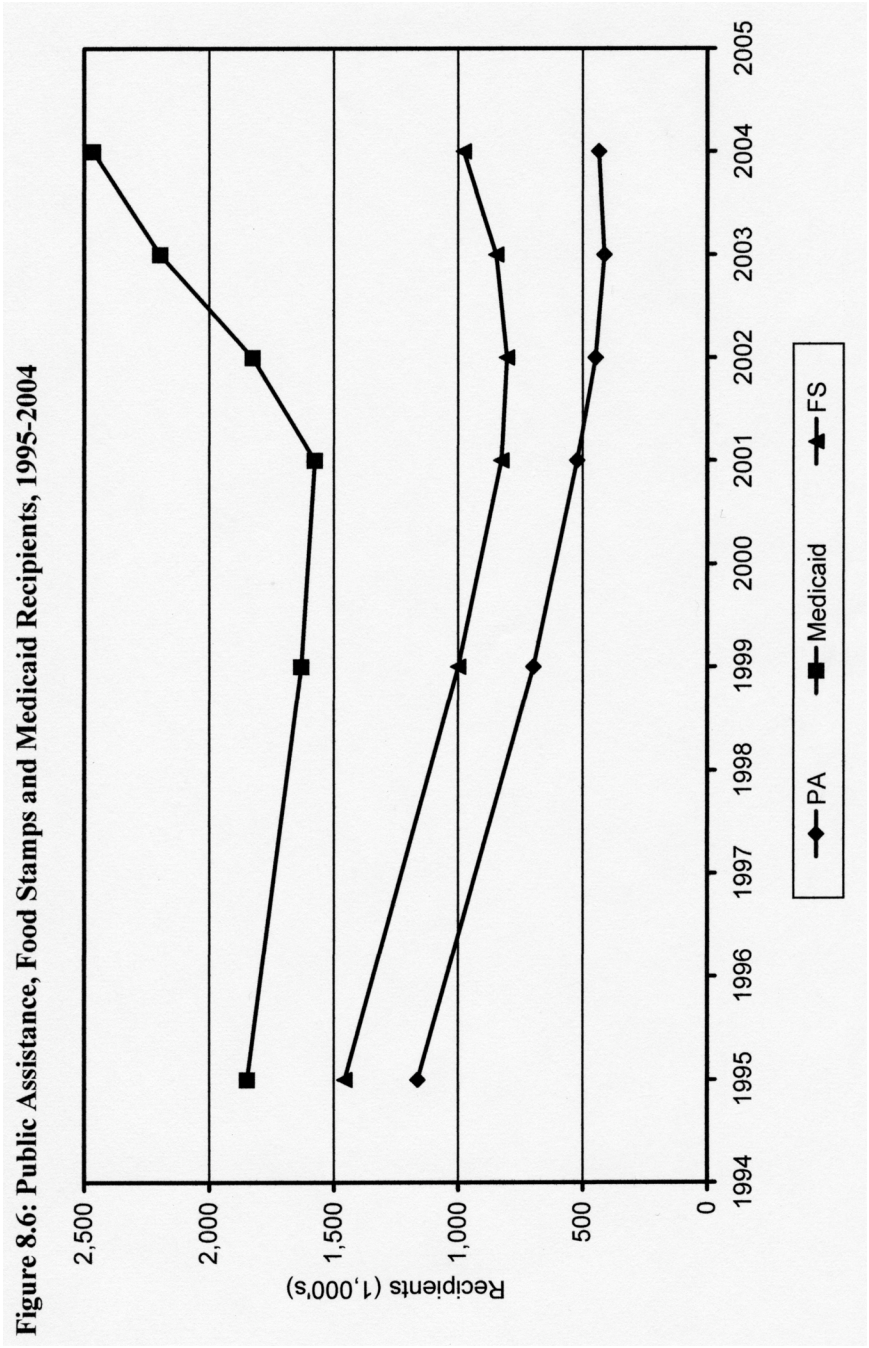

Figure 8.6: Public Assistance, Food Stamps and Medicaid Recipients, 1995-2004

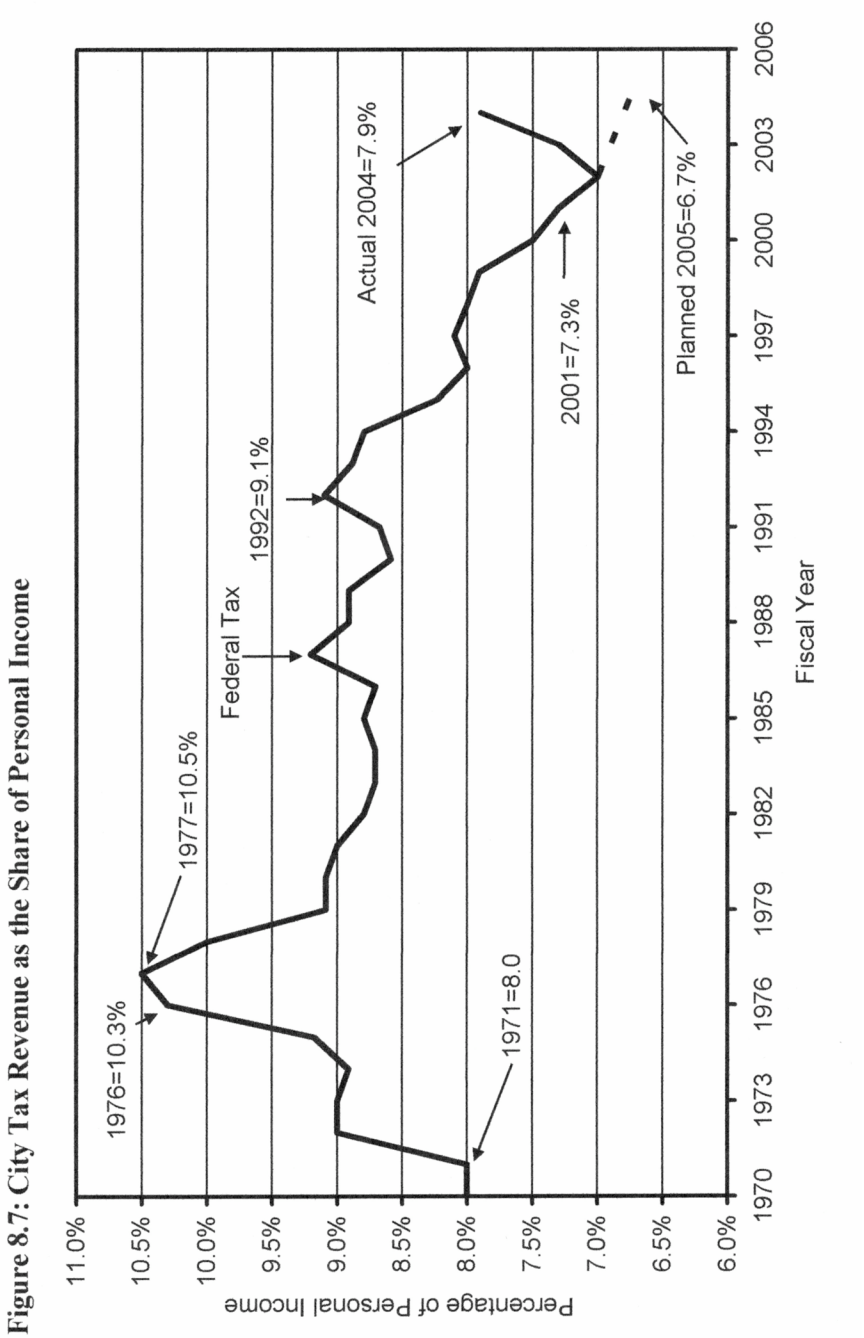

Figure 8.7: City Tax Revenue as the Share of Personal Income

The city's budget office (City of New York Office of Management and Budget, 2004) estimates that 9/11-related tax losses in 2002 were $926 million, or 4.3 percent, and $1.6 billion in 2003, or 7.1 percent, after accounting for policy changes.[13] In 2004 and 2005, the loss in business-sensitive taxes was about $420 million, while property tax losses are estimated at about $125 million at least until 2010. Over two years the per capita loss is $330 and over eight years it is $488.[14]

Tax Policy. To address the budget deficit in FY03 and FY04, property tax rates were increased by 18.5 percent. The top bracket for the personal income tax was increased from 3.65 percent to 4.45 percent for taxable incomes greater than $500,000. The sales tax rate was raised by 1.25 percentage points, bringing the combined state-city-transit-authority tax rate to 8.625 percent. There was a temporary suspension of the sales-tax exemption on clothing for items costing less than $110. Income tax revenues were increased by over $500 million per year between 2003 and 2005, while sales tax receipts were increased by about $300 million during 2003 and 2004.

Figure 8.7 provides a summary picture of New York City's overall tax rate as a percentage of personal income and the tax response after 9/11. The figure shows a steep decline in local tax burdens during the 1990s. By 2000, the tax burden had reached a level not seen since the early 1960s. Since 2002, tax burdens have grown by almost a full percentage point.[15] The magnitude of this increase, which exceeds substantially the increase associated with the previous economic downturn of the early 1990's, suggests the crucial role played by tax increases in closing large budget deficits caused by the 9/11 attack and the recession.

Tax revenues resumed their rise after 2002, up by 7.8 percent in 2003, 21.8 percent in 2004, 11.2 percent in 2005, and a projected 5.4 percent in 2006 (Comptroller, City of New York, 2006). Most of the 2003-2004 increase was due to increased tax rates, but by 2005 this was no longer the case. Rate-adjusted revenues rose 12.1 percent in FY05, and 7.9 percent (projected) in FY06. The strong post-9/11 market for residential and commercial property described above has translated into a sharp increase in revenues from taxes on property and real estate transactions. Revenues from the 2.5 percent tax on transactions went from $500 million

[13] Assuming an overall tax rate of seven percent of personal income, or about 5.5 percent of gross city product ("GCP"), the estimated tax losses exceed by a considerable amount the losses that would be implied by our earlier estimate of a loss in GCP of $5 billion. A portion of the difference stems from the fact that the attack also left destroyed or damaged nearly twenty-eight million square feet of office space, with a market value of about $30 billion dollars, causing significant losses in property tax revenue.

[14] The present calculation for the PDV of tax losses for 2002 through 2010 is $926 million for 2002, $1.546 billion for 2003, $495 million for 2004, $491 million for 2005, and $492 million total for 2006 through 2010, equaling a total of $3.95 billion, or $488 per capita.

[15] Roughly two-thirds of the increase in the tax burden represents policy actions, while the remaining third represents the automatic increase in tax burdens when personal income declines. This calculation is made under the assumption that the property tax, which provided about thirty percent of tax revenues in 2001, is fixed in the short run.

per year in the early 1990s to an average of $1.9 billion per year from 2003-2006. Property tax revenues rose six percent even in FY02, fifteen percent in both FY03 and FY04 (reflecting the rate increase), and are projected to increase by about seven percent per year between 2005 and 2009. Mayor Michael Bloomberg took advantage of the strong overall revenue performance to rebate a substantial portion of the 2003-2004 residential property tax increase during 2005-2006. Income taxes declined by 22.4 percent in 2002-2003, but then increased by 20.9 percent in 2004 (New York City Independent Budget Office, 2004a). Some eighty-five percent of this increase ($784 million) is due to the progressive rate hike that was imposed retroactively in 2003.

Despite some evidence that past tax increases in New York City have had an adverse effect on the tax base, the robust growth in income and real estate values since 9/11 suggests that any such effect after 9/11 has been small.[16] Potential negative effects of the tax increase may have been muted by its being only temporary. In addition, the city's tax burden prior to 9/11 was low in historic terms. Second, the overlying federal and state tax income tax burdens, particularly for high-income taxpayers, have fallen in recent years, increasing the city's ability to sustain rate increases on its high-income residents. Thirdly, tax rates have risen in the neighboring counties, reducing somewhat the competitive pressure the city would face if it were the only jurisdiction raising taxes.

C. The Fiscal Role of New York State

In assessing the fiscal impact of disasters on cities, the state is both a casualty and a potential rescuer. The state's fiscal capacity will be directly affected by the loss of tax base in affected areas in direct proportion to the extent the state shares the same tax base. The state may also shift some of the costs of the disaster from affected residents to all residents of the state, by reallocating fiscal resources. In the 9/11 attack, the main effect was the concomitant loss of state fiscal capacity.

The effect of a local disaster on the state's fiscal capacity depends on the magnitude of the disaster and the share of the state tax base in the affected area. Because the New York City economy makes up more than fifty percent of gross state product, the fiscal shock to the city was also a fiscal shock to New York State. The state effect is magnified because the city and the state share common tax bases for the sales and personal income tax. It is noteworthy that the eleven-percent loss in state revenue in 2002-2003 substantially exceeded the 6.4 percent loss to New York City. The reduction was greater for the state because all its major revenue sources are sensitive to economic conditions in the short run, while the city's property and related taxes, providing at least forty percent of tax revenues, are more stable.

[16] See Haughwout et al. (2004). The market value of real estate increased by seventeen percent between 2004 and 2005, and real-estate related taxes have increased strongly between 2003 and 2006 (New York City Independent Budget Office, 2004b).

A very rough estimate of the one-year loss in tax revenues to New York State due to 9/11 can be given by taking an estimate of the decline in GCP of $17.5 billion (Comptroller, City of New York, 2002), and multiplying that amount by the average New York state tax rate of six percent.[17] This gives an estimate of $1.05 billion. Multiplying this number by the city's personal income share yields a state-tax loss to city residents of about $473 million, or $59 per capita. Adding this amount to aggregate city costs gives a total 2002-2003 public-sector loss of $400 per capita for city government plus $59 per capita for the state, or a total of $459 per city resident. The PDV through 2010 equals $641 per capita.

The most significant state response was regulatory, rather than fiscal. The city was allowed to temporarily raise income and sales tax rates, and to isssue $2.1 billion in long-term debt to help cover its deficit. Over the Governor's veto, the state legislature agreed to assume some $500 million of prior debt obligations of New York City. In addition to these measures, the state signed off on the temporary relaxation of Medicaid eligibility rules, and in conjunction with the federal government, relaxed categorical restrictions on a number of federal and state grants. The minimal state fiscal response is consistent with the trend in fiscal politics in New York State over the past decade, with policy changes tending to favor suburban and upstate areas relative to the city.[18]

D. Federal Compensation

In the immediate aftermath of 9/11, President Bush pledged over $20 billion in aid to assist with recovery.[19] The city's budget office divides federal assistance into three phased categories (New York City Independent Budget Office, 2004b). About thirty percent of total funding, some $6.33 billion, goes toward: emergency response needs, rescue, recovery and cleanup under the oversight of the Federal Emergency Management Agency; redevelopment of the WTC site; and targeted cash assistance. The second phase of $4.43 billion focuses on economic recovery. The third phase is for long-term rebuilding and is worth $9.71 billion.

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[17] This estimate is an upper bound to the indirect state-tax effect because, as noted above, subsequent estimates of 9/11's effect on GCP have been revised downward.

[18] A number of fiscal policy initiatives taken by the state in the 1990s have had an adverse impact on the city's fiscal base or its costs. These include the elimination of the commuter tax, a state-funded property-tax relief program with a distributional formula favoring the suburbs over the city, and state-level intervention in collective bargaining for pension rights (Center for an Urban Future, 2002). The distribution of state aid is discussed in Chernick and Reschovsky (2001). The elimination of the commuter tax is considered in Chernick and Tkacheva (2002).

[19] The aid came in three allotments, appropriated through mid-2002: 9/11 emergency appropriations totaling $11.24 billion and providing cash assistance to individuals, local governments and small businesses; the "Liberty Zone" economic package, granting the equivalent of $5 billion in eventual tax relief to businesses located in downtown Manhattan; and a supplementary emergency appropriation package of $5.4 billion.

Typically the federal government does not provide general fiscal relief to local governments hit by natural disasters. However, in the case of the 9/11 attack $1.7 billion, or about eight percent of the total federal reimbursement, was provided directly to the city. Of that amount, $762 million essentially transferred the remainder of the original Congressional appropriation and went for unrestricted budgetary relief. The other part of general relief was achieved by waiving federal rules on the one-time refinancing of municipal debt, thus allowing the city to take advantage of lower interest rates for some of its general obligations and agency debt. While the cost to the federal government from the refinancing waiver is estimated at $937 million, the city reports related budgetary savings in FY2003 at about $550 million.[20] We use the latter figure in our calculations. Hence, federal budgetary compensation equaled $762 million plus $550 million, or about $1.31 billion.

E. Net Public Sector Cost to City Residents

The total cost to the public from transfers, expenditure increases, and tax losses is $400 per capita through 2003 (see Table 8.3). Losses through FY 2010 are equal to $582 per capita. Subtracting federal compensation of $162 per capita, the two-year net cost is $297 per capita. Through 2010, the net cost is $479 per capita. As a share of the $35,380 in mean personal income in 2002, the net cost to residents is roughly 0.7 percent on average. The PDV of net costs per resident through 2010 equals 1.35 percent of personal income. Specific federal compensation to the city's government offsets about one-third of the total public sector cost.

Federal tax deductibility reduces the net burden of the tax increase from $389 to $311 per capita.[21] Taking into account deductibility and Medicaid matching, as well as specific compensation, total federal compensation offsets about half of the public sector costs.

[20] In a later report, the Comptroller uses the $937 million figure (Comptroller, City of New York, 2004). The Liberty Zone economic incentives also include $1.2 billion in savings from the city's and state's issuance of a total of $8 billion in tax-exempt bonds, used to stimulate private investment in offices, residential units, and utilities. For a more detailed discussion of federal 9/11 compensation to NYC, see Chernick and Haughwout (2006).

[21] Schlain (2004) estimates that the rate of offset for the income tax surcharge is twenty-one percent. Deductibility of the sales tax is virtually zero in New York and property-tax payments are spread more equally through the income distribution than the income-tax surcharge. Hence, we use a lower figure of fifteen percent as the average rate of deductibility.

IV. Federalism and Risk Sharing

Experience with a range of disasters, whether due to war, terrorism, or forces of nature, has shown that the core economies of large cities tend to be quite resilient.[22] Nonetheless, when a catastrophic disaster strikes a city, there is likely to be strong pressure for publicly provided compensation for losses. In this section, using the 9/11 attack as an example, we consider briefly the principles and criteria which should underlie the intergovernmental fiscal response to disasters in cities. As pointed out by Wildasin (2006), these are important issues in the design of fiscal federalism because of the magnitude of the resources at stake and because the institutional design has important efficiency implications for the regional and national economy.

A. Equity Considerations

The equity argument for compensation is that the citizens of a federation, by virtue of membership, are entitled to some minimum level of public services, at reasonable tax rates. If disaster strikes, citizens are bound by an implicit contract for mutual aid to help offset the decline in economic and fiscal health, with the federal government as the appropriate agent for implementing this contract. In principle, the extent of compensation for a disaster should conform to the equalization standards of the federation, estimated in one recent study to be between ten and twenty percent for the US (Melitz and Zumer, 2002). These estimates imply that long-term compensation for disaster should be well below one-hundred percent.

B. Efficiency

Putting aside equity and politics, can intergovernmental compensation be justified on efficiency grounds? Or does a guarantee of compensation cause cities to under-invest in safety and disaster preparedness and lead to too much economic activity in areas that are prone to disaster? The main argument for *ex post* compensation is that a federation is an implicit contract for sharing risk among governments and that such risk sharing is efficient. Just as equalization schemes and uniform or progressive taxes are long-term devices for fiscal risk sharing, so disaster compensation is a device for sharing the risks of severe one-time shocks. The

[22] Davis and Weinstein (2000) document the recovery of Hiroshima and Nagasaki from nuclear attack. Horwich (2000) discusses the rapidity with which regional output was restored in Kobe, Japan, despite the high level of devastation caused by the 1995 earthquake. However, he does not address the relative roles of the local and national governments in financing the recovery.

pool over which risks are shared should be as broad as possible, implying that the national government should provide the bulk of compensation.

Given this risk-sharing role, intergovernmental compensation for disasters should be sufficient to reduce to a nationally acceptable level the losses incurred by residents and firms, and to allow the city to return to its pre-disaster level of economic well-being as speedily as possible. To this end, compensation should subsidize the replacement and improvement of damaged infrastructure.[23]

To reduce the moral hazard of underinvestment in safety, broadly construed, intergovernmental compensation should not completely offset the losses incurred. Ideally, the costs of compensation should be shared by the various levels of government, as well as the affected citizens. To the extent that the city itself is able to spread the fiscal costs of a disaster among its surviving residents and firms without causing additional reductions in its tax base, a significant part of the fiscal costs should be borne locally. While in the immediate aftermath of a disaster it may be difficult to assess a city's ability to recover on its own, the price of land and structures can provide useful clues as to changes in the viability of a city. After 9/11 there was considerable concern that the risk from terrorism could lead to a deconcentration of economic activity. Fortunately for New York, this has not turned out to be the case.

Fiscal responses should be centered on the lowest level of government that encompasses the entire disaster area. For multistate disasters, the focus of disaster relief should be at the federal level.

The economic dislocation to New York City is estimated at roughly $5 billion in foregone economic output and $30.5 billion in wealth. Though the absolute magnitudes are large - because the city's economy itself is larger than that of numerous states - in relative terms the effect turned out to be smaller than anticipated. Hence, a significant proportion of the costs of 9/11 could be borne locally. New York State's response contrasts with California's after the Northridge earthquake of 1993. In that case, the state levied a sales surtax with proceeds used to repair damaged infrastructure. The surtax was possible because the effect of the earthquake on state fiscal capacity was considerably smaller than the proportionate effect of 9/11 on the fiscal capacity of New York State.

Compensation should be based on *ex ante* rules that are automatically applied, as opposed to case-by-case relief *ex post*. The latter is likely to be heavily influenced by the political strength of the affected area's congressional delegation and by whether the state is a swing state in national political elections. It is unlikely that these political characteristics will be highly correlated with the appropriate economic criteria for risk sharing. Recognizing that there will always be some *ex post* political bargaining, the goal should be to maximize the proportion of compensation that follows transparent rules.

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[23] As pointed out by Horwich (2000), disasters vastly accelerate the normal rate of depreciation of fixed assets such as electric grids, transportation systems, and water and sanitary sewer systems. Replacement of those assets should allow both technological improvements and improvements in siting.

To minimize *ex post* strategic behavior on the part of cities, some of the compensation should carry with it a local matching requirement. In the case of 9/11, the federal government provided the equivalent of a lump-sum grant for immediate cleanup of the affected site. This seems entirely appropriate since in this activity there is no possibility of substituting federal for local funds. Other federal funds going to New York have an implicit matching component in that the total available is probably less than needed to fully replace and improve the damaged infrastructure. Since local information is superior, grants should be general rather than categorical.

C. People versus Governments?

The argument for compensating the residents of the disaster area, as opposed to the local government, is similar to the notion that cash is more efficient than in-kind transfers in improving individual well-being. It has been argued, for example, that New Orleans is a failed city, doomed by both geography and weak governance structures (Glaeser, 2005). It would be better to provide cash subsidies in such cases to individuals, allowing them to relocate to more economically productive areas. By contrast, New York managed its fiscal affairs with considerable competence despite the shock of 9/11.

However, there is a strong rationale for compensating governments. Public services are crucial to both individual well-being and firm productivity. Rapid restoration of vital services and stable tax rates provides a credible signal to private firms that reinvestment in the affected area is economically justified. Government action helps to solve a difficult problem of coordination for private firms in the aftermath of a disaster, since any individual firm may be reluctant to reinvest without the assurance that other firms will do so as well. Such coordination is a public good whose benefit is realized by all firms and landowners in the disaster area. Hence, at least up to some level, the marginal productivity of compensation to governments is likely to exceed that of grants to individuals.

A scheme of government compensation for individuals may be costly to implement and will likely suffer from problems of equity. Should compensation go to residents only, or to those who work in the city as well? Should compensation be lump-sum or proportional to losses incurred? Compensation to governments, assuming it is competently managed, automatically provides proportionally greater benefits to low- than to high-income individuals. Compensation to individuals is also more likely to crowd out private charitable contributions. After the 9/11 attack, about $2.8 billion of charitable contributions were received (Dixon and Stern, 2004). Most of these funds went to aid individual victims of 9/11 and first responders. Because private contributions are most likely to go to individuals, they are less likely to be crowded out if federal compensation is primarily directed to local governments.

D. Are Terrorist Attacks Different from Natural Disasters?

From the *ex post* standpoint of recovery, ultimately, a dollar's worth of damage is the same, whatever the cause of the catastrophe. However, the 9/11 attack has been likened to an act of war declared on the country as a whole. In this sense, a national response may be more justified than in the case of natural disaster. The moral-hazard argument may also be different for terrorism than for natural disasters. Terrorist attacks are likely to be more effective, i.e., they will cause more disruption to the economy and spread more anxiety, if carried out in large cities. It is the very density of settlement that makes cities attractive targets, and increases the risk of attacks. This "terror tax" on density seems fundamentally different from the inefficiencies of overdevelopment in flood plains or hurricane-prone areas. Given the importance of economic agglomerations to national productivity, the economy as a whole, rather than just landowners in large cities, will bear the cost of deconcentration in response to the perceived risk of terrorism. It is arguably more efficient, i.e., the deadweight loss is smaller, if the "terror tax" is borne primarily by the nation as a whole rather than a few large cities.

V. Conclusion

New York City has shown remarkable economic resilience to the attack of September 11, 2001 on the World Trade Center. Recent analysis estimates lost income for FY2001-FY2002 at around $5 billion. Rental real estate markets weakened, but somewhat less significantly. The downtown rental residential market remained strong, perhaps in part because of targeted subsidies. Demand for downtown rental office space appears to have declined. Long-run demand for residential and commercial locations appears to have been little affected by the attack.

9/11 led to severe fiscal pressure on the city that was addressed through additional debt, tax increases, and modest spending cuts. Costs through the public sector range from about 0.7 percent to 1.35 percent of personal income depending on the time period. The state of New York also suffered a substantial fiscal shock from 9/11. Its role in the responses has been mainly regulatory rather than fiscal, allowing New York City to issue additional long-term debt, raise its taxes, and relax eligibility standards for Medicaid. Total federal compensation, through direct grants and tax expenditures, will ultimately equal about $20.4 billion. Direct compensation to the city's government offsets about one third of public-sector costs. Direct plus indirect federal compensation is about half of public-sector costs.

Though city economies are naturally resilient, the example of 9/11 suggests that a robust federal response can help to accelerate the recovery from natural disaster. Intergovernmental aid should be directed both to governments and to individuals. *Ex ante* rules that specify compensation will be only partial, thus forcing cities and states to share in the costs of recovery, can help to minimize moral-

hazard problems. Further consideration of the institutions of federalism in relation to disasters is an important area for additional research.

Appendix

A Framework for Measuring the Local and Statewide Public-Sector Costs of a Disaster

New York City

After-tax income for a typical city resident *i* is equal to

$$y_i = (1-\tau_I)I_i + \rho V_i + T_i - \tau_{prop} V_i \quad (1)$$

where y is income after taxes, I is income before taxes, τ_I and τ_{prop} are local income- and property-tax rates, V is the value of property, ρ is the imputed rate of return on property, and T is income from transfers. To simplify the accounting framework, we ignore for the moment New York City's two other major taxes, on sales and corporate income.

Assuming that the level of public services does not change, the cost to residents can be expressed completely in terms of the change in after-tax income. That change is equal to the decrease in pretax income, magnified by the required increase in tax rates on the now lower tax base.

$$\Delta y_i = [\Delta I_i(1-\tau_I) + \rho \Delta V_i(1-\tau_{prop}) + \Delta T_i] - [\Delta \tau_I I_i + \Delta \tau_{prop} V_i] \quad (2)$$

The loss in pretax income comes from a decline in earnings (ΔI) from the disruption to the local economy, plus the imputed annual value of destroyed property ($\rho \Delta V$). These losses are partially offset by an increase in transfers (ΔT). The second part of the decline in after-tax income comes from the increase in tax rates ($\Delta \tau_{prop} V + \Delta \tau_I I$) needed to maintain public services and pay for increased transfer payments.

To simplify notation, we now collapse the city's multiple taxes into a single rate τ and a single base B_{NYC}, the average tax base per resident. Ignoring intergovernmental grants, the city's tax rate is given by expenditures (EXP) divided by the tax base $(B_{NYC})(N_{NYC})$, the denominator being the average tax base per resident times the number of city residents (N_{NYC}).[24]

$$\tau = \frac{ServiceCost + Transfers}{B_{NYC} N_{NYC}} = \frac{EXP}{B_{NYC} N_{NYC}} \quad (3)$$

The required change in the city's tax rate is equal to

[24] For simplicity, we ignore intergovernmental grants in this conceptual framework, though they are taken into account in the next section of the appendix.

$$\Delta\tau = \frac{\Delta(EXP)}{B_{NYC}N_{NYC}} - \tau\left(\frac{\Delta B_{NYC}}{B_{NYC}}\right) \tag{4}$$

where the change in expenditures equals the change in the cost of services plus the change in transfer payments. For each individual, the total change in after-tax income is

$$\Delta y_i = \Delta PrivateEconomy_i + \Delta PublicEconomy_i \tag{5}$$

Multiplying (4), the change in the tax rate, by the individual city resident's tax base B_i, the change in after-tax income from the required increase in the tax rate (i.e., the change in the public economy) is

$$\Delta PublicEconomy_i = \Delta\tau(B_i) \tag{6}$$

To determine the total change in the economic well-being of city residents *(ΔW)*, we sum the changes from the private and public economies for all individuals, with a weight ω_i applied to each individual.

$$\Delta W = \Sigma_i \omega_i \Delta y_i = \Sigma_i \omega_i (\Delta PrivateEconomy_i + \Delta PublicEconomy_i) \tag{7}$$

If we assign the same weight to each person ($\omega_i=1$), and assume that the cost per unit of public services does not change, the average welfare loss through the public sector from the 9/11 attack is

$$\frac{\Delta W_{Public}}{N_{NYC}} = \frac{\Delta T - \Delta EXP}{N_{NYC}} + \tau\Delta B_{NYC}\,, \tag{8}$$

or the change in transfers plus the loss in tax revenues, less the change in expenditures. The first term on the right-hand side of equation (8) is the per-capita difference between the changes in transfer payments and expenditures. Using an individual welfare-based calculus, an increase in transfer payments to residents is welfare-enhancing, helping to offset the disaster-induced loss in pretax income. This contrasts with the more traditional fiscal perspective, in which the increase in the local share of transfer costs has a negative effect on the city's fiscal condition. The *ΔEXP* term in equation (8) is the expenditure increase required to keep services at their pre-9/11 level. This extra cost will have a negative effect on the well-being of residents. The third term is the reduction in tax revenue arising from losses in the city's tax base. These losses will also have a negative effect on well-being.

To calculate the net per-resident cost for the public economy, we subtract direct federal compensation per resident.

$$\begin{aligned}\frac{NetCost_{NYC}}{N_{NYC}} &= \frac{\Delta W_{Public} - Compensation_{Federal}}{N_{NYC}} \\ &= \frac{\Delta W_{Public}}{N_{NYC}}(1 - S_{Federal})\end{aligned} \tag{9}$$

Federal compensation $S_{Federal}$ is a weighted average of three forms of subsidy: the federal matching share for transfer payments (m); federal direct compensation for increased service costs, expressed as a general subsidy rate s, and the rate d at which the increase in local taxes can be deducted from federal taxes.

$$NetCost_{NYC} = \left(\Delta W_{Public} - \left[m(\Delta T) + s(\Delta Services)\right]\right)(1 - d) \tag{10}$$

The overall subsidy or compensation rate is a weighted average of the three types of subsidies. Multiplying the entire expression in brackets by one minus the deductibility rate d implies that the net increase in costs and the loss in tax base are made up through an increase in tax rates. This reflects the assumption that service levels are maintained. In fact, there is likely to be some decline in the level or quality of public services after a disaster, and cities will spread the fiscal cost of the attack over time by increased borrowing. In that sense, equation (10) indicates the maximum potential role of deductibility in affecting net cost.

New York State

The aggregate loss to the state is given by the product of the state tax rate τ_{NYS} and the loss in state fiscal tax base due to the attack (ΔB_{NYS}). Since the loss in tax revenues is a cost to all residents of the state, the cost to residents of New York is the aggregate loss divided by the entire state population, N_{NYS}.

$$NetCost_{NYS} = \frac{\tau_{NYS}\Delta B_{NYS}}{N_{NYS}} \tag{11}$$

Assuming there are no required expenditure changes at the state level, then the required change in the state tax rate is

$$\Delta\tau_{NYS} = \tau_{NYS}\left(\frac{\Delta B_{NYS}}{B_{NYS}}\right) = \tau_{NYS}\left(\frac{\Delta B_{NYS}}{B_{NYC}}\right)\left(\frac{B_{NYC}}{B_{NYS}}\right) \tag{12}$$

As expressed in equation (12), the effect of a city disaster on the state's fiscal capacity depends on the city's share of the state tax base, as well as the magnitude of the disaster within the city. Because the New York City economy is so large relative to the entire state, the fiscal shock to the city was also a fiscal shock at the state level. The correlation is magnified by the fact that the city and the state share

common tax bases for the sales tax, as well as the personal and corporate income taxes.