AN ECONOMIC ANALYSIS OF RAPID TRANSIT IN NEW YORK

1870—2010

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ABBREVIATIONS AND INITIALISMS

BER	Brooklyn Elevated Railroad Company
BHR	Brooklyn Heights Railroad Company
BMT	Brooklyn-Manhattan Transit Corporation
BOT	New York City Board of Transportation
BRT	Brooklyn Rapid Transit Company
BUE	Brooklyn Union Elevated Railroad Company
GER	Gilbert Elevated Railway Company
IND	Independent City-Owned Rapid Transit Railroad
IRT	Interborough Rapid Transit Company
KCE	Kings County Elevated Railway Company
MER	Metropolitan Elevated Railway Company
MRC	Manhattan Railway Company
MTA	Metropolitan Transportation Authority
NYCTA or TA	New York City Transit Authority
NYE	New York Elevated Railroad Company[1]
SRT	Suburban Rapid Transit Company
UER	Union Elevated Railroad Company
WSE	West Side Elevated (Patented) Railway Company[2]

[1] Sometimes referred to as the New York Elevated *Railway* Company.
[2] Sometimes referred to as the West Side & Yonkers Patent Elevated Railway or other derivations thereof.

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EXECUTIVE SUMMARY

Rapid transit is crucial to Metropolitan New York's economy and quality of life. However, the long-term effectiveness and efficiency of the city's rapid transit system and the causes of its failures and successes are unknown. This research (1) examines the cost, capital investment, railway network, equipment, fares, and operations of rapid transit in New York from 1870 to 2010 and (2) identifies long-term economic and political causes of effectiveness and efficiency.

The figures reveal three distinct eras: 1870 to 1940, characterized by unprecedented expansion and improvement; 1940 to 1980, characterized by stagnation and decline; and 1980 to 2010, characterized by stabilization and rejuvenation. Rapid transit's rise (1870—1940) and fall (1940—1980) were astonishing in magnitude and unambiguous in direction, both in effectiveness and efficiency.

The success experienced in the last era (1980—2010), however, was neither as dramatic as the first era nor as clear in its overall direction. By most measures, the system's effectiveness has not reached its prewar peak, but it is getting close. Meanwhile, the system's efficiency and productivity has not materially improved since 1980 and remains a fraction of the prewar peak. The system's inefficiency threatens its long-term effectiveness (including recently begun Network Expansion projects). Rapid transit is on an economically unsustainable path.

The data support several conclusions regarding the causes of New York's rapid transit failure and success. First, it corroborates the importance of rapid transit to New York's economic health and quality of life. The condition of rapid transit depends on the condition of New York, but the reverse is also true. In particular, deteriorating rapid transit was more of culprit than a victim of the city's postwar decline.

Second, it demonstrates that most failures were not caused by a lack of money, and, correspondingly, increased spending does not sustain long-term success. Rapidly rising wages and benefits combined with declining labor productivity is the primary financial cause of the system's long-term efficiency decline. Unproductive capital investments are a secondary cause.

Finally, the central implication of this research is that—in the long-term—the best means of achieving effective and efficient rapid transit is via government establishment and protection of objective, secure, and just property rights for private ownership and operation. It suggests that government subsidies and controls (culminating in complete public ownership and operation) have been the central cause of the rapid transit system's long-term failures. This is consistent with a substantial body of economic theory, albeit not neoclassical economics, which frequently treats transit as an exception to the rule. The conflict is linked to faulty underlying assumptions of neoclassical economic theory.

In addition to a reevaluation of relevant political and economic theory, an examination of previous rapid transit legislation, financial terms, contracts, and other arrangements between New York City, New York State, and the private subway and elevated railway firms would suggest how to successfully structure and implement privatization.

CHAPTER 1

INTRODUCTION

INTRODUCTION

When the private, for-profit Interborough Rapid Transit Company (IRT) opened Metropolitan New York's first subway in 1904, it was the most advanced rapid transit system in the world. It was the world's first four-track line, with local and express trains in both directions. It was the world's fastest—express trains reached 50 miles per hour (Beach, 1904). The IRT's 59th Street electric generating plant was the world's largest, and the IRT was the first railroad in the world to use all-steel passenger cars (American Electrician, 1904; Cudahy, 2003). Its engineers developed a state-of-the-art electro pneumatic block signal system technology, in order to cope with the system's unequaled speed and traffic density (Beach, 1904; Interborough Rapid Transit Company, 1904). Creature comforts were not forgotten either. Sheltered platforms, elevators, and escalators were installed; cars were lighted and heated with electricity. Public bathrooms were provided at almost every station and furnished with mirrors, soap, and hand towels (Interborough Rapid Transit Company, 1904).

By 1920, the IRT, later joined by the Brooklyn Rapid Transit Company (BRT)[3], built this into the world's largest and busiest subway[4] system. In fact, it exceeded the *combined* track mileage of all other rapid transit systems in the world (Derrick, 2001). Furthermore, all of this was available for 56 cents a ride (in 2011 dollars) without taxpayer subsidies (Derrick, 2001; McAneny, Harkness, & O'Ryan, 1922; United States Bureau of Labor Statistics, 2011). New Yorkers were conceivably the most mobile people on earth.

A half-century later, the situation was quite different. For decades, maintenance was systematically deferred on tracks and other basic infrastructure. By the 1970s, rapid transit cars underwent no preventive maintenance—repairs were performed only after a failure occurred. Only one fourth of the track mileage received the required twice-weekly inspections, and by the early 1980s, the subway experienced a derailment every two to three weeks (Seaman, de Cerreno, & English-Young, 2004).

Today, however, the state of New York's rapid transit system is unclear. On one hand, the system is far safer, cleaner, and more reliable than it was during the 1970s and 1980s. New amenities have also appeared, ranging from air conditioning to countdown clocks. As New York City came back to life, so did the rapid transit system. Ridership has increased, particularly since the introduction of the MetroCard in the 1990s. In 2011, the subway recorded its highest ridership level since 1950 (Metropolitan Transportation Authority, 2012b; Seaman et al., 2004).

On the other hand, the subway is not the "emblem of technological modernity" it was in 1904 (Hood, 1993). Even basic amenities—such as bathrooms—have all but disappeared. Most of the stations, tracks, and tunnels look much like they did when they first opened. Even the original signal system has not significantly changed (Derrick, 2001).

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[3] The BRT was reorganized as the Brooklyn-Manhattan Transit Corporation (BMT) in 1923 (Brooklyn-Manhattan Transit Corporation, 1924).
[4] New York already had the world's largest rapid transit system (since 1880), consisting of elevated railways (Hain, 2011).

The Metropolitan Transportation Authority (MTA)—the regional public benefit corporation that now leases the subway from the City of New York (the "City")—has a large maintenance backlog, which is growing (Metropolitan Transportation Authority, 2010). Since 2008, fares have been raised three times while service levels have been reduced (The New York Times, 2011). The MTA continues to take on more debt to fund Network Expansion projects, increasing its annual debt service cost. As a result, in 2011 Fitch Ratings downgraded the authority's credit rating (Beja, 2011).

Apart from the short-term financial and maintenance difficulties, long-term challenges persist. Although it remains one of the largest and busiest systems in the world[5], it has not kept up with Metropolitan New York's growth (Ascher, 2005). The physical size of the city's rapid transit network—measured in miles of running track—has declined by 18% since 1940, when the City of New York consolidated the private systems and took control of operations. Meanwhile, the metropolitan area doubled in population during the same period (United States Census Bureau, 1941, 2010). Despite the introduction of substantial operating subsidies in the 1960s, the real base fare has quadrupled since 1920 (McAneny et al., 1922; State of New York, 1968).

RESEARCH QUESTION

Transportation is essential for society in general, as discussed in detail below (Jacobs, 1969; Morlok, 1978; Papacostas & Prevedouros, 2001; Wright & Ashford, 1989). In New York, transportation means rapid transit (i.e. the subway). Rapid transit is the only transportation technology presently available that can keep this populous, vast, dense metropolis functioning, owing to its unequalled combination of carrying capacity, grade separation, speed, and economy (Parkinson & Fischer, 1996). For this reason, the prosperity of Metropolitan New York (and, in some ways, that of the United States[6]) demands an *effective* and *efficient* rapid transit system.

This fact, in addition to the system's vicissitudes and its present ambiguity, leads to at least two crucial sets of questions. First, what was the actual state of the city's rapid transit system? Were, for example, the 1920s and 1930s really the glory days of rapid transit (and worthy of emulation), or is this merely a romantic fiction? Likewise, how is rapid transit doing today, and is it headed in a positive direction? Second, how can we avoid past failures and exceed past successes? If the effectiveness of rapid transit rose and fell, then what explains it? In sum, (1) how have we done, and (2) how can we improve? Clearly, we do not want to return to the subway of 1975, but we can learn from it, and from the rapid transit system of 1925, and even from that of 1880.

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[5] Ridership is the most common measure of a rapid transit system's size. By this measure, the New York City Subway ranks approximately 7th in the world (New York City Transit Authority, 2012b). However, it continues to have more passenger cars, stations, and miles of track than any other system (Railway Gazette, 2010).

[6] New York's Central Business District is the commercial hub of the world's largest economy, and the great majority of its employees commute via the subway (Zhou, Glogowski, & Patel, 2011).

New York's rapid transit history can answer both questions. First, it provides a fitting background against which the system's current state and direction may be evaluated. Rather than compare contemporaneous rapid transit systems across space, we can compare the system to itself across time. Few cities have comparable rapid transit systems, and none are on this side of the globe. In the field of rapid transit, New York is an industry leader. Even if the city's rapid transit performs well by national and international standards, it may not measure up to itself.

Second, the great length and tremendous variety of the city's rapid transit history provides a rich source of data. There are many instances of both extreme successes and failures, achieved by private, public, and public-private means. A study of the recognized economic metrics of effectiveness and efficiency can identify which factors led to progress and which led to decline. This, in turn, illustrates how to move forward. New York has 140 years of rapid transit experience—let us profit from it.

LITERATURE REVIEW

The principles of planning and engineering rapid transit—including criteria and methodology for evaluation—are well established in the literature. The vital and inextricable interrelationship between cities and transportation is widely appreciated (though not yet fully explained). The historical events of New York's rapid transit history (though not necessarily their magnitude, their causes, nor their impact on the system's effectiveness and efficiency) are well documented.

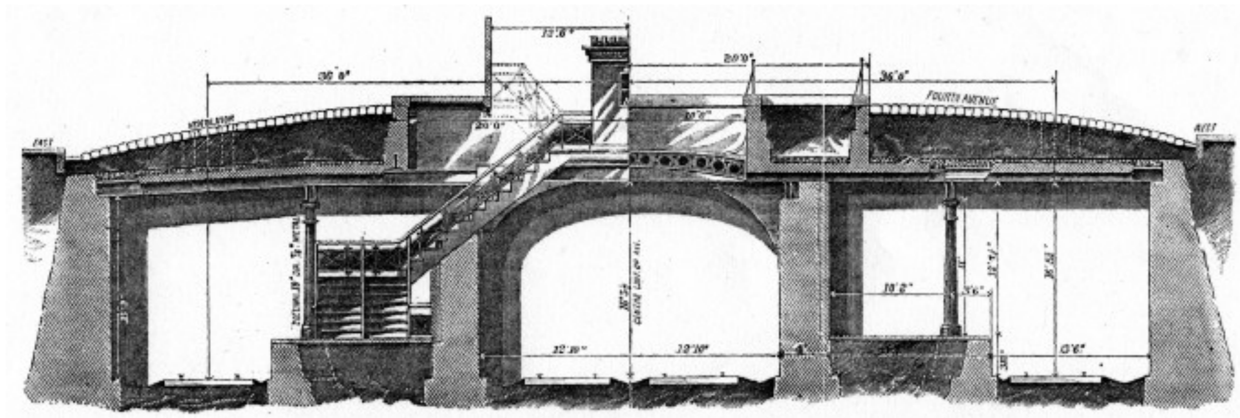
Definition of Rapid Transit

Rapid transit is a form of high-speed urban passenger transportation—usually a subway or elevated railway (also known as an "elevated" or "el"). It is roughly synonymous with the modern concept of a Metro or Heavy Rail system (Federal Transit Administration, 2012).

The crucial distinction of rapid transit is that vehicles operate on an exclusive, grade-separated right-of-way, allowing them to travel at high speed in urban areas, generally 40 to 60 miles per hour. Rapid transit is also characterized by the use of "high-level platforms" (boarding platforms level with passenger car floors, which eliminate the need to step up into the car), multiple sets of doors per car, long trains (up to 10 or more cars), and frequent service (2 to 10 minute headways). These features enable rapid transit to handle a large volume of passengers more quickly and efficiently than any other mode of transportation (Federal Transit Administration, 2012; Parkinson & Fischer, 1996).

In contrast with commuter railroads, which primarily serve suburbs and exurbs, rapid transit stops are spaced closer together and serve areas with a higher population density (Federal Transit Administration, 2012). Although it is expensive to build and operate, rapid transit is the ideal mode of transportation in high-density corridors—areas with large concentrations of origins and destinations (Federal Transit Administration, 2012; Parkinson & Fischer, 1996).

All references in this study to "rapid transit" mean *rail* rapid transit, though some of the principles would apply to *bus* rapid transit[7]. Nearly all of New York's existing elevated railways were constructed in conjunction with subways—usually in neighborhoods that were less- or un-developed at the time. Perhaps for this reason, during the second half of the 20th century, "subway" began to refer to New York's entire rapid transit system, whether elevated or underground. Thus, since that time, rapid transit has become synonymous with the subway.



Cross section of the 86th Street station in the Park Avenue Tunnel, arguably New York's first subway. The station closed in 1910, but tunnel is still used by Metro North (Brennan, 2005).

Although commuter railroads had already been in operation, the West Side Elevated (Patented) Railway Company represents New York's first rapid transit system, which opened in 1868. The expansion of this elevated network, the construction of competing elevated networks, and the development of subways thus constitute New York's rapid transit system. In 1876, the Park Avenue Tunnel was completed from 59th Street to 96th Street for the New York Central railroad. It was built with underground stations at 59th Street, 72nd Street, and 86th Street, and it arguably qualified as rapid transit, making it New York's first subway. However, only the 86th Street station was used, and it closed in 1910. The tunnel is still used by the Metro-North Railroad for commuter trains (Brennan, 2005).

In the 19th century, rapid transit passenger cars were much like traditional full-size passenger coaches, and they were pulled by lightweight coal-fired steam locomotives (Brennan, 2005; Greene, 1876; Seymour, 1881). Since the early 20th century, they have almost exclusively been high-performance electric multiple-unit cars receiving their power from a third rail (Parkinson & Fischer, 1996).

[7] Bus rapid transit is a relatively recent development and the term is used inconsistently. For example, the United States Federal Transit Administration recognizes two forms of bus rapid transit (Federal Transit Administration, 2012). In Metropolitan New York, the Lincoln Tunnel's Exclusive Bus Lane would meet the criteria for rapid transit as defined in this study, except for high-level platforms (Port Authority of New York and New Jersey, 2012). Although materially faster than traditional bus service, the MTA's Select Bus Service lacks crucial elements of rapid transit as defined herein, including a grade-separated right-of-way (Metropolitan Transportation Authority, 2012a).

Figure 1.1 *New York's rapid transit network in 2012 (solid black lines). Grey dashed lines represent other passenger and freight rail lines.*

Rapid transit is vital to New York (and other large, dense metropolises). Cars, buses, streetcars, and ferries—alone or in combination—cannot provide the combination of speed and capacity that is required to support the City's high-density commercial and residential development (Morlok, 1978; Papacostas & Prevedouros, 2001).

Objective of Rapid Transit

The principal objective of rapid transit is to move large numbers people from where they are to where they want to be, without delay. That is, rapid transit should provide *mobility* (Morlok, 1978; Papacostas & Prevedouros, 2001; Wright & Ashford, 1989). It is increasingly argued—and often persuasively so—that the related concept of *accessibility* is the most fundamental objective of transportation (El-Geneidy & Levinson, 2006; Handy, 2002; Reggiani, Bucci, & Russo, 2010).

Accessibility refers to the "ease of reaching destinations or activities rather than ease of traveling along the network itself" (El-Geneidy & Levinson, 2006). Unfortunately, the concept has not been sufficiently developed for use in this type of economic performance analysis, and generally accepted evaluation metrics do not exist. Also, it is often used to mean something else, such as the spacing of freeway entrances and exits (Handy, 2002; Papacostas & Prevedouros, 2001). Indeed, mobility forms the core of the MTA's present mission statement and stakeholder assessments, while accessibility remains absent (Metropolitan Transportation Authority, 2009).

This study is premised on the proposition that mobility is the fundamental objective of rapid transit. Certainly, rapid transit can and does achieve many other noble objectives such as urban development, a cleaner environment, and a higher standard of living. This study takes the view that mobility is not the only purpose of transit, but that it is the only *indispensible* purpose. Transportation without mobility is not transportation. This is the central normative assumption that underlies the data analysis, and it affects whether particular facts are interpreted as indicative of failure or of success.

Fortunately, the great majority of transportation literature supports this proposition, and mobility has been the primary motivation (explicitly and implicitly) behind almost every effort to begin, expand, and improve New York's rapid transit system. This makes sense, because transportation is movement—getting people and things from where they are now to a place where they are of greater value.

Evaluation of Rapid Transit

In the field of transportation engineering and planning, performance evaluations of transportation are built on two essential concepts—effectiveness and efficiency (Gleason & Barnum, 1982; Morlok, 1978; Papacostas & Prevedouros, 2001; Wright & Ashford, 1989). As mobility is the central objective of rapid transit, measures of effectiveness and efficiency, in essence, aim to identify and isolate aspects of mobility. For the purpose of this study, they are defined as follows:

> Effectiveness—the level of success in achieving an objective (i.e. mobility).
> Efficiency (or Productivity)—the ratio of effectiveness to cost (i.e. output/input).

Although the concepts are widely accepted, they are not always used consistently and there is disagreement on certain technical aspects of their use. Some draw a bright line between the two concepts and view them as mutually exclusive. Others deemphasize the distinction and view efficiency as a type of effectiveness. After all, if one's goal is efficiency, then a more efficient system is also more effective. There is near unanimous agreement, however, that transportation professionals should use the terms more precisely, and this study has endeavored to do so (Gleason & Barnum, 1982; Havelick, 1983; Lave, 1991).

This paper maintains a distinction between effectiveness and efficiency, albeit not a mutually exclusive one. The distinction clarified the data analysis and its interpretation, and hopefully it will likewise clarify understanding for the reader.

In general, *effective* rapid transit should have a well-designed network, provide a high level of service, and be convenient, comfortable, and safe. The network should correspond to land use and travel patterns. It should provide connections to the entire region. A high level of service means high travel speeds, low travel times, and short headways. It also means service should be reliable. There should be little variation in the total travel time. A comfortable and convenient rapid transit system has characteristics such as clean and bright stations with adequate seating. It also includes amenities such as climate control, maps and information, and bathrooms. Finally, a safe system has few injuries and hazards (Morlok, 1978; Papacostas & Prevedouros, 2001).

Efficient rapid transit is economical. It is low cost, including both subsidies and fares, in relation to its effectiveness (Morlok, 1978; Papacostas & Prevedouros, 2001; Wright & Ashford, 1989). The objectives of rapid transit and the means of quantifying effectiveness and efficiency receive a detailed treatment in Chapter 2.

<u>*Value of Rapid Transit*</u>

> *Access is what cities are all about. Man invented cities as an economic and social tool to create easy accessibility through collocation. Economically, many need access to one another to produce and distribute good efficiently. Socially, people need access between the generations, lifestyles and economic strata.*
> (Sclar & Schaeffer, 1980)

> *The point of cities is multiplicity of choice. It is impossible to take advantage of multiplicity of choice without being able to get around easily…Furthermore, the economic foundation of cities is trade…Trade in ideas, services, skills and personnel, and certainly in goods, demands efficient, fluid transportation and communication.* (Jacobs, 1961)

Transportation is integral to the functioning of every civilization, not just New York. It is intertwined with economic growth and the spatial organization of cities (Jacobs, 1969). Cities serve a crucial function of reducing transportation costs, and thus the type and cost of a society's transportation infrastructure and technology are a major influence on the location and structure of cities. The development of new transportation technologies have not only enabled but also caused changes in the societies that use those technologies (Morlok, 1978; O'Sullivan, 2007; Papacostas & Prevedouros, 2001; Sclar & Schaeffer, 1980).

The way that one travels is paramount to one's personal quality of life. For example, the cost and convenience of different transportation modes influences how long it takes to pick up groceries and how expensive they are. Transportation has a major effect on the accessibility of employment, shopping, recreation, and one's home (Morlok, 1978; Papacostas & Prevedouros, 2001; Wright & Ashford, 1989).

Transportation creates indirect but profound economic benefits. Transportation improvements can trigger further investment and economic development. They can reduce the cost of business and increase the productive capacity of the economy (Morlok, 1978; Papacostas & Prevedouros, 2001; Wright & Ashford, 1989).

New York, more than any other American city, depends on its transit system for transportation, and rapid transit is the backbone of this system. For example, subways are used by 63% of all persons entering the central business district during the morning peak period (Zhou et al., 2011). The physical structure of the city itself has been largely influenced by its rapid transit. For example, the great expansion of the subway during the 1910s (known as the "Dual Contracts" or "Dual System") subsequently allowed hundreds of thousands of New Yorkers to leave crowded tenements for much larger and higher-quality homes and apartments in the outer boroughs of Brooklyn, the Bronx, and Queens (Derrick, 2001).

History of Rapid Transit

The literature has also established the history of rapid transit in New York. James B. Walker (1918) and Joseph Brennan (2005) have written detailed accounts of the political and engineering history of the elevated railways. Clifton Hood (1993) and Peter Derrick (2001) have written similarly detailed accounts of the development of the subway. While the more recent history is somewhat scattered, there are several journal articles and reports which provide more than enough information about the major historical events. In addition, the quality of the MTA's own record keeping improved after 1980, as part of their effort to evaluate the progress of their five-year capital plans. Mark Seaman, Allison L. C. de Cerreno, and Seth English-Young (2004) published a thorough analysis of the MTA's Capital Program, from 1982 to 2004.

By the 1830s, horsecars, ferries, and omnibuses were New York's dominant form of mass transit (Hood, 1993). By the 1860s, however, these modes could no longer cope with the City's swift growth and street congestion. It was during this time that the first serious proposals for rapid transit in New York were made. In 1860, Hugh B. Willson raised private money for a subway in Manhattan and obtained permission from the New York State Legislature. However, William M. Tweed (known as "Boss Tweed", the leader of Tammany Hall) persuaded the governor to veto the bill in exchange for the backing of the horsecar companies (Walker, 1918).

Elevated railways were the first form of rapid transit to be realized in the city. Charles T. Harvey opened the city's first elevated railway in 1868. Fortunately, Harvey had friends of his own in New York State government. Although its cable propulsion system was unreliable, the line was successfully converted to operation by steam locomotives in 1871 (Sweet, 1872).

The Rapid Transit Act of 1875 created a formal process for establishing and securing property rights in elevated railway structures *above* New York City streets, replacing ad hoc legislation unique to each proposal and the concomitant political battles (Walker, 1918). Immediately after the courts ruled on the more contentious parts of the act, privately owned and operated steam powered elevated railways proliferated across New York and then Brooklyn. By the 1880s, the nominal base fare fell from $0.10 to $0.05 (approximately $2.30 to $1.15 in 2011 dollars), owing to internal productivity gains, scale economies, and the threat of competition (Hain, 2011).[8]

Property rights *below* the streets, however, remained of "doubtful legality", and the Rapid Transit Commission refused to consider any underground proposals based on the advice of their legal counsel (Seligman, Brown, Delamater, Mott, & Canda, 1875). In addition, the $0.05 fare became so popular that elected officials soon mandated it. This meant that subways (which were costlier and riskier) also remained of doubtful profitability. The Rapid Transit Act of 1894 permitted City financing, sufficiently reducing private sector risk to make the nickel fare possible (DeFreest, 1896).

Ultimately, the City would pay roughly 40% of the capital costs and would own the right-of-way (Fullen, Godley, & Lockwood, 1931). Private firms paid the other capital costs, leased the subways from the City, and operated them for $0.05 a ride (Brooks, 1903; Dunn, Baker, & Dickey, 1904). Thereafter and until 1940, the IRT and BRT rapid transit systems expanded swiftly, joined by the Independent City-Owned Subway System (IND) in the 1930s (Fullen, Haskell, & Fertig, 1942).

When the IRT and BRT (later BMT) agreed to the nickel fare in the early 20th century, the United States had experienced a century of gradual deflation, and this trend was expected to continue (Gallman, 1966; Rhode, 2002). However, the creation of the Federal Reserve System in 1913, the inflation of World War I, competition from the heavily subsidized IND, political intimidation, and the Great Depression eventually bankrupted the IRT and BMT (Dahl, 1940; Derrick, 2001; Greenspan, 1966; Hedley, 1921; Hood, 1993).

For these reasons, the IRT and BMT had long been asking for a fare increase in order to upgrade equipment and expand their networks (Brooklyn-Manhattan Transit Corporation, 1924; Hood, 1993; Interborough Rapid Transit Company, 1914). The City refused, however, and in 1940 the City pressured the IRT and BMT to sell, in order to take over operations of the entire system—an event known as "unification". The central argument for municipal unification was that the City could build and operate rapid transit more economically (mainly by reducing interest expense and eliminating profit) and the nickel fare could be preserved indefinitely. Instead, New York's rapid transit system began a long decline (Gordon, 1925; Hood, 1993).

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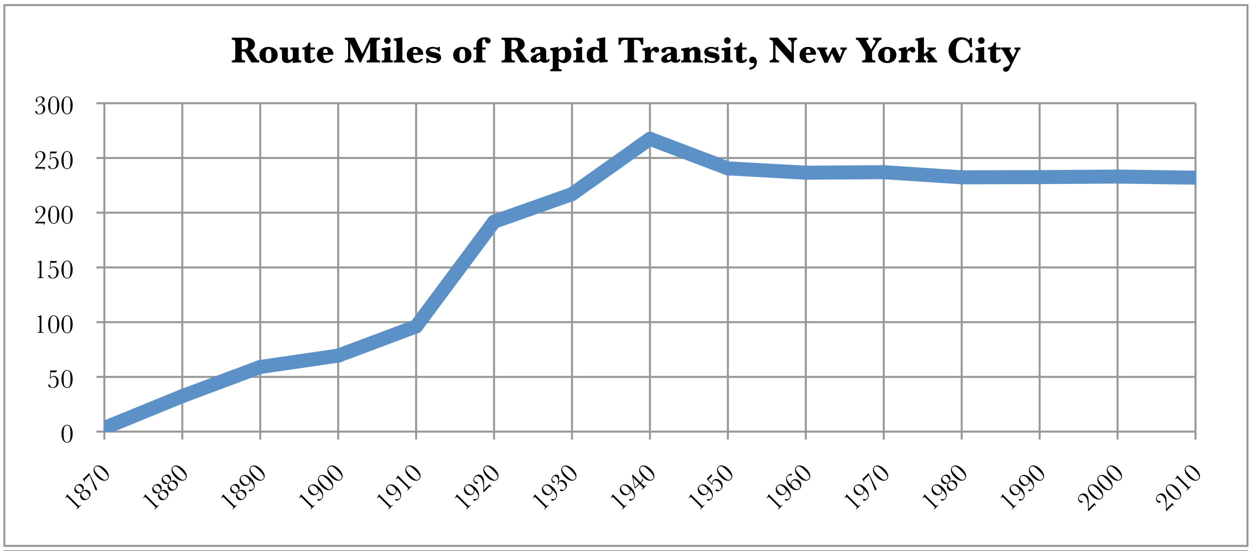
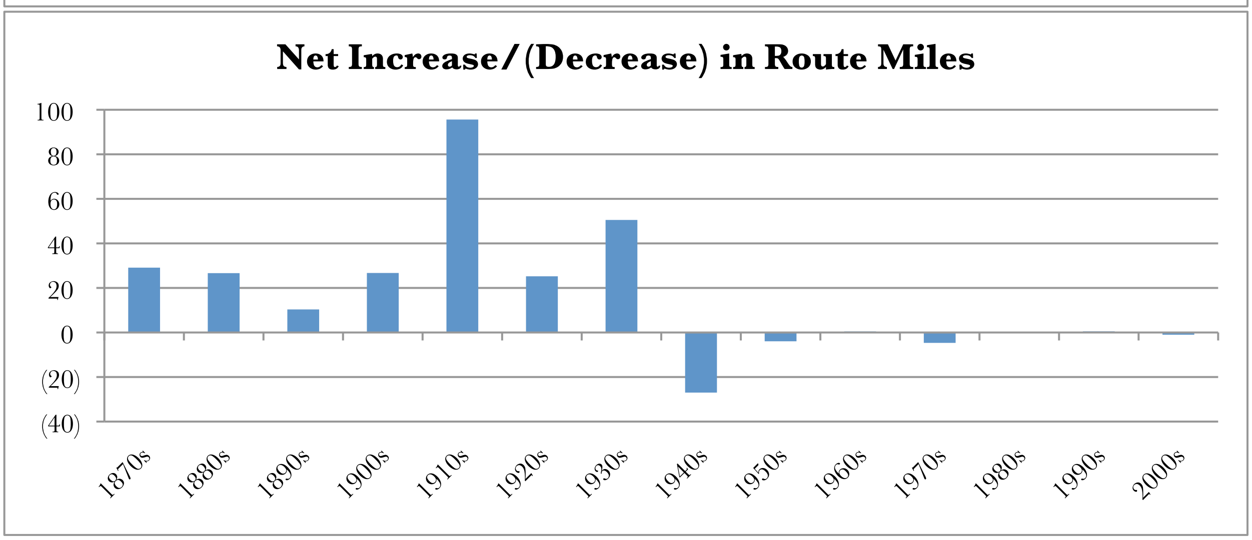
[8] Elevated railways were permitted to charge from $0.10 to $0.17 per ride (approximately $2.25 to $3.75 in 2011 dollars), depending on distance, but the Rapid Transit Commission required them to charge half price during rush hour, which were referred to as "commission trains" (Cooper, 1874; Seymour, 1881; Walker, 1918).





Figures 1.2, 1.3 *Nearly half of the city's existing rapid transit system was constructed in one decade—the 1910s. The system has contracted since 1940. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: compiled from annual reports of the State Engineer and Surveyor of the State of New York, the Board of Railroad Commissioners of the State of New York, the Public Service Commission for the First District of the State of New York, and the State of New York Transit Commission (Beardsley, Rickard, & Chapin, 1897; Cooper, 1874; Dunn et al., 1904; Dunn, Baker, Dickey, Aldridge, & Rockwell, 1907; Fullen et al., 1936; Fullen et al., 1931; Fullen et al., 1942; Greene, 1876; McAneny et al., 1922, 1926; McCall et al., 1915; Richmond, 1870; Rogers, Baker, & Rickard, 1890; Seymour, 1881, 1882; Straus et al., 1917; Sweet, 1872), private transit firms' annual reports to stockholders (Brooklyn Rapid Transit Company, 1921; Brooklyn-Manhattan Transit Corporation, 1924; Dahl, 1940; Hedley, 1921; Interborough Rapid Transit Company, 1904, 1914; Shonts, 1911, 1915; Williams, 1911, 1915), public transit agencies' annual reports (Conway, 1996; Daly, 1941; Delaney et al., 1939; Delaney et al., 1936; Fisher, 1977; Foran, 2011; Kiley, 1986; Metropolitan Transportation Authority, 1971, 1993, 2001b, 2006b; New York City Transit Authority, 1954, 1960, 1967; Ravitch, 1980; Reid et al., 1949) and author's calculations.*

The most significant change during the 1940s and 1950s was the demolition of the bulk of the elevated network. Since the Rockaway line in Queens opened in 1956, no major new lines have been added to the rapid transit network[9] (Derrick, 2001). Ridership steadily fell, and the system reached its nadir during the 1970s and 1980s, becoming notorious for crime, graffiti, and unreliability (Havelick, 1983; Ramsey, 1987).

The system improved significantly since then. This is credited primarily to the MTA Capital Program championed by Chairman Richard Ravitch, and the first five-year capital plan commenced in 1982. Rather than Network Expansion, these plans were primarily aimed at first returning the system to a State of Good Repair and then establishing scheduled Normal Replacement (Seaman et al., 2004). The success of the Capital Program subsequently enabled the MTA to embark on System Improvement and Network Expansion, and a new subway line beneath Manhattan's Second Avenue and an extension of the No. 7 Subway Line are presently under construction (Metropolitan Transportation Authority, 2011).

Despite several satisfactory accounts of the historical events, there are no systematic economic or performance analyses, other than those examining roughly 1980 to 2010. More recent studies use what was effectively the subway's lowest level (around 1980, when detailed performance data became much more readily available) as their starting point. Moreover, relatively little has been written about the elevated railways, especially in proportion to their significance in rapid transit history and their impact on the development of New York. The subway is often implicitly treated as the beginning of the city's rapid transit.

In addition, other academic papers on the subject of improving New York's subway make only a cursory glance at history, and usually this is done as mere background, not as a potential source of solutions. For example, at least two detailed privatization proposals—specifically for the New York City Subway—do not mention the fact that their schemes are remarkably similar to the legal framework enabling the city's elevated railway system in the 19th century (de Bartolome & Ramsey, 1992; Ramsey, 1987).

<u>*Conclusion*</u>

The literature has established what rapid transit is, what it is for, and how its effectiveness and efficiency can be evaluated. The literature has established the importance of effective and efficient rapid transit for large and dense cities. It has documented the major events comprising New York's rapid transit history; it is rich with examples of extreme success and failure; and it suggests a general rise, fall, and subsequent rise.

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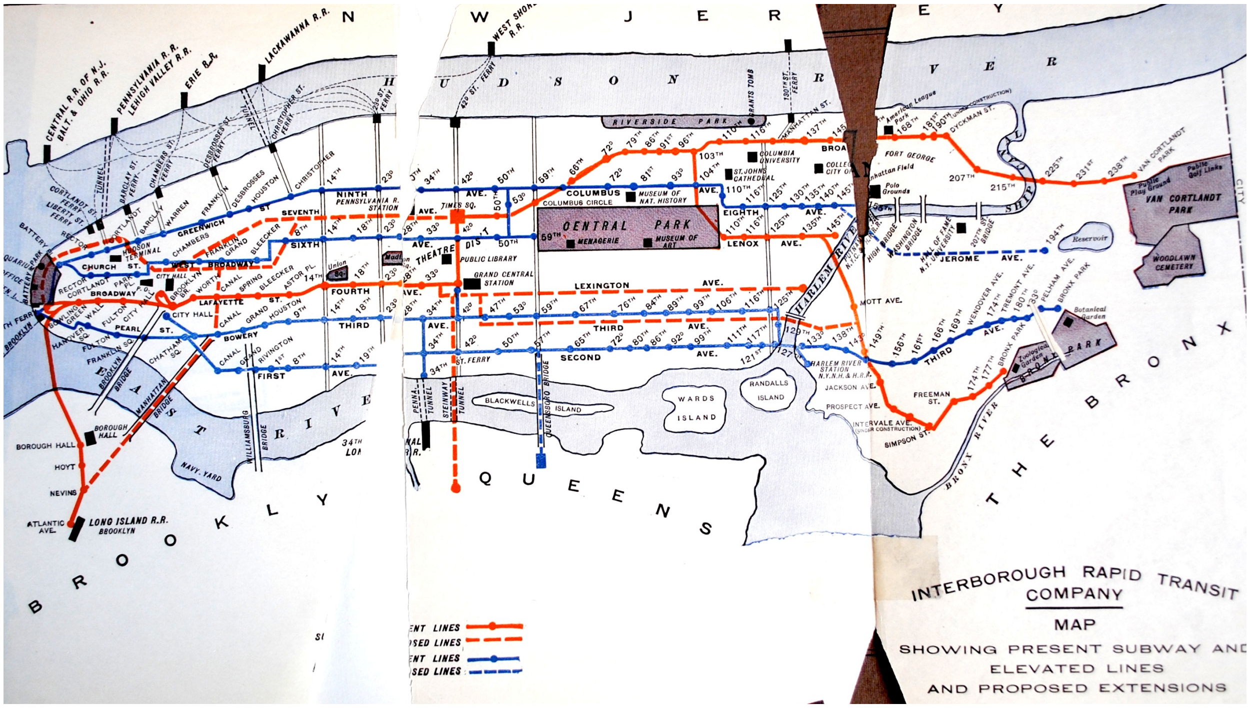
[9] New segments have opened since 1956, such as the Christie Street Connection in 1967 and the 63rd Street Tunnel Connector in 2001. They were important links and they enabled the creation of new subway routes, but the amount of additional track was relatively small. For example, the 63rd Street Tunnel Connector allowed the creation of the V subway line (which was subsequently discontinued). However, only 0.28 route miles of the line was new construction. The remainder of the line shared existing right-of-way with other lines (New York City Transit Authority, 2012c).



Third Avenue subway alignment for an additional trunk line on Manhattan's East Side, as proposed by the IRT in 1911—the predecessor of today's Second Avenue Subway (Shonts, 1911).

In addition, there is a great deal of agreement among city planners, economists, and transportation engineers on how to evaluate rapid transit and even on many specific ways to make New York's rapid transit system more effective and efficient. Action, however, has been lacking. For example, it has been recognized for 100 years that a second subway trunk line is required on Manhattan's East Side. The IRT advocated a Third Avenue alignment as early as 1911, in addition to the proposed (but not then yet built) Lexington Avenue subway line (Hedley, 1921; Metropolitan Transportation Authority, 1971, 2008; Reid et al., 1949; Shonts, 1911, 1915; State of New York Transit Commission, 1922).

We can use the historical data to quantify the magnitude of the system's achievements and to identify the larger causes of those achievements.

RESEARCH DESIGN / METHODOLOGY

The research for this study consisted of three main steps. First, historical data on the costs, assets, network, operations, and performance of New York's rapid transit system were obtained. Second, the data were input into spreadsheet software to calculate performance metrics, create charts, identify trends, and otherwise quantitatively evaluate effectiveness and efficiency. Third, potential causes of the successes and failures—as indicated by the data analysis—were examined.

Collection and Analysis of Historical Data

The first step was to collect historical data from primary sources as required to measure effectiveness and efficiency. These are discussed in Chapter 2, and include cost, asset, network, and other performance data from the principal entities that operated rapid transit within the present-day New York City boundary, including Brooklyn, Queens, and the Bronx. This included about 20 different private firms and public authorities. The data also include relevant information from numerous parent firms, construction firms, holding corporations, subsidiaries, and special purpose entities.

Most of the data were published in various annual reports. In the 19th century, the State of New York State published numerous compilations of railroads' financial and operational data. This included the annual reports of the State Engineer and Surveyor of the State of New York, the Board of Railroad Commissioners of the State of New York, the Public Service Commission for the First District of the State of New York, and the State of New York Transit Commission (Beardsley, Rickard, & Chapin, 1897; Cooper, 1874; Dunn et al., 1904; Dunn, Baker, Dickey, Aldridge, & Rockwell, 1907; Fullen et al., 1936; Fullen et al., 1931; Fullen et al., 1942; Greene, 1876; McAneny et al., 1922, 1926; McCall et al., 1915; Richmond, 1870; Rogers, Baker, & Rickard, 1890; Seymour, 1881, 1882; Straus et al., 1917; Sweet, 1872).

In the early 20th century, the private rapid transit operators' own annual reports to stockholders contained this data (Brooklyn Rapid Transit Company, 1921; Brooklyn-Manhattan Transit Corporation, 1924; Dahl, 1940; Hedley, 1921; Interborough Rapid Transit Company, 1904, 1914; Shonts, 1911, 1915; Williams, 1911, 1915). Thereafter, reports by the City of New York, the New York City Transit Authority (NYCTA or TA), and the MTA contained this data (Conway, 1996; Daly, 1941; Delaney et al., 1939; Delaney et al., 1936; Fisher, 1977; Foran, 2011; Kiley, 1986; Metropolitan Transportation Authority, 1971, 1993, 2001b, 2006b; New York City Transit Authority, 1954, 1960, 1967; Ravitch, 1980; Reid et al., 1949).

Data was obtained at roughly five-year intervals. However, the years are irregular due to the unavailability of data. On average, the data points are 4.5 years apart. All figures refer to heavy rail rapid transit operations only. Commuter rail, streetcar, bus, trolley bus, and other surface modes were excluded. The descriptive statistics are summarized in the table below.

Data Summary—Principal Entities Operating Rapid Transit in New York City

					NOMINAL FIGURES			
Year	Operating Firm / Agency	Route Miles	Running Track Miles	Passenger Trips	Total Annual Cost	Capital Assets in Operation	Fare	Source
1871	WSE	3.4	3.7	53,912	$ 7,992		$ 0.10	Sweet, 1872
1873	NYE	4.0	4.2	644,025	$ 76,034	$ 1,500,000	$ 0.10	Cooper, 1874
1875	NYE	4.0	4.4	920,571	$ 88,372	$ 1,456,807	$ 0.10	Greene, 1876
1880	MRC	32.4	79.4	60,831,757	$ 5,103,283	$ 13,003,949	$ 0.10	Seymour, 1881
1881	MRC	32.4	79.5	75,585,778	$ 5,964,262	$ 13,005,000	$ 0.10	Seymour, 1882
1889	MRC	32.4	90.1	179,497,433	$ 8,406,473	$ 27,833,685	$ 0.05	Rogers, 1890
1889	BER	17.1	34.8	21,486,939	$ 1,113,848	$ 9,726,631	$ 0.05	Rogers, 1890
1889	KCE	5.9	13.5	12,640,420	$ 618,297	$ 8,713,049	$ 0.05	Rogers, 1890
1889	SRT	3.2	7.2	3,327,740	$ 144,290	$ 1,573,645	$ 0.05	Rogers, 1890
1896	MRC	36.1	102.3	184,769,098	$ 10,171,355	$ 57,892,171	$ 0.05	Beardsley, 1897
1896	BER	16.9	34.7	35,575,514	$ 1,962,482	$ 26,594,726	$ 0.05	Beardsley, 1897
1896	KCE	8.3	21.7	14,825,306	$ 1,077,786	$ 14,675,776	$ 0.05	Beardsley, 1897
1903	IRT	36.8	119.3	264,421,744	$ 11,258,608	$ 85,401,335	$ 0.05	Dunn, 1904
1903	BUE	38.6	92.1	87,409,475	$ 3,384,274	$ 42,692,490	$ 0.05	Dunn, 1904
1906	IRT	59.5	189.5	395,716,386	$ 20,129,705	$ 116,514,986	$ 0.05	Dunn, 1907
1906	BUE	37.0	90.5	111,401,960	$ 4,041,245	$ 46,866,713	$ 0.05	Dunn, 1907
1911	IRT	63.4	203.3	578,154,088	$ 27,777,314	$ 202,339,840	$ 0.05	Shonts, 1911
1911	BRT	32.6	71.3	224,366,482	$ 8,428,782	$ 49,414,764	$ 0.05	Williams, 1911
1915	IRT	64.9	205.9	647,378,266	$ 32,365,258	$ 246,854,794	$ 0.05	Shonts, 1915
1915	BRT	61.1	160.4	247,261,922	$ 9,271,561	$ 66,348,162	$ 0.05	Williams, 1915
1921	IRT	114.7	348.6	1,013,678,831	$ 57,065,272	$ 456,313,653	$ 0.05	Hedley, 1921
1921	BRT	90.2	244.4	404,970,640	$ 27,772,942	$ 258,952,110	$ 0.05	BRT, 1921
1925	IRT	114.8	347.7	1,089,544,225	$ 51,759,492	$ 478,683,890	$ 0.05	McAneny, 1926
1925	BMT	95.6	265.7	591,256,029	$ 28,127,930	$ 295,112,336	$ 0.05	McAneny, 1926
1930	IRT	117.5	356.6	1,334,110,909	$ 68,746,874	$ 520,134,749	$ 0.05	Fullen, 1931
1930	BMT	99.5	273.3	714,433,616	$ 36,083,902	$ 351,099,947	$ 0.05	Fullen, 1931
1935	IRT	117.2	355.7	1,015,717,127	$ 56,213,132	$ 524,431,001	$ 0.05	Fullen, 1936
1935	BMT	100.8	276.6	598,231,061	$ 30,757,192	$ 374,367,794	$ 0.05	Fullen, 1936
1935	IND	34.0	120.3	202,975,574	$ 33,912,931	$ 538,647,444	$ 0.05	Fullen, 1936
1939	IRT	112.1	344.8	926,266,154	$ 52,685,295	$ 513,589,884	$ 0.05	Fullen, 1942
1939	BMT	100.8	276.1	543,050,814	$ 26,628,432	$ 379,376,321	$ 0.05	Fullen, 1942
1939	IND	52.3	180.7	383,627,489	$ 50,285,196	$ 708,485,861	$ 0.05	Delaney, 1939
1940	BOT	267.5	808.4	1,842,675,316	$ 150,004,946	$ 1,175,237,863	$ 0.05	Daly, 1941
1946	BOT	238.1	749.6	2,067,227,010	$ 156,443,363	$ 1,118,366,405	$ 0.05	Reid, 1949
1949	BOT	241.6	738.4	1,721,554,350	$ 195,469,919	$ 1,021,168,890	$ 0.10	Reid, 1949
1954	NYCTA	236.2	726.3	1,416,371,403	$ 290,704,100	$ 1,354,405,149	$ 0.15	NYCTA, 1954
1960	NYCTA			1,344,952,725	$ 303,260,081		$ 0.15	NYCTA, 1960
1967	NYCTA			1,298,484,890	$ 460,041,789		$ 0.20	NYCTA, 1967
1970	NYCTA	237.0		1,257,569,000	$ 626,656,282		$ 0.30	MTA, 1971
1976	NYCTA			1,010,497,000	$ 1,124,354,259		$ 0.50	Fisher, 1977
1980	NYCTA			1,009,333,000	$ 1,367,804,466		$ 0.60	Ravitch, 1980
1985	NYCTA	230.0		1,010,210,633	$ 1,327,473,653	$ 2,030,845,500	$ 0.90	Kiley, 1986
1992	NYCTA	233.0		996,802,847	$ 1,797,583,880	$ 9,290,006,100	$ 1.25	MTA, 1993
1995	NYCTA	233.0	656.0	1,092,796,601	$ 2,715,822,040	$ 18,515,075,400	$ 1.50	Conway, 1996
2000	NYCTA	233.0	656.0	1,381,078,913	$ 3,258,707,918	$ 21,412,500,000	$ 1.50	MTA, 2001
2005	NYCTA	233.0	659.0	1,453,000,000	$ 4,784,566,832	$ 33,012,750,000	$ 2.00	MTA, 2006
2010	NYCTA	232.0	659.0	1,604,198,017	$ 6,836,418,514	$ 47,193,000,000	$ 2.25	Foran, 2011

Figure 1.4 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Compiled from annual reports of the State Engineer and Surveyor of the State of New York (1869—1882), the Board of Railroad Commissioners of the State of New York (1889—1907), the Public Service Commission for the First District of the State of New York (1910—1917), the State of New York Transit Commission (1921—1939), private transit firms' annual stockholder reports (1911—1940), and public transit agencies' annual reports (1935—2011).*

The befitting setting for the author's historical data collection at the New York Public Library.

After the data was collected, it was input into Microsoft Excel spreadsheets to manipulate, graph, and otherwise analyze the data. In these analyses, cost has been calculated to include all expenses incurred and/or paid—both fixed and variable cost—to operate rapid transit in a given fiscal year. This is because all costs are variable in the long-term. It is designed to be the broadest possible financial measure of cost, and it includes depreciation (the amortized cost of replacing fixed capital assets—tracks, trains, buildings, etc.), interest, dividends, and taxes.

Capital assets include non-operating costs such as the cost of real estate, right-of-way, construction, track, equipment, etc. The capital costs represent only assets in operation (during a given year) and not those abandoned or under construction. Although accounting methods and financial reporting changed over time, the cost figures used and presented in this study have been calculated to represent identical concepts.

The data are presented in the appendix. All monetary data were adjusted for inflation, and are presented in 2011 United States Dollars. No single price index was found that covered the entire period from 1870 to 2010. Data from 1913 to 2011 were adjusted using the United States Bureau of Labor Statistics' Consumer Price Index (2011). Data from 1870 to 1912 were adjusted using Peter H. Lindert and Richard Sutch's historical price index (2006), which was also furnished by the Bureau of Labor Statistics.

Identification of Causes

This paper briefly looks at several major factors that stood out as being of crucial importance during this economic analysis of rapid transit. Interpretation of the data is complicated by the fact that the relevant political and economic theories have diverse views on the subject of rapid transit. Transportation is often treated as a special type of product. See the appendix for a brief discussion of the conflicting theory.

Conclusion

We know that rapid transit is crucial to Metropolitan New York's economic health and overall quality of life. Significant improvements and expansions are long overdue, especially given the continued growth of the city and of the region. We can see that rapid transit surmounted obstacles in the past that were as great or greater than the present problems of the subway, and we can also appreciate that the subway is significantly cleaner, safer, and more reliable than it was at its low point, 30 or 40 years ago.

What is less well understood and appreciated, however, is from what height the system fell to reach that nadir. The history of rapid transit in New York indicates a rise, a fall, and second rise. However, neither the system's present state, nor the magnitude of past failures and successes, nor their causes are clear. This long-term economic analysis of the city's rapid transit aims to provide (1) an evaluation of the system's long-term effectiveness and efficiency and of its present state and (2) evidence of how past failures can be avoided and past successes surpassed.

The proposition of this research is that an economic analysis of the history of rapid transit in New York will—by revealing the nature, magnitude, and cause of the system's failure and success—identify how to build and operate radically improved rapid transit.

CHAPTER 2

FAILURE AND SUCCESS: WHAT AND WHEN

QUANTIFYING SUCCESS

As discussed above, mobility is the principal objective of rapid transit. That is, its purpose is to carry large numbers people from where they are to where they want to be one, without delay. The aim of this study is, in part, to evaluate the extent to which New York's rapid transit system succeeded or failed in achieving this objective.[10]

In order to perform an economic evaluation of rapid transit, it is useful to distinguish measurements of *effectiveness* from measurements of *efficiency*. To reiterate, in the field of transportation engineering and planning, they are defined as follows:

> Effectiveness—the level of success in achieving an objective (i.e. mobility)
> Efficiency (Productivity)—the ratio of effectiveness to cost (i.e. output/input).

In theory, metrics of efficiency can be reduced to metrics of effectiveness, such as cost-effectiveness. In practice, however, it is difficult to collapse all impacts into one dimension (Morlok, 1978; Papacostas & Prevedouros, 2001; Wright & Ashford, 1989). The MTA's current mission statement, which is "the cost-efficient provision of safe, on-time, reliable, and clean transportation services", includes elements of both effectiveness and efficiency (Metropolitan Transportation Authority, 2009).

For the purpose of this paper, *success* means effective and efficient rapid transit, and *failure* means ineffective and inefficient rapid transit. Emphasis has been placed on the rate and especially the direction of change, rather than the absolute numbers. In the long-term, the rate and direction of change govern the absolute level of success or failure. It is important to bear in mind that this study is evaluating the success and failure of rapid transit, not merely the success and failure of a particular rapid transit firm or agency. Thus, we are not limited to metrics that measure factors within the control of a given rapid transit system's management. Indeed, many of the metrics measure factors well beyond the control of a rapid transit provider.

The metrics used in this paper are limited to the available historical data and are admittedly imperfect. Fortunately, however, data for the key measurements were obtained. Most of the metrics presented are standard measurements that are typically used in economic analyses of the transportation industry (de Bartolome & Ramsey, 1992; Gleason & Barnum, 1982; Havelick, 1983; Lave, 1991; Metropolitan Transportation Authority, 2009; Ramsey, 1987; Seaman et al., 2004).

All "New York" economic, demographic, and rapid transit data includes the area within the present day boundaries of New York City. Thus, Brooklyn (Kings County), Queens, and the Bronx (along with the Annexed District) are included in all data presented before municipal consolidation in 1898.

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[10] Rapid transit is frequently built and operated to achieve other objectives, such as to facilitate economic development, clean the environment, achieve social equity, provide high-paying jobs, etc. However, these are not the central objectives of rapid transit and were not evaluated in this research.

However, the Hudson & Manhattan Railroad (now the Port Authority Trans-Hudson System or PATH), Staten Island Rapid Transit, and AirTrain JFK were omitted for simplicity. In total, the omitted systems represent 10% of New York's present rapid transit track mileage.

Effectiveness

Aspects of effectiveness include mobility (and accessibility), network design, level of service, comfort and convenience, and safety. Mobility is the central purpose of rapid transit, and aspects of effectiveness can be thought of as aspects of mobility. The concept of accessibility, unfortunately, does not have well established metrics and it is not presently mentioned in the MTA's mission statement or stakeholder assessment, as discussed above. Regardless, improvements in mobility tend to also improve accessibility (Handy, 2002; Morlok, 1978; Papacostas & Prevedouros, 2001; Wright & Ashford, 1989).

The most important measurement of mobility is ridership—the number of passengers. The purpose of rapid transit is to take people where they want to go, and presumably people will not patronize it otherwise. Thus, ceteris paribus, if the system is moving more people, then it is providing more mobility (Morlok, 1978; Seaman et al., 2004). Ridership is the key performance indicator used by the MTA to measure success in achieving its goal of "enhancing the mobility of the region" (Metropolitan Transportation Authority, 2009).

Ridership is influenced by many factors; for this reason, it reflects all aspects of effectiveness and is the broadest measure of mobility. Ridership is generally measured in terms of unlinked passenger trips. In this context, unlinked means that passengers are counted each time they enter the rapid transit system, including passengers who transfer from another mode, such as a bus or streetcar. Passengers who use multiple rapid transit lines to reach their destination, however, are counted only once, unless they leave and reenter a fare control area. In this paper, the terms "passengers", "ridership", and "trips" all refer to the number of unlinked rapid transit passenger trips.

Passenger trips are generally recorded as annual totals. In order to facilitate analysis and comprehension, this study usually presents ridership as the daily average, which equals the annual total divided by 365 days. Bear in mind that typically weekday ridership is slightly higher than the daily average and weekend ridership is lower (New York City Transit Authority, 2007).

Because employment levels tend to influence transit ridership, passengers per job measures mobility apart from local economic conditions (Seaman et al., 2004).

The effectiveness of a rapid transit system can also be measured by the size and scope of its network, equipment, and operations. All else being equal, a larger network will be able to take more people to more of the places that they'd like to travel to, making it a measure of both mobility and accessibility (Handy, 2002; Morlok, 1978).

Network size can be measured in terms of revenue track miles or route miles. Revenue track miles refer to the total mileage of track in passenger (or "revenue") service, regardless of direction. Revenue track miles exclude rail yards and sidings. All mentions of track miles in this paper refer to *revenue* track miles. Route miles refer to the total mileage of routes in passenger service, without regard to the number of parallel tracks that may share a given right-of-way. Network size can also be measured by the number of stations (Federal Transit Administration, 2012).

The size and scope of a network are also reflected in the number of revenue car miles and the number of passenger cars. In the context of this study, passenger cars (or simply "cars") are rapid transit railcars with seating and/or standing room for the purpose of transporting passengers. In the 19th century, steam locomotives pulled rapid transit passenger cars, but in the 20th century, they were replaced by (or converted into) electric self-propelled multiple-unit passenger cars (Derrick, 2001; Dunn et al., 1904; Federal Transit Administration, 2012).

Revenue car miles refer to the number of miles that passenger cars travel while in revenue service, and they exclude maintenance, training, charter services, and deadhead mileage. Deadhead miles include changing routes and leaving or returning to a rail yard. Revenue car miles are sometimes referred to as revenue *vehicle* miles, but this paper avoids that term to avoid confusion with revenue *train* miles, which was a common metric in the 19th century (Beardsley et al., 1897; Dunn et al., 1904; Federal Transit Administration, 2012; Rogers et al., 1890; Seymour, 1881; Steinway, Starin, Spencer, Inman, & Bushe, 1891).

The effectiveness of a rapid transit system can be measured by the real (inflation-adjusted) fare. A lower fare allows more people to afford to travel more frequently to more places.

Spending and investment in operations and capital improvements is another measure of a rapid transit system's effectiveness. All else being equal, more spending translates into a more extensive and higher quality transportation system. The MTA uses Capital Program commitments and completions as a performance indicator (Metropolitan Transportation Authority, 2009).

The most important measures of effectiveness have been analyzed in this study, but there are many other valid measures that were not included. In some cases, such as passenger miles, travel times, and the percentage of passengers seated, this was due to sporadic and/or unavailable historical data. Other factors, such as comfort and convenience, are difficult to quantify. In other cases, such as level of service and safety, it was due to self-imposed scope limits.

The principal rapid transit effectiveness metrics used in this paper are:

- Ridership—passengers per day
- Passengers per job
- Route miles

<u>*Efficiency*</u>

Efficiency, like productivity, is the ratio of an output to an input. Typically, the output is a measure of effectiveness and the input is a cost. It is roughly synonymous with the concept of economic productivity. Economic productivity frequently uses labor (number of employees or person-hours) as the input. Performance analyses of transit sometimes use the terms "efficiency", "productivity", and "effectiveness" interchangeably. In the context of this study, efficiency and productivity mean the same thing, while effectiveness is a distinct concept, as defined earlier (Gleason & Barnum, 1982; Goodwin, Nelson, Ackerman, & Weisskopf, 2009; Hall & Lieberman, 2008; Havelick, 1983; Lave, 1991). Efficiency is just as important as effectiveness. Because resources (i.e. inputs) are limited, a more efficient rapid transit system is also a more effective one, by definition.

Outputs are measured using the effectiveness metrics indicated above. Some measurements, such as revenue car miles, can be validly used as an input or an output. The central input measure is cost. A secondary input measure is the number of rapid transit employees.

In this paper, cost has been calculated to include all expenses incurred and/or paid—both fixed and variable cost—to operate rapid transit in a given fiscal year. It is the broadest possible financial measure of cost. In particular, it is broader than "operating expenses", and it includes depreciation (the amortized cost of replacing fixed capital assets—tracks, trains, buildings, etc.), interest, dividends, and taxes. It may be thought of as "long-term cost" because, in the long-term, equipment wears out, and a rapid transit system will not be able to survive for long if it can only pay operating expenses. Even though they only affect the private, for-profit transit firms, dividends and taxes are similarly included because they are necessary for such firms to remain in business. Costs, however, do not account for externalities (Federal Transit Administration, 2010, 2012; Lave, 1991).

Although they are already incorporated into the cost measure discussed above, capital cost has also been collected separately in order to compare construction cost with other cost. Capital cost refers to the cost of capital assets that are in operation at a certain point in time, and they represent the cost of constructing and equipping new and existing rapid transit lines.

Cost or the number of employees can be compared with the effectiveness metrics to create efficiency ratios. Traditionally, efficiency and productivity metrics are calculated by dividing an output by an input. However, sometimes the output is the numerator in order to make the ratios more meaningful (Hall & Lieberman, 2008; Havelick, 1983; Lave, 1991).

This is the case with the central measurement of efficiency—cost per passenger. This is similar to (but broader than) the MTA's performance indicator of *operating* cost per passenger (Metropolitan Transportation Authority, 2009). Cost per revenue car mile is also an important measure of efficiency. Labor productivity (the efficiency of labor) can be measured in terms of employees per unlinked passenger trip and employees per revenue car mile. Efficiency of capital investments can be measured in terms of capital cost per track mile.

The principal rapid transit efficiency metrics used in this study are:

- Cost per passenger
- Cost per revenue car mile
- Employees per revenue car mile
- Cost per track mile

NEW YORK: EXTRAORDINARY SUCCESS AND SEVERE FAILURE

Analysis of New York's historical rapid transit data reveals extraordinary progress followed by severe decline—by nearly every basic measure of effectiveness *and* efficiency.

Although there were many variations from year to year, three distinct eras emerge from the data, broadly speaking. First, the system briskly expanded and improved from approximately 1870 until 1940. Then, from approximately 1940 to 1980, the system contracted and deteriorated. Finally, from approximately 1980 to 2010, the system was stabilized and revitalized. Unless otherwise noted, all figures presented below are the author's calculations and are based on data as explained in Chapter 1, and all charts present rapid transit data for New York.

The rise and fall in efficiency is exceptionally striking. As shown in the chart below, real cost *per passenger* fell by 75% from 1870 to 1930, which equates to a 295% increase in productivity. Real cost per passenger rose by 185% from 1940 to 1980, which equates to a 65% decrease in productivity. Efficiency is notably flat from 1980 to 2010, with productivity decreasing only 16% during the entire period. Revenue car miles per employee illustrate a similar trend.

A similar (but less extreme) trend is seen is other efficiency metrics, including cost per revenue car mile and passenger trips per employee. In addition, improving efficiency correlates with a lower real fare while declining efficiency parallels a rising real fare.

The rise and fall in effectiveness is also striking. From 1880 to 1940, rapid transit ridership grew three times as fast as the population. Namely, ridership rose by a compounded rate of 77% per decade from 1880 to 1940, while New York City's population (including areas before municipal consolidation) increased by a compounded rate of 25% per decade. Ridership also grew faster than employment, which increased by a compounded rate of 26% per decade.

From 1940 to 1980, ridership fell by a compounded rate of 15% per decade, while the City's population fell by only 1% per decade. Moreover, the City's total employment slightly increased during this period—by a compounded rate of 2% per decade.

In addition, there is steady growth in the size of New York's rapid transit network from 1870 to 1940, whether measured in track-miles, route miles, or number of stations. The number of route miles then contracts by 10% during the 1940s. Subsequent additions and deletions have had almost no net effect on the total network size, and in 2010 the network remained 4% smaller than it had been in 1950.

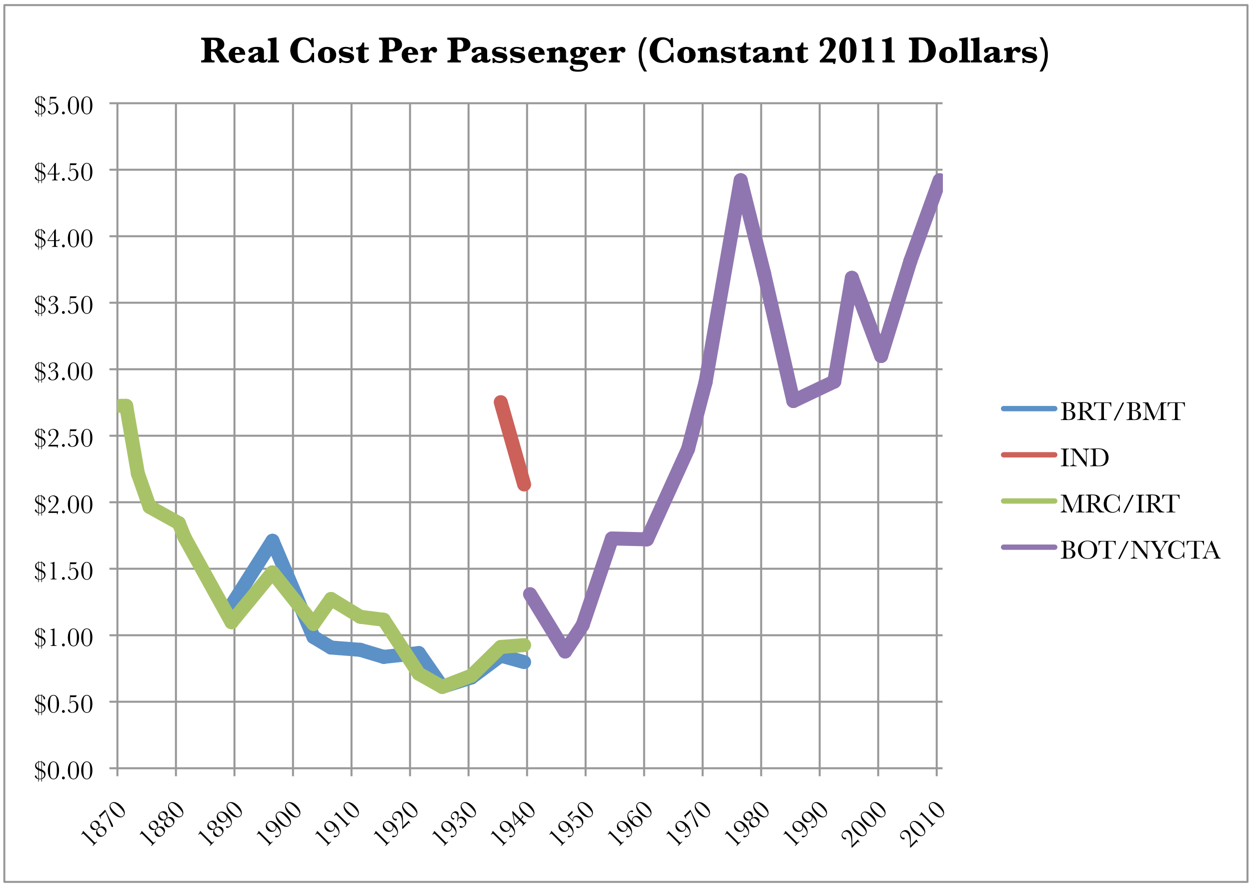
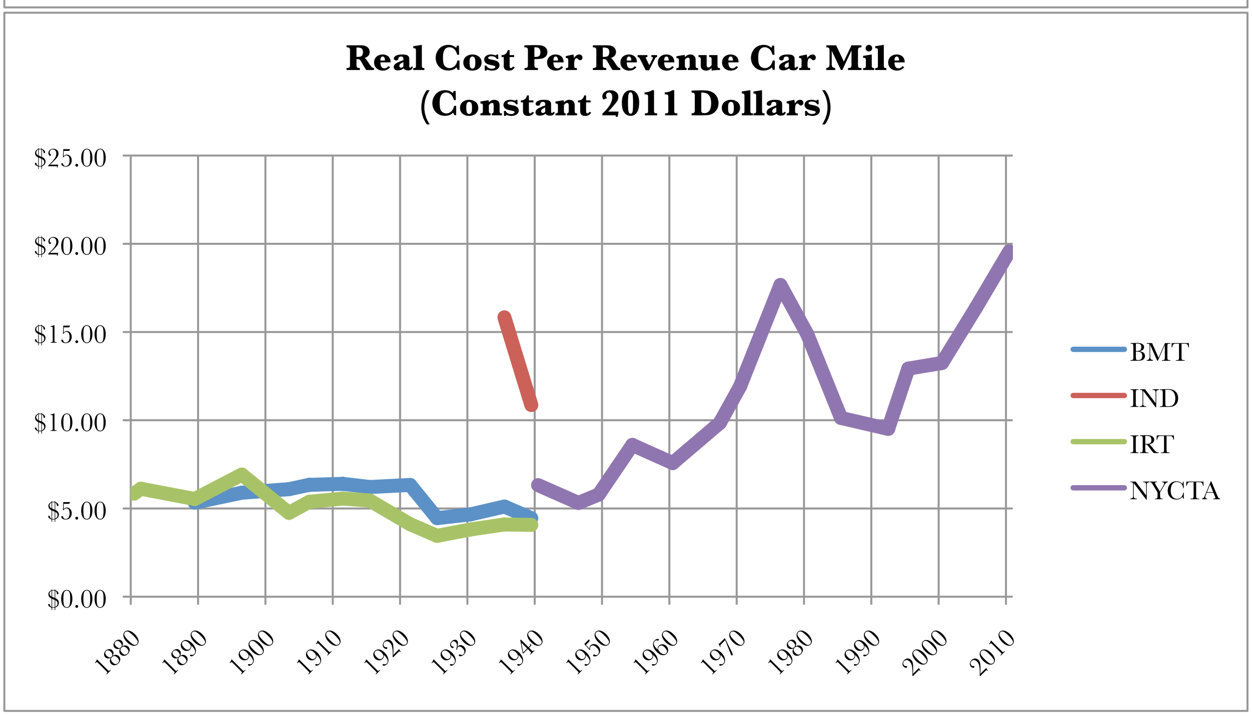


Figure 2.1 *Real cost per passenger fell by 75% from 1870 to 1930, which equates to a 295% increase in productivity. Real cost per passenger rose by 185% from 1940 to 1980, which equates to a 65% decrease in productivity.*

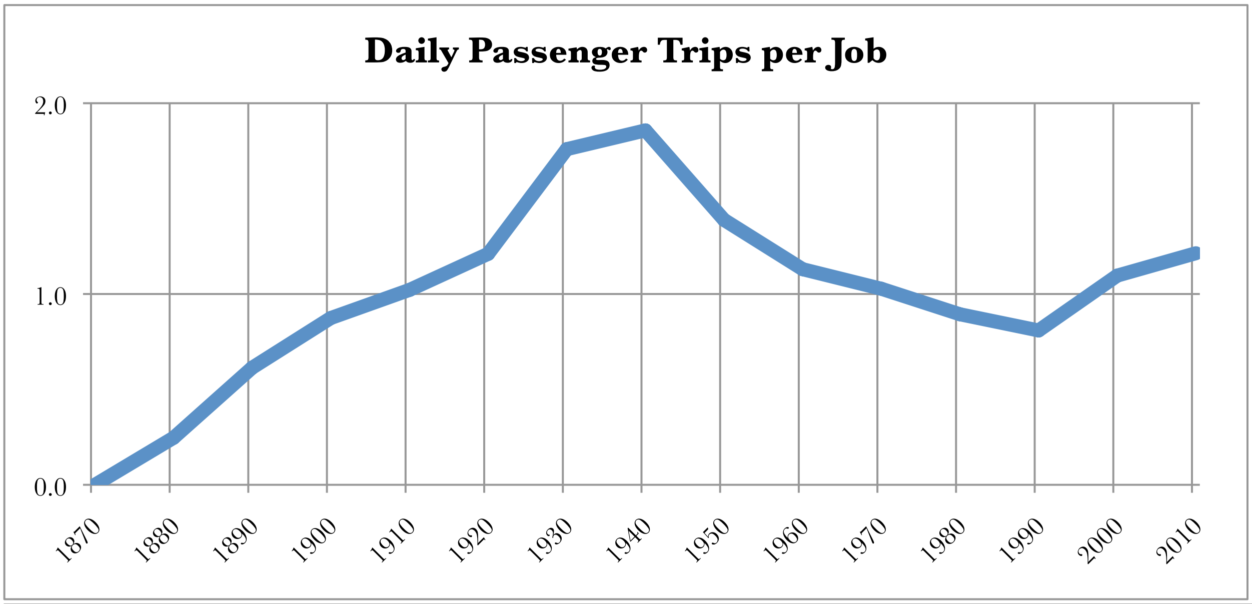
All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: compiled from annual reports of the State Engineer and Surveyor of the State of New York, the Board of Railroad Commissioners of the State of New York, the Public Service Commission for the First District of the State of New York, and the State of New York Transit Commission (Beardsley, Rickard, & Chapin, 1897; Cooper, 1874; Dunn et al., 1904; Dunn, Baker, Dickey, Aldridge, & Rockwell, 1907; Fullen et al., 1936; Fullen et al., 1931; Fullen et al., 1942; Greene, 1876; McAneny et al., 1922, 1926; McCall et al., 1915; Richmond, 1870; Rogers, Baker, & Rickard, 1890; Seymour, 1881, 1882; Straus et al., 1917; Sweet, 1872), private transit firms' annual reports to stockholders (Brooklyn Rapid Transit Company, 1921; Brooklyn-Manhattan Transit Corporation, 1924; Dahl, 1940; Hedley, 1921; Interborough Rapid Transit Company, 1904, 1914; Shonts, 1911, 1915; Williams, 1911, 1915), public transit agencies' annual reports (Conway, 1996; Daly, 1941; Delaney et al., 1939; Delaney et al., 1936; Fisher, 1977; Foran, 2011; Kiley, 1986; Metropolitan Transportation Authority, 1971, 1993, 2001b, 2006b; New York City Transit Authority, 1954, 1960, 1967; Ravitch, 1980; Reid et al., 1949) and author's calculations.

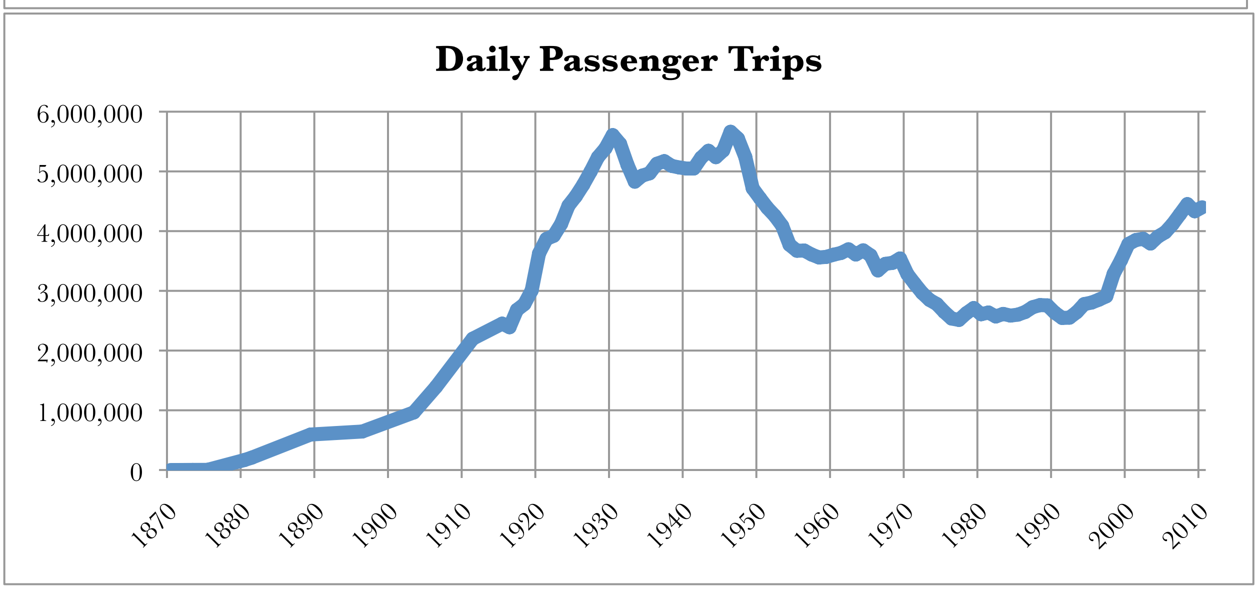


Figures 2.2, 2.3 *By nearly every metric, efficiency and productivity steadily improved until approximately 1940 and it then declined until approximately 1980. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

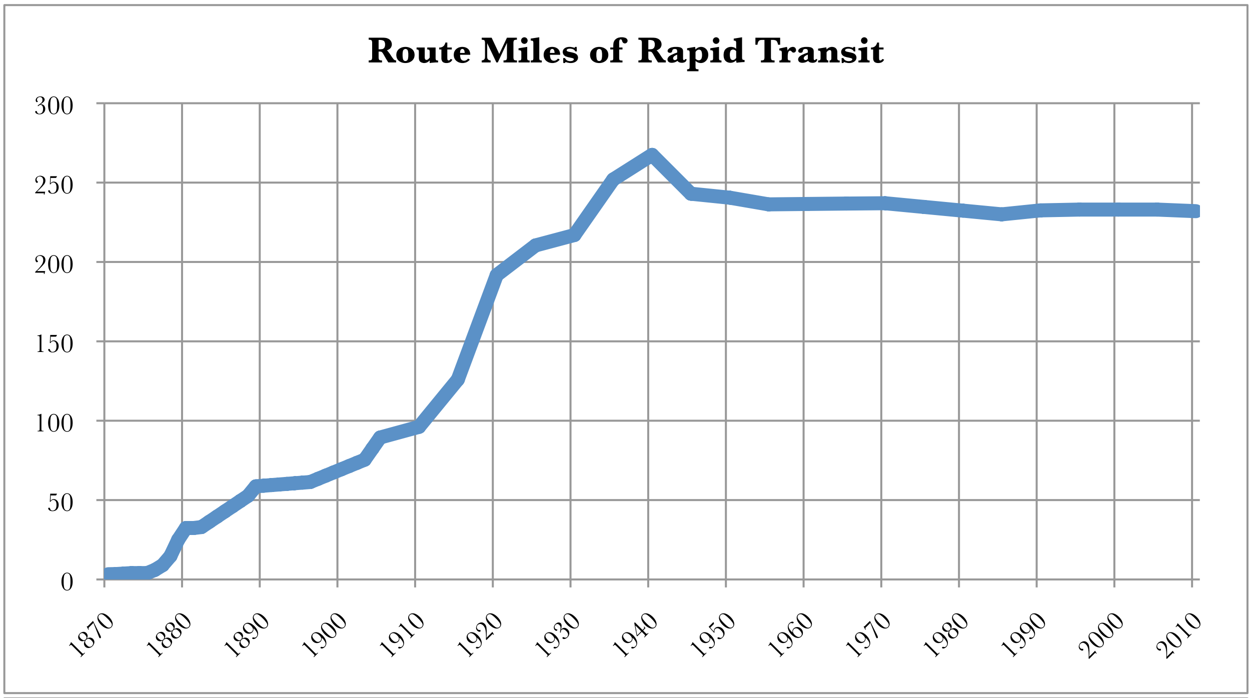
The metropolis continued to decentralize during this era. Unlike the development that occurred because of the rapid transit system, however, this decentralization was spurred by the expanding road network and increasing automobile use, and it produced densities insufficient to support or require rapid transit (Derrick, 2001).

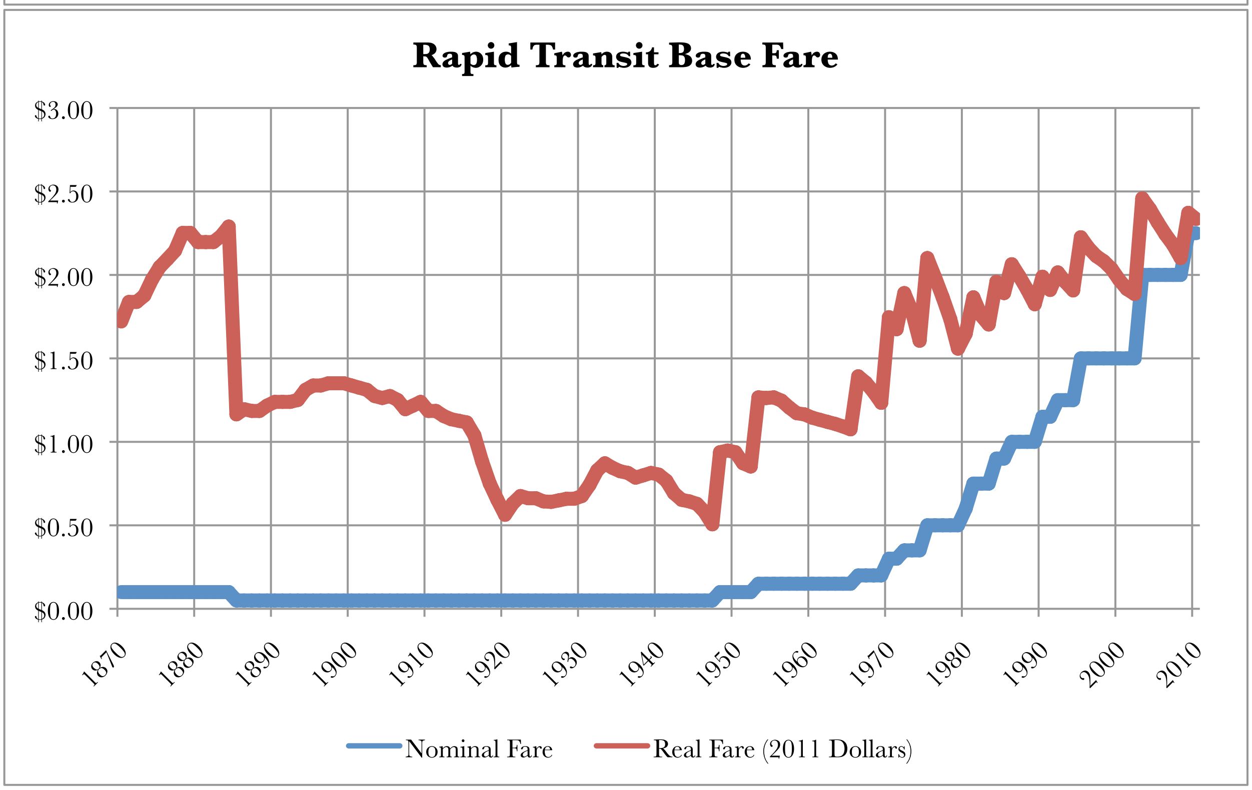
Given the significant role of employment in driving rapid transit ridership, the ratio of daily passengers to the number of jobs strongly indicates that much of the rise and fall in effectiveness occurred independently of the city's economic condition.





Figures 2.4, 2.5 *The rise and fall in ridership occurred both in absolute terms and relative to employment, which is a major driver of ridership. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*





Figures 2.6, 2.7 *As the system grew, the real fare fell. The fare reached its lowest level in the 1940s. Over the long-term, the fare rises and falls with the system's levels of efficiency and effectiveness. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

CONCLUSION

The dramatic successes and failures in New York's rapid transit history have enormous implications for how we might build and operate better rapid transit today. In particular, it is unusual to find a long-term productivity decline—such as occurred in New York's rapid transit—in *any* industry. Productivity generally rises over time (Goodwin et al., 2009; Hall & Lieberman, 2008; Lave, 1991).

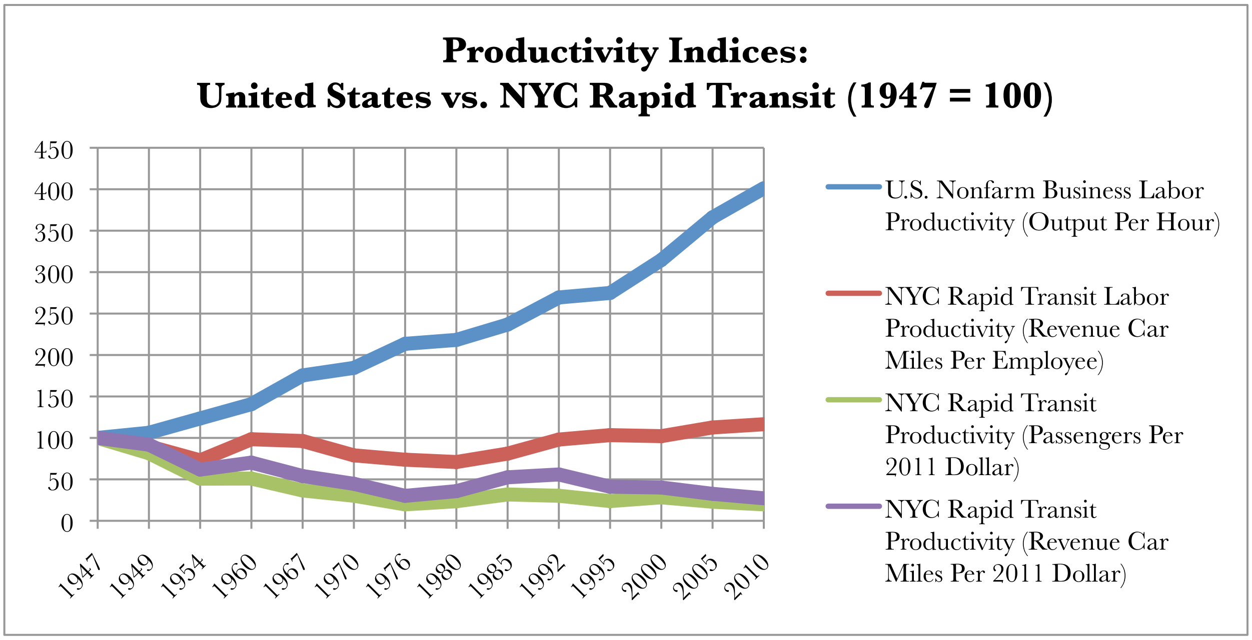


Figure 2.8 *New York's long-term decline in rapid transit productivity is abnormal. All data refer to rapid transit in New York City, unless otherwise indicated. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid. and (United States Bureau of Labor Statistics, 2002, 2012). Irregular years because of limited data. U.S. productivity data begins in 1947; U.S. surface transportation productivity data available from 1960 to 2000.*

If the New York City Subway could achieve its productivity level of 1930 (cost per passenger), the fare could be reduced to $0.70, and all subsidies could be eliminated. Alternatively, the current fare structure could be maintained, and the resulting $2.1 billion annual surplus could be dedicated to fund a major capital expansion. This would raise enough money to pay for the full build-out of the Second Avenue Subway in less than nine years.

Deeper analysis is warranted. The following three chapters explore each of three broad eras—two of success and one of failure:

- Expansion and Improvement: 1870—1940
- Stagnation and Decline: 1940—1980
- Stabilization and Rejuvenation: 1980—2010

CHAPTER 3

EXPANSION AND IMPROVEMENT 1870—1940

INTRODUCTION

Immense improvement in both effectiveness and efficiency occurred from 1870 to 1940. This era can be further broken down into three major (overlapping) components, based on their distinctive political and legal structures:

- Private Elevated Railways: 1870—1910
- Public-Private Subways: 1900—1940
- Public (Government) Subways: 1930—1940

PRIVATE ELEVATED RAILWAYS: 1870—1910

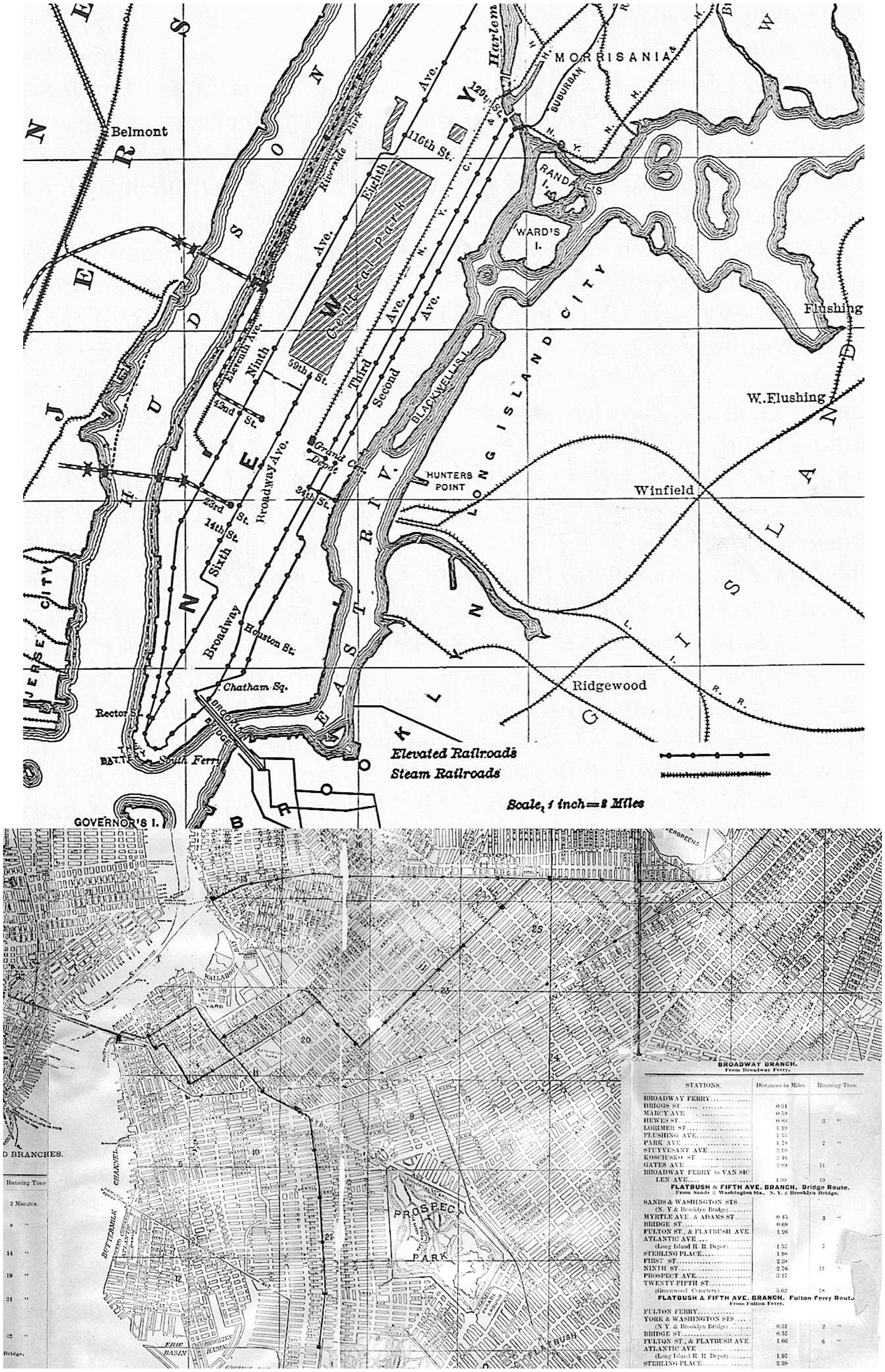
In the 19th century, privately owned and operated elevated railways (also known as "elevateds" or "els") transformed the city and profoundly improved New Yorker's mobility. Coal-fired steam-powered elevated railways were the city's first significant form of rapid transit, and for 40 years they were also the dominant form. The 1870s were arguably the greatest period of the city's rapid transit improvement and expansion. For the first time, New York had a practical, effective system of rapid transit. Residents could travel farther, faster, and more cheaply than ever before.

In the 1860s, most New Yorkers traveled by omnibus, horsecar, ferry, or on foot. Omnibuses and horsecars were slow, crowded, and uncomfortable. Commuter railroads were costly, and ferries were both expensive and unreliable. Owing to the difficulty of transportation, the city was tightly concentrated in southern Manhattan and around the ferry terminals in Brooklyn. In 1868, the West Side Elevated (Patented) Railway Company opened the world's first elevated rapid transit line on Greenwich Street, but its cable propulsion system was unreliable and costly to operate (Jackson, 2010; Olmsted, 1991; Walker, 1918).

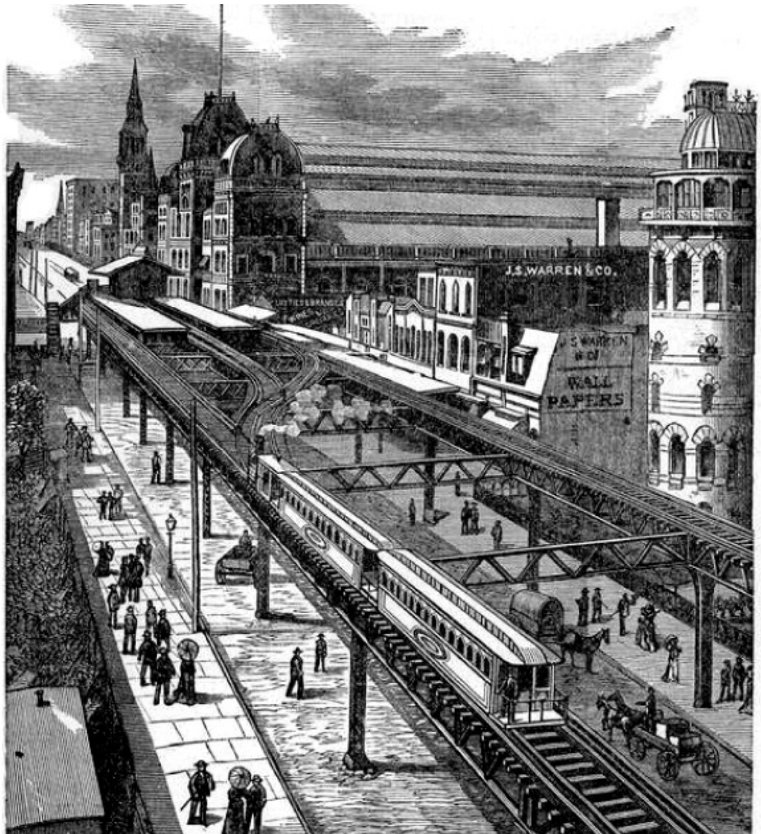
The company reorganized as the New York Elevated Railroad Company (NYE), and by 1871 it was providing regular service with steam locomotives—demonstrating that elevated railways were practical. In less than a decade, the NYE, joined by the Metropolitan Elevated Railway Company (MER), had build the world's largest rapid transit system (Hain, 2011; Parsons, 1894; Real Estate Record and Builders' Guide, 1893; Sweet, 1872).

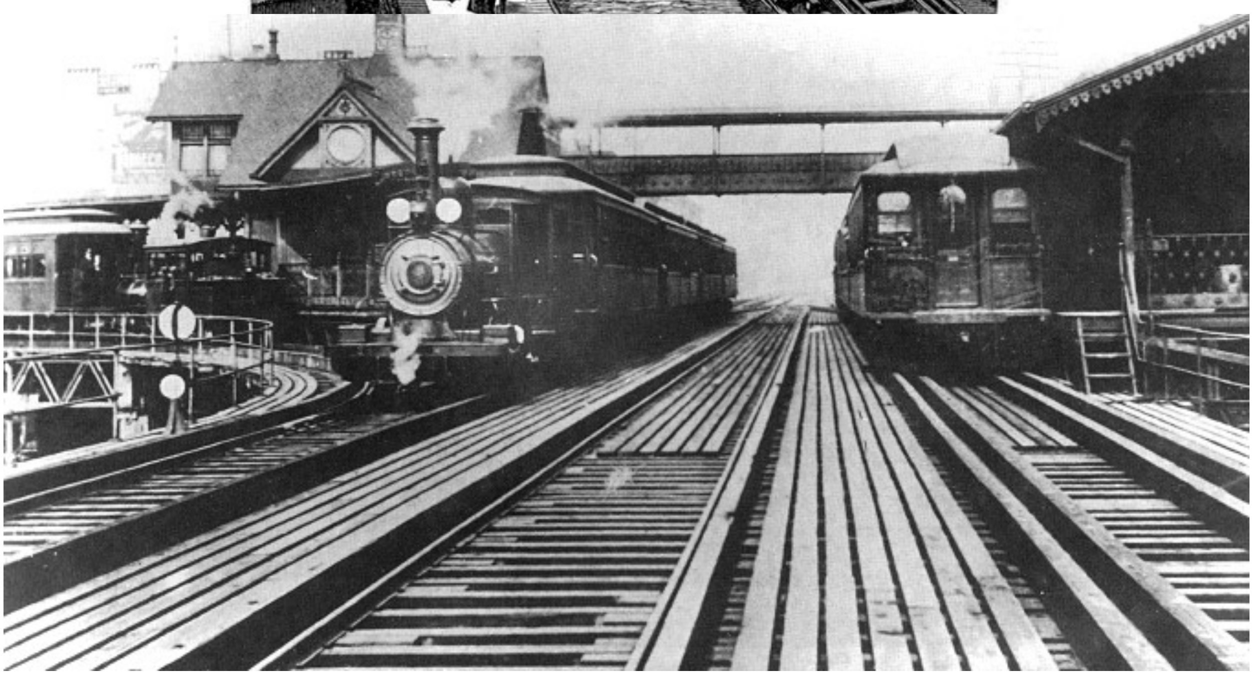
The Rapid Transit Act of 1875 enabled this proliferation of mobility. It established a procedure to plan and build rapid transit lines without the State Legislature's direct involvement. Residents could petition the mayor for a rapid transit line. A temporary Rapid Transit Commission (RTC) would be established to solicit proposals from private companies, to grant franchises, and to monitor construction. Fares were not fixed, though the RTC set certain limits. The RTC would dissolve once the line was in operation (Brennan, 2005; Derrick, 2001).

The first elevated railways were built in the face of immense barriers: corrupt politicians; court challenges by adjacent property owners who claimed ownership rights of the streets; residents and sensational newspaper reports that elevated railways would collapse; aggressively competing horsecar companies; several severe financial panics, which threatened to bankrupt them; and engineering problems in design and construction, especially regarding motive power and safe signal systems (Walker, 1918).

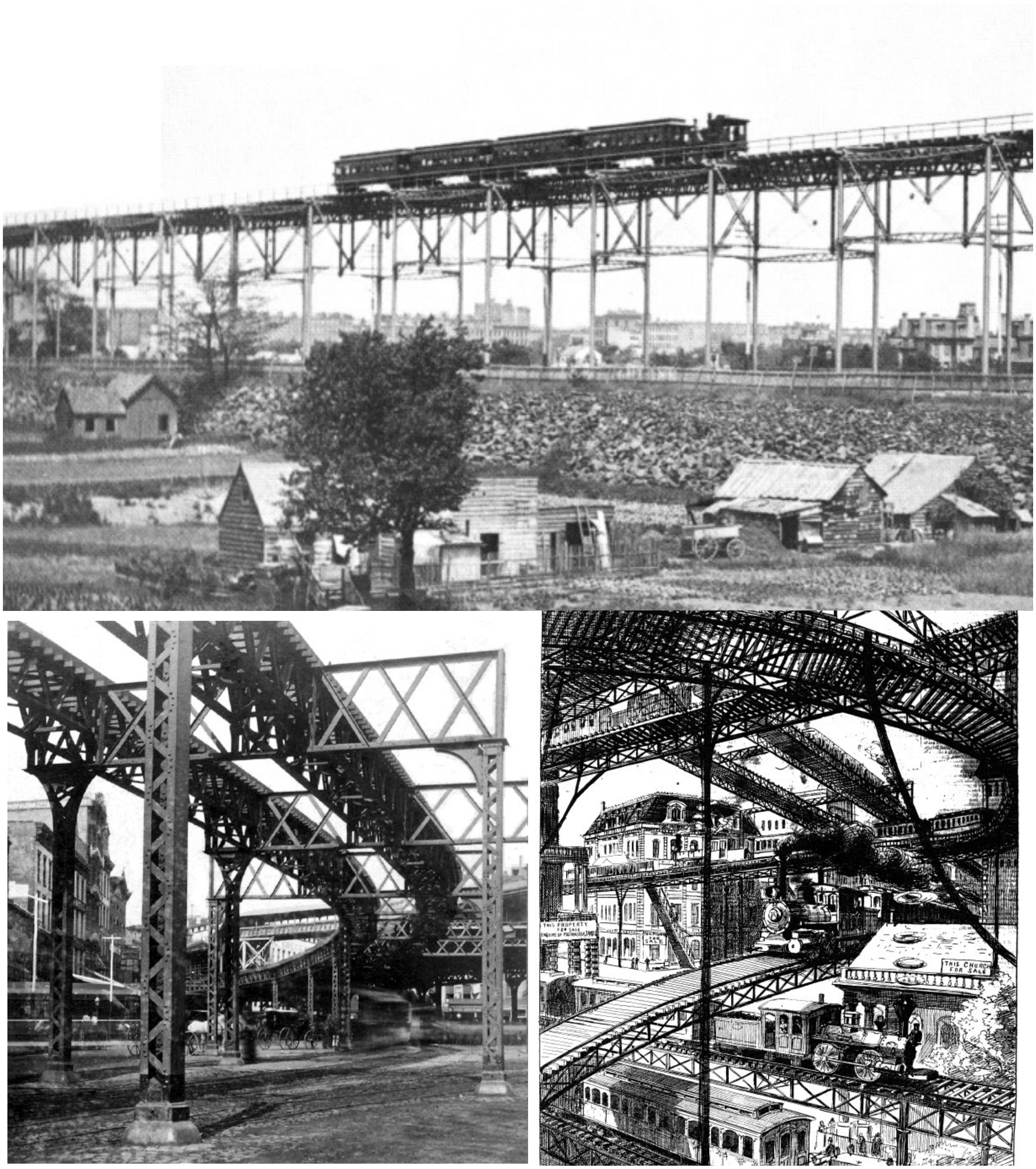


Elevated railway network in Manhattan circa 1890 (top) and in Brooklyn circa 1888 (bottom) (Brooklyn Historic Railway Association, 2012).





In the 19th century, coal-fired steam-powered elevated railways were the city's dominant form of rapid transit, and they had a major physical presence. By 1880, New York's elevated railway network was larger than any other city's rapid transit system, including London's. The 42nd Street elevated railway to Grand Central Terminal circa 1878 (top), from Frank Leslie's Illustrated Newspaper. Elevated railway at Third Avenue and 42nd Street in the early 1880s, looking north (bottom). The shuttle to Grand Central is on the far left (Brennan, 2005).

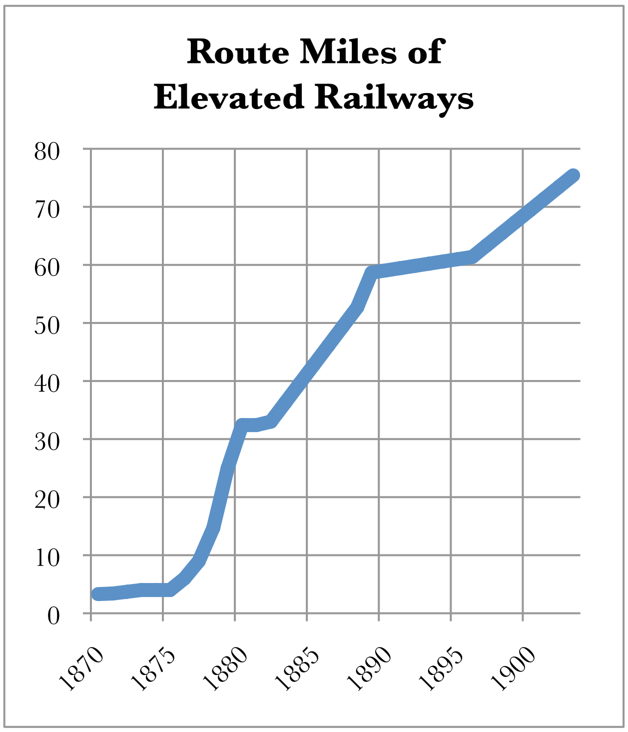


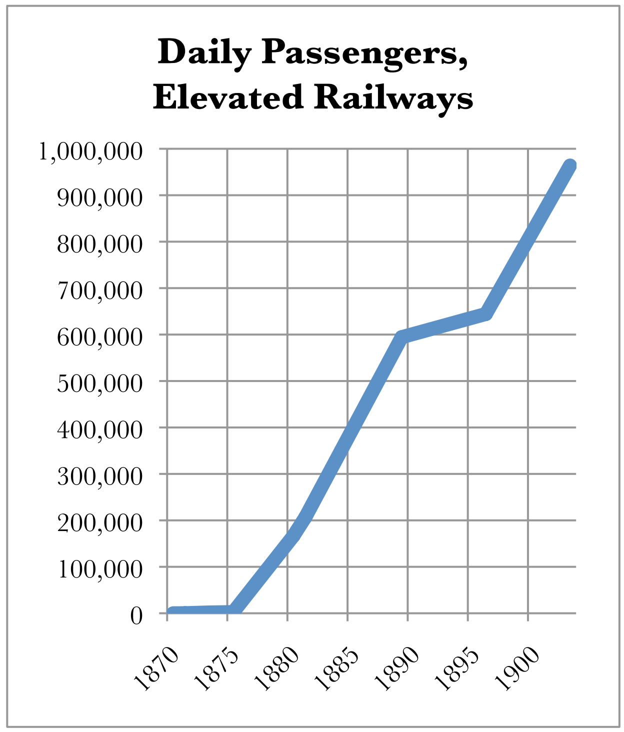
During the 1870s and 1880s elevated railways expanded rapidly in Manhattan and Brooklyn—in developed and undeveloped areas—and revolutionized the city's historical pattern of development. An elevated train running over Eighth Avenue near 120th Street (top). Chatham Square in Lower Manhattan, where the NYE's Third Avenue line crossed the MER's Second Avenue line (bottom left). An 1879 cartoon depicting elevateds taking over the city, published in the Daily Graphic (bottom right) (Brennan, 2005).

Though effective, this act had two main problems. It was ostensibly a general law, but it was written to benefit only two companies, the NYE and MER. New firms seeking to enter the rapid transit business still faced legal barriers to entry. Also, the RTC (understandably) ruled out all subway proposals due to the legal uncertainty of underground property rights (Walker, 1918).

By 1880, Manhattan had four major elevated lines, three of which traversed the entire length of the island. That same year, more than 150,000 passengers rode the elevateds each day. During the 1880s, elevateds spread across Brooklyn, and by 1890 there were nearly 600,000 passengers daily (Rogers et al., 1890; Seymour, 1881).

London opened the world's first subway in 1863, and by the 1880s there were rapid transit lines operating in London, Paris, Berlin, Glasgow, and Liverpool. However, New York's elevated network was larger. During the 1880s and 1890s, more passengers rode the city's elevated lines than any other rapid transit system in the world (Hain, 2011; Parsons, 1894; Simmons & Biddle, 2000).





Figures 3.1, 3.2 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: compiled from annual reports of the State Engineer and Surveyor of the State of New York, the Board of Railroad Commissioners of the State of New York, the Public Service Commission for the First District of the State of New York, and the State of New York Transit Commission (Beardsley, Rickard, & Chapin, 1897; Cooper, 1874; Dunn et al., 1904; Dunn, Baker, Dickey, Aldridge, & Rockwell, 1907; Fullen et al., 1936; Fullen et al., 1931; Fullen et al., 1942; Greene, 1876; McAneny et al., 1922, 1926; McCall et al., 1915; Richmond, 1870; Rogers, Baker, & Rickard, 1890; Seymour, 1881, 1882; Straus et al., 1917; Sweet, 1872) and author's calculations.*

Elevated railways altered New York's historical pattern of development on a massive scale. Since the city's founding, development spread northward from the tip of Lower Manhattan. With ferries, Brooklyn also began to develop, spreading eastward from the ferry terminals. Omnibuses, horsecars, then cable cars each enabled development to spread farther, but in the same pattern. Elevateds created an entirely new accessibility paradigm. Spreading across Manhattan and Brooklyn, they enabled development to leapfrog well beyond preexisting edges. Development instead radiated outward from the stations, until the circles overlapped and filled in on themselves (Dolkart, 2012; Stern, Mellins, & Fishman, 1999).

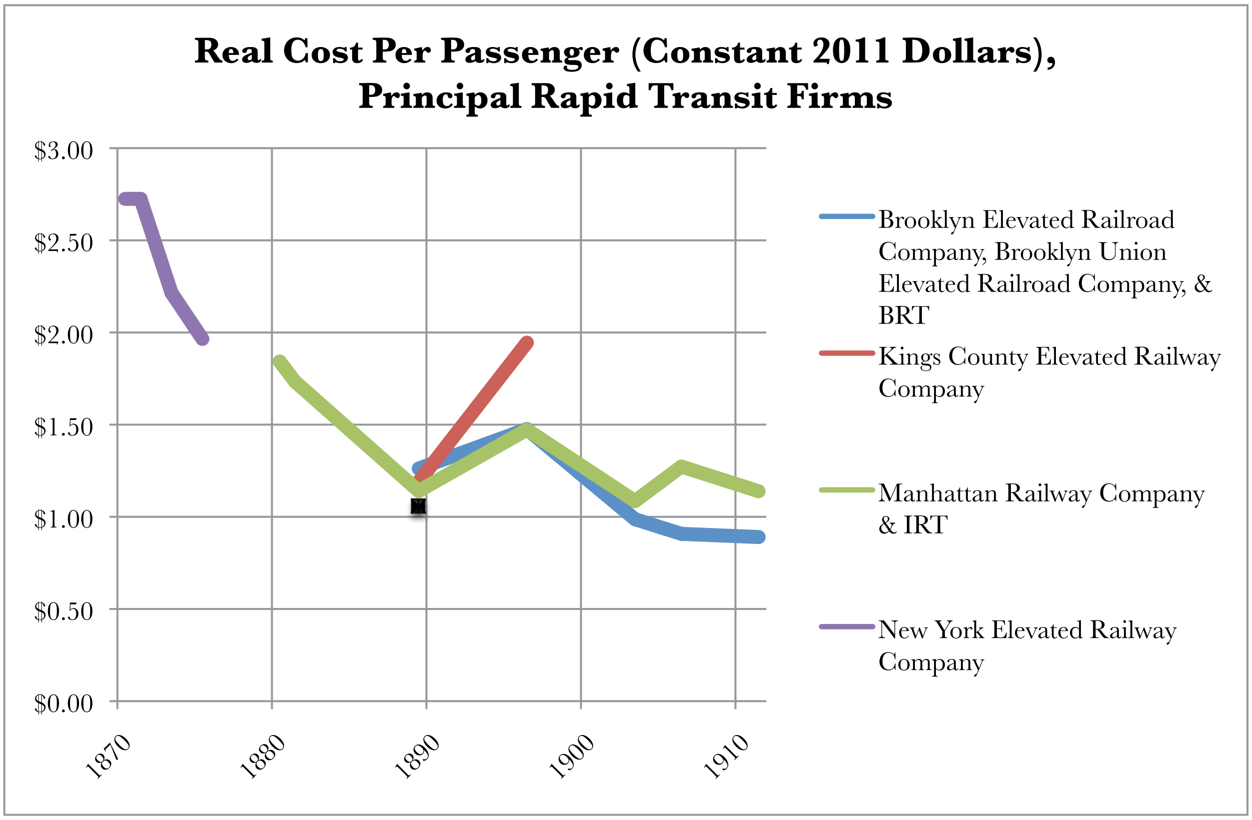


Figure 3.3 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: compiled from annual reports of the State Engineer and Surveyor of the State of New York, the Board of Railroad Commissioners of the State of New York, the Public Service Commission for the First District of the State of New York, and the State of New York Transit Commission (Beardsley, Rickard, & Chapin, 1897; Cooper, 1874; Dunn et al., 1904; Dunn, Baker, Dickey, Aldridge, & Rockwell, 1907; Fullen et al., 1936; Fullen et al., 1931; Fullen et al., 1942; Greene, 1876; McAneny et al., 1922, 1926; McCall et al., 1915; Richmond, 1870; Rogers, Baker, & Rickard, 1890; Seymour, 1881, 1882; Straus et al., 1917; Sweet, 1872), private transit firms' annual reports to stockholders (Brooklyn Rapid Transit Company, 1921; Brooklyn-Manhattan Transit Corporation, 1924; Dahl, 1940; Hedley, 1921; Interborough Rapid Transit Company, 1904, 1914; Shonts, 1911, 1915; Williams, 1911, 1915) and author's calculations.*

Following the initial bursts of construction in Manhattan and Brooklyn, the system continued to advance over the following decades. Twenty-four hour service was inaugurated in the 1880s (The New York Times, 1882). Lines were extended into the Bronx and Queens. Some lines were also triple-tracked for express train service and stations were extended to allow longer trains. Steam engines were replaced with cleaner, quieter, more flexible, and lower maintenance Electric Multiple Units (EMU) (Dunn et al., 1904; Rogers et al., 1890; Steinway et al., 1891).

While horsecars, the els main competitor, averaged 4-6 miles per hour and travelled up to 6-8 miles per hour, elevated trains averaged 13-15 miles per hour and expresses reached 30-35 miles per hour (Brooks, 1903; Cooper, 1874; Greene, 1876; Seymour, 1881; Sweet, 1872; The New York Times, 1880).

Despite the qualitative improvements discussed above, the system also became more efficient during this era. The fare was cut from \$0.10 to \$0.05, and real operating expenses fell even further. Meanwhile, the elevated railways received no subsidies, paid property and franchise taxes, and generally turned a profit (Beardsley et al., 1897; DeFreest, 1896; Dunn et al., 1907; Seymour, 1881; Steinway et al., 1891).

PUBLIC-PRIVATE SUBWAYS: 1900—1940

Subways, which had been planned and discussed for decades, were not realized until the 20th century. However, once built, the system grew rapidly. Most of the city's existing rapid transit system (i.e. the subway) was built during this period, particularly the 1910s.

The first subway contract—Contract No. 1—was executed in 1900 under the provisions of the Rapid Transit Act of 1891 (as amended in 1894)[11], which defined the terms of the deal. Under this law, the City of New York would own the subway and it could bond up to \$55 million towards subway construction. It created a Rapid Transit Board to plan the route and to contract with a private firm to build and operate the subway. The private operator paid for all rapid transit cars and other equipment. It had a fifty-year lease and had to pay rent to the City to cover the City's interest on the bonds, in addition to a local franchise tax, a local real estate tax, and other state and federal taxes. The City also provided the right-of-way. It was a true public-private partnership, and Contract Nos. 2—4 also followed this basic form (McAneny et al., 1922; Walker, 1918). Most of New York's existing rapid transit system was built under the authority of the Rapid Transit Act of 1891 (State of New York Public Service Commission, 1915).

Contract No. 2—an extension of the original subway—was signed before the first subway even opened. Immediately after it did open, a great effort for many more subway lines began. Indeed, the central problem with the first subway was insufficient capacity (Arnold, 1907, 1908). The culmination of this effort was Contract No. 3 with the IRT and Contract No. 4 with the New York Municipal Railway Corporation (a subsidiary the BRT).

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[11] The Rapid Transit Act of 1891 was amended by a referendum in 1894. This amendment allowed City ownership of a subway, and was essential to the Act's success (State of New York Public Service Commission, 1915).

These two contracts, known as the Dual Contracts, were signed in 1913. Most of the Dual System lines opened by 1920, and just the track mileage *added* by these two contracts exceeded the track mileage of any rapid transit system in the world. When combined with New York's existing elevated and subway lines, it exceeded the *combined* track mileage of all other rapid transit systems in the world (Derrick, 2001).

There were valid objections to the risk of using the City of New York's credit to back a private subway owner, particularly fears of political manipulation and corruption. By allowing City ownership, the Rapid Transit Act of 1894 enabled City financing. This City financing, in turn, made the $0.05 fare possible.

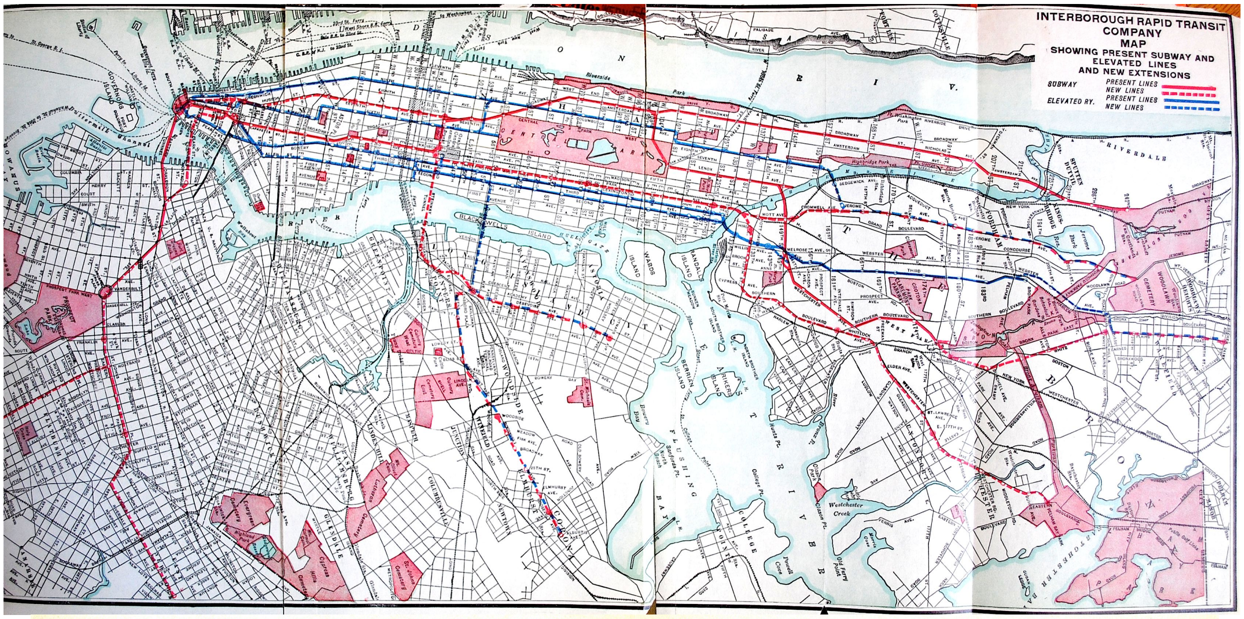
The Act also overcame fears of corruption in two ways. First, the Rapid Transit Board (RTB), which administered the law, was mainly composed "not of politicians" but of "merchants of the very highest standing in the community" (Interborough Rapid Transit Company, 1904), and the board could fill its own vacancies, insulating itself from the machinations of New York City government. Second, it overcame the public's fears of government waste and abuse by having a private company build and operate the subway (Derrick, 2001).

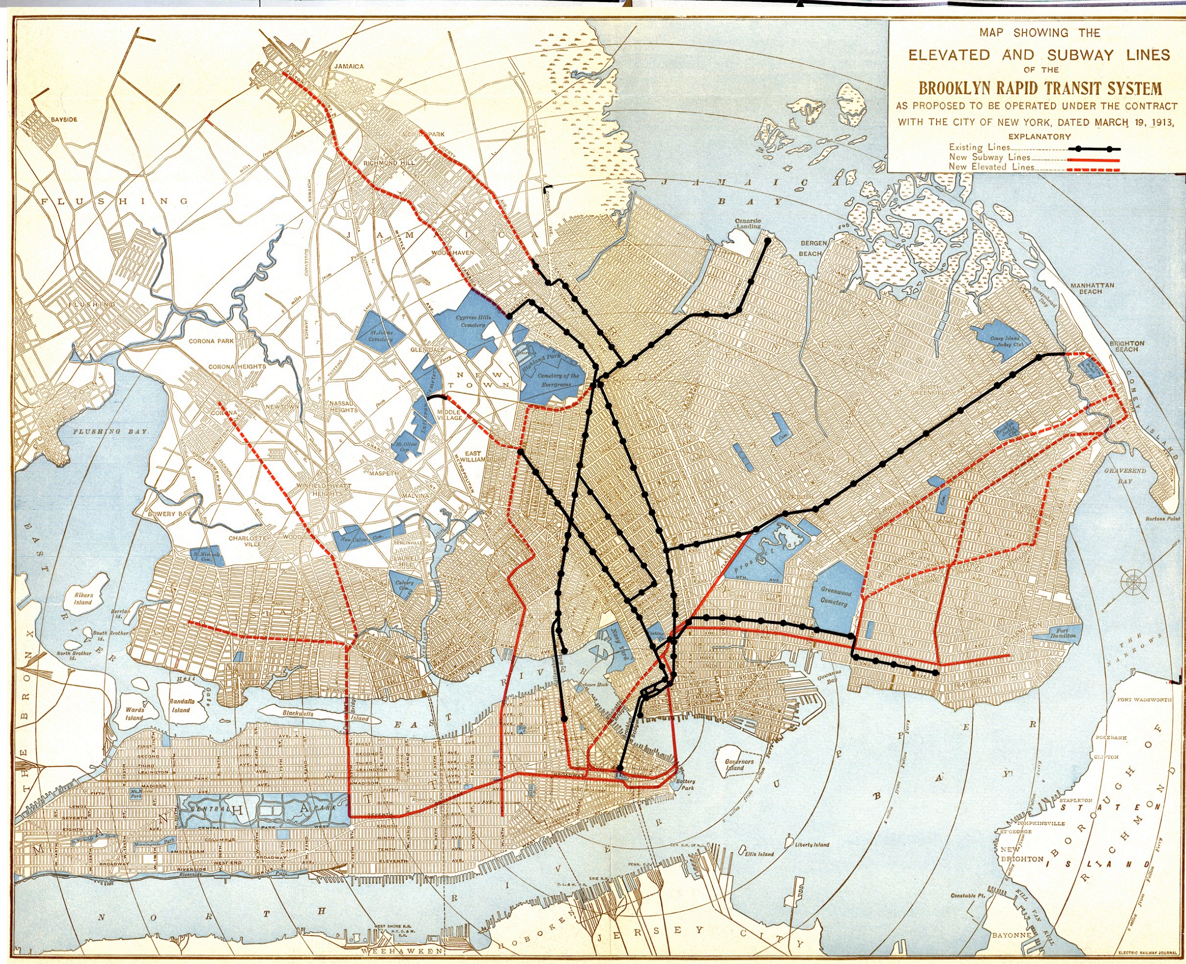
Subways were significantly more expensive to construct than elevated railways, and gathering sufficient government or private funding was a major obstacle. Some groups had argued for municipal ownership of a subway since at least the 1870s. Until the 1890s, however, the basic assumption held by most people was that the city's subways would be privately financed, owned, and operated, just like the elevated railways, horsecars, and ferries (Derrick, 2001).

Several companies were organized from the 1860s to the 1890s to build "underground railways" in parts of New York City, but none succeeded. The greatest obstacle to subway construction was simply obtaining permission to build, which required getting a special bill passed by the New York State Legislature. Many politicians accepted bribes from the established horsecar firms, and they vehemently opposed rapid transit. Exacerbated by the unfavorable political environment, gathering the necessary capital was also challenging. Most of the major subway promoters (with serious proposals) were engineers and inventors, not lawyers or financiers, and they had difficulty in persuading politicians and in attracting investors (Walker, 1918).

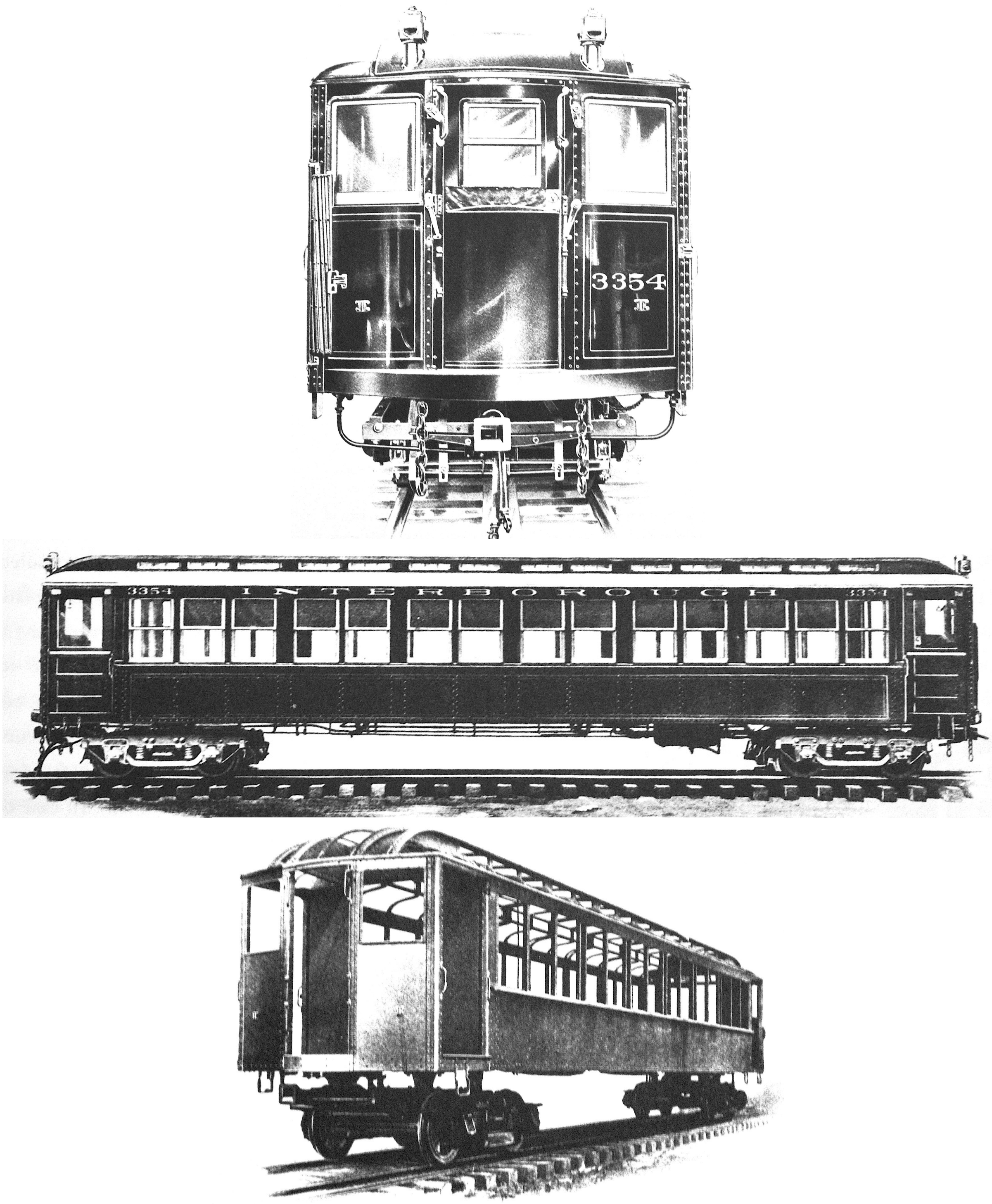
Many of the plans were bankrupted by financial panics, especially during the major panics of 1873 and 1893, which were ignited by the collapse of railroad speculation. Much of the private subway financing also collapsed during the 1880s, when investors were instead attracted to the demonstrated success of the city's elevated railways. Proposals for government funding further deterred private investment (Brennan, 2005).

By the 1890s, it became more widely accepted that government funding was necessary to build a subway with a $0.05 fare. Politically, financing by the City of New York was acceptable only with City ownership, and in 1894, voters approved a referendum permitting the City to own—and thus finance—a subway. This amended the Rapid Transit Act of 1891. The City lacked sufficient borrowing capacity to finance a subway due to its debt limit (which was a percentage of property values), but with municipal consolidation in 1898, the City finally had room to finance a subway (Interborough Rapid Transit Company, 1904).

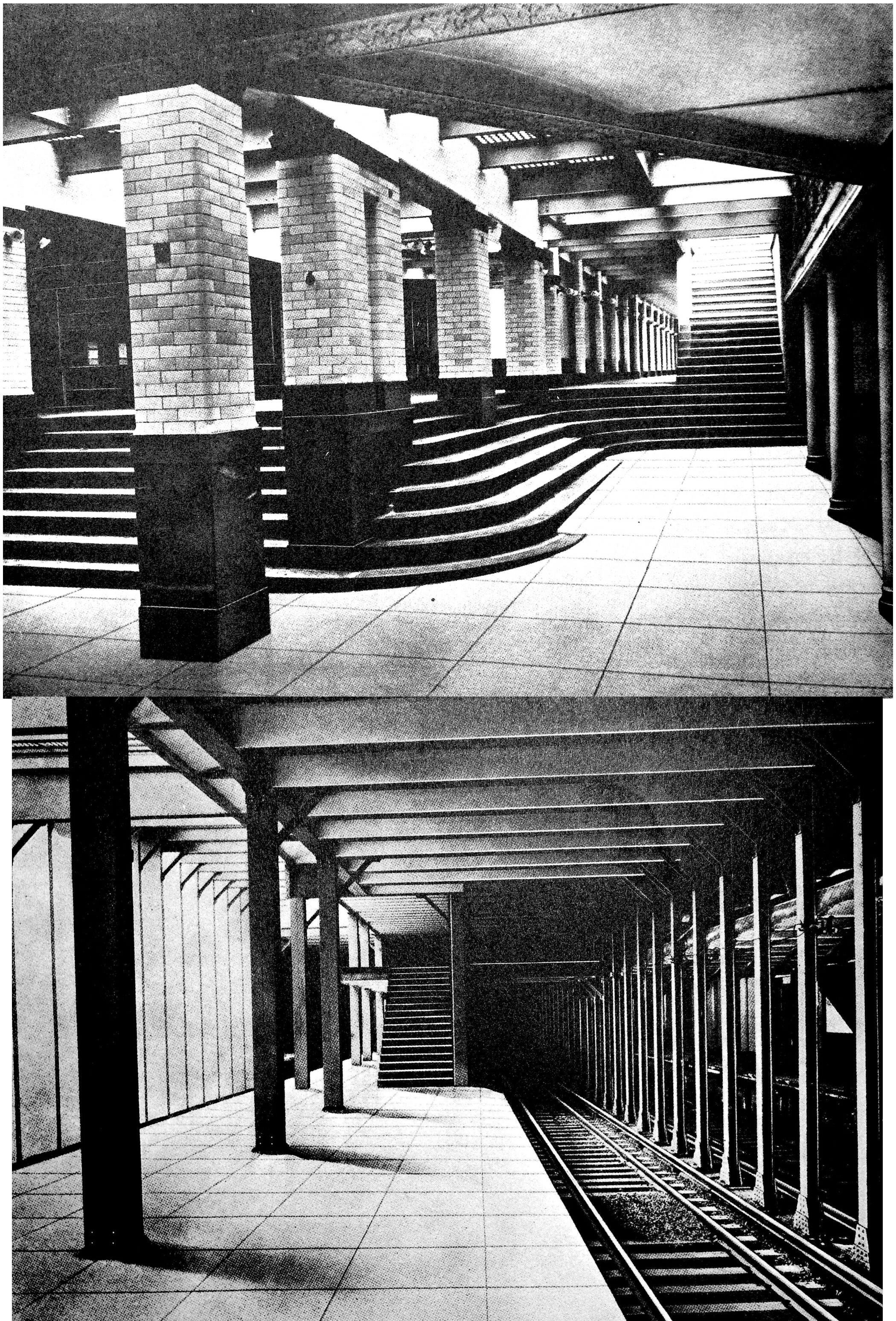




The Dual System rapid transit expansion (and preexisting lines) of the IRT (top) and BRT (bottom), finalized in 1913 (Interborough Rapid Transit Company, 1914; Nicholas, 1913).

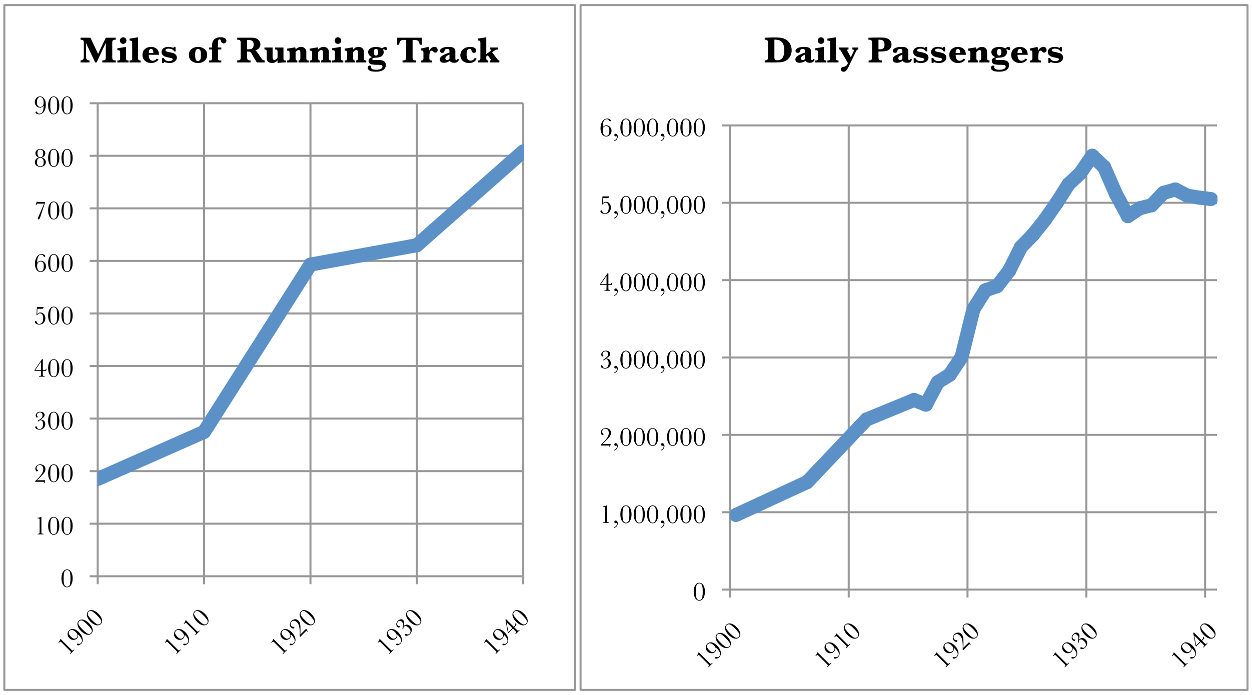


When it opened in 1904, the IRT subway was the most advanced rapid transit system in the world. It was the first railroad to use all-steel passenger cars, pictured above (Interborough Rapid Transit Company, 1904). At 50 miles per hour, it was also the world's fastest, and it was the first four-track rapid transit line, with local and express trains in both directions (American Electrician, 1904; Cudahy, 2003).



Photographs of the original IRT subway in 1904, just prior to opening—the west side of the 23rd Street Station (top) and the express platform at the 14th Street Station (bottom) (Interborough Rapid Transit Company, 1904).

To reduce the disturbance to the street, the Dual Contract subways abandoned the "open cut" construction method and instead were built using the "cut-and-cover" construction method, pictured above (Scientific American, 1913).



Figures 3.4, 3.5 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

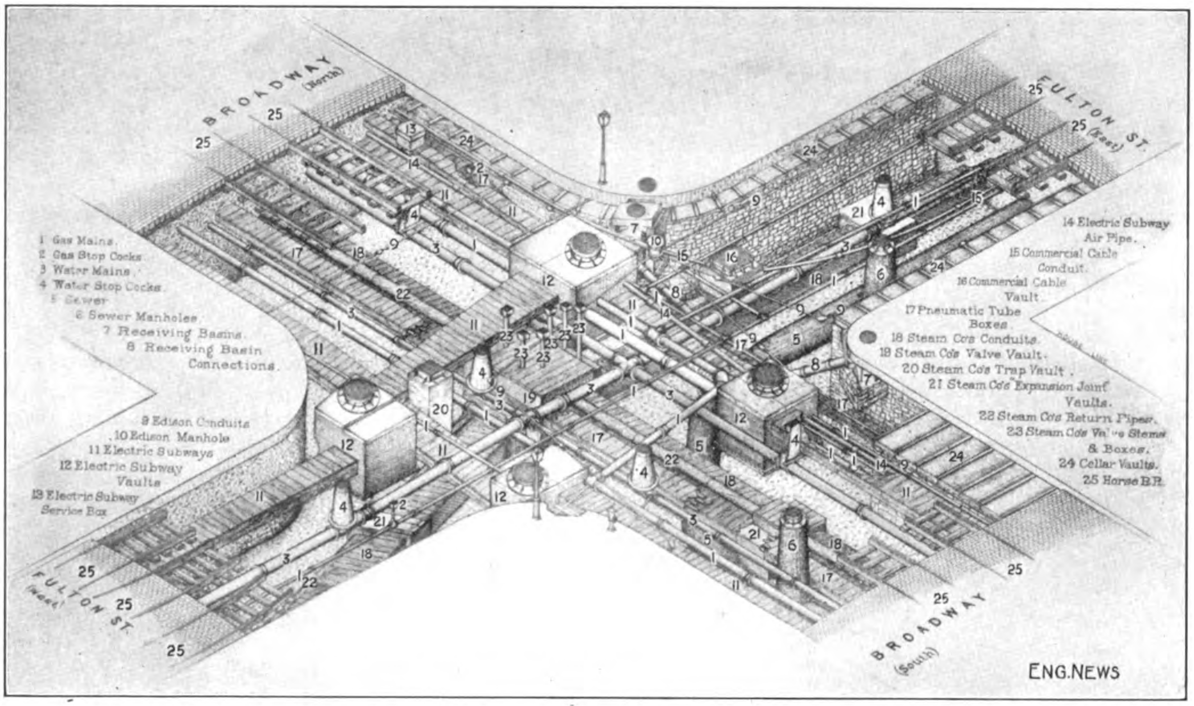
The solution was for the City to offer up to $55 million (from City bonds) to a private firm under essentially a Design-Build-Operate-Maintain (DBOM) agreement. This did not cover the entire cost of construction, but the private firm would collect the $0.05 fare revenue. Given the political constraints, the financial solution worked well. The bids were well below the amount of available funds (Walker, 1918).

City ownership effectively enabled the City to finance the artificially low fare that it demanded. No operating subsidies were required. In addition, the Rapid Transit Board was able to plan and administer the funds in a relatively fair and objective manner, free of known corruption. Private investors had relatively secure title to their capital and equipment.

The first subway had to overcome many other problems as well. There had never been an underground railway in New York, and the issues of property rights of adjacent buildings had to be sorted out, including new property rights of air, light, and access. It required many separate pieces of legislation under different administrations and a U.S. Supreme Court Decision.[12]

[12] The Underground Railroad Company, which never built or operated a railway, claimed that its previously granted franchise gave the company an exclusive property right beneath certain City streets, and they tried to enjoin the first IRT subway. The United States Supreme Court ruled in favor of the IRT in 1904, when the subway was nearly complete (Interborough Rapid Transit Company, 1904).

There were also financial panics, and there was the omnipresent competition with the existing elevated railways and streetcar companies (Derrick, 2001; Interborough Rapid Transit Company, 1904; Walker, 1918).



The city's complex network of underground utilities was not a product of the 20th century. Above is an isometric view of underground utilities at the intersection of Broadway and Fulton Street as they existed in 1890 (Lavis & Griest, 1915).

There were the engineering challenges of construction, such as relocating utilities and building underneath active elevated railways and streetcar tracks (Heller, 2004). The streets themselves already contained a complex network of electric lines, sewer, water, and gas mains, and they had to continue carrying a large volume of traffic on the surface (Steinway et al., 1891). The subway had to be built directly adjacent to (and even underneath, in some cases) the foundations of some of the world's tallest buildings (Lavis & Griest, 1915). Construction methods were greatly improved in the 1910s. In order to reduce the disturbance to the streets and sidewalks above, the Dual Contract subways used the "cut-and-cover" construction method rather than the "open cut" method used on Contracts No. 1 and 2 (Scientific American, 1913).

Although the City of New York contributed real estate and capital funding, in every way possible all of the risk was transferred to the private bidder—the Rapid Transit Subway Construction Company (which became a subsidiary of the IRT). The company had to front millions of dollars in sureties and performance bonds. In addition, they had to deposit $1 million in cash with the City, and the City had the first lien on all of the company's equipment (Walker, 1918). Although a significant increase in land values was anticipated, unfortunately, neither the City nor the IRT attempted to leverage this. Despite the City's capital subsidies (no operating subsidies were provided at this time) to fund the subway system, the private companies still paid nearly 60% of the capital costs of Contract Nos. 1—4, in addition to rent and taxes.

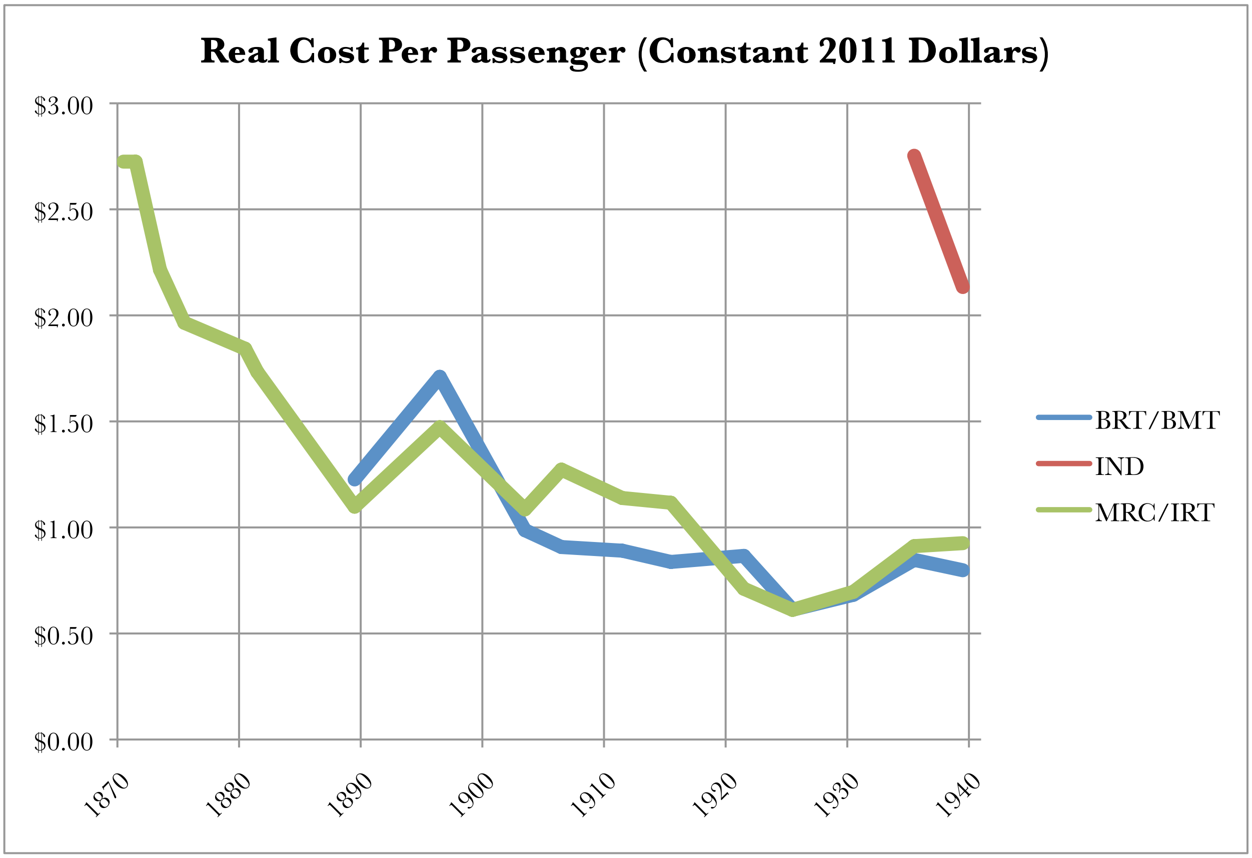


Figure 3.6 *Efficiency and productivity steadily improved during this era. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

PUBLIC (GOVERNMENT) SUBWAYS: 1930—1940

The opening of the Independent City-Owned Subway System (IND), from 1932-1940, was the last major expansion of New York's rapid transit system. Upon completion in 1940, it was about half the size of either the IRT or BMT rapid transit networks. However, it was massive in comparison with recent transit projects. For example, in terms of track miles, the IND system is nine times larger than the planned full build-out of the Second Avenue Subway, of which Phase I is currently under construction (Fullen et al., 1942; Grossman, 2011).

The IND was an entirely "independent" system, separate from the IRT and BMT networks. Unlike the IRT and BMT, it was entirely owned *and* operated directly by the City of New York, via the Board of Transportation. Two-term Mayor John F. Hylan (1918-1925) intended to discredit and bankrupt the IRT and BMT, which were allied with Hylan's political opponents.

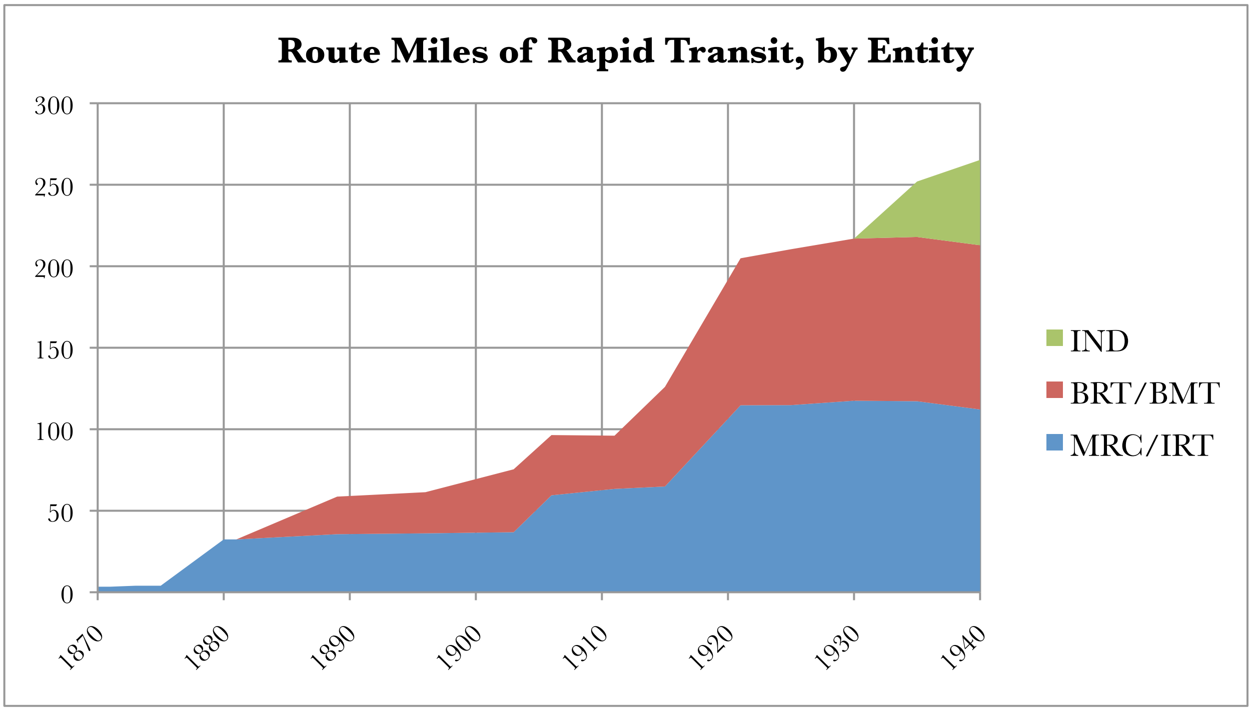


Figure 3.7 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

Transit—especially the nickel fare—had long been a hot political issue. For example, in 1883, Theodore Roosevelt (then a member of the New York State Assembly) sponsored a bill to cap the elevated railway fares at $0.05. As with Hylan and the IRT, Roosevelt tapped into popular resentment against Jay Gould, who then controlled the Manhattan Railway Company. Grover Cleveland (then governor of New York) believed, however, that it was improper for the State of New York to interfere with private contracts, and he vetoed the bill (Hood, 1993; Reed, 2011).

In the early 20th century, the City of New York mandated the $0.05 fare under subway Contract Nos. 1—4. The inflation of World War I badly hurt the finances of the IRT and the BRT/BMT. The City refused to consider fare increases, and it used the resultant declining quality of subway service as a justification for a third, City-owned subway system, which became the IND. Elected officials, such as Hylan in particular, denounced the IRT and BRT/BMT as corrupt monopolies that provided poor service (Delaney et al., 1936; Gordon, 1925; Hood, 1993; Jackson, 2010; Savas, 2005).

Meanwhile, the need for additional rapid transit lines was apparent before the Dual Contracts had even been completed. The State of New York Transit Commission indicated that "the new lines provided under the dual contracts, which more than doubled the mileage of the original subway and elevated system, have been open but a few years, and are already crowded to capacity". The Commission recommended a major subway expansion in cooperation with the IRT and BRT/BMT (State of New York Transit Commission, 1922).

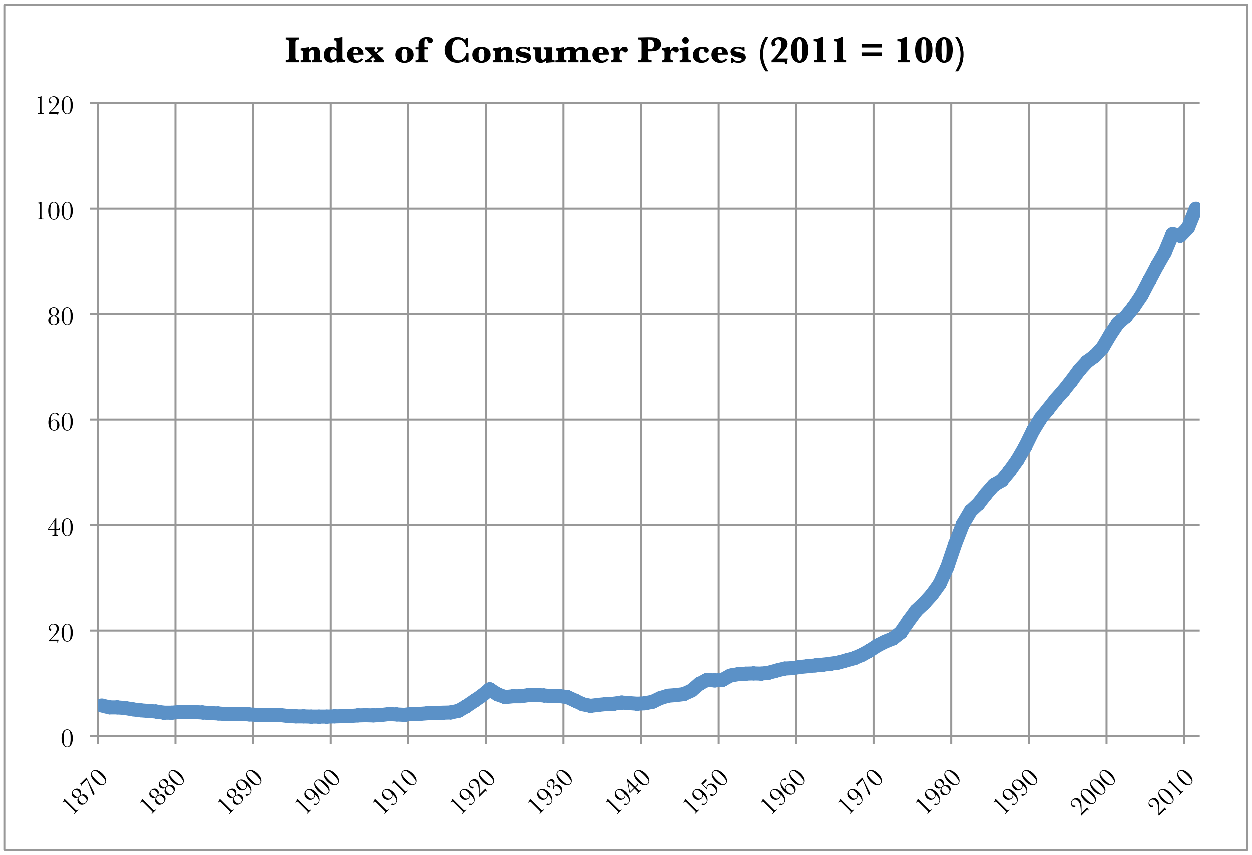


Figure 3.8 *The IRT and BMT could not have anticipated 20th century inflation. Prices were remarkably stable during the 19th century, primarily because the United States was on a de facto gold standard. World War I followed by the abandonment of the gold standard in 1931 led to unprecedented inflation (Greenspan, 1966). Source: derived from Lindert (2006) and U.S. Bureau of Labor Statistics (2011) price level indices.*

The IRT and BRT/BMT reiterated the need for new subway lines, and they reiterated their willingness to pay for them under a renegotiated fare. The BMT's 1924 annual report to stockholders emphasizes that "The big problem confronting your Corporation is that of providing adequate facilities to handle the tremendous increase in traffic which is bound to result in the future, under the limitations and restrictions imposed under the contract with the City" (Brooklyn-Manhattan Transit Corporation, 1924). The IRT's 1920 annual report stresses that "the City is now in a position to expand its rapid transit system to almost any length by the simple expedient of permitting a charge for service sufficient to attract the necessary capital" (Hedley, 1920).

Nonetheless, the City refused to cooperate with the IRT, BMT, or the State of New York Transit Commission to expand the subway network (Delaney et al., 1936; Hood, 1993). Moreover, the Hylan administration did not even want to complete the Dual System. Hylan introduced a report to the New York City Board of Estimate and Apportionment that stated the City "is chained, to a partnership with the traction companies through the betrayal of the City's interests, by the outrageous Dual Contracts of 1913" (Gordon, 1925).

During the 1920s, Hylan attempted to repudiate the City's obligation to complete the BMT Canarsie (L) and Nassau Street (J, Z) subway lines, which were agreed to under the Dual System Contract No. 4. The BMT ultimately brought a lawsuit against the City and successfully compelled it to complete the subway lines (Brooklyn-Manhattan Transit Corporation, 1924).

The New York City Board of Transportation adopted the basic plan of the IND in 1924. The construction of the IND was the last major subway expansion in New York. IND subway lines opened between 1932 and 1940 (Jackson, 2010; State of New York Transit Commission, 1922).

CONCLUSION

By 1940, New York's subway network was far more extensive than the network of elevated railways had ever been. There were many more routes and lines, and it covered a larger geographic area. The subways also had a greater capacity, owing to longer trains and the provision of four-track local and express service.

The subway was also a higher-quality transportation system, for riders and non-riders alike. Some of the subway lines were explicitly built to replace unsightly elevated railways (State of New York Transit Commission, 1922). The elevated trains were noisy and dropped ash, oil, and cinders on the streets below (Brennan, 2005).

The subway greatly enhanced the mobility of New Yorkers. In addition to the larger network, subways traveled roughly twice as fast as elevated railways. Although the first subway quickly became overcrowded, in general, New York's subways had roomier cars, platforms, and stations than the elevated railways (Walker, 1918).

Thus, the subway transported New Yorkers farther, faster, and cheaper than any previous generation. However, the City's religious commitment to the straight nickel fare—which lasted until 1948—led to a deterioration in the subway's overall quality, which began surprisingly early and became apparent by the 1920s. When they agreed to the $0.05 fare, the IRT and BRT could not have anticipated such inflation. Throughout most of the 19th century, the United States was on a de facto gold standard, and the economy experienced a gradual, long-term deflation in the general price level (Higgs, 1971). In addition, the transit companies faced new competition from the automobile and the heavily subsidized IND (Hood, 1993).

The subway's deterioration occurred mainly in the form of soot and litter. Subway cars and stations were cleaned less frequently; paint on stations and benches peeled and chipped. Cars and equipment were replaced only when absolutely necessary. However, service remained reliable and major new subway lines continued to open until the 1940s. Moreover, serious crimes were almost unknown. The subway remained safe, both in actual fact and in the public's mind (Hood, 1993).

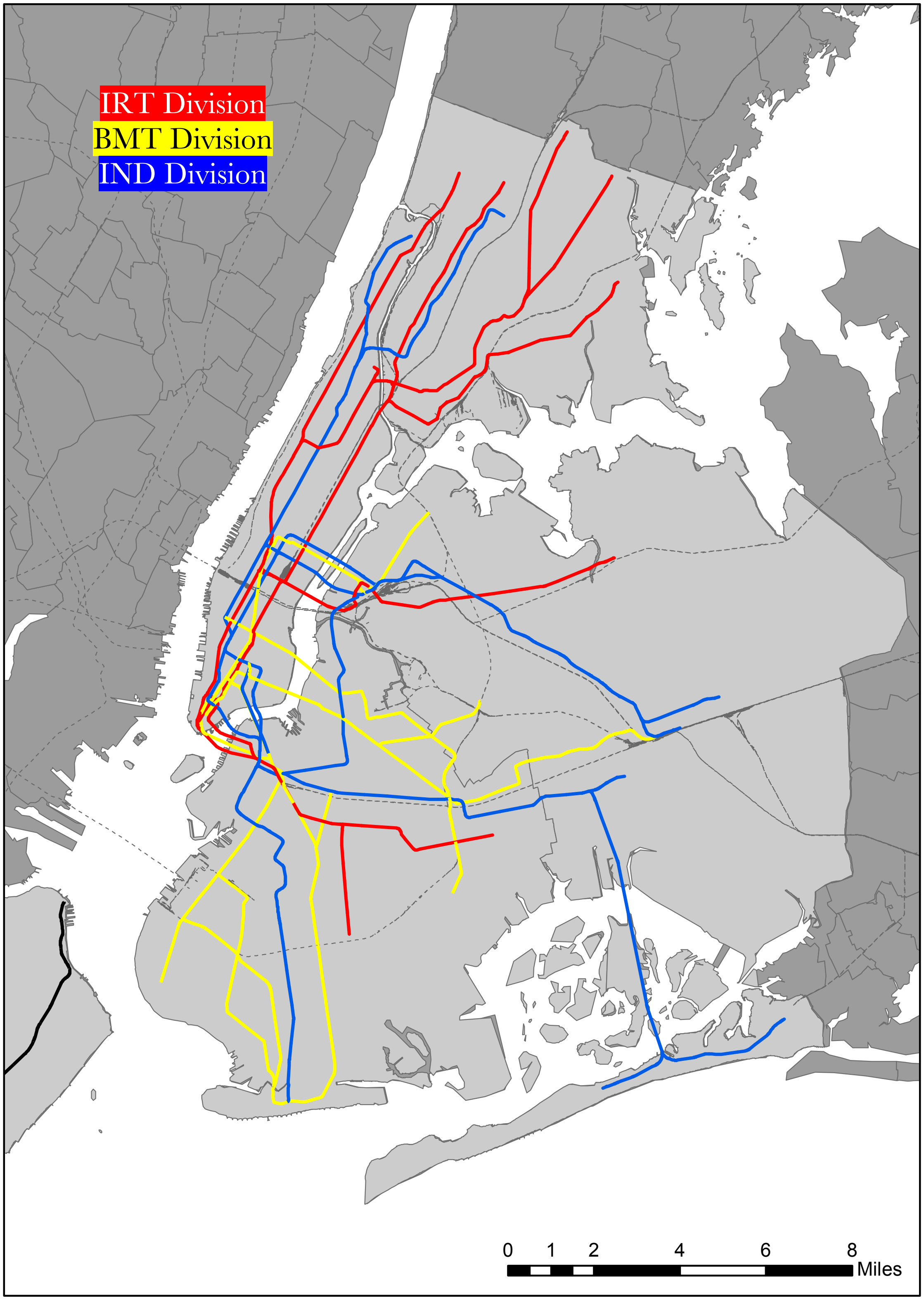


Figure 3.9 *New York's rapid transit network in 2012 showing IRT (red), BMT (yellow), and IND (blue) divisions. Grey dashed lines represent other passenger and freight rail lines.*

CHAPTER 4

STAGNATION AND DECLINE 1940—1980

INTRODUCTION

Major declines in both effectiveness and efficiency occurred from 1940 to 1980. During this era, New York's rapid transit system contracted and deteriorated. The total number of track miles decreased by approximately 18% (Daly, 1941; Foran, 2011; Ravitch, 1980). Most of the original elevated railways (those not constructed in conjunction with new subways) were torn down in the 1940s and 1950s.

1956 saw the opening of the system's last major new line, the Rockaway line to Queens[13] (New York City Transit Authority, 2012c). This new line, though, was simply the conversion of a passenger railroad to a rapid transit line. Moreover, these and other minor additions did not offset the losses elsewhere. Meanwhile, the system was not extended into vast areas of Queens and Staten Island, despite significant population growth there (Fullen et al., 1942; Metropolitan Transportation Authority, 1971; New York City Transit Authority, 1954, 1960, 1967).

EFFICIENCY

When the IRT and BRT agreed to the nickel fare in the early 20th century, the United States was on a de facto gold standard and prices had been stable for a century—this was expected to continue (Gallman, 1966; Rhode, 2002). However, the creation of the Federal Reserve in 1913 and the inflation of World War I unexpectedly reduced the value of a dollar (Greenspan, 1966). In 1910, the nickel fare was worth $1.19 in 2011 dollars; by 1920, it was worth $0.56 in 2011 dollars. As a result, the IRT and BMT had long been asking for a fare increase to upgrade equipment and expand their networks. Mayor Hylan made the nickel fare into a sacred political issue, however, and the City refused to negotiate with the IRT or the BMT (Brooklyn-Manhattan Transit Corporation, 1924; Hood, 1993; Savas, 2005). Hylan also blamed the members of the Transit Commission of the State of New York, who "aim at but one purpose—to forever compel the City to remain in bondage to these traction corporations" (Gordon, 1925).

Despite going though bankruptcy and receivership, the companies were able to survive by implementing major cost-cutting measures and greatly increasing their efficiency. They cut their workforce by installing automatic turnstiles and automatic door controls—a ten-car subway train could now be operated by two people instead of six. They also slowed the replacement of equipment, reduced headways, and limited cleaning (Brooklyn Rapid Transit Company, 1921; Hedley, 1921). Nonetheless, in general, the subway system did remain safe and reliable during the 1920s, 1930s, and 1940s (Hood, 1993).

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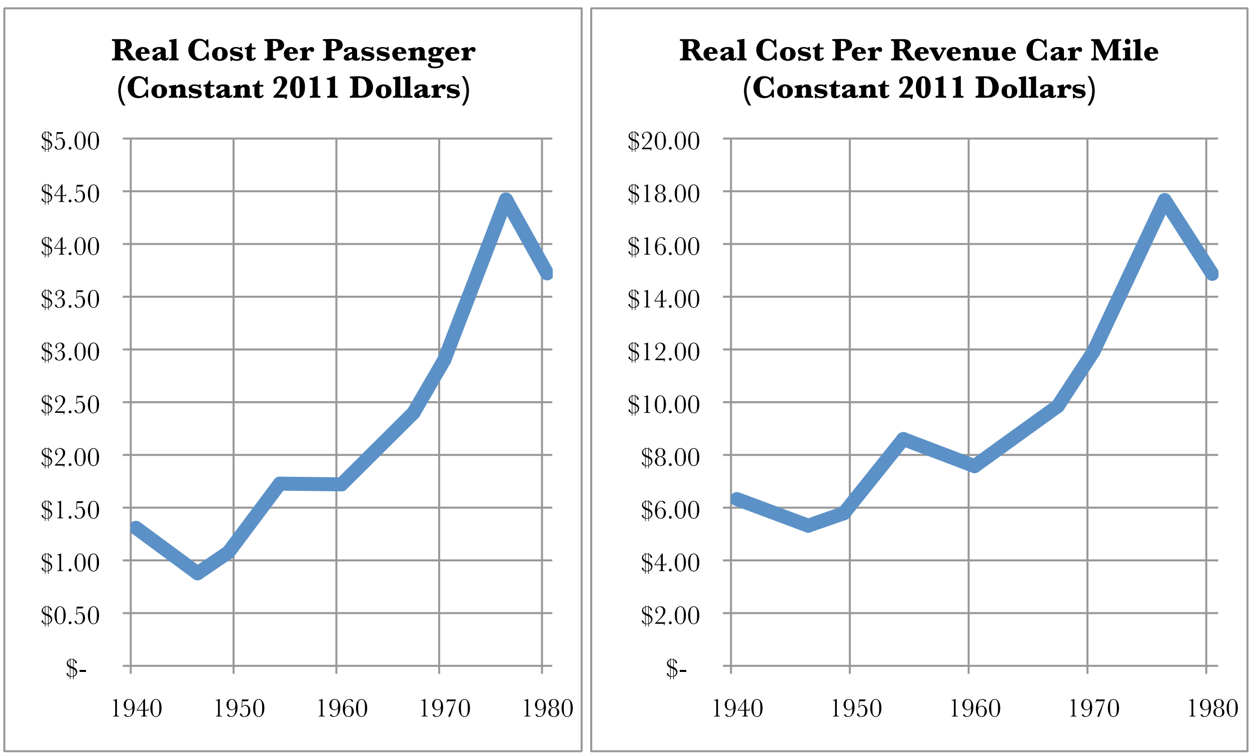
[13] New segments have opened since 1956, such as the Christie Street Connection in 1967 and the 63rd Street Tunnel Connector in 2001. They were important links and they enabled the creation of new subway routes, but the amount of additional track was relatively small. For example, the 63rd Street Tunnel Connector allowed the creation of the V subway line (which was subsequently discontinued). However, only 0.28 route miles of the line was new construction. The remainder of the line shared existing right-of-way with other lines (New York City Transit Authority, 2012c).

Eventually, however, competition from the heavily subsidized IND (the $0.05 fare covered just over 1/3 of its costs), political intimidation, and the Great Depression bankrupted the IRT and BMT. In 1940, the City finally reached an agreement with the IRT and BMT to acquire their assets, in order to take over operations of the entire system—an event known as "unification" (Dahl, 1940; Derrick, 2001; Greenspan, 1966; Hedley, 1921; Hood, 1993).

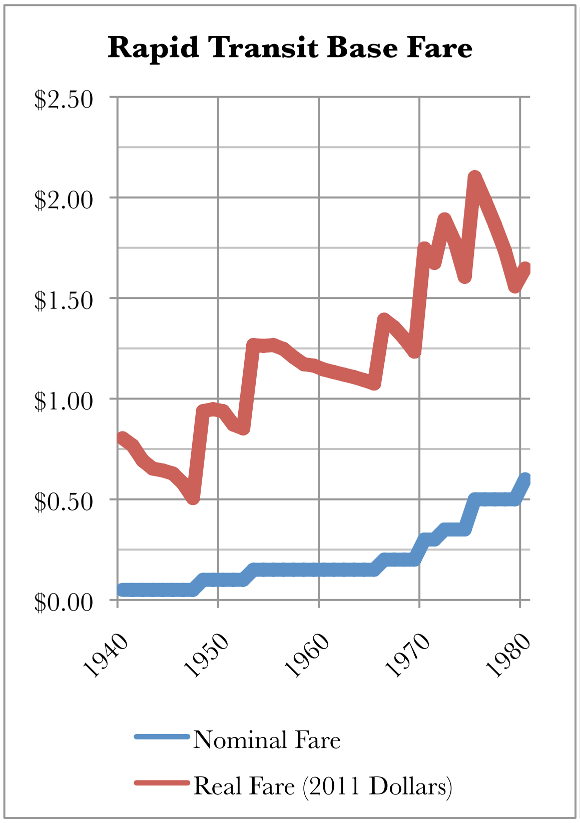
The City's central argument for unification was that the $0.05 fare could be preserved indefinitely; free and convenient transfers were secondary. Unification, it was argued, would preserve the nickel fare by enabling the City to achieve significant scale economies, refinance debt at lower interest rates, and eliminate profits and preferential payments (Delaney et al., 1939; Delaney et al., 1936; Hood, 1993). In 1925, Mayor Hylan sponsored a report that asserted:

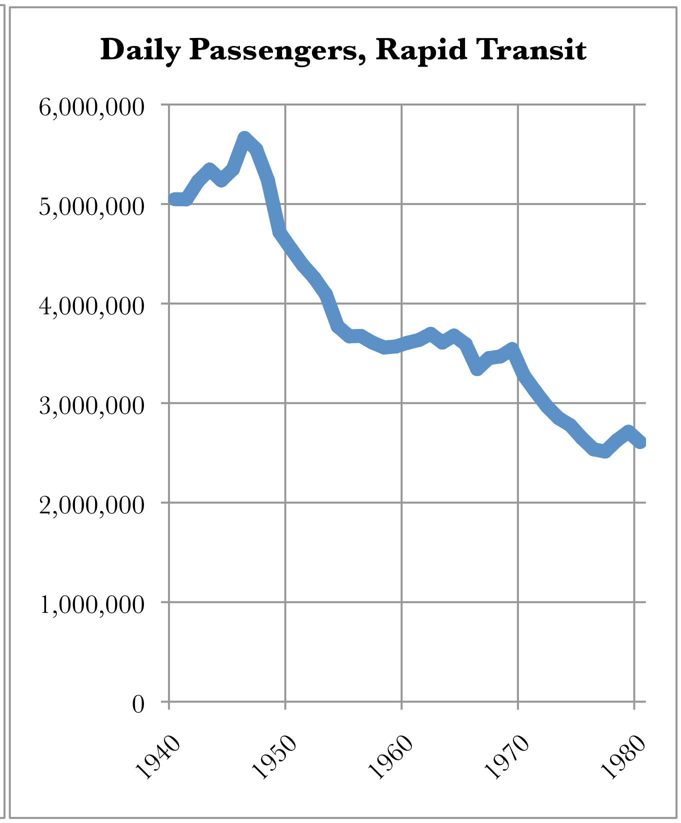
> *There can be no question but that under municipal operation the income from our subways will not only provide for all operating and maintenance expenses, depreciation, and interest on investment, but furnish substantial sums for the construction of future subways.*
> (Gordon, 1925)



Figures 4.1, 4.2 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: compiled from New York State Transit Commission reports (Fullen et al., 1936; Fullen et al., 1931; Fullen et al., 1942; McAneny et al., 1922, 1926), transit agency annual reports (Conway, 1996; Daly, 1941; Delaney et al., 1939; Delaney et al., 1936; Fisher, 1977; Foran, 2011; Kiley, 1986; Metropolitan Transportation Authority, 1971, 1993, 2001b, 2006b; New York City Transit Authority, 1954, 1960, 1967; Ravitch, 1980; Reid et al., 1949), price level indices (Gallman, 1966; Lindert & Sutch, 2006; Rhode, 2002; United States Bureau of Labor Statistics, 2011), and author's calculations.*

However, losses accumulated almost immediately after unification. The City finally raised the fare to $0.10 in 1948 and made a surplus, but losses returned the following year. From 1940 to 1980, the fare rose twice as fast as inflation. Expected cost savings were not realized. As costs rose, preventive maintenance ceased, and a policy of deferred maintenance began. Nonetheless, *real* operating expenses per passenger doubled between 1946 and 1960, then they doubled again between 1960 and 1976 (Daly, 1941; Fisher, 1977; Fullen et al., 1942; Metropolitan Transportation Authority, 1971; New York City Transit Authority, 1954, 1960, 1967; Ravitch, 1980; Reid et al., 1949).





Figures 4.3, 4.4 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

The City's direct control of the rapid transit system was never envisioned to be the final solution. In 1953, the New York City Transit Authority (NYCTA or TA), a public benefit corporation, was created to operate the subway on behalf of the City. As a public benefit corporation with independent control over the subway, it was intended to insulate transit from municipal politics, in order to manage it in a business-like manner. However, the TA was unable to reverse the decline. Costs briefly leveled off, and then resumed their upward trend (Hood, 1993; New York City Transit Authority, 1954, 1960, 1967).

EFFECTIVENESS

In 1968, the New York State Legislature created the Metropolitan Transportation Authority to consolidate the Metropolitan Commuter Transportation District, and the Triborough Bridge and Tunnel Authority (TBTA), and the TA. As stated in the enacting legislation, "the purposes of the authority shall be the continuance, further development and improvement of commuter transportation and other services related thereto" and "to develop and implement a unified mass transportation policy" (State of New York, 1968). The publicly stated objective was to create a regional, multi-modal transportation system. Practically speaking, the short-term aim was to use the TBTA's surplus the plug the TA's deficits. The TA still operates the City's rapid transit and remains a subsidiary of the MTA (Metropolitan Transportation Authority, 1971; New York City Transit Authority, 1967; State of New York, 1968).

Despite these changes, ridership fell by half from 1940 to 1980. Although ridership actually peaked in 1946, this was not representative of the long-term trend. Rather, it was a short-term consequence of rationing and the dearth of automobiles caused by World War II. Nonetheless, by 1980 ridership was lower than it had been in 1917 (Delaney et al., 1939; McAneny et al., 1922; Ravitch, 1980; Reid et al., 1949). Acute disrepair and financial collapse were not the only problems. Crime had gotten noticeably worse on the subway by the 1950s, and violent crimes became a serious concern in the 1960s. Security became such a major burden on the TA that the City began to reimburse policing costs. Graffiti, which proliferated during the 1970s, further diminished the quality of the rapid transit system (Seaman et al., 2004).

In the postwar era, capital investment entered a steep decline, and the subway was depreciating at four times the rate of new capital replacement. Although deferred maintenance produced some savings in the short-term, it meant that the system was steadily destroying itself.

Although the network contracted, the demolition of elevated railways was partly by design. For example, the IND Eighth Avenue subway line was built to replace the Ninth Avenue elevated railway. However, other elevateds were torn down without replacements (Reid et al., 1949; State of New York Transit Commission, 1922). Replacements had been planned and promised, but they were not realized.

For instance, a Second Avenue Subway Line was first planned in 1929 to replace the Manhattan portions of the Second Avenue and Third Avenue elevated railways, which were almost entirely pulled down between 1940 and 1956 (New York City Transit Authority, 1954; Reid et al., 1949). A major effort to build the Second Avenue Subway was resurrected after World War II, and voters approved a major bond issue in 1951 for that purpose. However, the money was instead used to replace badly deteriorated subway cars. In 1968, shortly after the creation of the MTA, the Second Avenue subway was revived as part of its ambitious "Program for Action" (Brooks, 1903; Metropolitan Transportation Authority, 1971).

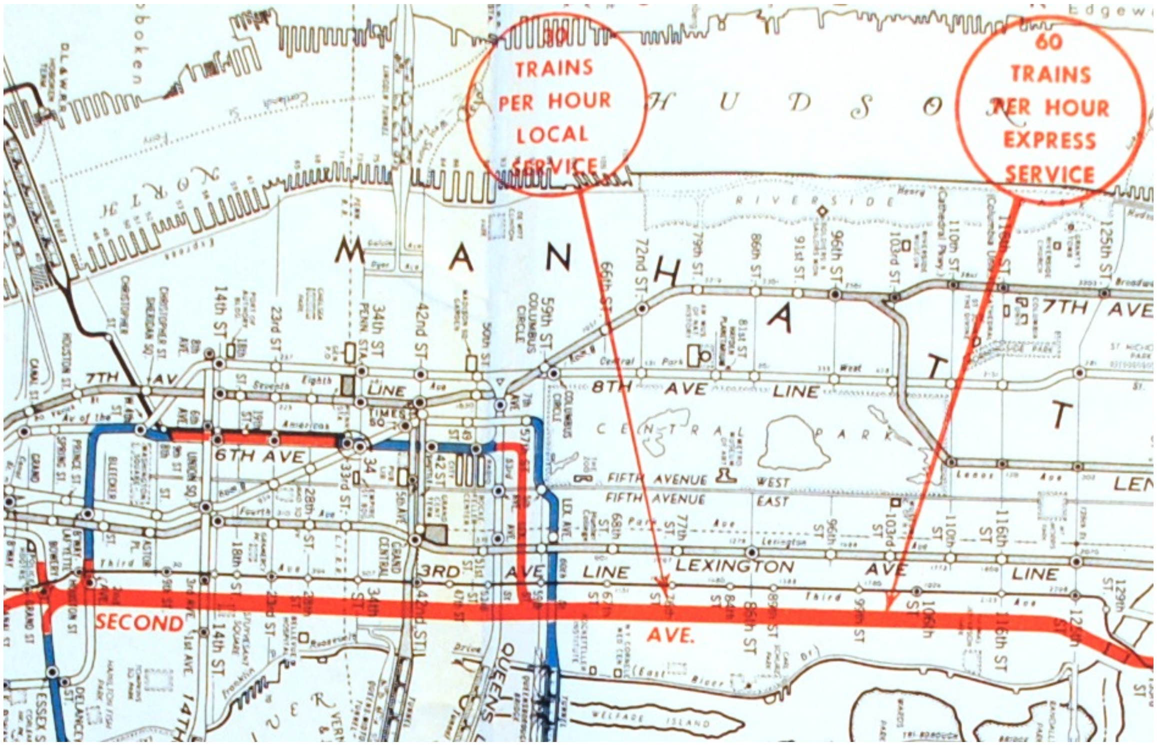


Illustration from the New York City Board of Transportation's 1947 Second Avenue Subway proposal, one of many such plans (Reid et al., 1949).

Work actually began on sections of the subway, but construction was halted in the 1970s when it became clear that major portions of the existing subway network were decaying severely (Derrick, 2001; Reid et al., 1949). As a result, millions of dollars that could have been spent on crucial maintenance and repairs was instead locked up in incomplete—effectively useless—expansion projects.

By the early 1980s, the subway system experienced a derailment every two to three weeks. Tracks did not receive regular inspections, and late or abandoned trains became typical. On an average day, over 300 train runs—roughly 5% of all trains—were abandoned, meaning that the train was unable to complete its route (Seaman et al., 2004).

There were some important accomplishments during this period. There were several subway line extensions, platforms were lengthened to accommodate ten-car trains on portions of the IRT subway, free transfers greatly expanded, and the three subways systems gradually began to integrate (New York City Transit Authority, 1954, 1960). The trend, however, was overwhelmingly one of decline.

CHAPTER 5

STABILIZATION AND REJUVENATION 1980—2010

INTRODUCTION

In general, from 1980 to 2010, effectiveness improved while efficiency held steady. The dominant trend is positive, though not as strong as the era from 1870 to 1940. Although, the subway faces several serious problems in the long-term, this was certainly an era of success.

During this era, the city's rapid transit system was stabilized and revitalized. Although the size of the network changed little, the system improved in many significant ways, especially by measures of effectiveness. Graffiti was officially eradicated in 1989, and reliable air-conditioning was brought to the entire system. Stations were rehabilitated, deteriorating passenger cars were replaced and rebuilt. Subway cars and tracks (but not stations) achieved a State of Good Repair by 1992 (Metropolitan Transportation Authority, 1993; Seaman et al., 2004).

Electronic fare payment—the MetroCard—was introduced, and ridership surged nearly 70% during this period. In 2011, ridership had surpassed that of 1950 (Metropolitan Transportation Authority, 2012b). No significant sections of track were closed, and a few small additions opened. Further, significant expansions are currently under construction (Conway, 1996; Foran, 2011; Kiley, 1986; Metropolitan Transportation Authority, 1993, 2001b, 2006a; Ravitch, 1980).

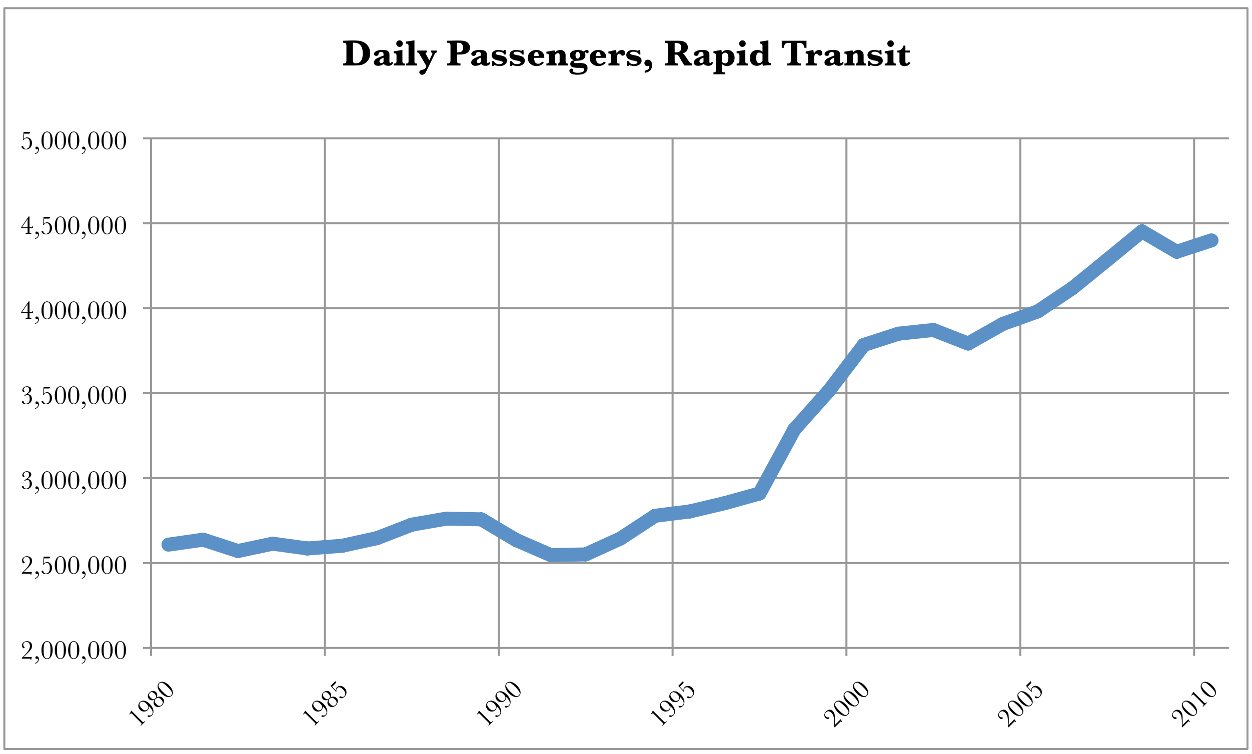


Figure 5.1 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid. Excludes Port Authority Trans-Hudson System, Staten Island Rapid Transit, and AirTrain JFK.*

EFFECTIVENESS

As the City's transit crisis worsened in the 1970s, a political consensus formed around reconstructing the rapid transit system. Richard Ravitch was appointed MTA Chairman in 1979, and he advocated a large, sustained Capital Program to restore the region's transit system, particularly rapid transit. Ravitch oversaw a comprehensive assessment of the system's needs, and in 1980, he proposed a ten-year Capital Program to restore the system to a State of Good Repair. Ravitch then proceeded to secure financial commitments from the City, the federal government, and the State of New York. In addition, the New York State Legislature approved a five-year capital planning process, which limited their funding approval to an all-or-nothing vote on the entire plan. In 1982, the funding was finally in place for the first five-year plan. By providing reliable funding, this enabled the MTA to proceed with planned long-term investments (Kiley, 1986; Ravitch, 1980; Seaman et al., 2004). Incidentally, the MTA also benefited from the repurposing of former Westway Interstate Highway funds for transit in 1985 (Altshuler & Luberoff, 2003). Impressively, the system has sustained this basic Capital Program model for three decades, even after the initial crisis had passed.

For the first time since the Great Depression, continual capital investments were made in the city's rapid transit system. In the first 10 years (1982-1991), almost all subway track was replaced or rebuilt, and thousands of subway cars were replace or overhauled. Nearly half of the passenger stations were renovated, and many had elevators installed. By the early 1990s, subway cars and tracks had reached a State of Good Repair (Seaman et al., 2004).

To protect these investments, regularly scheduled maintenance cycles were reintroduced, and a formal Scheduled Maintenance System (SMS) was rolled out in 1989. During the 1970s, crews simply waited for subway cars to break down before performing maintenance. SMS, in addition to new cars, significantly improved reliability. On time performance increased from below 85% during the 1980s to over 95% by the 2000s (Seaman et al., 2004).

The subway also began an aggressive program to eradicate graffiti. Cars with graffiti were immediately taken out of service, both to repaint them and to discourage future graffiti artists. By 1989, the subway had officially become graffiti free (Seaman et al., 2004).

Subsequent five-year capital plans enabled the system to move beyond State of Good Repair projects to Normal Replacement, System Improvement, and even Network Expansion projects (Metropolitan Transportation Authority, 2001a). As a result, reliability, on-time performance, and the overall passenger environment improved significantly during this era. In 2003, an 8.1-mile elevated railway opened—the AirTrain JFK—connecting the subway system to John F. Kennedy International Airport. It was built to handle standard subway cars. Although, at present it is privately operated, and it is not yet part of the subway system (New York City Transit Authority, 2012c).

The results of this investment have coincided with substantial increases in ridership. Indeed, New York City itself turned around during this period, but that does not fully explain the improvement in rapid transit. Ridership increased faster than employment or population.

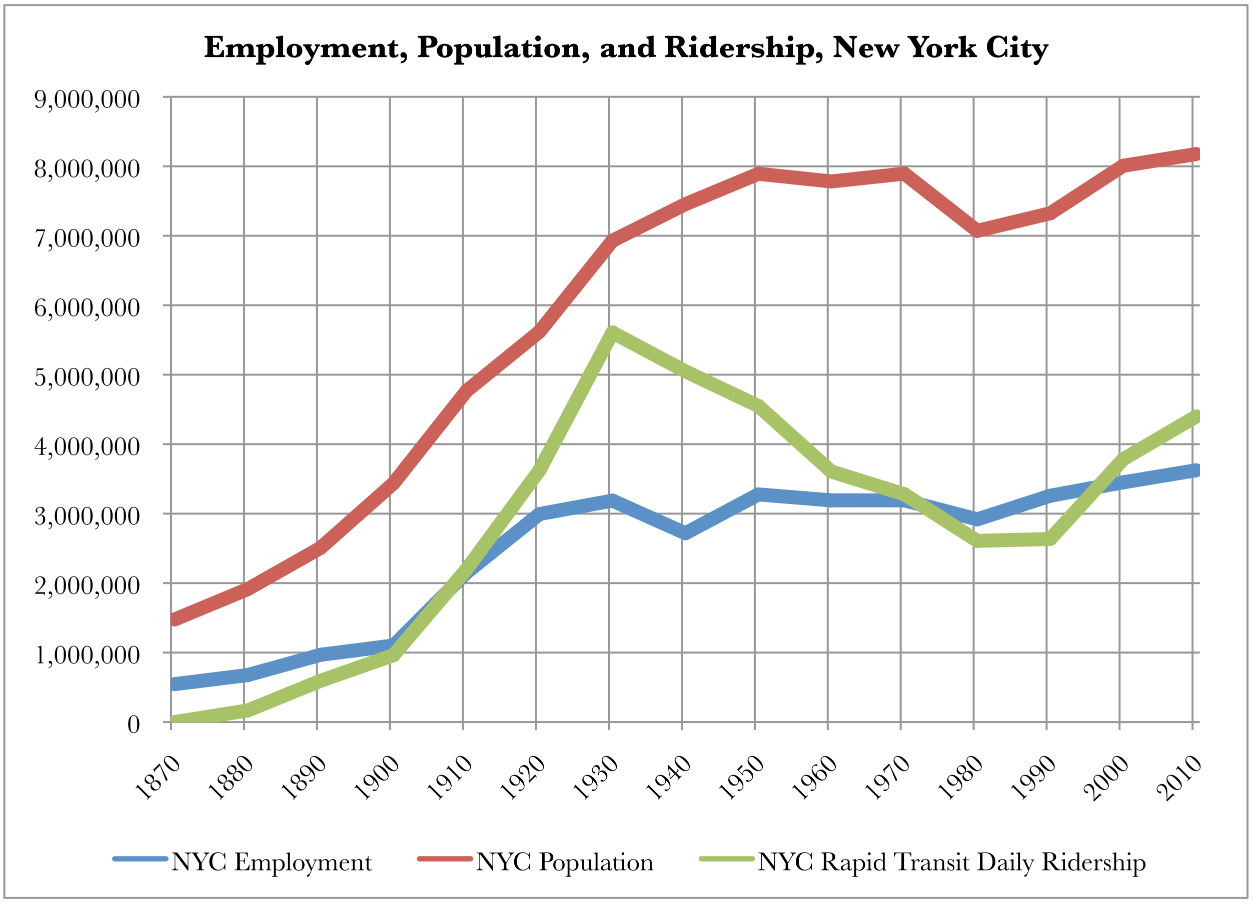
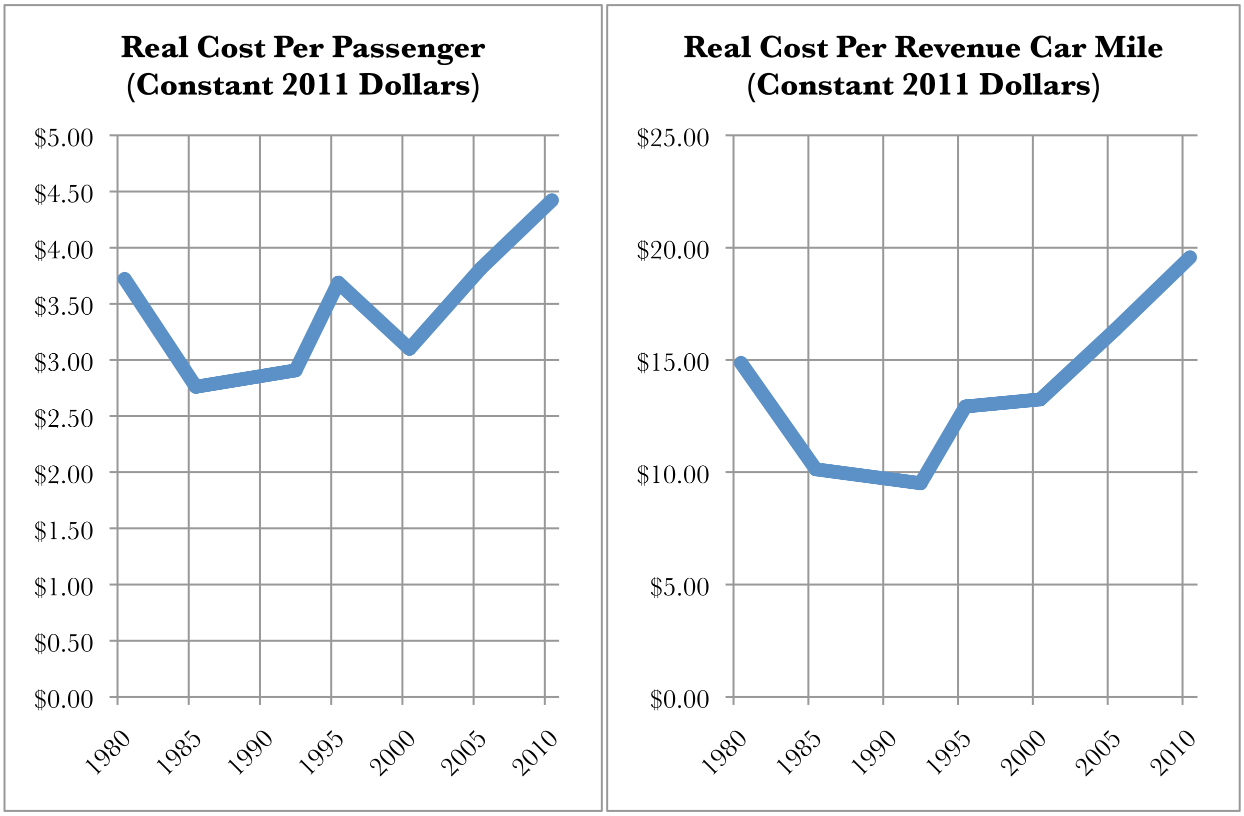


Figure 5.2 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

Still, overall, the size and scope of the network changed little. The number of track miles, route miles, and subway cars remained about the same. Other measures were also flat, especially measures of efficiency. That is, the steeply declining effectiveness and efficiency of the previous era was halted, but not necessarily reversed.

EFFICIENCY

A goal of the original the Capital Program was to provide service "at a reasonable operating cost", and certainly gains in efficiency are to be expected with such a program. Newer and better cars, tracks, repair shops, and other capital equipment should improve employees productivity, reduce the number of breakdowns, and cut the cost of maintenance, spare parts, and labor (Lave, 1991; Seaman et al., 2004).

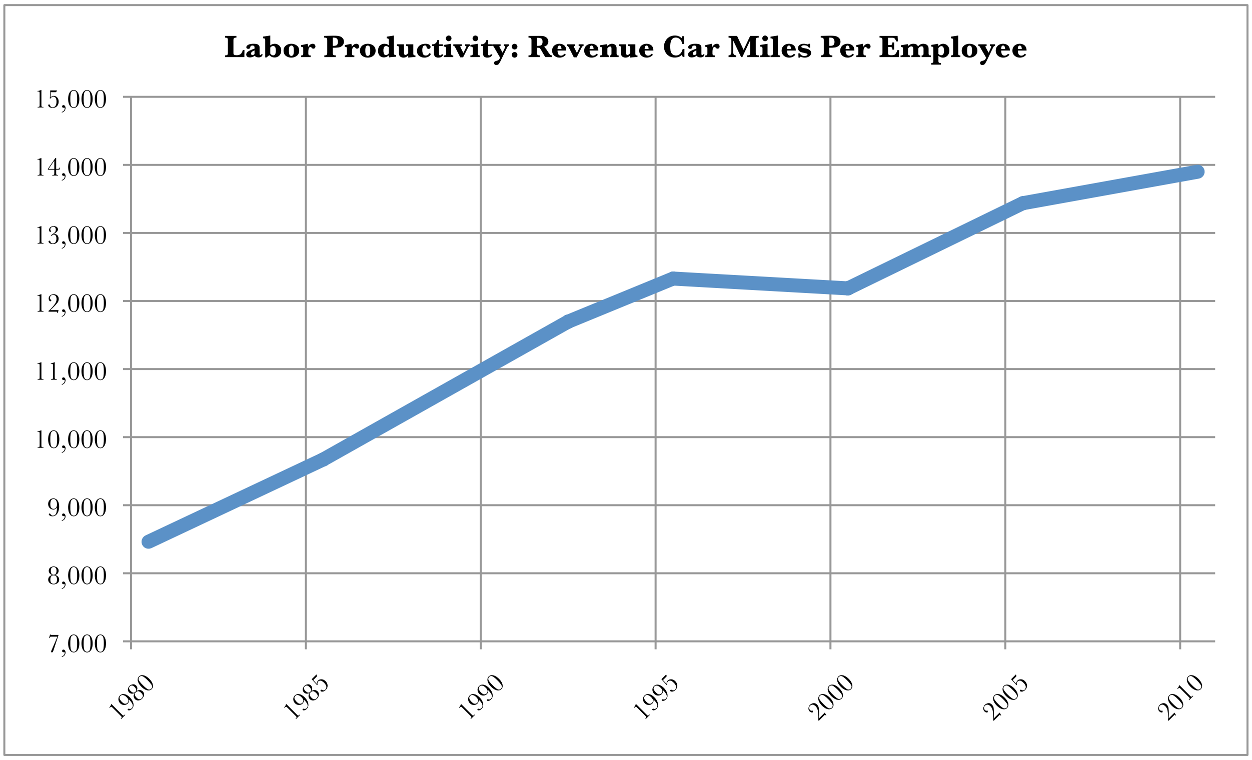


Figures 5.3, 5.4 *By most measures, efficiency was flat or declining from 1980 to 2010. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

There was little or no improvement, however, in most measures of efficiency. Some reports do show a modest increase in the efficiency of the subway, such as a reduction in operating cost per revenue car mile. Further, they indicate that by the 2000s, operating costs had fallen to roughly the average level of the next five largest rapid transit systems (New York's "peer group") (Federal Transit Administration, 2010; Seaman et al., 2004). These reports, however, do not include fixed costs. In addition, it is not always meaningful to compare New York to other American cities.

This study, however, analyzes full (or "long-term") costs, not just operating costs. Using the full cost, efficiency gains (as measured both in cost per passenger and cost per revenue car mile) made in the 1980s stopped in the 1990s, and were more than offset by the 2000s, as indicated in the charts above.

The capital improvements discussed above came at an enormous cost. Approximately $47 billion was spent on rapid transit capital improvements since 1982. In comparison, the entire cost of constructing the rapid transit system as it existed in 1940 was $19 billion in 2011 dollars (Foran, 2011; Fullen et al., 1942).



Figures 5.5, 5.6 *Labor productivity rose from 1980 to 2010, but labor cost rose in tandem. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

Federal financial support for New York's rapid transit system remained steady during this era. In the early 1990s, New York State began providing dedicated tax funds, pledged for the purpose of paying debt service. Meanwhile, City and State capital grants were significantly reduced. As a result, the MTA has become increasingly reliant upon debt, and nearly half of the 2010-2014 Capital Program (currently funded portion) is financed by debt (Metropolitan Transportation Authority, 2010; Seaman et al., 2004).

The real cost per passenger and cost per revenue car mile was essentially flat over the era, and both measures began increasing during the 2000s (implying a decline in efficiency). Labor productivity measured in terms of revenue car miles per employee and passengers per employee, improved steadily and significantly. Namely, they increased by 64% and 82%, respectively, from 1980 to 2010. This improvement is consistent with the massive capital investment that occurred. However, real labor costs per employee rose by 72% during this period, so the productivity gains produced no savings to the TA (or riders or taxpayers). Of course, this is an improvement over the increasing labor costs and *decreasing* labor productivity of the previous era (Conway, 1996; Foran, 2011; Kiley, 1986; Metropolitan Transportation Authority, 1993, 2001b, 2006b; Ravitch, 1980).

The stagnation in efficiency may alternately be interpreted as stabilization. It might reflect a greater cognizance of the importance of productivity. Real pay increases stayed roughly even with productivity increases, which had the effect of maintaining a constant the efficiency level.

This may or may not have been a deliberate policy. During the 1980s, however, labor productivity did receive a great deal of attention. Many economists and others viewed declining productivity as the dominant source of the problems in the 1940—1980 era. Moreover, as discussed in Chapter 3, productivity was declining at an alarming rate. Several academic papers were published on specifically on New York's transit productivity decline (Gleason & Barnum, 1982; Havelick, 1983; Lave, 1991).

NETWORK EXPANSION

New York's rapid transit system is now in the midst of the largest program of Network Expansion since the completion of the IND in 1940. With the achievement of most of the State of Good Repair and Normal Replacement objectives, the MTA's 2000-2004 Capital Program began major investments in Network Expansion. The IRT Flushing Line (No. 7 Subway) is being extended southwest into the Hudson Yards area, and Phase 1 of the Second Avenue Subway is under construction. In addition, the East Side Access project will bring Long Island Railroad commuter trains into Grand Central Terminal, although this is not part of the rapid transit network.

The year 2000 might have been the beginning of a new era in New York's rapid transit history, but it is difficult to tell. Because these expansion projects are not yet in operation, they were not included in most of this paper's analyses. They are, however, worth noting. Previous attempts at expansion during the 1950s, 1960s, and 1970s failed. Money was ultimately redirected to more urgently needed maintenance, repair, and equipment replacement. This time the rapid transit system is in much better condition.

Yet, it remains to be seen whether these Network Expansion projects can continue without compromising the system's State of Good Repair and Normal Replacement programs. Funding for the future phases of the Second Avenue Subway are not clear, and there is a limit to how much debt the MTA can sustain. In addition, during the last few years operating subsidies have become increasingly volatile while efficiency has ticked downward. This has resulted in service cuts and fare hikes. If that trend continues, it may again be tempting to redirect money from expansion to operations.

EVALUATION OF RAPID TRANSIT TODAY

In some specific ways, New York's rapid transit system as of 2010 is better than ever. Conveniences like electronic fare payment, air conditioning, and countdown clocks are as effective (or widespread) as ever. Broadly speaking, however, the system is neither as effective nor as efficient as it has been in the past, even when adjusting for population and employment levels.

Fortunately, the system's *effectiveness* is not far from its peak. Ridership in 2010 was 22% below the all-time peak in 1946. Presently, the number of route miles is 13% below the record level of 1940. Although the declines are real, they have been improving during the most recent era. Ridership continues to rise, and projects to expand the system are currently under construction. In addition, the decline (from the peak) in effectiveness is relatively small in comparison with the decline in efficiency.

Unfortunately, the system's level of *efficiency* is only a fraction of its peak level. The decline in productivity and efficiency from 1940 to 1980 was severe. This decline has been halted but not reversed, despite the massive capital investment. New Yorkers are still paying the price for this. Unless the system's efficiency improves, it will be difficult to improve its effectiveness. To put it another way, if the system does not become more efficient, then without additional subsidies or fare hikes, service cuts will be inevitable.

Moreover, long-term challenges endure. The subway network has not responded to major land use changes in Greater New York, such as the post World War II shift of the commercial core from Lower Manhattan to Midtown and the development in Midtown East and the Upper East Side. Although the subway has been under the control of the MTA since 1968, it has never been extended into any of New York City's suburbs. Even large sections of Queens that were built up after World War II were part of a two-fare system, in conjunction with bus service, and today they still lack direct subway connections (de Bartolome & Ramsey, 1992; Derrick, 2001).

Improvements in efficiency and productivity are crucial to the future of New York's rapid transit. Without these, the system cannot continue to improve effectiveness. In the long-term, efficiency underlies the financial sustainability of providing effective rapid transit. If major efficiency and productivity gains can be achieved, however, then expanding and improving the rapid transit system will be much easier.

CHAPTER 6

FAILURE AND SUCCESS: WHY AND HOW

INTRODUCTION

The preceding economic history of rapid transit in New York explains the ostensibly ambiguous state of rapid transit today and enables us to project into the near future. In order to build and operate radically improved rapid transit in the long-term, however, we must identify the *cause* of past failure and success. That is the *ultimate* aim of this research. Although the main contribution of this paper to that aim is a foundation of economic figures on the performance of New York's rapid transit, the data strongly implies several conclusions about the causes of rapid transit's failure and success. They are related to (1) the relationship between the prosperity of a metropolis and its transportation system, (2) the transformation of rapid transit's cost structure, which may be regarded as a proximate cause of the system's rise and fall, and (3) the significance of the evolution from private to public control.

The first implication is that rapid transit has tremendous power over New York's fortunes, and, for instance, deteriorating rapid transit was more of culprit than a victim of the city's postwar decline. The second implication is that money does not cause success. Rising wages and benefits combined with declining labor productivity are the primary financial cause of the system's long-term efficiency decline. Rising capital costs are a secondary cause. The third implication is that government subsidies and controls (culminating in complete public ownership and operation) were the central cause of rapid transit's long-term failures, and the establishment of a sound framework of property rights for private operation and ownership were the central cause of the system's long-term success. There is a substantial body of economic theory supporting the privatization of rapid transit (Block, 2009; Coase, 1960; Hakim, Seidenstat, & Bowman, 1996; Hayek, 1944; Lave, 1991; Mises, 1949; Ramsey, 1987; Rand, 1959; Simpson, 2005; Smith, 1776; Winston, 2010). Although neoclassical economic theory typically supports government intervention in mass transit, it relies on assumptions that are neither realistic nor desirable (Adler, 2010; Goodwin et al., 2009; Hall & Lieberman, 2008; O'Sullivan, 2007; Pigou, 1951).

POPULATION AND EMPLOYMENT

The economic prosperity and physical structure of cities are profoundly tied to the nature and effectiveness of cities' transportation systems. New York is no exception. Thus, it is important to consider the extent to which the rise and fall of rapid transit was caused by the rise and fall of New York. The growth and prosperity of a city (or lack thereof) will naturally be a boon (or burden) to the success of a transportation system. The relationship between a city and its transportation system works in both directions, of course, and transportation similarly influences cities.

The subway reorganized New York on a large scale. The subway made vast new areas of undeveloped and underdeveloped land accessible, especially in Queens, Brooklyn, and the Bronx.[14] This reduced crowding in Manhattan and simultaneously allowed tremendous growth in the city as a whole.

[14] The subway was not extended to the Borough of Staten Island

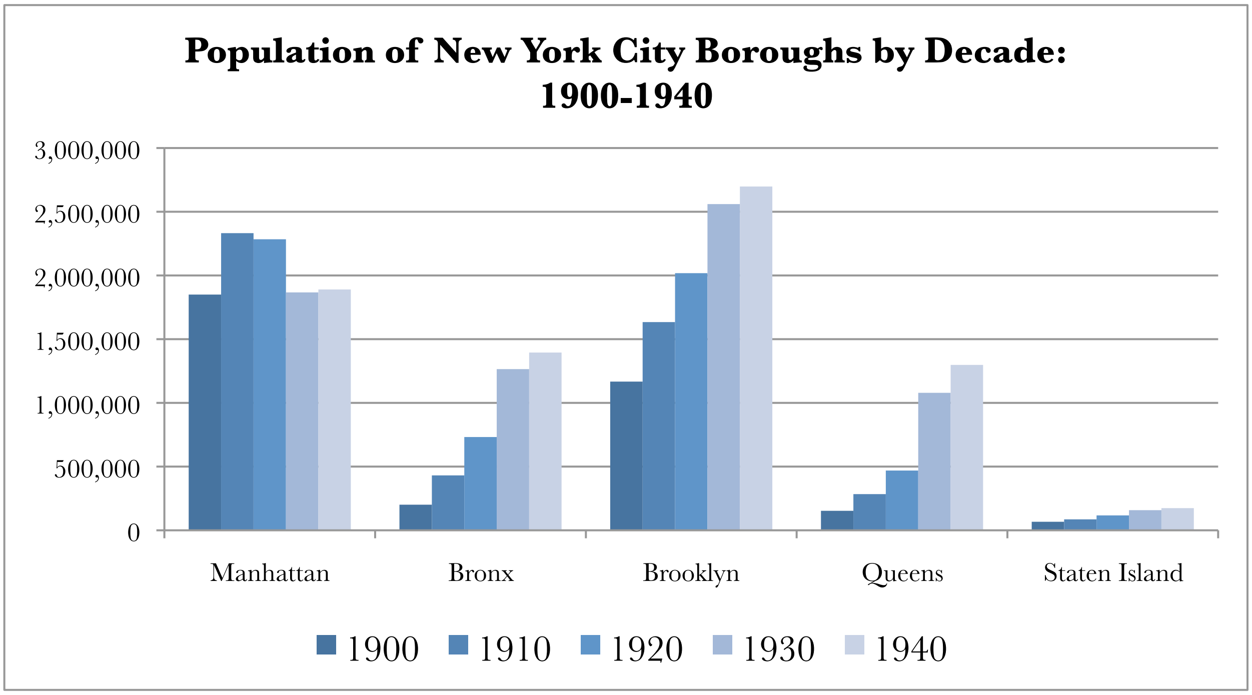


Figure 6.1 *New York's major subway expansion redirected the City's growth from Manhattan to the Bronx, Brooklyn, and Queens. Source: population data (Derrick, 2001; Jackson, 2010) and author's calculations.*

These new residential neighborhoods in the outer boroughs were often called "subway suburbs". For the same cost, the subway suburbs offered a much higher standard of living than could be achieved in Manhattan.

In Manhattan's crowded slums, population fell dramatically. However, in the desirable residential areas of Manhattan, such as the Upper West Side, the development of the subway made Midtown and Downtown even more accessible. This raised property values significantly (Lavis & Griest, 1915). This, in combination with the loosening of residential height restrictions, accelerated the trend of replacing row houses and walk-up buildings with large elevator apartment buildings (Derrick, 2001; Stern, Gilmartin, & Massengale, 1983).

Real estate developers almost always emphasized proximity to the subway, based on the review of several dozen brochures from the New York Real Estate Brochure Collection of Columbia University's Avery Architectural & Fine Arts Library. They are keen to highlight proximity to an *express* subway station, usually by the 2nd or 3rd sentence.

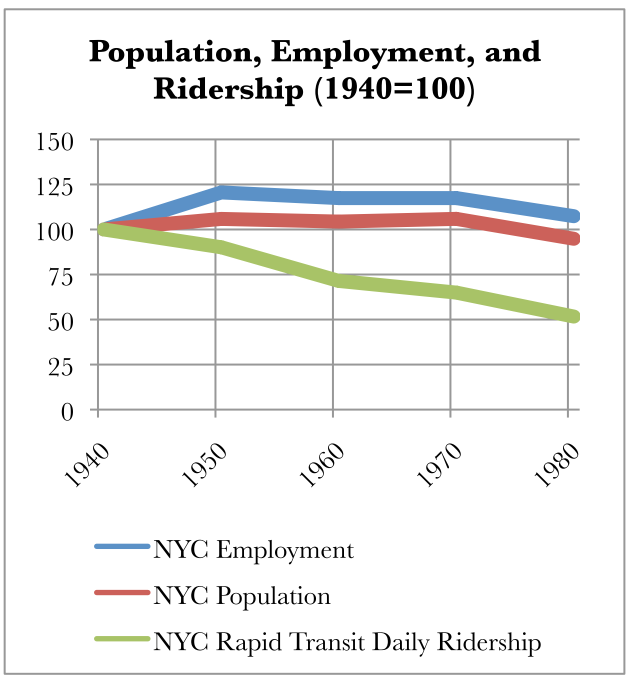
While the subway shifted residential growth to the outer boroughs, it also enabled employment to concentrate in Manhattan. In particular, employment clustered in areas where multiple subway lines converged. For example, during the 1900s and 1910s, several new subway lines converged around Grand Central Terminal. When combined with the development of air rights north of the terminal, this allowed Midtown to rival Lower Manhattan during the 1920s. The subway's cheap and quick transportation made it possible for a much larger population to access Manhattan.

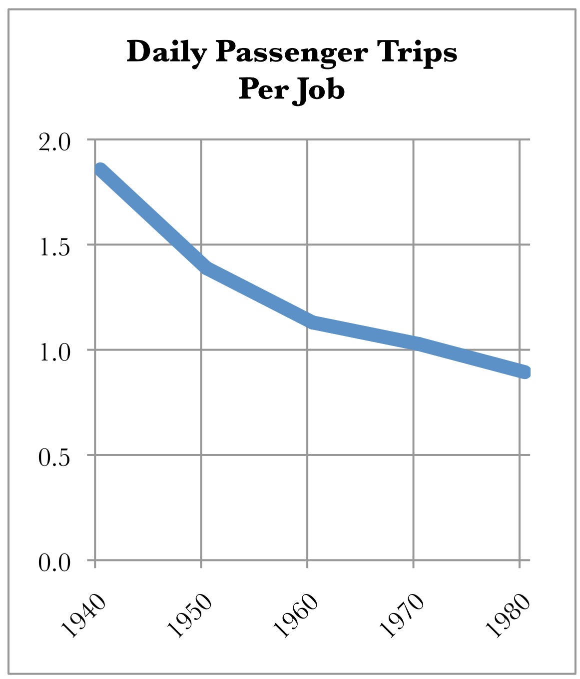
The subway was crucial to the development of the air rights adjacent to Grand Central Terminal, and it enabled the transformation of Midtown. Looking south towards Midtown around 1913 (top) and 1931 (bottom) (Stern et al., 1983; Stern, Gilmartin, & Mellins, 1987).

In contrast, Pennsylvania Station did not have a direct subway connection until 1932. The area around it developed much more slowly, despite the fact that Penn Station handles two to three times as many passengers as Grand Central Terminal (Jonnes, 2007).

Although the role of expanding and improving rapid transit in cultivating New York is widely-recognized, the role of the declining rapid transit (especially from 1940 to 1980) may be under appreciated in explaining New York City's postwar decline, which roughly corresponded with the rapid transit system's decline.

The subway system is frequently regarded as having been a victim of the city's decline during this period. New York's population and economic conditions, however, do not fully explain the deterioration of rapid transit. Employment levels are often regarded as the strongest influence on ridership. During the 1930's, however, employment fell by 15% but ridership dipped by less than 10%. On the other hand, during the first decade of unification (the 1940s), employment *increased* by 20% while ridership *decreased* another 10%. This data suggests that deteriorating rapid transit was more of culprit than a victim of the city's decline. If so, this underscores the importance of improving the effectiveness and efficiency of New York's rapid transit system.





Figures 6.2, 6.3 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

COST STRUCTURE

In the long-term, the base fare correlates with the cost of providing rapid transit. This is not surprising, particularly during periods when rapid transit was financially self-sustaining. The introduction and growth of capital and operating subsidies allowed the fare to decouple from the cost, but the general relationship has persisted. Thus, even if subsidies are not paid by riders, patrons of New York's rapid transit nevertheless have an interest in reducing costs. In fact, greater subsidies (represented by the gap between the cost and the fare) correlate with higher real costs.

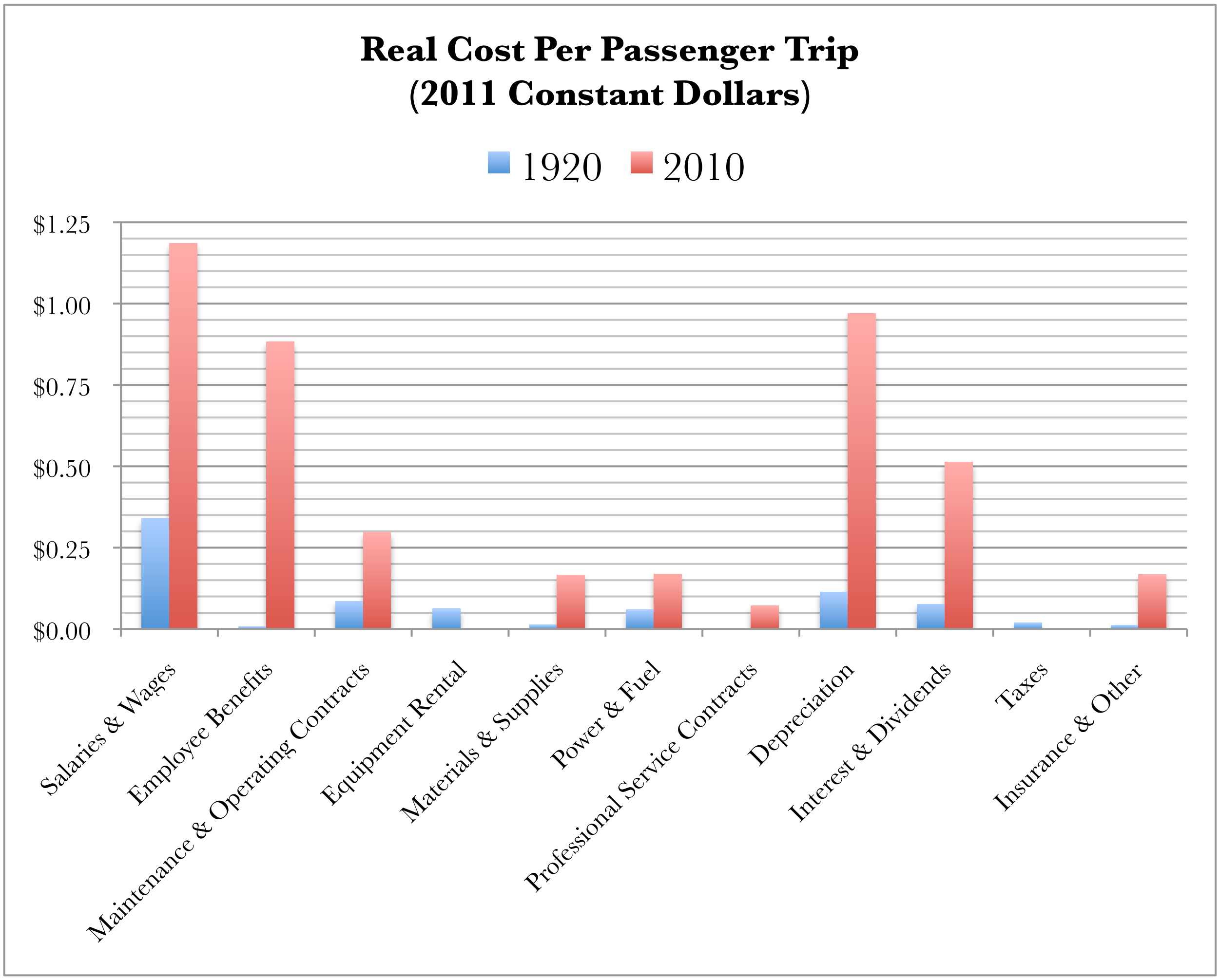
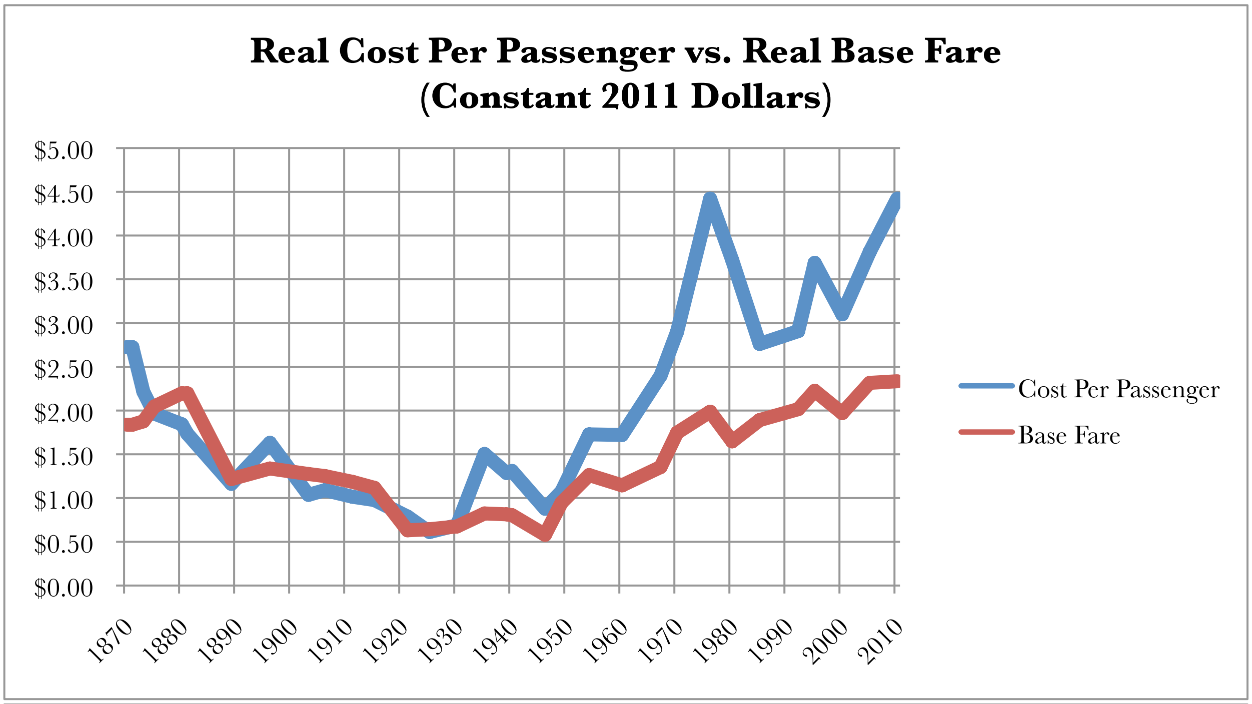
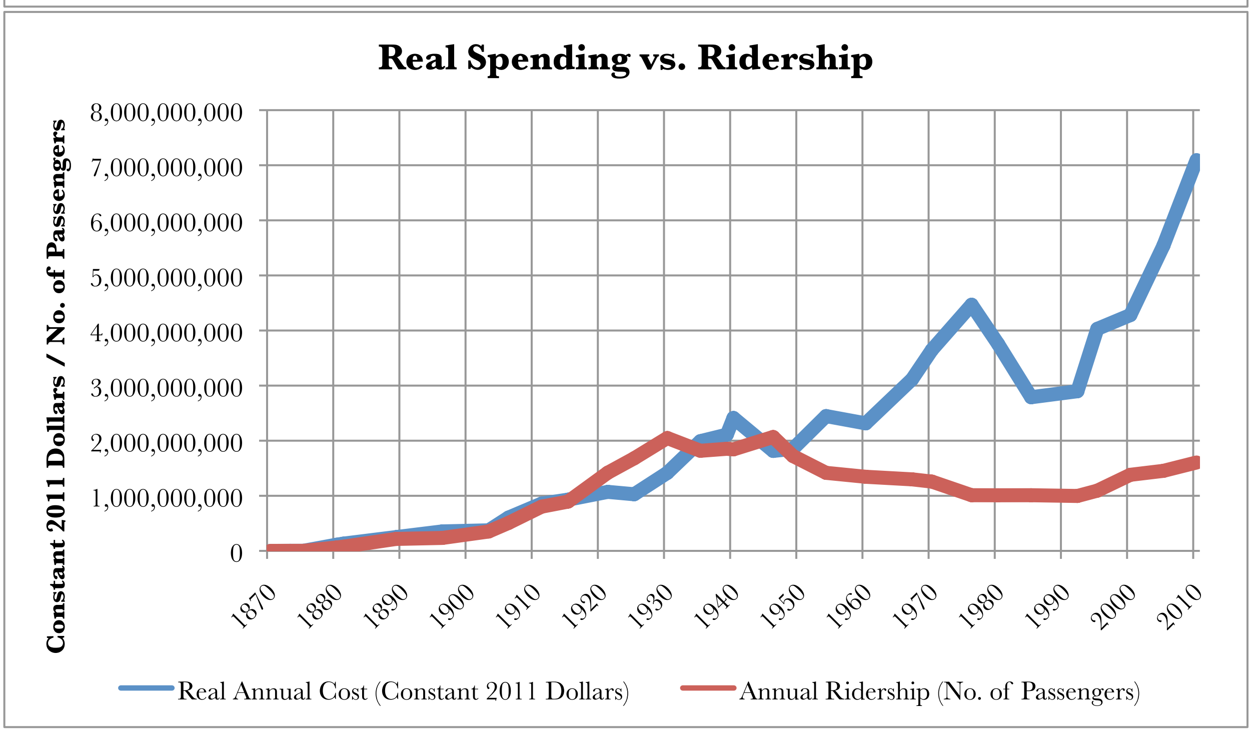


Figure 6.4 *The total cost per passenger rose from $0.79 in 1920 to $4.42 in 2010 (in constant 2011 dollars). The relative cost structure has been stable over time, but nearly all costs have risen. Of the total cost per passenger, labor remains by far the largest cost component of rapid transit. In 2010, each ride cost over $2.00 in payroll and benefits, which nearly equaled the $2.25 base fare. Depreciation—the annualized cost of capital improvements—was a distant second. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*





Figures 6.5, 6.6 *The fare has been rising, but costs have been rising faster. Lack of money is not and has not been the cause of New York's rapid transit failures. For example, real annual spending more than doubled from 1950 to 1975, while ridership sank. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

A lack of money has not been the cause of rapid transit's failure, and increased spending has not been the cause of its success. On the contrary, effectiveness increased when the cost (and spending) per passenger decreased (as shown in the Spending vs. Ridership chart above). That is, gains in effectiveness and efficiency have gone together. This makes sense, because lower costs (i.e. greater efficiency and productivity) translated into lower fares allowing more people to consume more rapid transit. Part of the reason the MTA's Capital Program was successful is that it actually reduced labor and certain other operating costs.

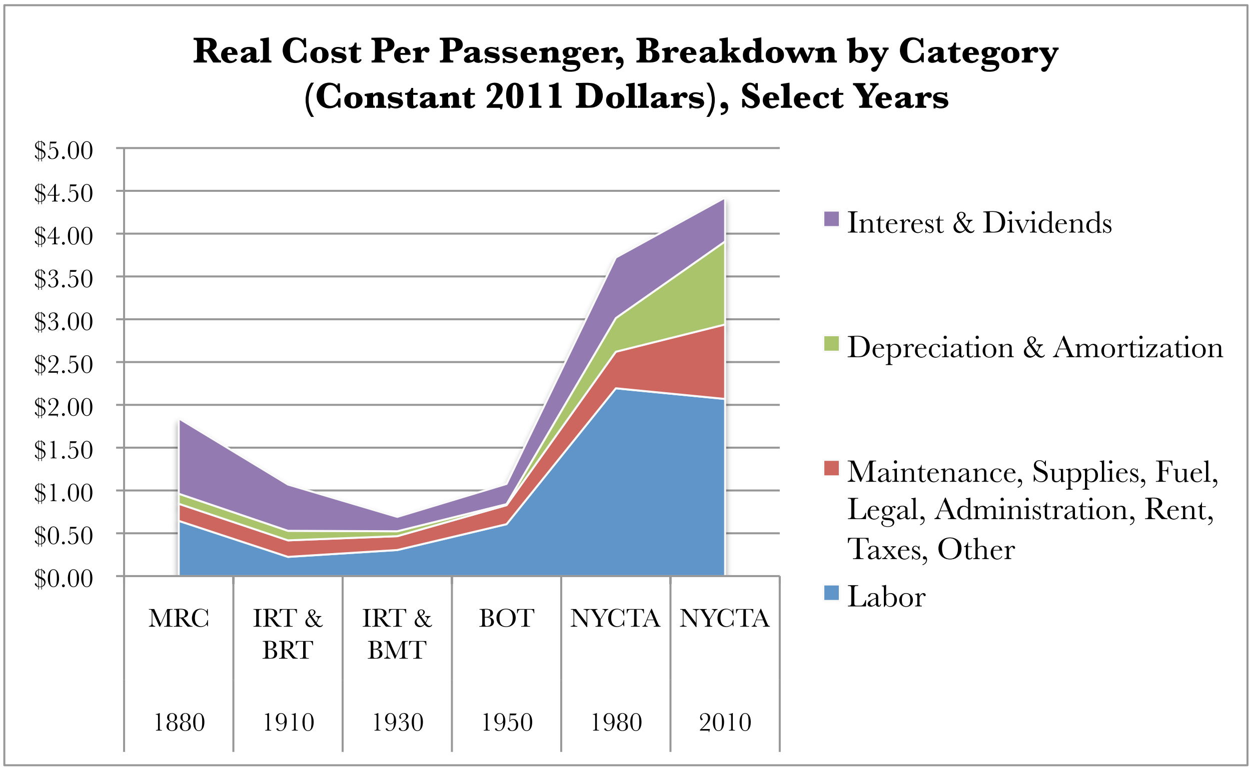
This phenomenon is not unique to rapid transit. For example, in the early 20th century, the efficiency of mass-production lowered the real cost of automobiles and greatly expanded their use and effectiveness. In the long-term, the effectiveness of any product—ranging from petroleum to computers—is limited by its cost, which depends on efficiency. This is because resources are limited. Efficiency and productivity lie at the root of economic growth, because they are a means of doing more with less (Goodwin et al., 2009; United States Bureau of Labor Statistics, 2002).

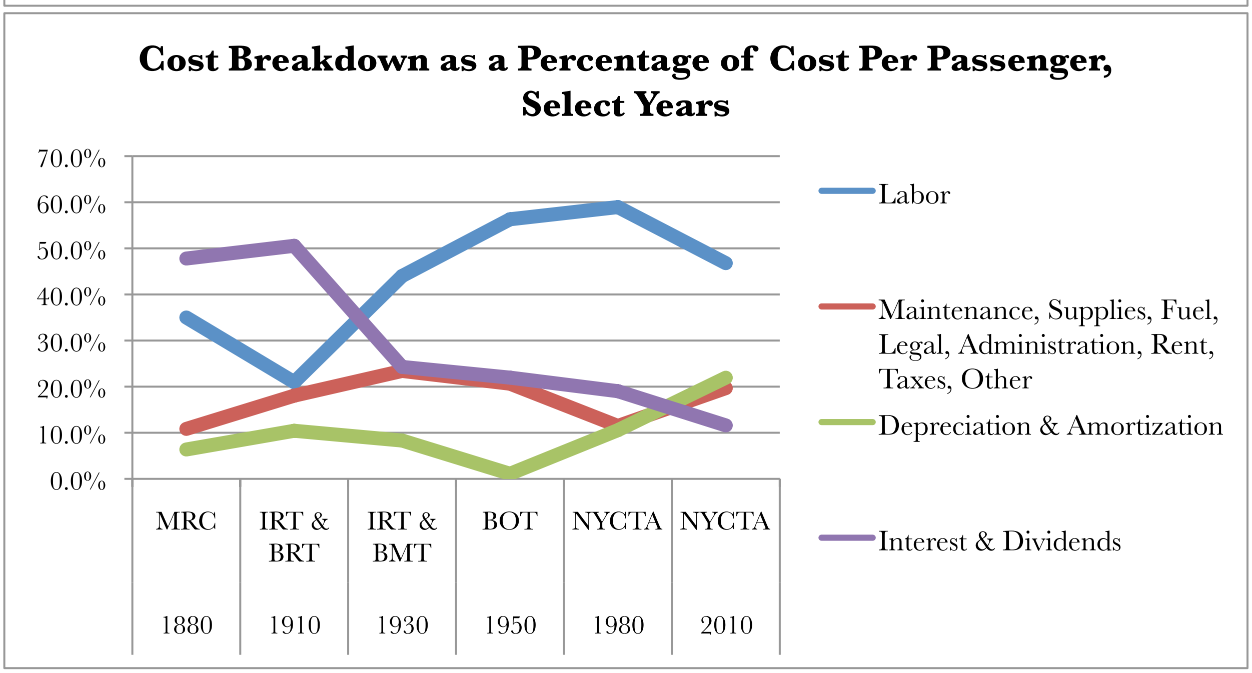
Below is a high level breakdown of rapid transit costs (on a per passenger basis) for selected years. Labor is by far the largest natural (as opposed to functional) expense category. The cost of labor actually fell (per passenger) slightly from 1980 to 2010 owing to productivity gains discussed above. However, real labor costs rose sharply from 1940—1980, and they remain four to eight times greater than from 1870—1940. In addition, non-labor costs increased significantly from 1980 to 2010. The increase in depreciation expense since 1980 primarily represents the MTA's Capital Program (for rapid transit). If the profits (interest and dividends) of the elevated railways and private subway operators were omitted from the costs, then the efficiency of that era would appear even greater.

As illustrated in the chart below, the cost of labor *as a percentage* of the total cost per passenger (approximately 45%) is actually similar to the percentage during the 1920s and 1930s, when efficiency peaked. As would be expected, during periods of increased capital investment (represented by rising depreciation and amortization), the relative cost of labor fell, and during periods of decreased capital investment, the relative cost of labor rose.

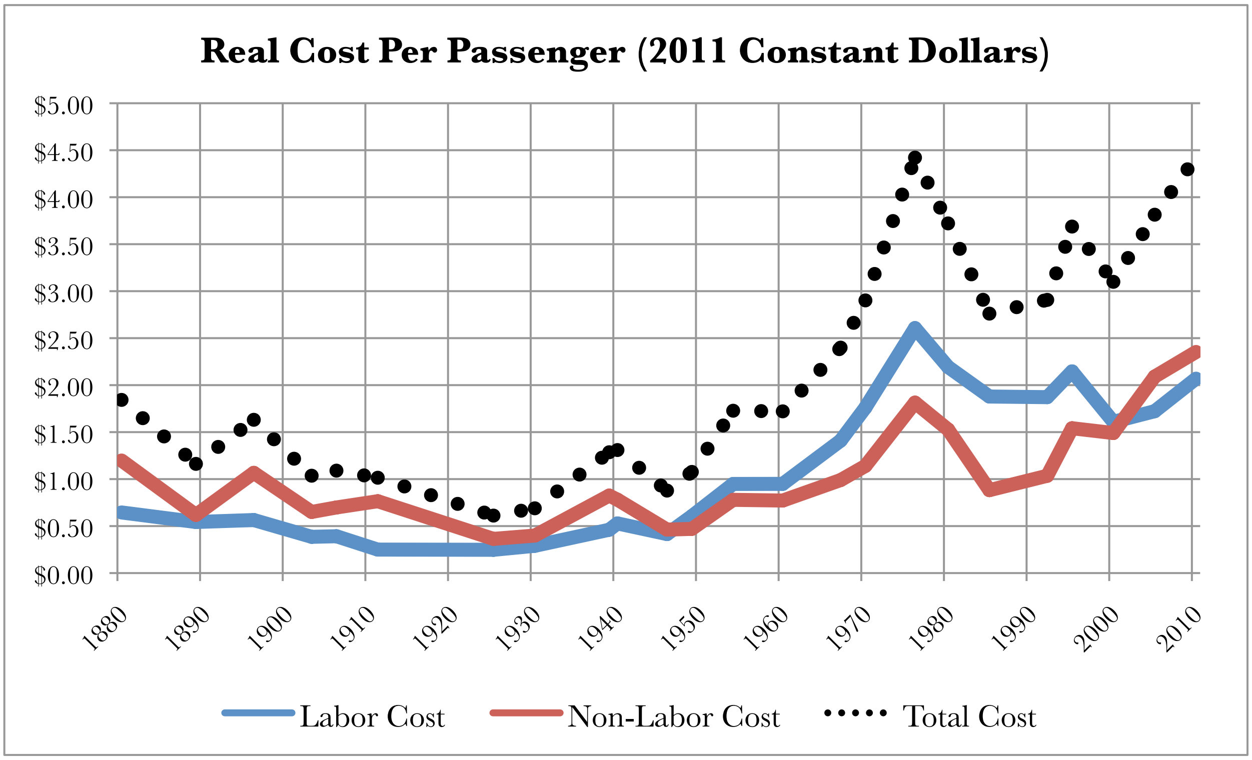
There is not a clear relationship, however, between capital investment and maintenance or other costs. The relative and absolute cost breakdown charts indicate that, essentially, all types of costs are significantly higher now than during most of the 1870—1940 era. A more detailed and comprehensive cost breakdown could increase our understanding of the long-term efficiency decline.

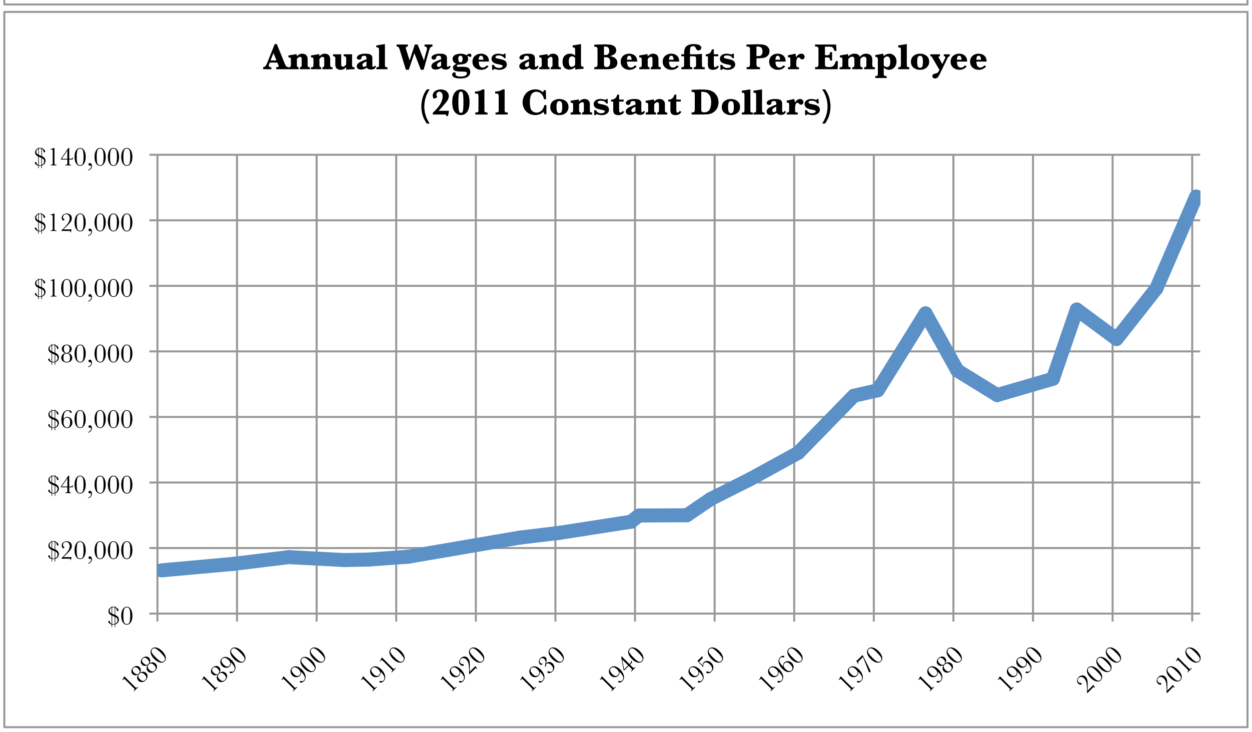
One fact, however, is clear. Labor remains by far the largest component of rapid transit's cost, and it continues to grow in absolute terms. Thus, as was identified in the 1980s, New York's rapid transit system must increase labor productivity (and/or reduce labor costs) in order to produce major improvements in efficiency and, in the long-term, effectiveness. Reductions in administrative costs, fraud, waste, and abuse, for example, can only produce marginal gains, even if they were eliminated entirely.





Figures 6.7, 6.8 *In the early years, subways and elevated railways made large profits and significantly reduced the real cost of rapid transit. In recent years, non-labor costs have grown faster. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*





Figures 6.9, 6.10 *Average annual labor cost—wages and benefits. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

Website header created by the Transport Workers Union (TWU) Local 100, www.mtamoneythrownaway.com. The TWU states that "the MTA is throwing money out the door – money that could be being used to restore service, keep fares low, and provide decent wages" (2012). Although the website identifies many valid examples of waste, none could produce a material improvement in effectiveness or efficiency. Ironically, major reductions in labor spending and/or increases in labor productivity are in fact required to expand service and lower fares.

Equally important, growth in wages and benefits must not exceed productivity growth. Otherwise, the system's overall efficiency will fall. As discussed above, labor productivity gains made from 1980 to 2010 were more than offset by increases in employee compensation—especially benefits. As a result, the real cost per passenger actually rose by 19% during the period. All of the productivity gains—and then some—were captured by labor, increasing the cost paid by riders and taxpayers.

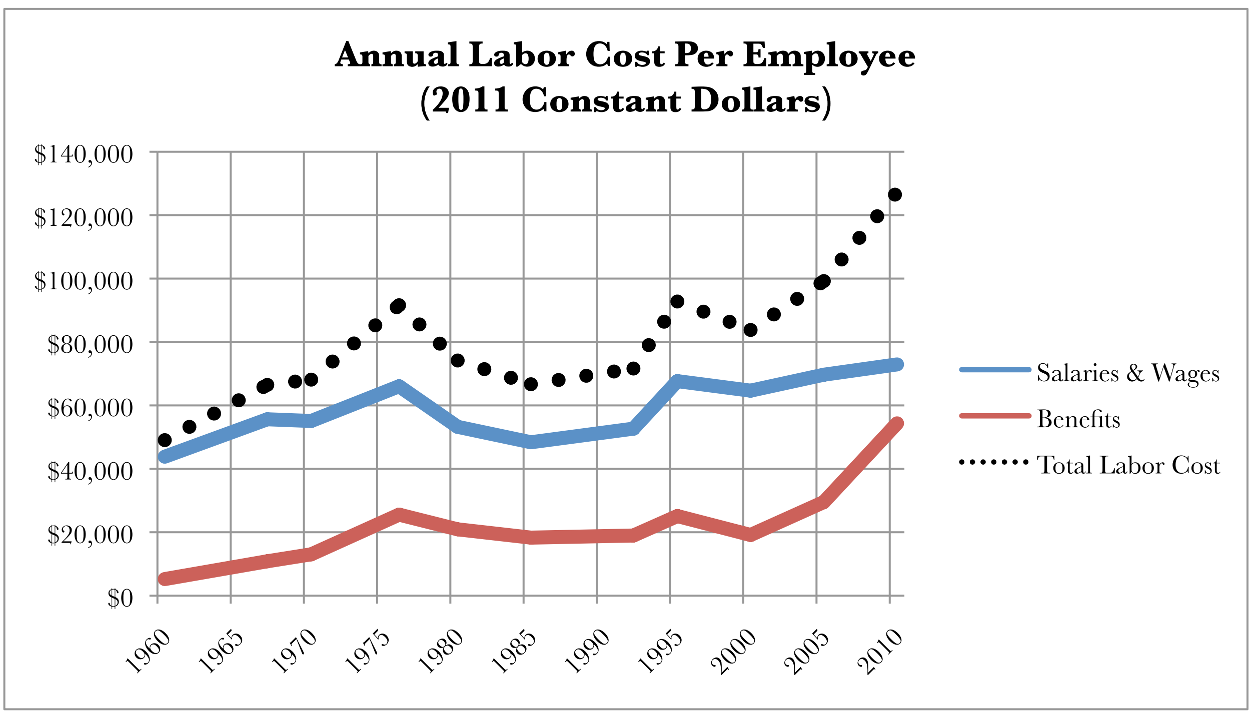


Figure 6.11 *All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

In 2010, the average cost per employee exceeded $120,000. This is abnormal; in general, productivity gains lead both to higher wages and to lower real cost. For example, from 1980 to 2010, the productivity of the privately owned and operated U.S. freight railroads increased by 163%, and, during the same period, real freight rail shipping rates fell by 51% (measured by revenue per ton-mile) (Association of American Railroads, 2011; United States Bureau of Labor Statistics, 2012).

In addition, New York's rapid transit system still suffers from the legacy of the 1940—1980 era. During that period, labor productivity (revenue car miles per employee) fell by 28% while real wages and benefits rose by 148%. The basic operation of the subway changed little during this period. As a result, employees today are likely being compensated far above the market wage. For example, in 2003, shortly after the TA allowed non-employees to apply for the motorman (train operator) position, 14,000 people showed up to compete for 300 positions.

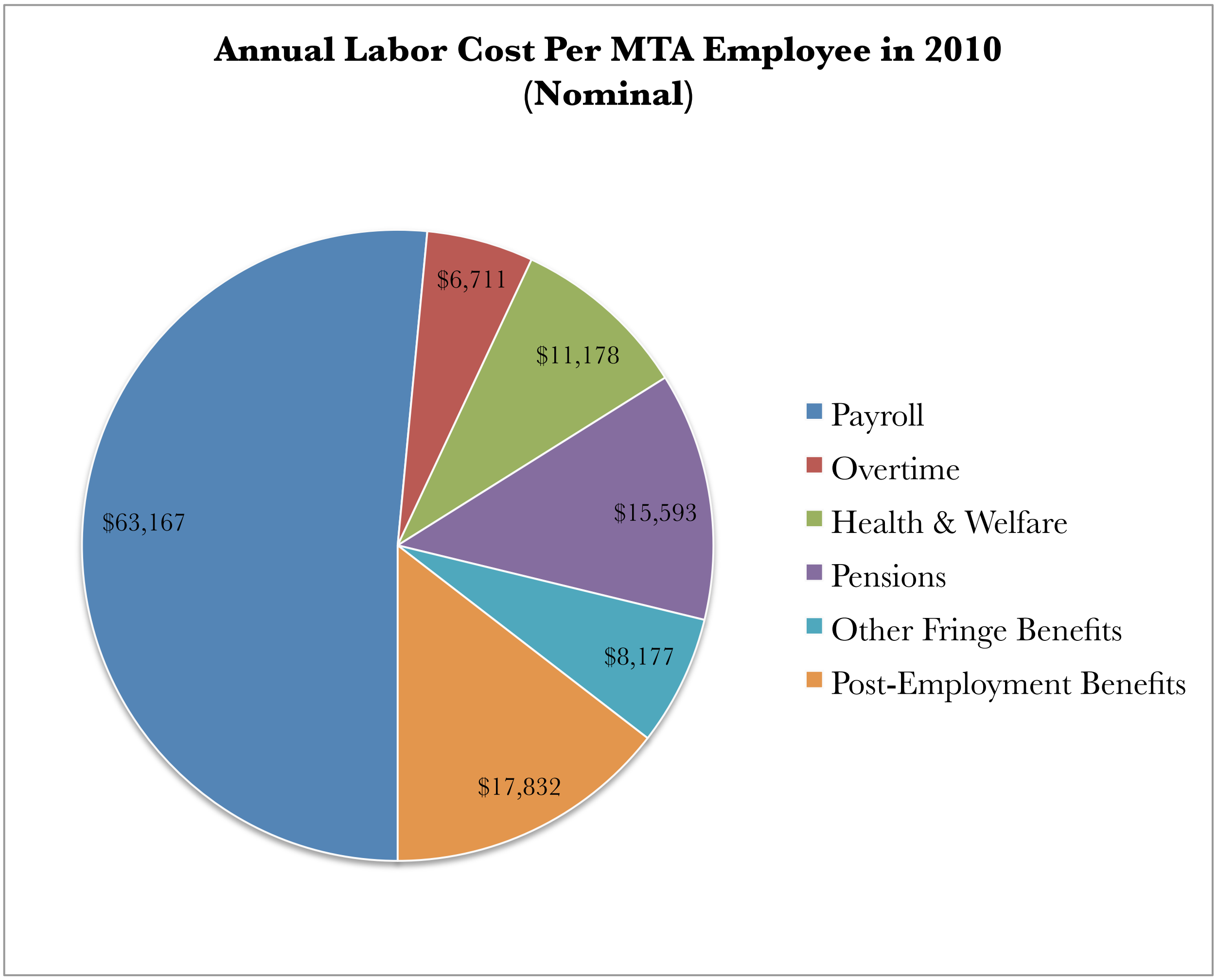


Figure 6.12 *The inflation-adjusted cost of benefits (per employee) nearly tripled from 2000 to 2010. In 2010, the total annual labor cost was $123,000 per MTA employee (Foran, 2011).*

Reducing employee compensation to free market levels (the minimum required to attract sufficient talent) would immediately and substantially improve the system's efficiency without affecting operations. Given the likely opposition of the Transport Workers Union of America, a more feasible solution would be to strictly link compensation with some measure of labor productivity, whether it rises or falls. Although this does not solve the legacy cost of overcompensation, it would at least help stabilize efficiency and prevent a vicious cycle of declining quality and escalating costs, as occurred from 1940 to 1980.

In addition to increasing labor costs, another ominous trend is rising capital costs. Depreciation expense, which is the annualized cost of capital investments, now exceeds the total of all other non-labor costs (excluding interest) and has been rising. The increase is due to the tremendous investment made by the MTA's Capital Program since 1982. As discussed above, the Capital Program is costly. As of 2010, the total cost of the Capital Program (related to rapid transit) was more than double the total inflation-adjusted cost of constructing the entire rapid transit network as it existed in 1940.

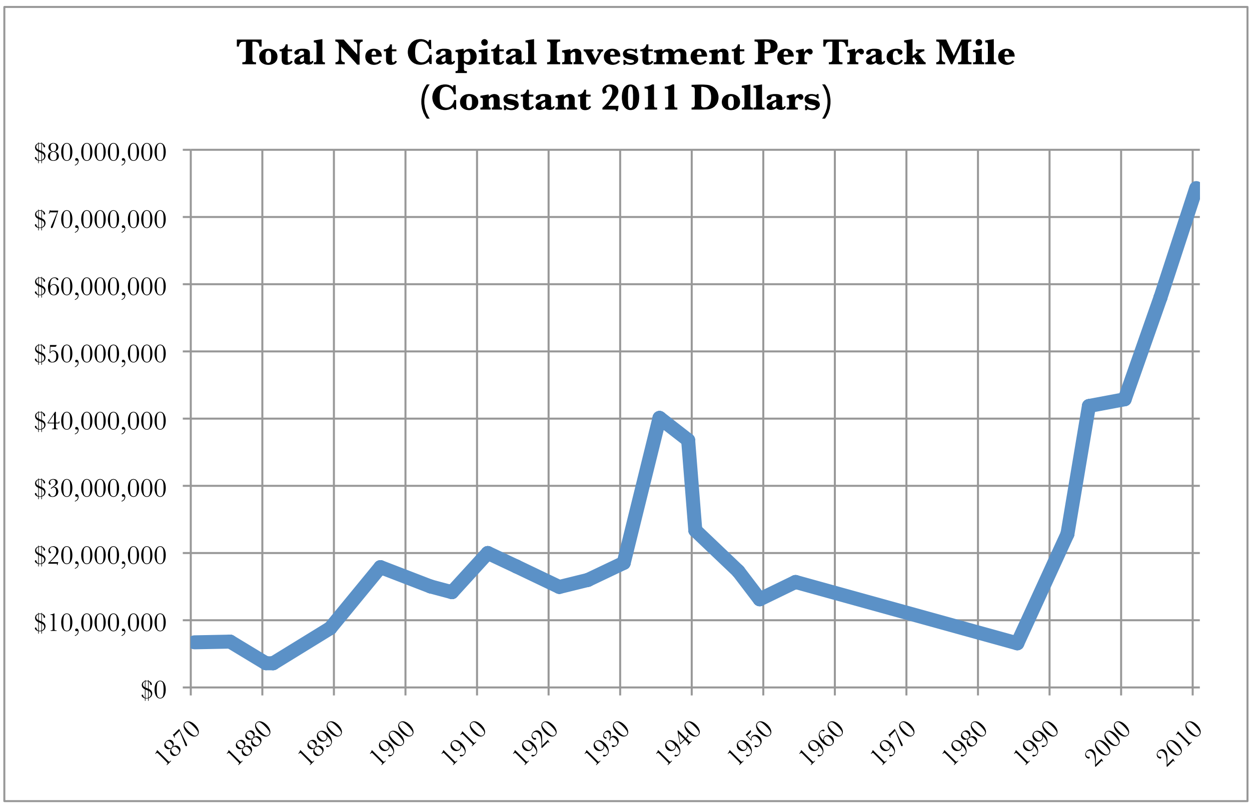


Figure 6.13 *The above figures include only costs related to capital assets in operation. Costs related to the Second Avenue Subway or the No. 7 Subway extension, for example, are not included. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

In real terms, the total capital investment *per track mile* is nearly twice the capital investment per track mile in 1940, but the system is not twice as effective. The capital costs appear to be disproportionately high relative to the quality of the rapid transit system, particularly since 2000. Rising capital costs are also a theme of Network Expansion projects under construction, such as the Second Avenue Subway (Grossman, 2011).

Construction technology has advanced since 1940, and new equipment and methods (such as tunnel boring machines and slurry wall construction) enables construction to be faster, less labor intensive, and more efficient than in 1940 (Mehta, Scarborough, & Armpriest, 2010). Notably, environmental legislation is one major difference between 1940 and today. In 1969, the National Environmental Policy Act was enacted. This law required federally funded projects assess the environmental impact and produce an Environmental Impact Statement. This has grown into a demanding requirement, which increases the time and cost of major capital projects. Other regulations increase costs as well. The Federal Transit Administration's (FTA) "Buy American" provisions also increase capital costs, and federal capital subsidies encourage transit agencies to spend more money on new equipment instead of efficiently maintaining old equipment (Hakim et al., 1996; Winston, 2010).

Making the environmental review process simpler, faster, and more predictable could substantially reduce Network Expansion costs. This could be accomplished by limiting the amount of research and materials required to be submitted. Especially for transit projects, the review could focus more narrowly on the infrastructure and services that are directly related to the project, in order to integrate it with the existing transportation network. Time limits could also be established for each main component of the process, especially for the certification. While some time limits do already exist, they should be applied uniformly to all levels of government—federal, state, and local (this would be especially helpful in New York). This would also add predictability to the process. Further investigation into the source of rising capital costs will be increasingly important, particularly if Network Expansion is to be sustained.

PRIVATIZATION AND THE ROLE OF GOVERNMENT

The central implication of this research is that—in the long-term—the best means of achieving effective and efficient rapid transit is via government establishment and protection of objective, secure, and just property rights for private ownership and operation. Each time that the government did more than this *or less than this*, long-term improvement slowed or reversed. Although this does not prove causation, a substantial body of economic theory does support this explanation. Given sound property rights, the price system and the profit motive coordinate the production and consumption of rapid transit more effectively and efficiently than direct government control (Block, 2009; Coase, 1960; Hakim et al., 1996; Hayek, 1944; Lave, 1991; Mises, 1949; Ramsey, 1987; Rand, 1959; Simpson, 2005; Smith, 1776; Winston, 2010).

However, conventional neoclassical economic theory does not support this explanation. There are different viewpoints within neoclassical economics, but it generally treats mass transit as a special case (owing to scale economies and other characteristics) and supports a larger role for government, including government subsidies, regulations, network planning, and sometimes ownership (Adler, 2010; Goodwin et al., 2009; Hall & Lieberman, 2008; O'Sullivan, 2007; Pigou, 1951). This research, however, did not identify any neoclassical theory that adequately explains the empirical findings presented above. This contradiction can be explained by the underlying assumptions of neoclassical economics, which are neither realistic nor desirable (Block, 2009; Simpson, 2005). The appendix contains a brief discussion of the opposing economic theories in relation to rapid transit. It highlights the weaknesses of the neoclassical model of perfect competition and explains how property rights actually enable greater competition.

The preceding research has empirically demonstrated (1) the substantial long-term improvements in effectiveness and efficiency achieved by private, for-profit elevated railways and subways following the establishment of secure property rights and (2) the slowing progress after 1920 and the long-term reversal of progress after 1940, as government first restricted private control and then secured complete control. Even during the 1930s, when public and private subway networks were operating simultaneously, the cost per passenger of the publicly-operated IND was roughly three times the cost per passenger of the privately run IRT and BMT. This further suggests that privatization would improve the effectiveness and efficiency of rapid transit, and it warrants further investigation into the various means of privatization.

Privatization means to "transfer (a business, industry, or service) from public to private ownership and control" (New Oxford American Dictionary, 2009). The right to property means the right to "exclusive acquisition, use, and disposal" of property (Mossoff, 2003). Ultimately, the nature and extent of the property rights created and/or transferred constitute the product of privatization. Privatization does not mean extracting government. Rather, as this research implies, government plays a crucial role—it must establish and protect objective, secure, and just property rights. Without this, rapid transit will languish as it did before 1875 and after 1940.

A more detailed understanding of the legal and financial relationships used by the private subways, elevated railways, and the City would be enormously useful. Understanding the nature of the property rights is of particular importance.

Although far from perfect, the key virtues of the Rapid Transit Act of 1875 (and the subsequent settling of court cases) were (1) its establishment of objective and reliable property rights, in order to attract the large capital investment required and (2) its removal of arbitrary and conflicting political motives from the approval process of individual proposals. An editorial in The New York Times (1865) implicitly identified this need ten years earlier, after the disappointing defeat of Hugh B. Willson's second subway bill:

> *The one point for the Government to satisfy itself about, is whether the proposed excavation will affect the houses, or sewerage, or streets of the city injuriously. Whether the new line is needed, and whether it will pay, are not matters for the consideration of the Legislature. It is no part of its business to prevent speculators from sinking their money in unprofitable enterprises.*

As indicated earlier, absent the $0.05 fare requirement, private capital could have financed subway construction if sound property rights existed. Even with the $0.05 fare, the net public subsidy amounted to little. The IRT and BRT/BMT paid rent on the City-owned subway infrastructure in addition to franchise, property, and income taxes. Moreover, the IRT and BRT/BMT paid most of the capital costs, in addition to all of the operating costs. The $0.05 fare mandated under subway Contract Nos. 1—4 combined with the federal government's World War I currency inflation amounted to a de facto abrogation of the IRT and BRT/BMT's property rights. Perhaps if, instead of unification, the City of New York had allowed the private companies to raise their fares (or otherwise renegotiate their agreement) and make improvements as recommended by the State of New York Transit Commission, we would have a larger and more robust rapid transit system today.

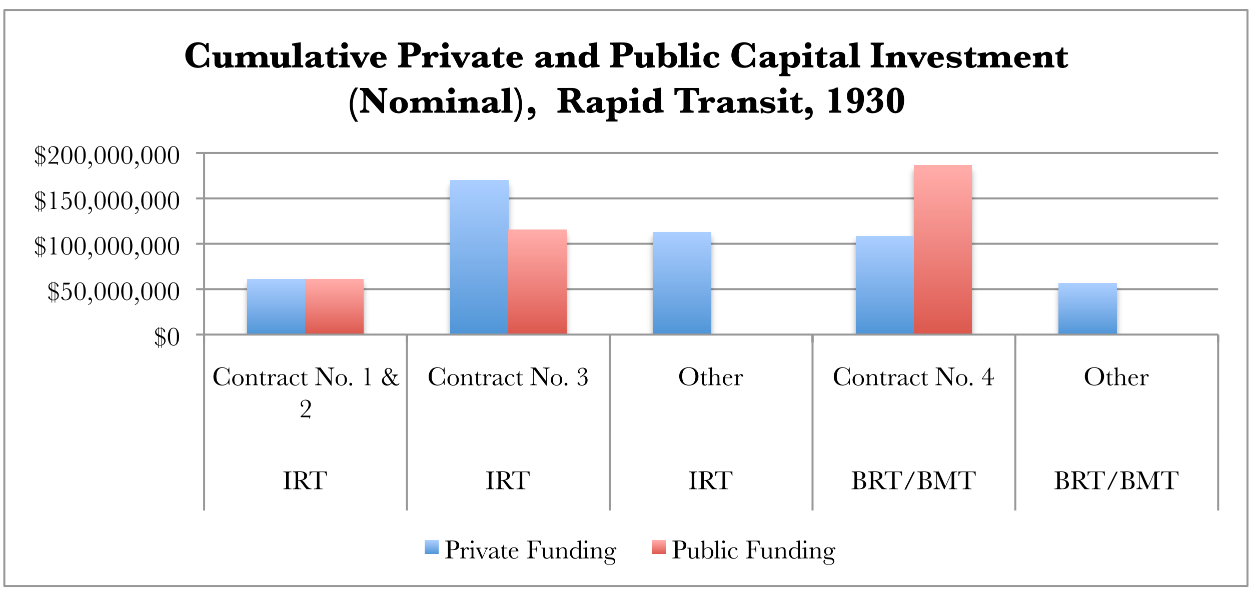


Figure 6.14 *Despite government capital subsidies (no operating subsidies were provided at this time) to fund the subway system, the private companies still paid nearly 60% of the capital costs, in addition to rent and taxes. All data refer to rapid transit in New York City. Excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid.*

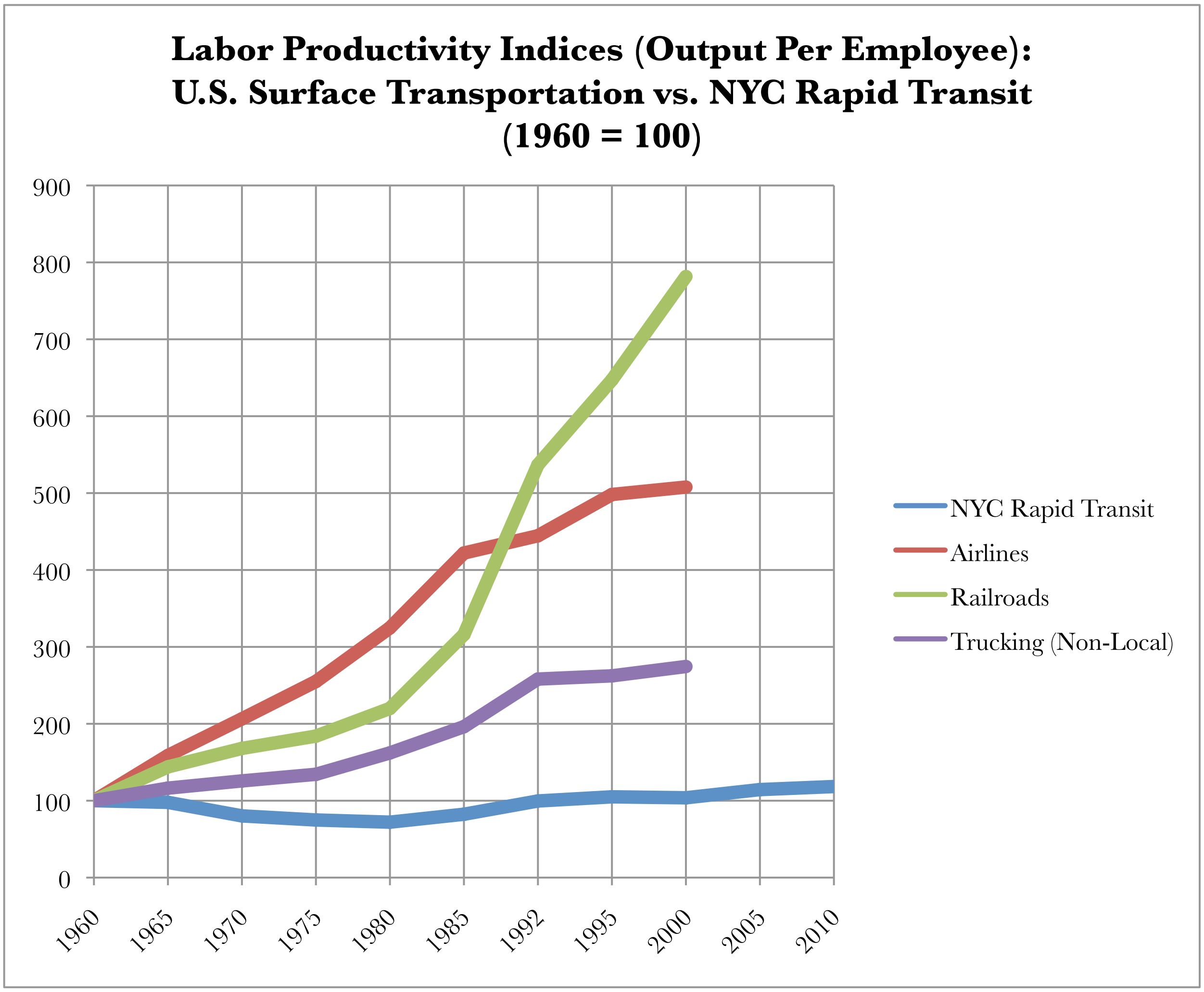


Figure 6.15 *Privately operated (and owned, to a varying degree) modes of surface transportation experienced major productivity gains in recent decades. Rapid transit data excludes streetcar, bus, trolley bus, and other surface modes. Includes Brooklyn, Queens, and the Bronx before municipal consolidation in 1898. Excludes Port Authority Trans-Hudson system, Staten Island Rapid Transit, and AirTrain JFK. See appendix for additional information. Source: ibid. and (United States Bureau of Labor Statistics, 2002, 2012). Irregular years because of limited data. U.S. surface transportation productivity data available from 1960 to 2000.*

In the United States, the private sector already operates the bulk of the transportation network, including ships, barges, airlines, trucks, automobiles, and freight trains. In those modes, efficiency has steadily climbed for decades, particularly for goods movement. As shown in the above chart, while New York's publicly operated rapid transit system experienced flat or declining productivity, privately operated (and owned, to a varying degree) modes of surface transportation made substantial productivity gains (United States Bureau of Labor Statistics, 2002). This also suggests that some form privatization would improve the effectiveness of rapid transit and improve its underlying efficiency.

The subway lacks sustainable funding sources for both operations and capital projects. Private sector participation can be used to help in both areas, and a phased-in privatization program could begin with either one. Not surprisingly, there are many models for using private operators, as rapid transit in New York was privately operated for over 70 years and most modes of transportation are already privately operated. This can be as simple as competitive sourcing, where private firms would be allowed to compete for contracts with the TA's own employees. The scope of the contract work could be widened (depending on the results) as the TA gained experience in managing the process (Savas, 2005; Winston, 2010).

Private sector participation in major capital projects is equally feasible. Competitive sourcing is already the dominant method of building U.S. transportation infrastructure. However, the private sector's role can be expanded to improve the quality of design and construction, to reduce project costs, and to open up new funding sources (Mandri-Perrott, 2010). For example, by combining the design, construction, and operation (for a fixed period, such as 20 years) into one contract, the bidding firms would have a strong incentive to design a rapid transit line that is economical to construct and efficient to operate, and they have a strong incentive to construct it well, in order to reduce operating costs. The more flexibility that is provided to the bidders, the more those firms will be able to innovate and reduce their bids. This model is known as a Design-Build-Operate-Maintain (DBOM) agreement. It was successfully used to construct the AirTrain JFK, an 8.1-mile elevated railway, which opened in 2003, and 70% of the existing subway system (Contract Nos. 1—4) was constructed by this means (New York City Transit Authority, 2012c; Savas, 2005; Winston, 2010).

As this research has also demonstrated, the private sector is willing and able to fund large-scale rapid transit expansion, such as with Contract Nos. 1—4. Although the City contributed real estate and capital funding, in every way possible all of the risk was transferred the IRT and BRT, as discussed earlier. The private firms also contributed most of the capital funding, in addition to paying rent and taxes once the lines were in operation(Fullen et al., 1931; Interborough Rapid Transit Company, 1904; McAneny et al., 1922; Walker, 1918).

Ridership has already returned to 1950 levels. If productivity also returned to 1950 levels, building and operating rapid transit would be extremely profitable (at today's fares), and the price system would trigger correspondingly massive private investment. This would first require removing legal barriers for new firms to enter the rapid transit business (i.e. establishing a process of homesteading or selling property rights below city streets) (Block, 2009; Hakim et al., 1996; Mises, 1949; Roth, 2006; Savas, 2005).

However, attracting private capital requires objective and secure property rights to protect that investment. This is especially important given the high cost and long time scale of rapid transit investment. Attracting private capital also requires a revenue source. This can be extended beyond traditional advertising and farebox revenues by monetizing other value created by transit investment. In addition to the mobility benefits realized by passengers, rapid transit creates substantial positive externalities, which may accrue to passengers and non-passengers alike (Mandri-Perrott, 2010; Yeung, 2008).

Value capture refers to strategies to internalize such positive externalities. Increased property values and real estate development are a major source of value created by rapid transit expansion and improvement. Private firms or public agencies can capture this value (or a major a portion of it) by developing property near transit investments (Mandri-Perrott, 2010; Yeung, 2008).

The City of New York is using value capture to finance a $2.4 billion extension of the No. 7 Subway Line (IRT Flushing Line), which is currently under construction. The subway is being extended into Hudson Yards, on the west side of Midtown Manhattan. Hudson Yards is being developed to allow expansion of the Midtown central business district. This subway extension will increase the value of property in the area, and it will support intense commercial and residential development. For this reason, the City financed the subway extension by creating a Tax Increment Financing (TIF) district in the Hudson Yards area (New York City Department of City Planning, 2012; New York City Transit Authority, 2012a).

Under a TIF, the City sells municipal bonds to pay for the construction of a long-term capital investment within a defined geographic area—the TIF district. Following construction, property values in the TIF district increase, presumably because of the capital investment. Tax revenue from the increased property assessments (over and above the property assessments before the TIF) are used to pay off the bonds. Thus, the development value of the subway extension is captured via local property taxes (Hudson Yards Development Corporation, 2012; New York City Department of City Planning, 2012; New York City Independent Budget Office, 2002; New York City Transit Authority, 2012a).

Value capture can also be applied to the development of air rights directly above rapid transit infrastructure. The MTA Long Island Railroad (LIRR) recently used this form of value capture on another project, which is near the No. 7 Subway Extension. Hudson Yards contains the LIRR's West Side Yard, which is used for train storage and maintenance. In 2008, the MTA leased the development air rights over six blocks of the West Side Yard to a real estate developer for 99 years. The MTA received a financial package worth approximately $1 billion, which the it has used to fund its Capital Program (Brown, 2008; Metropolitan Transportation Authority, 2007).

Private, for-profit firms, in particular, have an incentive to capture as much of the value they create as possible. They can do this by simply owning the property that stands to benefit from transit improvements. Real estate developers, owners of large properties near subway lines, and owners of large properties *without* subway access would likely be attracted to investments in rapid transit expansion and improvement, as they could capture a greater share of the value of rapid transit investments than from farebox and advertising revenue alone (Mandri-Perrott, 2010).

Value capture is not new. In the early 20th century, the New York Central Railroad used its air rights in Midtown Manhattan to privately develop Terminal City, as first conceived by William J. Wilgus. Air rights financed the entire reconstruction of Grand Central Terminal, its underground rail yards, and the electrification of its lines, and it produced decades of profit for the railroad (Schlichting, 2001, 2012).

Other potential rapid transit investors could include manufacturers of railcars, signal systems, and track components. Airlines may be induced to build airport connections, such as to LaGuardia Airport, particularly those with a LaGuardia hub. In fact, tearing down legal barriers to entry and developing a framework of property rights could also be the first step towards privatization. It could be achieved without altering the TA's operations or financial structure, and it would cost relatively little. A private rapid system could then grow up around the static public system, if passengers preferred it (Block, 2009; Hakim et al., 1996; Savas, 2005; Yeung, 2008).

Until a process of homesteading or selling property rights below city streets has been implemented, however, public subsidies will be required, and private contractors (under DBOM or other methods) should receive a lump sum or fixed payment. They should not be entitled to farebox revenue. Until a free and open rapid transit market exists, private franchisees will be unable to plan for competition, aim to charge monopoly prices, and likely oppose future expansion. A crucial failure of the Rapid Transit Act of 1875 was the lack of a (non-political) means of permitting new firms to enter the market. This reduced the incentive to expand and improve service, and the elevated system would have probably otherwise been larger. In the long run, surface transportation should be similarly opened to competition. This would put additional pressure on rapid transit firms to remain effective and efficient, and it would enable better service coordination with buses, taxis, and ferries.

The profit motive stimulates innovation, improved quality, and reduced cost while the price system guides that activity towards the most effective and efficient possible means. However, this incentive will only be effective insofar as firms and individuals are free to compete, meaning they have full rights to acquire, use, and dispose of their property as the owners see fit. Simply transferring rapid transit from the TA to a private company under the same laws and regulations would produce little improvement. For instance, federal labor regulations and collective bargaining agreements make it costly to reorganize service patterns or perform nighttime maintenance work. Meanwhile, environmental and other laws would continue to impede expansion, as discussed above. Thus, another strategy to improve rapid transit is to begin reforming and/or repealing FTA, EPA, and other regulations that presently straightjacket the TA and impede its ability to adapt its operations and expand its network (Hakim et al., 1996; Winston, 2010).

Ultimately, protecting the property rights of private investment means the government must not cap or manipulate the fare. In the long-term, innovation and competition is the best way to reduce the fare. Such manipulation greatly diminished rapid transit's efficiency and effectiveness. The $0.05 fare led to the system's ruin and eventually led to higher real fares.

In the 1870s, the Rapid Transit Commission required half-price fares during the peak period (5:30 a.m.—7:30 a.m. and 5:00 p.m.—7:00 p.m.) to aid the working class. This led to extreme congestion during peak hours and underutilization during off peak hours. By the 1880s, however, the elevateds reduced the fare (which varied from $0.10 to $0.17, depending on distance) to a flat $0.05, due to the companies' internal productivity gains, economies of scale, and the external threat of competition (Cooper, 1874; Seymour, 1881; Walker, 1918).

Counterproductive pricing remains an impediment to the system's efficiency, and the fare is often well below the marginal cost. In particular, firms should be permitted to vary fares with distance and time of day (Hakim et al., 1996; Savas, 2005; Winston, 2010).

If the government wishes to promote equity, it could establish a transit welfare program and provide payments or vouchers directly to the needy. As new franchises were auctioned and as the MTA divested itself rapid transit assets, the proceeds could be dedicated to fund a generous transit welfare program.

Expanded government funding can improve rapid transit in the short-term, perhaps for even more than a decade. In the long-term, however, government subsidies inexorably raise costs. This has also occurred, for example, in housing, higher education, healthcare, agricultural commodities, and housing. Eventually, the activity becomes so inefficient that even massive subsidies are not capable of maintaining quality. While federal capital subsidies encourage greater spending on capital investments, operating subsidies encourage higher spending on labor (Block, 2009; Hakim et al., 1996; Mises, 1949; Winston, 2010).

Rather than being a *response* to declining rapid transit, this research indicates that increasing public control was a *cause* of it. Indeed, there is a substantial body of economic theory supporting the privatization of rapid transit (Block, 2009; Hakim et al., 1996; Hayek, 1944; Lave, 1991; Mises, 1949; Ramsey, 1987; Rand, 1959; Simpson, 2005; Smith, 1776; Winston, 2010). Neoclassical economic theory often treats transit as a special case and supports government subsidies and regulations. However, it rests on several unrealistic assumptions (Adler, 2010; Goodwin et al., 2009; Hall & Lieberman, 2008; O'Sullivan, 2007).

Further evaluation of the advantages and disadvantages of the Rapid Transit Act of 1875 (enabling fully private elevated railways) and the Rapid Transit Act of 1894 (enabling public-private subways) would illustrate how privatization could be successfully structured and implemented. In addition, this would require an examination of major new factors, such as the influences of the Transport Workers Union and the environmental review process.

CONCLUSION

The history of rapid transit in New York illustrates both severe failures and extraordinary successes. An economic analysis of this history—in terms of effectiveness and efficiency—reveals three distinct eras: 1870 to 1940, characterized by unparalleled expansion and improvement; 1940 to 1980, characterized by stagnation and decline; and 1980 to 2010, characterized by stabilization and rejuvenation.

Rapid transit's rise (1870—1940) and fall (1940—1980) were astonishing in magnitude and unambiguous in direction, both in terms of effectiveness and efficiency. The success experienced in the last era (1980—2010), however, was neither as dramatic as the first era nor as clear in its overall direction. By most measures, the system's effectiveness has not reached its prewar peak, but it is getting close. Meanwhile, the system's efficiency has not materially improved and remains only a fraction of the prewar peak. The system's relative inefficiency could be the greatest threat to a continued increase in effectiveness, including recently begun Network Expansion projects.

Although they do not prove causation, the data support several conclusions. These imply key factors in building and operating better rapid transit. First, the data corroborates the indispensability of rapid transit to New York. The condition of rapid transit depends on the condition of New York, but the reverse is also true. At times, rapid transit has fueled the city's growth and, at other times, accelerated its decline.

Second, it indicates that the system is presently on an unsustainable path. On balance, efficiency has steadily declined since 1940, and rising labor costs have been the main factor. Costs (per passenger and per revenue car mile) have risen faster than inflation across the board—labor, interest, overhead, capital, and other costs. Since at least 2000, rising capital costs have also begun to dampen efficiency. This endangers recent gains in effectiveness and the long overdue but fragile Network Expansion program. Linking wages and benefits to productivity and reforming the environmental review process are potential short-term solutions.

Third, the data implies that—in the long-term—the best means of achieving effective and efficient rapid transit is via government establishment and protection of objective, secure, and just property rights for private ownership and operation. Unification marked the reversal of a positive, long-term trend, and the subsequent decline cannot be entirely attributed to external conditions. The turnaround achieved by the public sector since 1980 has been costly and is not sustainable in its current form. Some form of privatization could improve both effectiveness and efficiency. This would require a suitable framework of property rights—the transmission belt between the public and private sectors. In a fully privatized rapid transit system, the sale of underground property rights and of existing assets could be dedicated to a transit welfare fund for low-income passengers, to alleviate concerns of social equity.

In addition to a reevaluation of relevant political and economic theory, an examination of previous rapid transit legislation, financial terms, contracts, and other arrangements between the City of New York, the State of New York, and the private subway and elevated railway firms would suggest how to successfully structure and implement privatization.

APPENDIX

ECONOMIC AND POLITICAL THEORY

Rapid transit is a service that is produced, distributed, and consumed. There is a market for transit. It can be understood as an economic entity and analyzed in the framework of economic theory. However, the economics of rapid transit (and all goods and services) are shaped by the surrounding political system. Economic theory is closely related to the political theory upon which it rests (implicitly or explicitly). Because the evolving role of government is a central aspect of understanding the successes and failures of rapid transit, both economic and political theories are applicable, but this brief discussion does not endeavor to make a fine distinction between the two.

The literature on economic theory does not consistently explain the past and present failures and successes of rapid transit. The central debate is over what the respective functions of the public and private sectors should be. The data discussed above suggests that expanding the private sector's role would improve the effectiveness and efficiency of rapid transit. However, economists point in many conflicting directions. In general, the arguments can be classified according to whether they support a larger role for government or a smaller role.

Neoclassical Economics

The economic arguments for greater government control, whether in the form of regulation, subsidies, or government ownership, center around the identification of market failures. This view is articulated by the theory of neoclassical economics, which is the dominant school of thought in economics today (Goodwin et al., 2009).

Neoclassical economics begins with an idealized model of profit-maximizing firms and utility-maximizing households. Economic actors are rational, and they make exchanges in perfectly competitive markets. In a perfectly competitive market, there are many buyers and sellers, firms produce identical products, there are no barriers to entry, everyone has perfect information, and firms cannot influence the price. Such a model is Pareto efficient—no action can be taken to make at least one person better off without someone else (Hall & Lieberman, 2008).

Market failure occurs when markets in the real world deviate from this perfectly competitive model. That is, market failure exists when markets yield inefficient outcomes. The role of government is to prevent or correct market failures. Government intervention may be in the form of taxes, subsidies, or regulations. Indeed, given the strict assumptions underlying perfectly competitive markets, market failures are common and several types of market failures are attributed to the markets for rapid transit service (Goodwin et al., 2009; Gwilliam, 2008; Mees, 2010).

For example, rapid transit has characteristics of a "public good" because (without government intervention) some people indirectly benefit from transit without paying for it and because a less-than-full train can accommodate additional passengers at almost no additional (marginal) cost. Because of the "free riders" and because a private firm will charge higher than the marginal cost, neoclassical theory suggests that not enough rapid transit will be provided without government subsidies (O'Sullivan, 2007).

Rapid transit leads to market failure in other ways. Rapid transit possesses significant scale economies, which naturally reduces the number of firms providing transit and leads to monopolies. In addition, network externalities, cream skimming, and transaction costs are also argued to prevent free markets from providing rapid transit efficiently (Simpson, 2005).

These market failures lead most neoclassical economists to conclude that government intervention can improve the efficiency of rapid transit in several key ways. Rapid transit should (1) be subsidized to increase the supply above the free market level, (2) be regulated and subsidized to set the fare below the free market level, and (3) be required to provide service along a network planned by the government (and using cross-subsidies to create a network that is more efficient overall) (Gwilliam, 2008; Mees, 2010).

However, within neoclassical economics, there are many different views on the precise nature and extent of government involvement. For example, some argue that direct government operation of rapid transit is most efficient, owing to the high transaction costs involved in contracting with and supervising private operators in a highly regulated industry (Goodwin et al., 2009).

Austrian Economics

The theories advocating greater private control, whether in the form of deregulation, public-private partnerships, franchises, or private ownership, emphasize the protection of individual rights, especially private property rights. The school of Austrian economics is the most consistent proponent of this view (Mises, 1949).

Austrian economics argues for a system in which the government protects individual rights, including property rights, but otherwise leaves economic actors free to pursue their own self-interest. Under this system, all property is privately owned, all market transactions are voluntary, and the initiation of physical force (including fraud) is banned from human activities. Property rights guarantee that an individual will be able to keep what one has produced (Mises, 1949).

The division of labor creates enormous value through voluntary trade, and it enables the multiplication of society's knowledge. The profit motive incentivizes people to produce goods and services, and the price system coordinates the activities of firms and individuals across the economy (Block, 2009; Simpson, 2005).

Austrian economics views competition as a rivalrous process in which participants seek to surpass their competitors. In their view, the neoclassical model of perfect competition actually represents the absence of competition. This is because under perfect competition firms do not compete to differentiate their products (all products are identical), they do not compete to gain economies of scale and reduce costs (there must be many sellers and firms cannot influence the price), and they do not compete to gain or spread information (everyone has perfect information) (Simpson, 2005).

According to the Austrian view, rapid transit may produce "limited-space monopolies", which result from the fact that the physical conditions restrict the field of operation such that only one or a few firms can provide service on the same street, for example. Monopolies, however, do not necessarily mean monopoly prices. Moreover, monopolies do not necessarily mean an absence of competition. In fact, in the unhampered market economy, only an intensely competitive firm can create and sustain even a partial monopoly (Mises, 1949).

In this sense, there is nothing unique about rapid transit. Just like any other economic good or service, Austrian economists conclude that rapid transit should be privately owned and controlled, and the most efficient and dynamic system of rapid transit can be achieved by protecting the property rights of peaceful market participants. This includes allowing and protecting the property rights of new competitors who would build over, under, and around existing rapid transit firms (Block, 2009).

Other Economics

There are many other theories of economics, such as Marxist economics, institutionalist economics, feminist economics, post-Keynesian economics, and others. However, neoclassical and Austrian economics seem to be the most relevant to the economic history of New York's rapid transit.

Ethical and Philosophical Theory

This research deliberately focused on economic issues. The economic debate over public versus private control of rapid transit, however, is a microcosm of the *political* debate over socialism versus capitalism and the *ethical* debate over altruism vs. egoism. Ultimately, economic ideas rest on more fundamental philosophical ideas. For example, egalitarianism and altruism form the ethical basis of the ideal of perfect competition. Likewise, the ideal of private property rights is based on an ethics of rational egoism and individualism (Marx & Engels, 1850; Rand, 1959). Thus, the economic arguments over rapid transit can also be criticized and defended at a more fundamental level, but that is beyond the scope of this paper.

DATA—EXPENSES, CAPITAL ASSETS, AND FARES

Principal Entities Operating Rapid Transit in New York City[15]

			REAL FIGURES (CONSTANT 2011 DOLLARS)								
Year	Operating Firm / Agency	Price Level Multiplier	Labor Cost		Total Annual Cost		Capital Assets in Operation		Fare		Source
1871	WSE	18.38			$ 146,901				$ 1.84		Sweet, 1872
1873	NYE	18.76			$ 1,426,694		$ 28,145,833		$ 1.88	i	Cooper, 1874
1875	NYE	20.47			$ 1,808,948		$ 29,820,398		$ 2.05	i	Greene, 1876
1880	MRC	21.97	$ 39,239,169		$ 112,106,266		$ 285,663,985		$ 2.20	j	Seymour, 1881
1881	MRC	21.97			$ 131,019,804		$ 285,687,073		$ 2.20	i	Seymour, 1882
1889	MRC	24.34	$ 74,671,352		$ 204,633,244		$ 677,537,089		$ 1.22		Rogers, 1890
1889	BER	24.34	$ 11,684,909		$ 27,113,669		$ 236,768,982		$ 1.22		Rogers, 1890
1889	KCE	24.34	$ 7,940,034		$ 15,050,797		$ 212,096,022		$ 1.22		Rogers, 1890
1889	SRT	24.34	$ 1,950,722		$ 3,512,357		$ 38,306,205		$ 1.22		Rogers, 1890
1896	MRC	26.75	$ 98,327,225		$ 272,108,923		$ 1,548,758,872		$ 1.34		Beardsley, 1897
1896	BER	26.75	$ 18,907,419		$ 52,501,251		$ 711,474,749		$ 1.34		Beardsley, 1897
1896	KCE	26.75	$ 9,333,564		$ 28,833,443		$ 392,613,334		$ 1.34		Beardsley, 1897
1903	IRT	25.49	$ 94,418,484		$ 286,988,291		$ 2,176,928,370		$ 1.27	k	Dunn, 1904
1903	BUE	25.49	$ 36,227,675	m	$ 86,267,047	m	$ 1,088,255,736		$ 1.27		Dunn, 1904
1906	IRT	25.02	$ 84,834,044		$ 503,615,397		$ 2,915,032,335		$ 1.25	k	Dunn, 1907
1906	BUE	25.02	$ 63,436,995	m	$ 101,105,955	m	$ 1,172,535,727		$ 1.25		Dunn, 1907
1911	IRT	23.70	$ 110,902,646	m	$ 658,371,074		$ 4,795,809,190		$ 1.19		Shonts, 1911
1911	BRT	23.70	$ 69,085,054	m	$ 199,776,916	m	$ 1,171,216,594	m	$ 1.19		Williams, 1911
1915	IRT	22.33			$ 722,734,935		$ 5,512,410,359		$ 1.12		Shonts, 1915
1915	BRT	22.33			$ 207,039,315	m	$ 1,481,592,840	m	$ 1.12		Williams, 1915
1921	IRT	12.63			$ 720,515,724		$ 5,761,492,946		$ 0.63		Hedley, 1921
1921	BRT	12.63			$ 350,665,838		$ 3,269,572,903		$ 0.63		BRT, 1921
1925	IRT	12.87	$ 299,070,793	a	$ 665,972,130		$ 6,159,066,051		$ 0.64		McAneny, 1926
1925	BMT	12.87	$ 130,705,519	a	$ 361,912,699		$ 3,797,112,057		$ 0.64		McAneny, 1926
1930	IRT	13.51	$ 449,117,659		$ 928,770,268		$ 7,027,020,459		$ 0.68		Fullen, 1931
1930	BMT	13.51	$ 174,041,981		$ 487,493,516		$ 4,743,360,284		$ 0.68		Fullen, 1931
1935	IRT	16.48			$ 926,145,626		$ 8,640,320,516		$ 0.82		Fullen, 1936
1935	BMT	16.48			$ 506,743,493		$ 6,167,937,679		$ 0.82		Fullen, 1936
1935	IND	16.48			$ 558,736,220	c	$ 8,874,545,083	e	$ 0.82		Fullen, 1936
1939	IRT	16.28	$ 471,341,014		$ 857,564,260		$ 8,359,758,232		$ 0.81		Fullen, 1942
1939	BMT	16.28	$ 246,703,314	b	$ 433,433,875		$ 6,175,149,514		$ 0.81		Fullen, 1942
1939	IND	16.28	$ 161,095,665		$ 818,497,589	c	$ 11,532,101,183		$ 0.81		Delaney, 1939
1940	BOT	16.08	$ 973,667,501		$ 2,412,579,551	c	$ 18,901,742,297	f	$ 0.80		Daly, 1941
1946	BOT	11.60	$ 857,919,109	m	$ 1,814,205,867	c,m	$ 12,969,210,417	m	$ 0.58		Reid, 1949
1949	BOT	9.48	$ 1,043,438,618	m	$ 1,853,192,002	c,m	$ 9,681,397,683	m	$ 0.95		Reid, 1949
1954	NYCTA	8.42	$ 1,343,156,319	m	$ 2,446,985,913	m	$ 11,400,631,503	m	$ 1.26		NYCTA, 1954
1960	NYCTA	7.63	$ 1,276,610,536		$ 2,314,713,948	d		g	$ 1.14		NYCTA, 1960
1967	NYCTA	6.77	$ 1,830,184,172		$ 3,115,370,713	d		g	$ 1.35		NYCTA, 1967
1970	NYCTA	5.82	$ 2,215,140,260	m	$ 3,649,192,398	d,m		g	$ 1.75		MTA, 1971
1976	NYCTA	3.97	$ 2,634,539,400	m	$ 4,467,654,716	d,m		g	$ 1.99		Fisher, 1977
1980	NYCTA	2.75	$ 2,214,066,552	m	$ 3,755,902,102	d,m		g	$ 1.65		Ravitch, 1980
1985	NYCTA	2.10	$ 1,897,885,558	m	$ 2,789,139,822		$ 4,266,986,424	h,m	$ 1.89		Kiley, 1986
1992	NYCTA	1.61	$ 1,866,011,483	m	$ 2,898,014,107		$ 14,977,086,207	m	$ 2.02		MTA, 1993
1995	NYCTA	1.48	$ 2,345,403,392	m	$ 4,029,737,041		$ 27,472,670,912	m	$ 2.23		Conway, 1996
2000	NYCTA	1.31	$ 2,222,246,597	m	$ 4,280,519,589	m	$ 28,126,677,200	m	$ 1.97		MTA, 2001
2005	NYCTA	1.16	$ 2,502,924,748	m	$ 5,541,320,008	m	$ 38,234,226,532	m	$ 2.32		MTA, 2006
2010	NYCTA	1.04	$ 3,318,937,341	m	$ 7,093,703,082	m	$ 48,969,080,645	m	$ 2.33		Foran, 2011

15 See notes to data.

DATA—EXPENSES, CAPITAL ASSETS, AND FARES

Principal Entities Operating Rapid Transit in New York City[16]

		NOMINAL FIGURES								
Year	Operating Firm / Agency	Labor Cost		Total Annual Cost		Capital Assets in Operation		Fare		Source
1871	WSE			$ 7,992				$ 0.10		Sweet, 1872
1873	NYE			$ 76,034		$ 1,500,000		$ 0.10	i	Cooper, 1874
1875	NYE			$ 88,372		$ 1,456,807		$ 0.10	i	Greene, 1876
1880	MRC	$ 1,786,239		$ 5,103,283		$ 13,003,949		$ 0.10	j	Seymour, 1881
1881	MRC			$ 5,964,262		$ 13,005,000		$ 0.10	i	Seymour, 1882
1889	MRC	$ 3,067,550		$ 8,406,473		$ 27,833,685		$ 0.05		Rogers, 1890
1889	BER	$ 480,024		$ 1,113,848		$ 9,726,631		$ 0.05		Rogers, 1890
1889	KCE	$ 326,182		$ 618,297		$ 8,713,049		$ 0.05		Rogers, 1890
1889	SRT	$ 80,137		$ 144,290		$ 1,573,645		$ 0.05		Rogers, 1890
1896	MRC	$ 3,675,444		$ 10,171,355		$ 57,892,171		$ 0.05		Beardsley, 1897
1896	BER	$ 706,754		$ 1,962,482		$ 26,594,726		$ 0.05		Beardsley, 1897
1896	KCE	$ 348,886		$ 1,077,786		$ 14,675,776		$ 0.05		Beardsley, 1897
1903	IRT	$ 3,704,056		$ 11,258,608		$ 85,401,335		$ 0.05	k	Dunn, 1904
1903	BUE	$ 1,421,219	m	$ 3,384,274	m	$ 42,692,490		$ 0.05		Dunn, 1904
1906	IRT	$ 3,390,850		$ 20,129,705		$ 116,514,986		$ 0.05	k	Dunn, 1907
1906	BUE	$ 2,535,602	m	$ 4,041,245	m	$ 46,866,713		$ 0.05		Dunn, 1907
1911	IRT	$ 4,679,090	m	$ 27,777,314		$ 202,339,840		$ 0.05		Shonts, 1911
1911	BRT	$ 2,914,765	m	$ 8,428,782	m	$ 49,414,764	m	$ 0.05		Williams, 1911
1915	IRT			$ 32,365,258		$ 246,854,794		$ 0.05		Shonts, 1915
1915	BRT			$ 9,271,561	m	$ 66,348,162	m	$ 0.05		Williams, 1915
1921	IRT			$ 57,065,272		$ 456,313,653		$ 0.05		Hedley, 1921
1921	BRT			$ 27,772,942		$ 258,952,110		$ 0.05		BRT, 1921
1925	IRT	$ 23,243,844	a	$ 51,759,492		$ 478,683,890		$ 0.05		McAneny, 1926
1925	BMT	$ 10,158,460	a	$ 28,127,930		$ 295,112,336		$ 0.05		McAneny, 1926
1930	IRT	$ 33,243,350		$ 68,746,874		$ 520,134,749		$ 0.05		Fullen, 1931
1930	BMT	$ 12,882,456		$ 36,083,902		$ 351,099,947		$ 0.05		Fullen, 1931
1935	IRT			$ 56,213,132		$ 524,431,001		$ 0.05		Fullen, 1936
1935	BMT			$ 30,757,192		$ 374,367,794		$ 0.05		Fullen, 1936
1935	IND			$ 33,912,931	c	$ 538,647,444	e	$ 0.05		Fullen, 1936
1939	IRT	$ 28,957,294		$ 52,685,295		$ 513,589,884		$ 0.05		Fullen, 1942
1939	BMT	$ 15,156,458	b	$ 26,628,432		$ 379,376,321		$ 0.05		Fullen, 1942
1939	IND	$ 9,897,069		$ 50,285,196	c	$ 708,485,861		$ 0.05		Delaney, 1939
1940	BOT	$ 60,538,912		$ 150,004,946	c	$ 1,175,237,863	f	$ 0.05		Daly, 1941
1946	BOT	$ 73,980,441	m	$ 156,443,363	c,m	$ 1,118,366,405	m	$ 0.05		Reid, 1949
1949	BOT	$ 110,059,218	m	$ 195,469,919	c,m	$ 1,021,168,890	m	$ 0.10		Reid, 1949
1954	NYCTA	$ 159,568,164	m	$ 290,704,100	m	$ 1,354,405,149	m	$ 0.15		NYCTA, 1954
1960	NYCTA	$ 167,253,934		$ 303,260,081	d		g	$ 0.15		NYCTA, 1960
1967	NYCTA	$ 270,260,357		$ 460,041,789	d		g	$ 0.20		NYCTA, 1967
1970	NYCTA	$ 380,394,182	m	$ 626,656,282	d,m		g	$ 0.30		MTA, 1971
1976	NYCTA	$ 663,022,499	m	$ 1,124,354,259	d,m		g	$ 0.50		Fisher, 1977
1980	NYCTA	$ 806,306,990	m	$ 1,367,804,466	d,m		g	$ 0.60		Ravitch, 1980
1985	NYCTA	$ 903,286,761	m	$ 1,327,473,653		$ 2,030,845,500	h,m	$ 0.90		Kiley, 1986
1992	NYCTA	$ 1,157,451,978	m	$ 1,797,583,880		$ 9,290,006,100	m	$ 1.25		MTA, 1993
1995	NYCTA	$ 1,580,673,419	m	$ 2,715,822,040		$ 18,515,075,400	m	$ 1.50		Conway, 1996
2000	NYCTA	$ 1,691,769,522	m	$ 3,258,707,918	m	$ 21,412,500,000	m	$ 1.50		MTA, 2001
2005	NYCTA	$ 2,161,111,561	m	$ 4,784,566,832	m	$ 33,012,750,000	m	$ 2.00		MTA, 2006
2010	NYCTA	$ 3,198,561,375	m	$ 6,836,418,514	m	$ 47,193,000,000	m	$ 2.25		Foran, 2011

16 See notes to data.

NOTES TO DATA—EXPENSES, CAPITAL ASSETS, AND FARES

General Notes

1. All figures refer to heavy rail rapid transit operations only. Commuter rail, streetcar, bus, trolley bus, and other surface modes are excluded.
2. Figures exclude PATH, SIRTOA, AirTrain JFK, and Coney Island excursion steam lines
3. Except as noted above, figures include all rapid transit operating within the present-day New York City boundary, including Brooklyn, Queens, and the Bronx.
4. Figures do not consider external costs.
5. Identified firms and agencies *operated* rapid transit. Parent firms, construction firms, holding corporations, subsidiaries, and special purpose entities are not identified, but relevant data is incorporated.
6. Price Level Multiplier converts current nominal dollars to constant 2011 dollars. Derived from price level indices; 1870 to 1912 from Lindert (2006); 1913 to 2011 from U.S. Bureau of Labor Statistics (2011).
7. Endeavored to obtain data at five year intervals; data points are 4.5 years apart on average. Irregular years due to availability of data.
8. Total Annual Cost includes all fixed and variable costs such as depreciation, interest, dividends, labor, taxes, operating expenses, overhead, etc.
9. Capital Assets in Operation include cost of real estate, right-of-way, construction, track, equipment, etc.
10. Grey cells indicate data was unavailable or not reported.

Referenced Notes

a. Annualized from weekly earnings.
b. Adjusted to exclude Brooklyn and Queens Transit Corporation and subsidiaries.
c. Interest and amortization/depreciation (paid by City) estimated at 5.0% of capital in operation (3% in interest and 2% in depreciation).
d. Interest and amortization/depreciation (paid by City) estimated at 42% of operating expenses (1954 level);15% amortization/depreciation, 27% interest.
e. Average of as of December 31, 1934 and as of June 30, 1936.
f. Estimate; calculated as cost of IND plus price paid for IRT and BMT
g. Capital assets recorded on City's books from approximately 1960 to 1981. No depreciation being charged to TA; depreciation estimated as indicated in note d.
h. Capital improvements began being recorded on NYCTA and MTA books in 1982.
i. Fare was $0.05 for children under eight years old.
j. Fare was $0.05 from 5:30-7:30am, and 5:00-7:00pm.
k. Fare was $0.05 at all times/distances, except $0.04 fare for passengers transferring to/from 3rd Avenue surface lines.
l. —
m. Cost adjusted to exclude non rapid transit costs (e.g. streetcar costs, bus costs, etc.).

DATA—EXPENSE CLASSIFICATION

Principal Entities Operating Rapid Transit in New York City[17]

NOMINAL FIGURES

Year	Operating Firm / Agency	Stated Operating Expenses	Labor Cost	Rent of Railway and Equipment	Depreciation & Amortization	Interest	Dividends
1880	MRC	$ 2,236,801	$ 1,786,239	$ 11,000	$ -	$ 1,138,958	$ 1,300,000
1910	IRT	$ 12,368,981	$ 4,679,090 a	$ 16,909	$ 31,269	$ 11,617,797	$ 4,200,000
1910	BRT	$ 4,773,236	$ 2,914,765 a	$ 554,773	$ 41,433 a	$ 1,604,491 a	$ 879,875 a
1930	IRT	$ 45,401,437	$ 33,243,350	$ 7,459,892	$ 52,500	$ 11,526,511	$ 2,836,599 c
1930	BMT	$ 22,915,511	$ 12,882,456	$ -	$ 320,000	$ 6,565,483	$ 4,524,160
1950	BOT	$ 144,411,474	$ 110,059,218 a	$ -	$ 2,149,847 a	$ 42,916,346 a	$ -
1980	NYCTA	$ 1,042,095,986	$ 806,306,990 a	$ 11,899,086	$ 144,486,387 a,b	$ 260,075,497 a,b	$ -
2010	NYCTA	$ 6,043,669,575	$ 3,198,561,375 a	$ -	$ 1,500,000,000 a	$ 792,748,939 a	$ -

NOMINAL FIGURES (CONTINUED)

Year	Operating Firm / Agency	Taxes	Other Costs	Total Annual Cost	Capital Assets in Operation	Accumulated Depreciation
1880	MRC	$ -	$ 867,086	$ 5,103,283	$ 13,003,949	
1910	IRT	$ 1,925,090	$ 5,307,159	$ 27,777,314	$ 202,339,840	
1910	BRT	$ 574,974	$ 1,858,471	$ 8,428,782 a	$ 49,414,764 a	
1930	IRT	$ 2,522,435	$ 11,105,587	$ 68,746,874	$ 520,134,749	
1930	BMT	$ 2,078,748	$ 9,713,055	$ 36,083,902	$ 351,099,947	
1950	BOT	$ -	$ 40,344,508	$ 195,469,919 a,d	$ 1,021,168,890 a,e	
1980	NYCTA	$ -	$ 145,036,506	$ 1,367,804,466 a,b		
2010	NYCTA	$ -	$ 1,345,108,201	$ 6,836,418,514 a	$ 47,193,000,000 a	$ (16,716,000,000) a

17 See notes to data.

NOTES TO DATA—EXPENSE CLASSIFICATION

<u>*General Notes*</u>

1. All figures in nominal term, not inflation-adjusted.
2. All figures refer to heavy rail rapid transit operations only. Commuter rail, streetcar, bus, trolley bus, and other surface modes are excluded.
3. Figures exclude PATH, SIRTOA, AirTrain JFK, and Coney Island excursion steam lines
4. Except as noted above, figures include all rapid transit operating within the present-day New York City boundary, including Brooklyn, Queens, and the Bronx.
5. Identified firms and agencies *operated* rapid transit. Parent firms, construction firms, holding corporations, subsidiaries, and special purpose entities are not identified, but relevant data is incorporated.
6. Total Annual Cost includes all fixed and variable costs such as depreciation, interest, dividends, labor, taxes, operating expenses, overhead, etc.
7. Capital Assets in Operation include cost of real estate, right-of-way, construction, track, equipment, etc.
8. Other Costs include maintenance, fuel, electricity, materials & supplies, insurance, legal, office, and overhead.
9. Grey cells indicate data was unavailable or not reported.

<u>*Referenced Notes*</u>

a. Cost adjusted to exclude non rapid transit costs (e.g. streetcar costs, bus costs, etc.).
b. Interest and amortization/depreciation (paid by City) estimated at 42% of operating expenses (1954 level);15% amortization/depreciation, 27% interest.
c. Dividends for Manhattan Railway Company, subsidiary of IRT.
d. Interest and amortization/depreciation (paid by City) estimated at 5.0% of capital in operation (3% in interest and 2% in depreciation).
e. Figures are for 1949.

DATA—EFFECTIVENESS, NETWORK, OPERATIONS, AND EQUIPMENT

Principal Entities Operating Rapid Transit in New York City[18]

Year	Operating Firm / Agency	Route Miles	Running Track Miles	Passenger Trips	Revenue Train Miles	Revenue Car Miles	No. of Employees	No. of Passenger Locomotives	No. of Passenger Cars / EMUs	Source
1871	WSE	3.4	3.7	53,912				1	3	Sweet, 1872
1873	NYE	4.0	4.2	644,025				4	8	Cooper, 1874
1875	NYE	4.0	4.4	920,571				8	16	Greene, 1876
1880	MRC	32.4	79.4	60,831,757	5,484,523	19,195,831	2,975	198	522	Seymour, 1881
1881	MRC	32.4	79.5	75,585,778	6,117,238	21,410,333			596	Seymour, 1882
1889	MRC	32.4	90.1	179,497,433	7,661,713	30,646,852	4,726	291	921	Rogers, 1890
1889	BER	17.1	34.8	21,486,939	2,044,561	5,111,403	783	76	210	Rogers, 1890
1889	KCE	5.9	13.5	12,640,420	936,124	2,808,372	500	42	130	Rogers, 1890
1889	SRT	3.2	7.2	3,327,740	399,308	798,616	139	13	26	Rogers, 1890
1896	MRC	36.1	102.3	184,769,098	9,827,702	39,310,808	5,424	334	1,123	Beardsley, 1897
1896	BER	16.9	34.7	35,575,514	3,383,813	10,151,439	1,122	95	286	Beardsley, 1897
1896	KCE	8.3	21.7	14,825,306	1,452,743	4,358,229	559	44	145	Beardsley, 1897
1903	IRT	36.8	119.3	264,421,744	11,262,061	60,401,656	5,668	179	1,501	Dunn, 1904
1903	BUE	38.6	92.1	87,409,475 a		14,156,063 a	2,262 a	120	650	Dunn, 1904
1906	IRT	59.5	189.5	395,716,386		93,654,185	5,189 a	-	2,318	Dunn, 1907
1906	BUE	37.0	90.5	111,401,960 a		15,947,513 a	3,818 a	-	818 a	Dunn, 1907
1911	IRT	63.4	203.3	578,154,088		118,405,957	6,444 a	-	2,877	Shonts, 1911
1911	BRT	32.6	71.3	224,366,482 a		31,237,281 a	3,950 a	-		Williams, 1911
1915	IRT	64.9	205.9	647,378,266		132,583,069		-	2,927	Shonts, 1915
1915	BRT	61.1	160.4	247,261,922 a		33,302,920 a		-		Williams, 1915
1921	IRT	114.7	348.6	1,013,678,831		175,363,179		-	4,148	Hedley, 1921
1921	BRT	90.2	244.4	404,970,640		55,372,070		-	1,658	BRT, 1921
1925	IRT	114.8	347.7	1,089,544,225		193,009,847	12,729	-	4,405	McAneny, 1926
1925	BMT	95.6	265.7	591,256,029		81,259,824	5,719	-	1,855	McAneny, 1926
1930	IRT	117.5	356.6	1,334,110,909		243,526,472	18,358	-	4,449	Fullen, 1931
1930	BMT	99.5	273.3	714,433,616		104,421,028	7,017	-	1,845	Fullen, 1931
1935	IRT	117.2	355.7	1,015,717,127		226,182,245	14,332	-	4,438	Fullen, 1936
1935	BMT	100.8	276.6	598,231,061		99,149,276	5,965	-	1,826	Fullen, 1936
1935	IND	34.0	120.3	202,975,574		35,287,802		-	800	Fullen, 1936
1939	IRT	112.1	344.8	926,266,154		210,759,008	15,389	-	4,332	Fullen, 1942
1939	BMT	100.8	276.1	543,050,814		97,377,365	8,214 b	-	1,819	Fullen, 1942
1939	IND	52.3	180.7	383,627,489		75,364,266	6,875 c	-	1,547	Delaney, 1939
1940	BOT	267.5	808.4	1,842,675,316		381,375,253	32,525	-		Daly, 1941
1946	BOT	238.1	749.6	2,067,227,010		341,260,630 a	28,599 a	-		Reid, 1949
1949	BOT	241.6	738.4	1,721,554,350		320,139,068 a	29,856 a	-	6,868	Reid, 1949
1954	NYCTA	236.2	726.3	1,416,371,403		284,496,250 a	32,711 a	-	6,575	NYCTA, 1954
1960	NYCTA			1,344,952,725		305,570,184	26,026 a	-	6,566	NYCTA, 1960
1967	NYCTA			1,298,484,890		316,263,593	27,533 a	-		NYCTA, 1967
1970	NYCTA	237.0		1,257,569,000		306,297,973	32,514 a	-	6,919	MTA, 1971
1976	NYCTA			1,010,497,000		252,936,102	28,761 a	-		Fisher, 1977
1980	NYCTA			1,009,333,000		252,644,743	29,854 a	-		Ravitch, 1980
1985	NYCTA	230.0		1,010,210,633		275,302,947	28,462	-	6,136	Kiley, 1986
1992	NYCTA	233.0		996,802,847		304,702,762	26,050	-	5,908	MTA, 1993
1995	NYCTA	233.0	656.0	1,092,796,601		311,723,272	25,282	-	5,806	Conway, 1996
2000	NYCTA	233.0	656.0	1,381,078,913		323,176,760	26,521	-	5,807	MTA, 2001
2005	NYCTA	233.0	659.0	1,453,000,000		339,000,000	25,229	-	6,285	MTA, 2006
2010	NYCTA	232.0	659.0	1,604,198,017		362,459,000	26,077	-	6,374	Foran, 2011

[18] See notes to data.

NOTES TO DATA—EFFECTIVENESS, NETWORK, OPERATIONS, AND EQUIPMENT

General Notes

1. All figures refer to heavy rail rapid transit operations only. Commuter rail, streetcar, bus, trolley bus, and other surface modes are excluded.
2. Figures exclude PATH, SIRTOA, AirTrain JFK, and Coney Island excursion steam lines
3. Except as noted above, figures include all rapid transit operating within the present-day New York City boundary, including Brooklyn, Queens, and the Bronx.
4. Identified firms and agencies *operated* rapid transit. Parent firms, construction firms, holding corporations, subsidiaries, and special purpose entities are not identified, but relevant data is incorporated.
5. Endeavored to obtain data at five year intervals; data points are 4.5 years apart on average. Irregular years due to availability of data.
6. Running Track Miles exclude rail yards.
7. Grey cells indicate data was unavailable or not reported.

Referenced Notes

a. Figures adjusted to exclude non rapid transit data (e.g. streetcar data, bus data, etc.).
b. Adjusted to exclude Brooklyn and Queens Transit Corporation and subsidiaries.
c. Figure is for 1940.

DATA—EFFICIENCY AND PRODUCTIVITY

Principal Entities Operating Rapid Transit in New York City[19]

			REAL FIGURES (CONSTANT 2011 DOLLARS)					
Year	Operating Firm / Agency	Price Level Multiplier	Cost Per Passenger Trip	Cost Per Revenue Car Mile	Cost Per Employee	Revenue Car Miles Per Employee	Passenger Trips Per Employee	Source
1871	WSE	18.38	$ 2.72					Sweet, 1872
1873	NYE	18.76	$ 2.22					Cooper, 1874
1875	NYE	20.47	$ 1.97					Greene, 1876
1880	MRC	21.97	$ 1.84	$ 5.84	$ 13,190	6,452	20,448	Seymour, 1881
1881	MRC	21.97	$ 1.73	$ 6.12				Seymour, 1882
1889	MRC	24.34	$ 1.14	$ 6.68	$ 15,800	6,485	37,981	Rogers, 1890
1889	BER	24.34	$ 1.26	$ 5.30	$ 14,923	6,528	27,442	Rogers, 1890
1889	KCE	24.34	$ 1.19	$ 5.36	$ 15,880	5,617	25,281	Rogers, 1890
1889	SRT	24.34	$ 1.06	$ 4.40	$ 14,034	5,745	23,941	Rogers, 1890
1896	MRC	26.75	$ 1.47	$ 6.92	$ 18,128	7,248	34,065	Beardsley, 1897
1896	BER	26.75	$ 1.48	$ 5.17	$ 16,852	9,048	31,707	Beardsley, 1897
1896	KCE	26.75	$ 1.94	$ 6.62	$ 16,697	7,796	26,521	Beardsley, 1897
1903	IRT	25.49	$ 1.09	$ 4.75	$ 16,658	10,657	46,652	Dunn, 1904
1903	BUE	25.49	$ 0.99	$ 6.09	$ 16,017	6,259	38,646	Dunn, 1904
1906	IRT	25.02	$ 1.27	$ 5.38	$ 16,350	18,050	76,265	Dunn, 1907
1906	BUE	25.02	$ 0.91	$ 6.34	$ 16,614	4,177	29,176	Dunn, 1907
1911	IRT	23.70	$ 1.14	$ 5.56	$ 17,210	18,375	89,720	Shonts, 1911
1911	BRT	23.70	$ 0.89	$ 6.40	$ 17,489	7,908	56,797	Williams, 1911
1915	IRT	22.33	$ 1.12	$ 5.45				Shonts, 1915
1915	BRT	22.33	$ 0.84	$ 6.22				Williams, 1915
1921	IRT	12.63	$ 0.71	$ 4.11				Hedley, 1921
1921	BRT	12.63	$ 0.87	$ 6.33				BRT, 1921
1925	IRT	12.87	$ 0.61	$ 3.45	$ 23,495	15,163	85,595	McAneny, 1926
1925	BMT	12.87	$ 0.61	$ 4.45	$ 22,855	14,209	103,385	McAneny, 1926
1930	IRT	13.51	$ 0.70	$ 3.81	$ 24,464	13,265	72,672	Fullen, 1931
1930	BMT	13.51	$ 0.68	$ 4.67	$ 24,803	14,881	101,815	Fullen, 1931
1935	IRT	16.48	$ 0.91	$ 4.09		15,782	70,871	Fullen, 1936
1935	BMT	16.48	$ 0.85	$ 5.11		16,623	100,299	Fullen, 1936
1935	IND	16.48	$ 2.75	$ 15.83				Fullen, 1936
1939	IRT	16.28	$ 0.93	$ 4.07	$ 30,628	13,695	60,190	Fullen, 1942
1939	BMT	16.28	$ 0.80	$ 4.45	$ 30,034	11,855	66,113	Fullen, 1942
1939	IND	16.28	$ 2.13	$ 10.86	$ 23,432	10,962	55,800	Delaney, 1939
1940	BOT	16.08	$ 1.31	$ 6.33	$ 29,936	11,726	56,654	Daly, 1941
1946	BOT	11.60	$ 0.88	$ 5.32	$ 29,998	11,933	72,283	Reid, 1949
1949	BOT	9.48	$ 1.08	$ 5.79	$ 34,949	10,723	57,661	Reid, 1949
1954	NYCTA	8.42	$ 1.73	$ 8.60	$ 41,061	8,697	43,299	NYCTA, 1954
1960	NYCTA	7.63	$ 1.72	$ 7.58	$ 49,052	11,741	51,678	NYCTA, 1960
1967	NYCTA	6.77	$ 2.40	$ 9.85	$ 66,472	11,487	47,161	NYCTA, 1967
1970	NYCTA	5.82	$ 2.90	$ 11.91	$ 68,130	9,421	38,678	MTA, 1971
1976	NYCTA	3.97	$ 4.42	$ 17.66	$ 91,601	8,794	35,134	Fisher, 1977
1980	NYCTA	2.75	$ 3.72	$ 14.87	$ 74,164	8,463	33,809	Ravitch, 1980
1985	NYCTA	2.10	$ 2.76	$ 10.13	$ 66,681	9,673	35,493	Kiley, 1986
1992	NYCTA	1.61	$ 2.91	$ 9.51	$ 71,632	11,697	38,265	MTA, 1993
1995	NYCTA	1.48	$ 3.69	$ 12.93	$ 92,770	12,330	43,224	Conway, 1996
2000	NYCTA	1.31	$ 3.10	$ 13.25	$ 83,792	12,186	52,075	MTA, 2001
2005	NYCTA	1.16	$ 3.81	$ 16.35	$ 99,208	13,437	57,592	MTA, 2006
2010	NYCTA	1.04	$ 4.42	$ 19.57	$ 127,275	13,900	61,518	Foran, 2011

[19] See notes to data.

NOTES TO DATA—EFFICIENCY AND PRODUCTIVITY

<u>General Notes</u>

1. All figures refer to heavy rail rapid transit operations only. Commuter rail, streetcar, bus, trolley bus, and other surface modes are excluded.
2. Figures exclude PATH, SIRTOA, AirTrain JFK, and Coney Island excursion steam lines
3. Except as noted above, figures include all rapid transit operating within the present-day New York City boundary, including Brooklyn, Queens, and the Bronx.
4. Figures do not consider external costs.
5. Identified firms and agencies *operated* rapid transit. Parent firms, construction firms, holding corporations, subsidiaries, and special purpose entities are not identified, but relevant data is incorporated.
6. Price Level Multiplier converts current nominal dollars to constant 2011 dollars. Derived from price level indices; 1870 to 1912 from Lindert (2006); 1913 to 2011 from U.S. Bureau of Labor Statistics (2011).
7. Endeavored to obtain data at five year intervals; data points are 4.5 years apart on average. Irregular years due to availability of data.
8. Cost includes all fixed and variable costs such as depreciation, interest, dividends, labor, taxes, operating expenses, overhead, etc.
9. Grey cells indicate data was unavailable or not reported.

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