A POSTSCRIPT TO "MANAGEMENT OBJECTIVES AND THE CAUSES OF MASS TRANSIT DEFICITS"

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<u>Abstract</u>

This paper updates an earlier analysis (Savage, 2004) that reviewed the finances of the Chicago Transit Authority (CTA) from its first full year of operation in 1948 through to 1997. The earlier paper found that exogenous decreases in demand and increases in costs reduced the annual profitability of the CTA by \$1 billion. Half of the decline was recouped by reductions in service, increased fares and increased productivity. Even more would have been recouped had the CTA not given away earlier productivity gains during the 1970s. The analysis of the original paper ended with the CTA's 50th anniversary, and the transition to a new administration under President Frank Kruesi.

This postscript deals with the subsequent period through the end of 2004. Between 1997 and 2004, the CTA annual operating loss (fare revenue less operating expenses) worsened by \$179 million in 2005 prices. The increased cost of providing demand-response services to persons with disabilities represents \$19 million of this decline. For the regular-route bus and rail services, the analysis finds that economy-wide exogenous cost pressures reduced profitability by \$42 million. In the late 1990s, the exogenous cost increases were offset by increases in productivity, but these gains had been given away by 2004. While the regeneration of the city led to a modest increase in demand in the late 1990s, CTA decisions on fares and service levels substantially weakened profitability. A decline in the real value of fares diminished annual revenues by \$31 million, and the net effect (incremental cost less generated revenue) of service increases on the rail and bus systems reduced annual profitability by \$77 million and \$11 million respectively.

Introduction

Savage (2004) reviewed the finances of the Chicago Transit Authority (CTA) from its first full year of operation in 1948 through to 1997. The analysis of that paper ended with the CTA's 50th anniversary, and the transition to a new administration under President Frank Kruesi. This postscript deals with the subsequent period through to the end of 2004. During this latter period, the annual operating deficit before subsidies increased from \$527 million to \$706 million (both figures in constant 2005 dollars). This paper is concerned with quantifying the magnitude of the various causes that resulted in the \$179 million decline in annual profitability.

Analytical Model and Data

This section describes the analytical model used to decompose the changes in operating revenues and costs, and the sources of the data used in the analysis. Readers who are familiar with the original paper can skip ahead to the next section.

The model is based on the identity that operating profit/deficit is equal to total farebox revenue minus total operating cost:

$$\pi = P(q_R(P, M_R, X_i) + q_B(P, M_B, X_i)) - (C_{RX} + C_{RN})M_R - (C_{BX} + C_{BN})M_B + TR_{DR} - TC_{DR}$$
(1)

where: π = Profit (positive) or deficit (negative), $q_R(..)$ = a demand function explaining rail passenger trips, $q_B(..)$ = a demand function explaining bus passenger trips, P = common price (fare) on both modes, M_R = railcar miles, M_B = bus miles, X_i = a vector of exogenous demand factors, C_{RX} = exogenously determined cost per railcar mile, C_{BX} = endogenously determined cost per railcar mile, C_{BX} = exogenously determined cost per bus mile, C_{BN} = endogenously determined cost per bus mile, TR_{DR} = total revenue collected from paratransit riders, and TC_{DR} = total cost of the subcontracted paratransit operation.

Exogenously determined costs are defined as the unit costs that the CTA inherited on its formation, adjusted to reflect nationwide changes in the unit costs of inputs. For example, real wages of all workers have increased over the past fifty years, and the CTA would have to respond to this in order to attract employees. Exogenous costs per bus mile and per railcar mile were calculated by taking modal unit costs in 1948, and forecasting them forward using an index of exogenous factor input prices. The index was composed of two parts. The first part is an index of real employee expense per labor hour for the entire economy. This index was applied to 90% of the 1948 unit costs. The second part of the index, applied to the remaining 10% of the 1948 costs, is the real value of the fuel and power component of the national producer price index. Of course, actual unit costs may be more than or less than the exogenously determined costs. The difference between actual and exogenously-determined costs will be called

endogenous costs. For example, if the introduction of productivity-enhancing technology or work practices reduces actual unit costs below exogenously determined unit costs, then the value of the variables representing endogenous-determined costs (C_{RN} and C_{BN}) will be negative. Alternatively, if labor is used less efficiently, or paid wages that are in excess of those in comparable occupations, actual unit costs will exceed the exogenously determined ones and C_{RN} and C_{BN} will be positive.

Our interest is not in equation (1) *per se*, but rather in how it changes from year to year. Using the expression Δ to represent the change in the value of a variable from one year to the next (for example, subtracting 1999 from 1998), the "first difference" of the profit function is:

$$\Delta \pi = q_R(..)\Delta P + P\Delta q_R(..) + \Delta P\Delta q_R(..) + q_B(..)\Delta P + P\Delta q_B(..) + \Delta P\Delta q_B(..) - M_R(\Delta C_{RX} + \Delta C_{RN}) - (C_{RX} + C_{RN})\Delta M_R - (\Delta C_{RX} + \Delta C_{RN})\Delta M_R - M_B(\Delta C_{BX} + \Delta C_{BN}) - (C_{BX} + C_{BN})\Delta M_B - (\Delta C_{BX} + \Delta C_{BN})\Delta M_B + \Delta TR_{DR} - \Delta TC_{DR}$$
(2)

Collecting terms on the right-hand side and disaggregating the change in demand into its constituent parts produces:

$$\Delta \pi = q_{R}(..)\Delta P + (P+\Delta P)[\partial q_{R}(..)/\partial P \Delta P + \partial q_{R}(..)/\partial M_{R} \Delta M_{R} + \Sigma_{i} \partial q_{R}(..)/\partial X_{i} \Delta X_{i}]$$

$$+ q_{B}(..)\Delta P + (P+\Delta P)[\partial q_{B}(..)/\partial P \Delta P + \partial q_{B}(..)/\partial M_{B} \Delta M_{B} + \Sigma_{i} \partial q_{B}(..)/\partial X_{i} \Delta X_{i}]$$

$$- M_{R}(\Delta C_{RX} + \Delta C_{RN}) - (C_{RX} + C_{RN})\Delta M_{R} - (\Delta C_{RX} + \Delta C_{RN})\Delta M_{R}$$

$$- M_{B}(\Delta C_{BX} + \Delta C_{BN}) - (C_{BX} + C_{BN})\Delta M_{B} - (\Delta C_{BX} + \Delta C_{BN})\Delta M_{B} + \Delta TR_{DR} - \Delta TC_{DR}$$

$$(3)$$

This equation can be made more intuitively appealing by substituting to remove the differential terms. For example, price elasticity for the rail system (ε_{PR}) is defined as: $\varepsilon_{PR} = (\partial q_R(..)/\partial P).(P/Q_R)$

where Q_R is the number of rail passenger trips. By manipulation:

 $\partial q_R(..)/\partial P = \varepsilon_{PR} Q_R/P$

which can be substituted into equation (3). There will be similar definitions for the other rail demand variables, and for the bus mode. Consequently equation (3) can be rewritten as:

$$\begin{split} \Delta \pi &= Q_R \Delta P + (P + \Delta P) [\epsilon_{PR} \ Q_R \Delta P / P + \epsilon_{MR} \ Q_R \Delta M_R / M_R + \Sigma_i \ \epsilon_{RXi} \ Q_R \Delta X_i / X_i \] \\ &+ Q_B \Delta P + (P + \Delta P) [\epsilon_{PB} \ Q_B \ \Delta P / P + \epsilon_{MB} \ Q_B \Delta M_B / M_B + \Sigma_i \ \epsilon_{BXi} \ Q_B \Delta X_i \ / X_i \] \\ &- M_R (\Delta C_{RX} + \Delta C_{RN}) - (C_{RX} + C_{RN}) \Delta M_R - (\Delta C_{RX} + \Delta C_{RN}) \Delta M_R \\ &- M_B (\Delta C_{BX} + \Delta C_{BN}) - (C_{BX} + C_{BN}) \Delta M_B - (\Delta C_{BX} + \Delta C_{BN}) \Delta M_B + \Delta T R_{DR} - \Delta T C_{DR} \end{split}$$
(4)

Terms can be collected in such a way that the change in profitability can be decomposed into seven effects. The first two and the last one are exogenous, and the other four are under the control of the CTA:

- A. Changes in the exogenous unit cost of existing service (- $M_R \Delta C_{RX}$ $M_B \Delta C_{BX}$)
- B. Revenue change from various exogenous demand factors (Σ_i (P+ Δ P). $\Delta X_i/X_i[\epsilon_{RXi}Q_R + \epsilon_{BXi}Q_B]$)
- C. Changes in the endogenous unit cost of existing service $(-M_R\Delta C_{RN} M_B\Delta C_{BN})$
- D. Changes in rail service, composed of the net effect of the increased mileage at the original unit costs, the effect of increased unit cost, the revenue consequences of generated ridership at existing prices, and the effect on generated revenue of price changes (ΔM_R [P. ϵ_{MR} Q_R/M_R ($C_{RX}+C_{RN}$)] + ΔM_R [$\Delta P.\epsilon_{MR}$ Q_R/M_R ($\Delta C_{RX}+\Delta C_{RN}$)])

- E. Changes in bus service, calculated in a similar fashion $(\Delta M_B \ [P.\epsilon_{MB} \ Q_B/M_B (C_{BX}+C_{BN})] +$
 - a. $\Delta M_B [\Delta P.\epsilon_{MB} Q_B/M_B (\Delta C_{BX} + \Delta C_{BN})])$
- F. Changes in fares, comprising the revenue effects from changing price to existing riders and from generated/discouraged riders $(\Delta P(Q_R + Q_B) + (P + \Delta P) \cdot \Delta P/P[\epsilon_{PR}Q_R + \epsilon_{PB}Q_B])$
- G. Changes in the net cost of providing subcontracted paratransit service for riders with disabilities ($\Delta TR_{DR} \Delta TC_{DR}$)

While equation (4) is developed as an accounting identity, in practice it is unlikely to fully explain the change in profitability. There will be a residual, unexplained, amount when the demand variables fail to capture all of the changes in demand. There are many sources for error. Elasticities are econometrically estimated with inherent standard errors. The original data may contain measurement errors, and there will always be random demand shocks. Some of these shocks may be exogenous (a snow storm, or the soccer World Cup) while others (such as a strike) may be endogenous.

The analysis uses published annual data on operating profit/loss, price (calculated as farebox revenue divided by total passenger trips), railcar and bus miles in revenue service, bus and rail unlinked passenger trips, and actual operating cost per railcar and bus mile. In recent years, these data have been obtained from the annual filing to the Federal Transit Administration's Nation Transit Database. All dollar amounts are adjusted to 2005 prices using the consumer price index. An appendix to the original paper contains additional notes on sources, and on specific data issues and problems.

The revenue side of the model includes variables (the X_i variables) that represent the many changes in society that have, in general, been unfavorable to transit. There has been a suburbanization of residential location. Jobs, even for city residents, have also moved to the suburbs. City dwellers have also become more motorized, with rising auto ownership. All of these changes are highly collinear to each other. In this analysis, the ratio of jobs in Chicago to total jobs in Cook County is used as the primary variable, and should be interpreted as representing the whole host of societal changes and not just the suburbanization of jobs.

Two other exogenous demand variables are used. Transit ridership is largely composed of the journey to work, and increased unemployment during recessions temporarily reduces travel. A "recession" dummy variable equals one for those years in which real Gross National Product per head of population in the United States fell. By this definition, a recession occurred in 2001. Finally, a spline dummy variable with the value of two in 1948, one in 1949, and zero thereafter is used to capture dissipation of the wartime boom in transit use.

Demand elasticities appear in the underlying demand functions that are part of equation (1), and also in equation (4). As discussed in detail in the original paper, these were obtained by estimating demand functions for both the rail and bus systems. Ridership was regressed on price, service level and the three exogenous demand variables. A first difference equation was specified for all variables (including the dummies). The continuous variables are specified in logarithms, which produced constant elasticities. Estimated price elasticities were -0.256 for the rail system and -0.457 for the bus system. Estimated service level elasticities were 0.334

for the rail system and 0.556 for the bus system. Exogenous societal change, represented by the suburbanization of jobs variable, was found to be especially strongly related to bus system ridership.

Decomposition of Changes in Finances 1998-2004

Figure P1 shows constant-dollar operating revenues and costs for each year from 1948 to 2004. Visual inspection suggests that cost increases are the primary cause of the decline in profitability since 1997. Real revenues declined modestly by 4% between 1997 and 2004. However, real total operating costs reversed a two-decade long decline, and since 2001 have increased at a rate not seen since the 1970s. By 2004 they were 15% higher than in 1997.

The underlying explanation for these trends in revenues and cost can be found by applying the methodology described above. The year-by-year decomposition of the change in operating profitability is shown in Table P1. Negative numbers in this table indicate profitability declines (cost increases and/or revenue decreases), and vice versa. To assist in the interpretation of this table, Figure P2 shows a graph of some key performance indicators concerning ridership, service provision, fares and costs. In this figure, the performance indicators are shown as indices with their value in 1948 set equal to 100.

Exogenous cost pressures, due to the overall rise in average wages in the economy and increased energy costs, are estimated to have reduced profitability by \$42 million. The effects of increases in energy prices in 2000 and again in 2003 and 2004 are particularly noticeable.

Between 1998 and 2000, the exogenous increases were more than compensated for by improvements in productivity, such as the introduction of automatic ticketing and one-person-operation on the rail system. These productivity enhancements led to an annual cost saving of \$69 million. Unfortunately, nearly all of these savings were subsequently given way, particularly during 2004. Consequently, endogenous action only offset \$2 million of the \$42 million exogenous cost pressures. The real cost per vehicle mile increased by 15% on the bus network, especially in 2003 when a new labor contract came into effect.

On the demand side, there appears to have been considerable exogenous effects. The primary variable reflecting the market environment for transit, the proportion of jobs in Cook County that are located in the City of Chicago, stabilized and even increased modestly, after decades in decline. The model therefore estimates a modest annual revenue increase of \$2 million. On top of this, there has been a regeneration of many areas of the city, and an increase in resident population of the City of Chicago for the first time since the early 1950s. Neighborhoods adjacent to century-old rail lines gentrified. The residual term in the regression captures the unusual increase in demand and revenue experienced in the period between 1998 and 2000. However, this upward trend did not last. The slow recovery from the short recession in 2001, combined with the uncertainties caused by the terrorist attacks on September 11, 2001, led to a stabilization of demand starting in the first quarter of 2002. Much of the ridership gain subsequently dissipated, with most of the loss occurring during 2003.

Nevertheless, unlinked passenger trips increased by 6% from 1997 to 2004. Most of the increases occurred on the rail system (which saw a 14% increase in demand), whereas the bus system saw a modest 2% rise. This was distinct improvement over the 1990-1997 period, when demand had declined by 11% on the rail system and 32% on the bus system. While the environment for transit has clearly been more favorable in recent years, a large proportion of the ridership increases can be attributed to CTA management decisions to increase service levels and to allow real fares to diminish. Prior to a 25¢ increase in January 2004, the base fare had been held constant since 1993, and its value was eroded by inflation. Even with the 2004 increase, the real yield per rider declined by 11% between 1997 and 2004. Service levels were increased, primarily on the rail system. Some of the service cuts of the early and mid-1990s were restored. While bus miles increased modestly by 3%, the rail system witnessed a 27% increase in car miles. On both the bus and rail systems the service increases exceeded the increases in demand, resulting in diminished average load factors, and worsened financial performance.

The analysis reported in Table P1 suggests that the erosion of the value of fares reduced annual revenues by \$31 million. In addition, the net effect (incremental cost less generated revenue) of service increases on the rail and bus systems reduced annual profitability by \$77 million and \$11 million respectively.

Overall, changes due to factors outside the control of the CTA (exogenous cost pressures, exogenous demand factors, and a decline in the financial situation of the subcontracted paratransit operations of \$19 million a year) are estimated to have reduced annual profitability between 1998 and 2004 by \$58 million. The situation was made worse by endogenous decisions with regard to productivity, fares and service levels that are estimated to have caused a financial decline of \$117 million.

Comparison of 1998-2004 with Earlier Time Periods

The estimated endogenous and exogenous changes between 1998 and 2004 are compared with earlier periods in the CTA's history in Table P2. This is an update of Table 3 in Savage (2004), with pre-1998 data revalued from 1997 prices to 2005 prices, an increase of approximately 22%. In a couple of cases, provisional data items from the mid-1990s have been updated with the actual data that are now available. In addition, the finances of paratransit demand-response services, which were excluded from the original paper, are now included. This is because these services have become a subject of public policy discussion.

In all time periods, the CTA has suffered exogenous pressures of increased economy wide wage increases and increased energy costs and/or changes in the locations of residences and workplaces that have undermined the market for public transportation. It is notable that 1998-2004 offered a respite from the unrelenting exogenous declines in demand.

However, for only the second time period in the CTA's history, recent endogenous decisions have made the financial situation worse. The recent cost increases, and the decline in the real value of fares, have a striking similarity to the situation in the 1970s. However, unlike the 1970s, the current management has further damaged the financial situation by expanding service provision.

Concluding Comments

When the original paper was written, the late 1990s were proving to be a good period for the CTA. The agency was benefiting from cost savings due to the service reductions and productivity enhancements implemented in the mid-1990s, and demand had reversed its longtime downward trend as a result of a booming economy and the regeneration of the city.

However, demand stabilized in early 2002, and costs started to increase. The situation was made worse because subsidy funds, which are based on sales tax revenues, were not increasing in the sluggish economy. Consequently, decisions to expand service levels and peg fares, which may have seemed reasonable when demand was increasing in the late 1990s, turned out to be financially disastrous. By 2004, the CTA had returned to the type of financial crises that were common in the early to mid-1990s. The 2004 increase in fares (and a subsequent increase in cash fares in January 2006, which was designed in part to encourage riders to change to electronic methods of payment) was not sufficient to prevent the financial crises continuing into 2005 and 2006.

In 2004, 16% of operating costs were unfunded (that is to say, were not covered by fare revenues or operating subsidies). The situation was much worse than in the crisis years of 1979 and 1993, when the proportion of unfunded operating costs was less than 10%. When the CTA threatened to severely reduce service levels in response to the financial troubles, the Illinois House of Representatives established a special Committee on Mass Transit in the fall of 2004 to explore ways to balance the CTA's finances.

In the short term, a special one-time grant was given to the CTA to cover the cost of providing paratransit demand-response services under the Americans with Disabilities Act of 1990. The net cost of these services, which had their origins in the early 1980s and are provided by subcontractors, had escalated from \$20 million a year (at today's prices) in 1990 to \$49 million in 2004. From July 1, 2006, the responsibility for provision of these services will be switched to Pace, the supplier of suburban bus services. In the longer term, the House committee is examining whether to alter the 1983 formula which allocates sales tax revenues between the CTA, Pace, and Metra (the commuter rail provider).

In many ways the current crisis is a reappearance of the financial troubles of the 1993-1996 period. The earlier crisis was averted by an unpredicted increase in demand in the late 1990s, productivity-enhancing improvements, and service cuts. This analysis suggests that the recurrence of the financial problems can be attributed one-third to adverse exogenous conditions, and two-thirds to decisions made by CTA management on costs, service levels and fares.

Reference

Savage, Ian (2004). Management objectives and the causes of mass transit deficits. *Transportation Research A* 38(3):181-199.



Figure P1: Operating Revenues and Expenses in 2005 dollars



Figure P2: Indices of CTA Key Indicators with 1948=100

Table P1Decomposition of the change in annual operating profitability by year 1998-2004

Millions of 2005 dollars	1998	1999	2000	2001	2002	2003	2004	Overall
Total Profit Change	50	7	- 5	- 57	- 44	- 60	- 70	- 179
Exogenous Changes in Unit Cost of Existing Service	4	- 6	- 15	- 3	4	- 14	- 11	- 42
Post-War Effect	na							
Chicago/Cook Employment	- 1	4	0	- 2	4	- 1	- 1	2
Recessions	0	0	0	- 4	4	0	0	0
Provision of Paratransit	- 1	1	0	- 5	- 4	- 5	- 5	- 19
Total Exogenous Changes	2	- 1	- 15	- 14	8	- 20	- 17	- 58
Endogenous Changes in Unit Cost of Existing Service	3	56	10	- 2	- 6	- 2	- 57	2
Changes in Rail Service	- 20	- 8	- 1	- 11	- 22	- 10	-4	- 77
Changes in Bus Service	28	- 2	- 4	- 12	- 15	- 4	- 2	- 11
Changes in Fares	- 5	- 15	- 11	- 6	- 10	12	5	- 31
Total Endogenous Changes	5	30	- 5	- 32	- 52	- 4	- 58	- 117
Unexplained Demand Effects	43	- 22	15	- 11	0	- 35	6	- 4

Notes: The Chicago/Cook County employment variable should be interpreted as including the effects of City depopulation and changes in automobile ownership. Data are rounded, so columns and rows may not add up exactly.

Table P2Decomposition of the change in annual operating profitability by time period

Millions of 2005 dollars	1948-57	1958-64	1965-70	1971-80	1981-90	1991-97	1998-04	Overall
Total Profit Change	20	- 8	- 117	- 692	141	26	- 179	- 809
Exogenous Changes in Unit Cost of Existing Service	- 208	- 117	- 170	- 166	4	- 40	- 42	- 740
Post-War Effect	- 85	na	na	na	na	na	na	- 85
Chicago/Cook Employment	- 83	- 79	- 68	- 77	- 52	- 40	2	- 397
Recessions	- 10	9	- 9	3	0	5	0	- 2
Provision of Paratransit	na	na	na	na	- 20	- 11	- 19	- 49
Total Exogenous Changes	- 385	- 188	- 247	- 241	- 68	- 86	- 58	- 1,273
Endogenous Changes in Unit Cost of Existing Service	223	79	- 22	- 268	110	10	2	133
Changes in Rail Service	9	1	- 29	9	- 50	50	- 77	- 87
Changes in Bus Service	17	14	23	68	64	47	- 11	221
Changes in Fares	209	76	101	- 247	51	44	- 31	203
Total Endogenous Changes	458	169	72	- 438	175	151	- 117	470
Unexplained Demand Effects	- 53	11	58	-13	33	- 38	- 4	- 6

Notes: The Chicago/Cook County employment variable should be interpreted as including the effects of City depopulation and changes in automobile ownership. Data are rounded, so columns and rows may not add up exactly.