A MEASURE OF SCALE ECONOMIES FOR POSTAL SYSTEMS

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Introduction

The delivery function is comparatively new to modern postal services. Originally the post was simply an inter-city letter service. One could deposit a letter at the post office in a city for transportation to the post office in another city where the recipient would call for it.[1] It was not until the mid-nineteenth century that city delivery began on a regular basis in the U.S. By the end of the century rural delivery was started on a limited basis, but it did not become ubiquitous until the early part of the twentieth century.

Delivery changed the post in many ways. No doubt it has been a substantial cause of the tremendous growth in volume since its inception. But delivery also changed the economics of the modern post because it introduced a large amount of fixed costs.

While the letter mail monopoly preceded the introduction of delivery service, the fixed costs associated with delivery underlie the two modern justifications for the letter monopoly. First, it is argued that a letter mail monopoly is necessary to assure universal service at a uniform price. Second, it is argued that delivery is a natural monopoly and that legal protection is necessary to prevent "cream skimming" and thereby to maximize the benefit of the universal delivery system.[2] The first argument is a political one which presumes significant urban-rural cross subsidizes in delivery. The second is an economic argument which presumes that the Postal Service as a monopolist is an efficient provider of delivery. The analysis presented here is an attempt to address the second argument.

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[1] Campbell, James I., Jr., "An Introduction to the History of the Postal Monopoly Law in the United States," The Last Monopoly, The CATO Institute, Washington, D.C., 1996.

[2] For purposes of this paper, "cream skimming" refers to concentration on serving only those markets that exhibit lower-than-average delivery costs, regardless of the characteristic that causes those costs to be less than average. Such characteristics are not confined to network density and could include favorable geographic, demographic, or operational characteristics. For example, in the U.S., curb delivery is less costly than park and loop delivery which is less costly than foot delivery.

In an unsubsidized postal system as in the United States, the postal customer bears all costs of the system. The customer therefore is the beneficiary where return to scale are maximized by having a single firm (a monopoly) provide delivery. On the other hand, monopolies can be harmful to consumers when they protect technically inefficient behavior, and allow economic rents to be extracted.[3] This paper sets up a framework to examine the following question: Do the economies of scale in the delivery function exceed the technical inefficiencies and economic rents of the Postal Service? In short, does the monopoly increase or decrease the price of postal services to postal customers?[4]

This paper measures the returns to scale of the U.S. delivery function. It then compares this benefit with the cost that the monopoly imposes on the consumer.

Because delivery involves so much fixed cost, it would create a tremendous barrier to entry even if the legal monopoly were abolished. Thus, it may be that having once enjoyed a *de jure* monopoly, national posts would enjoy a *de facto* monopoly even if the legal one were abolished.[5] This paper provides a quantification of the barrier to entry in the letter mail market in the United States caused by high fixed costs in the delivery function.

This paper next estimates the value of scale in delivery exhibited by 21 national postal systems based on data from an unpublished paper which was presented at the 1994 Stockholm conference on Postal and Delivery Services.[6] [7] Finally, it compares the estimated value of scale with an estimate of the wage premium in each country.

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[3] It is also claimed that monopolies harm consumers with lower quality of service and by being less innovative than firms which must compete.

[4] It is important to distinguish postal consumers (i.e., paying customers) from recipients of mail. The latter may derive great benefits from a monopoly in the form of services that would not be provided in a competitive postal environment. These might be called political rents. Consumers, being forced to underwrite the political rents and any inefficiencies and economic rents in the system, may be better off in a competitive environment.

[5] This may well be the case in Sweden which abolished its monopoly in 1993. A letter mail competitor began operations in Stockholm where it captured 20 percent of the market, but, nonetheless, failed.

[6] "An Exploratory Quantitative Comparison of Postal Administrations in Industrial Countries."

[7] The data for each country is from 1988 and is based on UPU statistics which have been verified and revised as necessary based on communications with officials in most of the countries.

The Uniqueness of the Delivery Function

We distinguish what is known in the U.S. as the "in-office" delivery function and the street delivery function. The former is an extension of mail processing; it is where the mail is sorted into the delivery sequence. "Delivery function" as used in this paper refers to street delivery.

Recent empirical research confirms the widely held belief that economies of scale exist in the delivery of mail.[8] Other functional components of the Postal Service are presumed here not to exhibit significant scale economies, although this has not been demonstrated.

John Panzar has characterized street delivery as a bottleneck function because a single firm can deliver to a recipient at a lower total cost than multiple firms delivering to the same customer. He suggests that processing and transportation of mail do not seem to be characterized by scale economies, and that they could be provided by competing firms. Under this scenario, he suggests that rates be set to allow nondiscriminatory access to the monopoly delivery service by the firms competing in processing and transportation.[9]

The Postal Rate Commission and the U.S. Postal Service have implicitly recognized the absence of significant scale economies in mail processing and transportation functions in the Postal Service's rate structure. Postal rates in the U.S. allow for a substantial degree of competition with the Postal Service in mail processing and transportation. For example, the U.S. Postal Service gives sorting and barcoding discounts to about 40 percent of First-Class letter volume. Mailers perform about 60 percent of this worksharing, while third parties perform the

[8] "Natural Monopoly and Technological Agnosticism: The Case of the U.S. Postal Service," Michael D. Bradley and Jeff Colvin, June, 1995.

[9] Panzar, John, "Competition, Efficiency, and the Vertical Structure of Postal Services," Regulation and the Nature of Postal and Delivery Services, Ed. Michael A. Crew and Paul R. Kleindorfer, Kluwer Academic Publishers, 1993.

rest.[10] [11] In some classes, mailers transport much of their mail to downstream locations to take advantage of zoned rates for transportation.

Street Delivery Cost

While the Postal Service collects extensive data on the cost behavior of city delivery carriers, it collects little data on the cost behavior of rural carriers[12] For purposes of this analysis, we assume throughout that rural delivery cost behavior is similar to that of city delivery.[13] In the U.S., street delivery costs for rural and city carriers combined comprises 21 percent of total costs. See Table 1.

Table 1
USPS Operational Costs by Major Function
(1993)

Function	Cost ($ billions)	Percent of Total Cost
Street Delivery	10.1	21.0
In-Office Delivery	7.1	14.7
Mail Processing	15.9	33.0
Transportation	3.7	7.7
Retail Services	2.5	5.1
Other	8.9	18.5

Note: Nonoperating costs, such as payments made to the Treasury for retroactive charges are excluded.

[10] These third-party sorters collect mail from mailers, sort and apply barcodes, and deliver the mail to the Postal Service for a portion of the discount. In addition, discounts encourage bulk advertising mailers to sort their mail all the way to the carrier's walk sequence, thereby avoiding the carrier "in-office" function.

[11] Economic rents in the form of a wage premium paid by the U.S. Postal Service partially explain why mailers and third parties can sort mail at a lower cost than the Postal Service. When third parties compete with the Postal Service, however, in highly automated operations such as applying barcodes with optical character readers and sorting barcoded mail, a wage premium would seemingly not be a very significant factor.

[12] The U.S. Postal Service has two types of delivery personnel; city delivery carriers and rural carriers. In 1993, there were 164 thousand city delivery routes with 80 million delivery points and 49 thousand rural routes with 23 million delivery points. Rural costs were 20 percent of total delivery costs.

[13] For example, it is assumed that the ratio of rural carrier in-office cost to total rural carrier cost is the same as the ratio of city carrier in-office cost to total city carrier cost.

This paper adopts the analysis of street delivery costs presented by the U.S. Postal Service in several rate proceedings over the past 20 years. That analysis disaggregates street delivery time into three subcomponents: route time, access time, and load time. "Route time" is the time it would take a carrier to walk or drive the route, passing, but not accessing, any delivery point. "Access time" is the time it takes a carrier to deviate from the route in order to make a delivery. This may mean departing from the basic line of travel and walking or driving to a delivery point and returning to the basic line of travel, or it may mean slowing down from normal driving speed, stopping to make a delivery to a curbside mail receptacle, and then resuming normal speed. Finally, "load time" is the time it takes a carrier to place the mail in a mail receptacle.[14] Table 2 disaggregates street time in the U.S.

Table 2
Components of Street Time
(1993)

Function	Cost ($ millions)	Percent of Total
Route Time	2,950	29.3
Access Time	5,205	51.7
Elemental Load Time	1,912	19.0
TOTAL	10,067	100.0

Note: For simplicity, coverage-related load time ($1,232 million) is included in access time, and street support is "piggybacked" on all three functions.

Route time costs are essentially fixed, while access is partly variable, and load time is 100 percent variable with volume. The analysis of variability of access time involves estimating the number of new accesses that would be caused by an increment of volume. In the U.S., approximately 93 percent of all possible stops receive mail each delivery day.[15] Consequently, the number of new accesses

[14] Load time is divided into elemental and coverage related load time. Elemental load time varies with the number of pieces being loaded. Coverage related load time is the fixed portion of load time at a stop; it varies with the number of stops. Thus, it is partly variable and partly fixed.
[15] A stop consists of one or more possible deliveries. For example, a 5 unit apartment house with a cluster of 5 mail boxes would be one stop and 5 possible deliveries.

caused by an increase in volume would be small. Regression analysis of carrier street data indicates that at the current volume, the variability of access cost is about 6 percent. In other words, a 10 percent increase in volume will yield a 0.6 percent increase in the number of accesses.

The Postal Service regularly collects a representative sample of street delivery costs, volumes, and delivery point characteristics for city delivery carriers. The Postal Service's FY 1993 data set contains observations from about 300 routes.[16] Observed every two weeks over a one year period, data is collected from about 270,000 stops. This data is used to model the behavior of access costs.

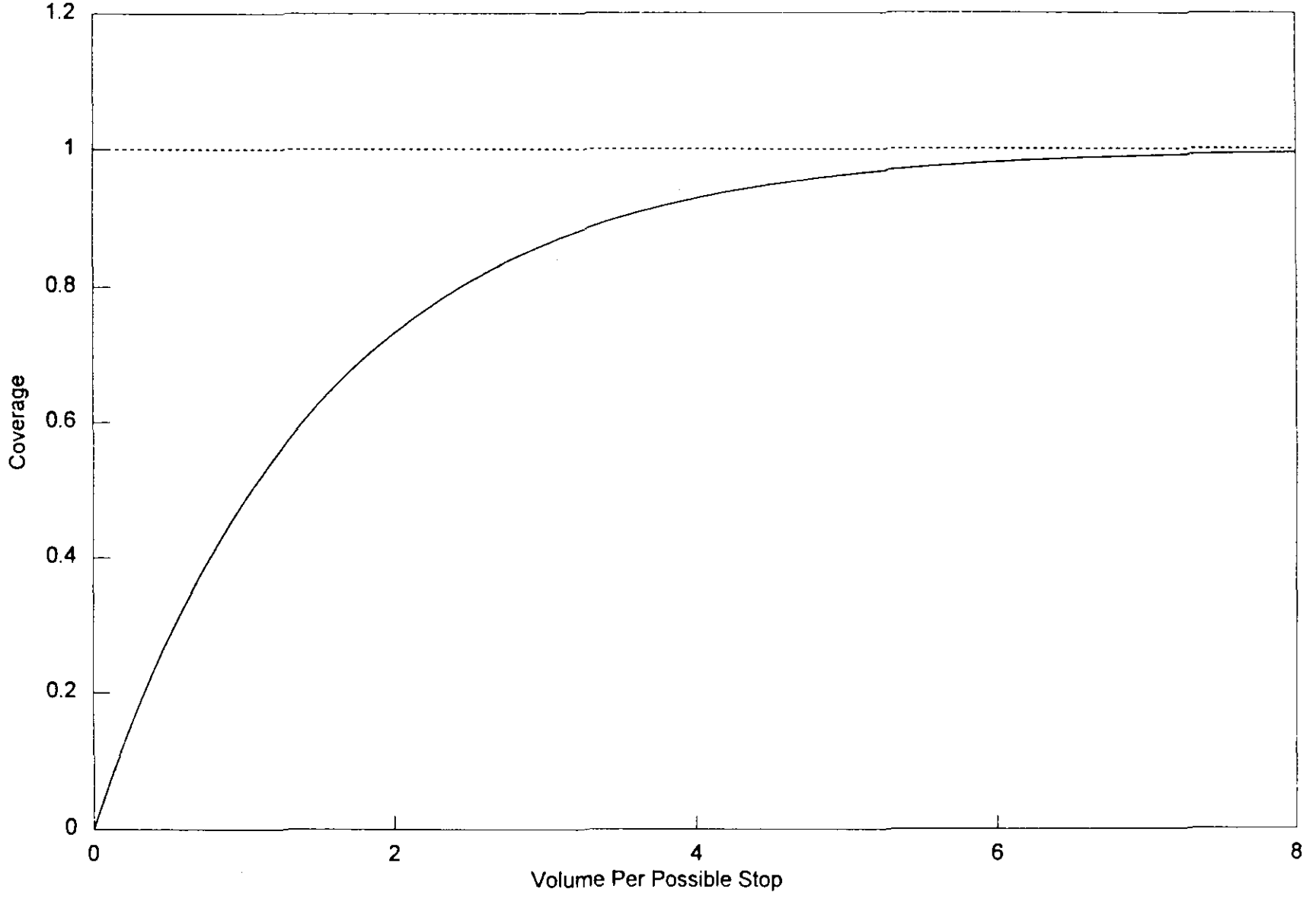
The coverage function shown in Figure 1 models the change in the percentage of possible stops that are accessed on a route as a result of changes in volume.[17] Marginal access cost can be estimated from the coverage function. As volume per stop grows and coverage approaches 100 percent, the volume variability of access cost approaches zero. As the volume per stop declines, coverage declines, and the volume variability of access costs rises.

Measure of Scale Economies

Our methodology for measuring scale economies essentially compares the cost of providing delivery by a single firm with the cost of providing delivery by two firms.[18] We measure the returns to scale in the U.S. postal delivery function by first determining the total cost of delivery provided by the Postal Service. Next, we determine the total cost of delivery performed by the incumbent and a second firm that is assumed to be equally efficient. We assume that the two firms share the market equally, each delivering a random half of the mail. Further, each firm serves

[16] See the testimony of U.S. Postal Service witness Bradley in Docket No. R94-1 (USPS-T-5) at pp. 5-10.
[17] The Postal Service developed the coverage function and first used it in the Docket No. R76-1 rate case. For this paper we have altered the Service's model slightly. Unlike the Postal Service's model, all stop types and mail classes are consolidated.
[18] Of course, the cost of providing delivery by a single firm could also be compared with the cost of three or more firms. This would simply inflate the measure of scale economies.

FIGURE 1
Coverage Function



the entire country each delivery day. Thus, each firm would have to incur the same route time costs that the incumbent currently incurs. Since each firm will have only half the volume, the number of accesses by each firm will be less than the incumbent currently experiences. The number of total accesses by the two firms will, however, be greater than the total experienced by the incumbent alone. This is because some stops receiving multiple pieces will receive delivery from both firms. We assume here that both firms provide the same frequency of delivery (daily).[19]

Since route time is essentially fixed,[20] it would double with two firms providing service, each with half the volume. Conversely, because load time is 100 percent variable with volume, it would not change, since total volume is assumed not to change. Access cost would fall somewhere in between, since it is partly variable and partly fixed. Access cost variability is estimated from the coverage function shown in Figure 1. Under the duopoly scenario described, it would grow by 61 percent. Given these responses to volume, total street time cost would increase from $10 billion to $16.1 billion. The difference, $6.1 billion, represents an upper bound on the benefits from scale economies of delivery.[21]

Monopoly Rents and Inefficiencies

In 1993, the average U.S. postal worker subject to collective bargaining received $35,001 in pay and allowances, and an additional $7,713 in fringe benefits.[22] To put these earnings into perspective, the median annual earnings

[19] A niche incumbent might provide delivery less frequently or to a subset of possible stops. These would be special cases of the more general case analyzed here.
[20] The slight variability the Commission has found in route time is ignored here for convenience.
[21] *Ceteris paribus*, less efficient postal services do not have greater scale economies than more efficient ones. Theoretically scale economies in delivery are not firm specific. They are a product of the territory served and the current state of technology which would be employed by an efficient firm. The $6.1 billion figure is inflated by any inefficiency and/or wage premium which characterize the U.S. Postal Service and in that sense it is an upper bound.
[22] The fringe benefit figure excludes unfunded civil service retirement liability, certain annuitant benefits, workers compensation, unemployment compensation, repriced annual leave, bonuses and awards.

(without fringe benefits) was $24,076 for full-time U.S. workers in that year.[23] Michael B. Wachter of the University of Pennsylvania and his colleagues conclude that there is a wage and fringe benefit premium for the postal bargaining labor force of 29.5 percent with respect to comparable workers in the private sector.[24] Such a wage premium would amount to $9 billion in monopoly rents for the entire postal system. Wachter's $9 billion system-wide wage premium exceeds the $6.1 billion delivery scale economy by $2.9 billion. Wachter's wage premium for the delivery network alone, however, amounts to only $2.3 billion which is $3.8 billion less than the value of the scale benefit from delivery.

Unlike labor costs, technical inefficiency of the Postal Service has not been analyzed. There is, however, some indirect evidence of inefficiencies in the Postal Service. Since 1970, total factor productivity has increased at an average annual rate of only 0.4 percent. This is in spite of the fact that little mechanization existed in the Postal Service prior to 1970 and large amounts were added in the 1970s. Beginning in the early 1980s and continuing to the present, about $5 billion has been invested to automated mail processing, including the in-office carrier sequence function and forwarding for undeliverable-as-addressed mail. Additional billions have been invested in buildings, in part to house the automation. In spite of this investment, productivity appears to have increased only in response to hiring freezes, or reductions in the average wage and fringe benefit package caused by special circumstances.[25] [26]

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[23] Statistical abstracts of the U.S., Table 665, 1994.

[24] "The Comparability of U.S. Postal Service Wages and Benefits to the Private Sector: Evidence from the Total Compensation Premium, New Hire Increases, Quit Rates and Application Rates," Michael L Wachter, Barry T. Hirsch, and James W. Gillula, July 10, 1995. Dr. Wachter has published a number of studies on the Postal Service's labor costs under contract to the USPS. Critics of previous Wachter studies claim that they ignore the fact that the Postal Service pays minorities the same as it pays white males. The critics argue that it is the Postal Service's minority employees (not white male employees) who earn more than their private sector equivalents, and this only means that the Postal Service does not discriminate.

[25] *See* "A study of U.S. Postal Service Productivity and Its Measurement," Staff Study of the Postal Rate Commission, May 9, 1990.

[26] Other indications of inefficiency are management claims that work rules are unnecessarily restrictive and that 73,075 grievances were filed by employees in FY 1995 and not resolved at the local level. In addition, the Postal Service has failed to capture a large market share in two areas of direct competition with the private sector which are relatively unaffected by the Private Express Statutes; Parcel Post and Express (overnight) Mail. This may have been in part caused by either a wage premium or technical inefficiencies or a combination of both. The Postal Service argues that a

Figure 2 presents the consumer benefit from delivery scale economies net of inefficiencies which are expressed as a percentage of total postal costs. The top curve incorporates any wage premium the Postal Service may have, the bottom curve nets out Wachter's 29.5 percent wage premium. The top curve shows that if the Postal Service has 0 percent inefficiencies with its current wage premium, the measure of scale economies equal $6.1 billion. If the Postal Service were about 13 percent inefficient, there would be zero net scale benefit. The bottom curve shows that at 0 percent inefficiencies, the net scale benefit is -$2.9 billion if the value of scale is adjusted for Wachter's wage premium. Any inefficiency would exacerbate the loss. If the wage premium is accurately calculated by Professor Wachter, it would be difficult to defend the U.S. postal monopoly on purely economic grounds. Moreover, understanding the net economic cost of the monopoly allows one to see how much universal service costs postal customers, at least under current institutional arrangements.

Figure 3 presents the same information considering the street function alone. Wachter's wage premium amounts to only $2.3 billion for the delivery function alone. Thus, the net scale benefit is initially positive, whether or not we adjust for the wage premium.

It is far more likely that a monopoly for delivery alone would produce net benefits for consumers than would a monopoly that included processing and transportation as well as delivery. This result lends support to the Panzar's suggestion of opening processing and transportation to competition while maintaining a monopoly in delivery.

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lack of pricing flexibility has contributed to the Postal Service's failure. Others argue that the quality of service, product features, and underlying cost of these Postal Service's offerings make them uncompetitive.

FIGURE 2

Measured Scale Economies Net of Inefficiencies for the USPS as a Whole

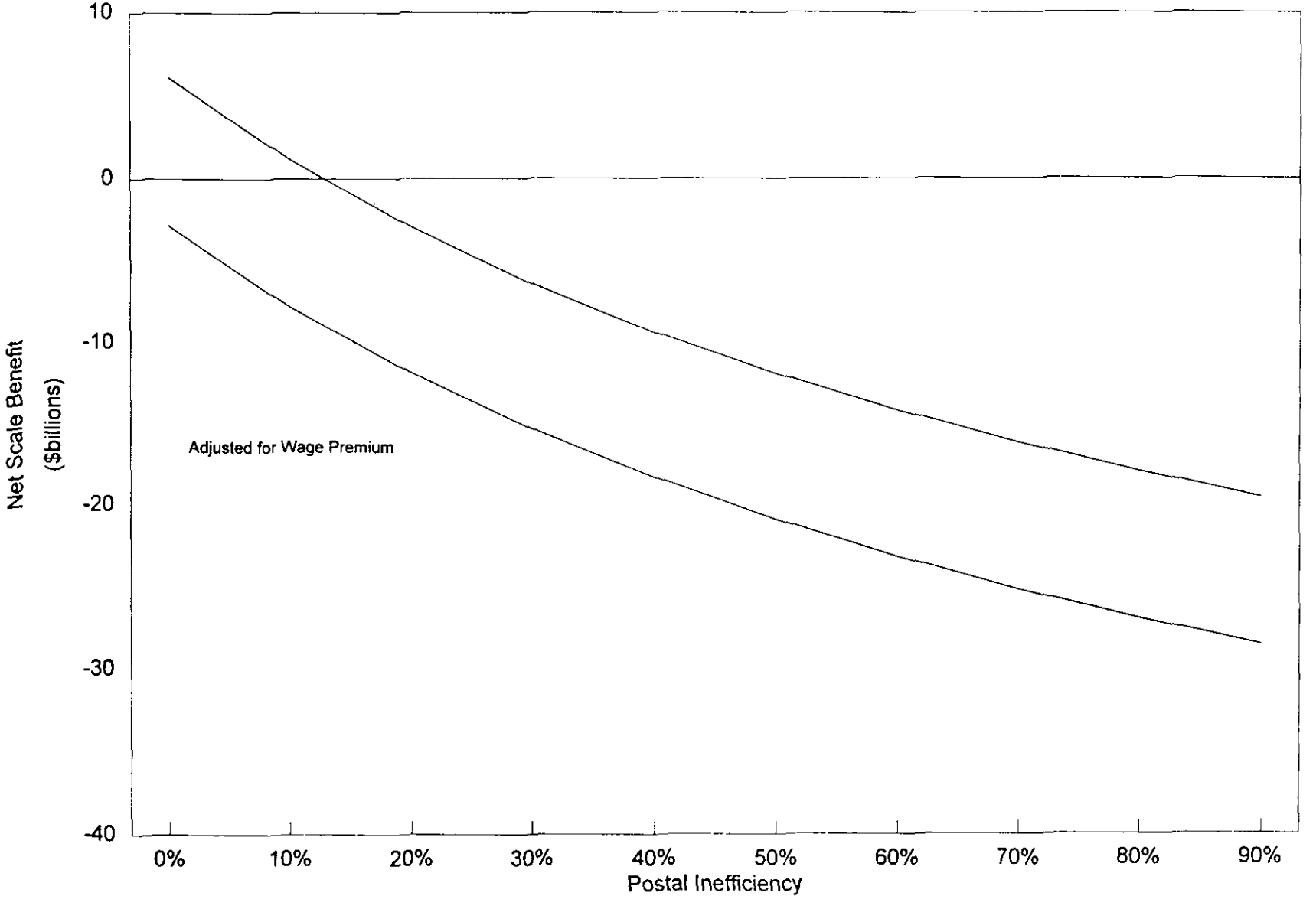
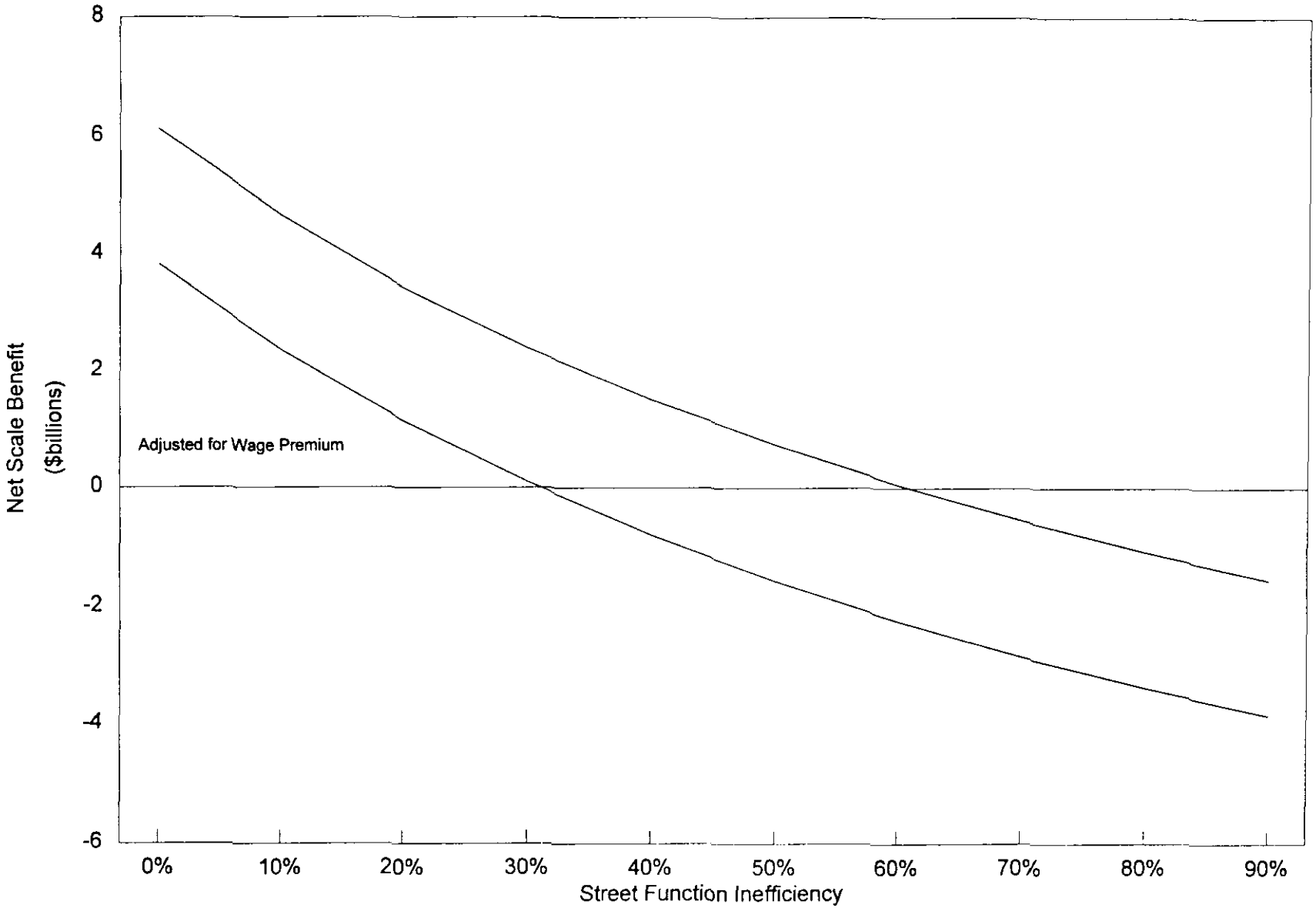


FIGURE 3

Measured Scale Economies Net of Inefficiencies for the Street Function Alone



Barriers to Entry

Because a large proportion of street costs are fixed,[27] the unit (per piece) street cost initially declines rapidly as volume increases and continues to decline at a decreasing rate. A firm with a small share of total volume that competes with an incumbent in delivery only, will find its unit cost high relative to the incumbent, even if the competitor pays no wage premium and or is more efficient. A competitor can reduce its fixed costs by reducing the level of service (i.e., deliver less frequently than the incumbent). Many First-Class mailers do not require daily delivery and most advertising mailers do not require daily delivery.

While it may be politically difficult, incumbent postal administrations have the possibility of reducing delivery frequency. Table 3 displays the cost savings if the U.S. Postal Service were to reduce delivery frequency. The savings are substantial relative to the current $10 billion delivery costs. They are not so substantial when considered in the context of the total Postal Service expenditure in 1993 of $48 billion.

Table 3
Cost of Delivery Frequency
($ billions 1993)

Delivery Frequency	Delivery Cost	Cost Savings
6 Days	10.07	
5	8.88	1.19
4	7.70	2.37
3	6.51	3.56
2	5.32	4.74
1	4.14	5.93

Table 4 illustrates how difficult it would be to enter the U.S. delivery market.[28] The table displays the market share that a competitor would have to capture in order

[27] In the U.S., about 71 percent of street cost are fixed.
[28] Over and above the problems discussed here, the U.S. mail box law represents a huge barrier to entry. The law forbids any private party from placing anything in a receptacle used to deliver mail to a residence or business.

to have the same unit costs as the U.S. Postal Service. For example, if a competitor delivered six days a week and its combined wage and efficiency advantage is 50 percent, the competitor would have to capture 35 percent of the total market in order to have the same unit delivery cost as the Postal Service. Even if this competitor delivered only one day per week, it would have to capture 15 percent of the total market in order to have the same unit delivery cost as the Postal Service on a national basis. This is about 27 billion pieces per year or 519 million pieces per week. Assuming a competitor would capture volume slowly and would have to charge rates no higher than the incumbent, the competitor would have to be ready to sustain large loses before it could break even. Thus, the effects of economies of scale in delivery present significant barriers to entry.

Table 4
Break-Even Market Share for Competitors

Competitor Delivery Frequency	Combined Wage and Efficiency Advantage of the Competitor		
	0%	33%	50%
6 Days	50	40	35
5 Days	46	36	31
4 Days	41	32	28
3 Days	37	27	24
2 Days	31	23	19
1 Day	25	18	15

An International Comparison of the Values of Scale in Delivery with Wage Premiums

As mail volume increases in postal systems, variable costs (processing and transportation) increase and fixed costs decrease as a percentage of total costs. Therefore, street delivery costs, which are largely fixed, decrease as a percentage of total costs as volume increases. Route time cost, which is a fixed cost and the largest component of street delivery costs, decreases with a rise in volume. The fixed access cost as a percentage of total cost would increase with volume until all

stops are covered while the variable access cost percentage decreases as volume increases. Figure 4 shows these relationships for the U.S. Postal Service costs.

Conversely as volumes decrease, fixed costs become a higher percentage of total costs. For example, if the U.S. Postal Service volume were one third of the 1993 level, then delivery costs as a percentage of total costs would increase from approximately 21 percent to 36 percent of total costs. In equally efficient but smaller volume postal systems, street delivery costs should also be a much greater percentage of total costs than the 21 percent in the U.S. Postal Service.

Table 5 displays the implied coverage, the percentage of total cost represented by street delivery cost, and the percentage of total cost represented by fixed delivery cost for the 21 countries based on their respective per capita volume in 1988.[29] For example, Germany had about 230 pieces per capita which yields a coverage of about 64 percent. Its per capita volume and corresponding coverage imply that its fixed portion of delivery equaled about 19 percent of its total costs. The U.S., by comparison, had about 535 pieces per capita and had 91 percent coverage for 1988. Thus, the fixed portion of delivery in the U.S. amounted to about 14 percent of total cost. The implied coverages range from 16 percent to nearly 100 percent. The implied proportions of fixed delivery cost tot total cost ranged from 12 percent to 43 percent.

[29] This assumes that the coverage function (Figure 1), developed from an analysis of delivery routes in the U.S., is valid for the other countries included in this analysis.

FIGURE 4
Comparison of Delivery Cost to Total Cost

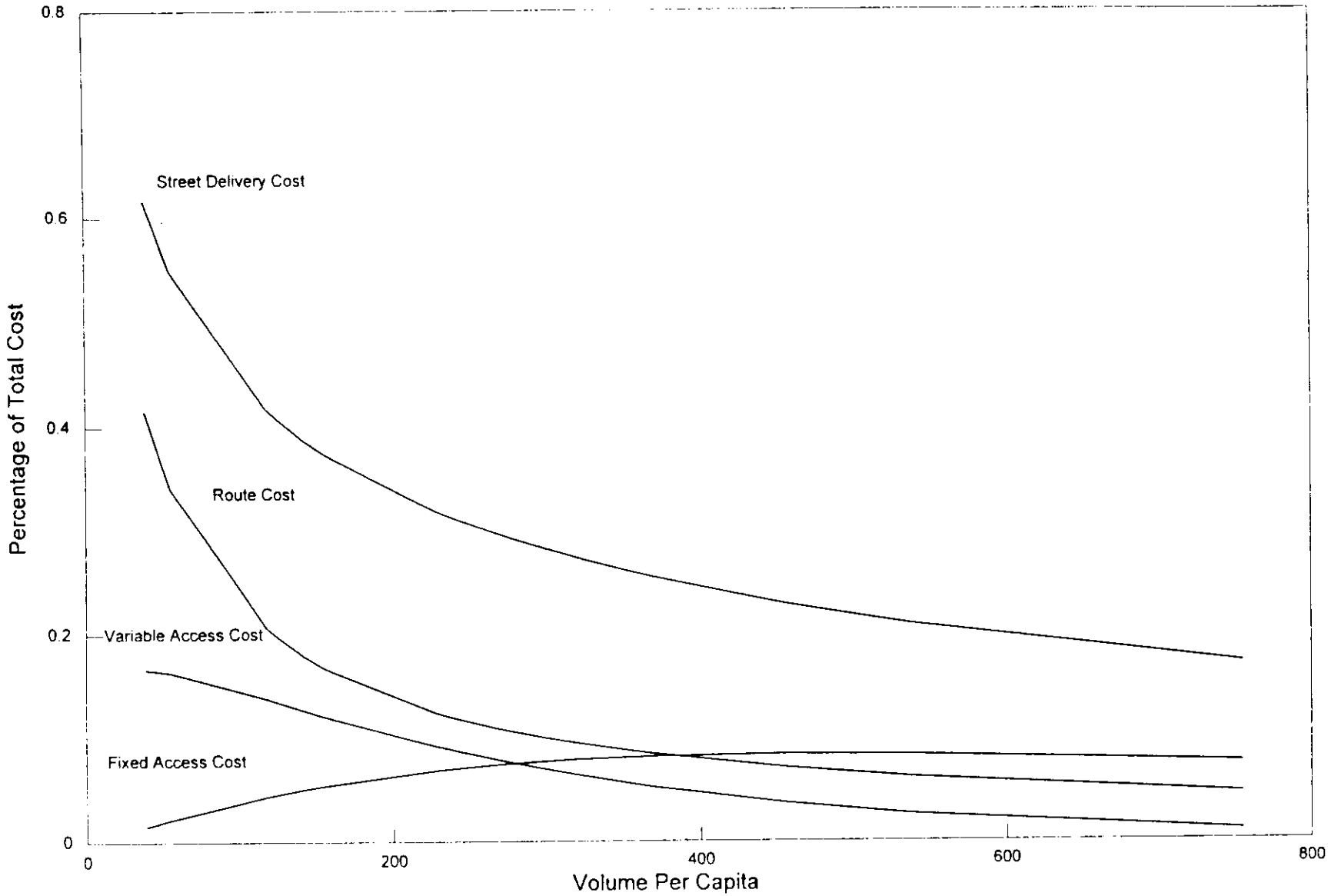


Table 5
Fixed Delivery Costs
(1988)

Country	Coverage (percent)	Street (percent	Fixed (percent)
Australia	65	32	19
Austria	76	27	17
Belgium	64	32	19
Canada	72	29	18
Denmark	77	27	17
Finland	66	31	19
France	70	30	18
Germany	64	32	19
Greece	16	62	43
Ireland	42	41	24
Italy	47	39	23
Japan	50	37	22
Luxembourg	81	25	16
Netherlands	74	28	18
Norway	80	26	17
Portugal	22	55	36
Spain	41	42	25
Sweden	87	23	15
Switzerland	97	17	12
United Kingdom	69	30	18
United States	91	21	14

Note: Assumes fixed costs are incurred only in the delivery function. All other functions are assumed to vary with volume.

For each of the 21 countries in the international data set described above, we calculate the value of scale in the delivery function using the same approach we used for the U.S. with a slight modification. For the U.S., we calculate the value of scale by comparing the cost of a hypothetical duopoly with the cost of a monopoly. This is calculated using volume per possible stops data and the coverage function. For the other 20 countries, we use a slightly different approach because detailed street delivery cost and point of delivery data are not available. We use volume per capita as a proxy for pieces per possible stop and assume that the street delivery cost to total cost relationship of the U.S. is the same for the other 20 countries. See the Technical Appendix for a more detailed discussion of the methodology.

Using the 1988 data, we use the per capita volume for each country to approximate pieces per possible stop. We assume a direct linear relationship between volume per capita and pieces per possible stop. Using the estimates of pieces per possible stop for each country, we then calculate the monopoly and the duopoly costs based on the U.S. costs. We then take the ratio of the value of scale to the monopoly cost and multiply that ratio by the actual total costs for each country to estimate the value of scale for each country.

For example, for the United Kingdom, the value of scale is about $4.46 billion using the U.S. model. In 1988, the total cost for the Postal Service was about $36.5 billion. When we adjust the total cost for the United Kingdom's coverage level, the total cost would be about $26.7 billion. If we assume that all cost segments other than street delivery vary with volume, the value of scale is about 17 percent of the total cost at the United Kingdom's volume and coverage levels. We then apply the 17 percent estimate to the United Kingdom's actual total cost for 1988 ($6.58 billion) to calculate the value of scale.[30] The value of scale for the United Kingdom is about $1.1 billion. Table 6 displays the estimates of value of scale for the 21 countries in our data set. The value of scale ranges from $14 million for Luxembourg to $4.5 billion for the U.S.

A measure of a wage premium can be calculated for each country by comparing the postal hourly wage with the average manufacturing wage in that country.[31] It should be noted that Belgium, Finland and Spain have a negative wage premium according to this measure. The net value of scale is the difference between the value of scale and the wage premium.

[30] The total costs for national postal systems other than the U.S. are expressed in purchasing power parities.

[31] The postal data for calculating the wage premium comes from the above mentioned paper. The private sector data comes from International Comparisons of Hourly Compensation Costs for Production Workers in Manufacturing, 1993, U.S. Department of Labor, Bureau of Labor Statistics, Report 873, June 1994.

Table 6
Comparison of Value of Scale in Delivery
with the Wage Premium in 21 National Postal Systems
($ millions - 1988)

Country	Total Cost	Value of Scale	Wage Premium	Net Value of Scale
Australia	$ 1,308	$ 232	$ 237	$ (5)
Austria	1,087	167	170	(4)
Belgium	1,134	203	(51)	254
Canada	2,561	416	248	168
Denmark	522	79	16	63
Finland	623	108	(107)	215
France	8,043	1,335	1,489	(155)
Germany	7,851	1,402	243	1,160
Greece	242	118	57	61
Ireland	258	65	55	10
Italy	7,313	1,689	141	1,549
Japan	8,455	1,854	3,030	(1,176)
Luxembourg	96	14	21	(7)
Netherlands	1,856	294	86	208
Norway	803	118	58	60
Portugal	402	162	157	6
Spain	1,051	272	(78)	351
Sweden	1,582	209	152	57
Switzerland	1,688	179	344	(164)
United Kingdom	6,582	1,098	1,044	54
United States	36,536	4,528	9,798	(5,270)

Note: Expressed in U.S. dollars based on purchasing power parities.

If the wage premium measure is valid, then seven countries have a wage premium alone which exceeds the value of scale in the delivery function; Australia, Austria, France, Japan, Luxembourg, Switzerland and the United States.

In these countries, it appears that it would be difficult to justify a postal delivery monopoly based on economic grounds. Better understanding of inefficiencies in national postal systems would allow further evaluation of the economic basis for the postal monopoly in the remaining countries.[32]

[32] Sweden and Finland do not have legal monopolies.

TECHNICAL APPENDIX

A. Estimating the Coverage Function

1. Data

We use the FY 1993 data from the Postal Service's City Carrier System (CCS) to model the behavior of access costs. The CCS data base contains a representative sample of street delivery costs, volumes, and delivery point characteristics for city delivery carriers. The CCS FY 1993 data set contains observations from about 300 routes. The Postal Service sampled each route every two weeks over a one year period resulting in about 8,000 route-level observations.

2. The Coverage Model

For this paper, we use a nonlinear regression model that establishes the relationship between volume and coverage. We define "coverage" as the percentage of stops on a route that receive mail. It has been well established that route coverages relate directly to the fixed and variable nature of access cost. The coverage model specification is as follows:

$$COV_i = 1 - e^{-b*PPS_i} \qquad (1)$$

where,

$COV_i = AS_i / PS_i$

AS_i = Number of actual stops on route i

PS_i = Number of possible stops on route i

PPS_i = Number of pieces per possible stop on route i

Since coverage cannot exceed 100 percent, we have specified an exponential function. The regression results from the model are highly significant. The estimated coefficient, b, is 0.6587.

B. Measure of Scale Economies

1. Scale Economies for the U.S.

We measure the returns to scale in the U.S. postal delivery function by first determining the total cost of delivery provided by the Postal Service:

$$SC_m = RC_m + EC_m + f_m * AC_m + v_m * AC_m \qquad (2)$$

where,

SC_m = street delivery cost

RC_m = route time cost

EC_m = elemental load cost

AC_m = access cost (also includes coverage-related load cost)

v_m = variable portion of access cost = $((e^{-b*PPS} * (b * PPS) / (1 - e^{-b*PPS})))$

f_m = fixed portion of access cost = $(1 - v_m)$

m = designates the monopoly case

For the year 1993, street delivery cost totaled about $10.07 billion:

$$SC_m = RC_m + EC_m + f_m * AC_m + v_m * AC_m \qquad (2)$$
$$= 2.95 + 1.91 + 0.8\ (5.20) + 0.2\ (5.20)$$
$$= 10.07$$

Next, we determine the total cost of delivery performed by the Postal Service and a second firm that we assume to be equally efficient. We calculate the cost for each of the two firms in our hypothetical duopoly by adjusting equation (2):

$$SC_{firmi} = RC_m + 0.5 * EC_m + f_{firmi} * AC_{firmi} + v_{firmi} * AC_{firmi} \qquad (3)$$

where,

SC_{firmi} = street delivery cost for firm i

AC_{firmi} = access cost for firm i = AC_m * NCOV

NCOV = new coverage a duopoly firm i = 1 - (COV_m - COV_d)

COV_m = coverage for a monopoly = $1 - e^{-b*PPS}$

COV_i = coverage for a duopoly firm i = $1 - e^{-b*PPS/2}$

v_{firmi} = variable portion of access cost = $((e^{-b*PPS/2} * (b * PPS/2) / (1 - e^{-b*PPS/2})))$

f_{firmi} = fixed portion of access cost = $(1 - v_{firmi})$

The total delivery cost for the duopoly market is simply

$$SC_{duopoly} = 2\ SC_{firmi} \qquad (4)$$

For the year 1993, total street delivery costs for the hypothetical duopoly in the U.S. are as follows:

$$SC_{firmi} = RC_m + 0.5 * EC_m + f * AC_{firmi} + v * AC_{firmi} \qquad (3)$$
$$= 2.95 + 0.5\ (1.91) + 0.52\ (4.19) + 0.48\ (4.19)$$
$$= 8.098$$
$$SC_{duopoly} = 2\ SC_{firmi} \qquad (4)$$
$$= 2 * 8.098$$
$$= 16.2$$
$$\text{Value of Scale} = SC_{duopoly} - SC_m$$
$$= 16.2 - 10.1$$
$$= 6.1$$

The value of scale in the U.S. is approximately $6.1 billion. In 1993, the total cost for the Postal Service was about $48.2 billion. If we assume that all cost segments other than street delivery (i.e., in-office delivery, mail processing, transportation, retail services, and other costs) vary with volume, the value of scale amounts to about 13 percent of the total cost.

2. Scale Economies for 21 Postal Systems[1]

For each of the 20 countries (other than the U.S.) described above, we use a slightly different approach because detailed street delivery cost and point of delivery data are not available. We use volume per capita as a proxy for pieces per possible stop and assume that the street delivery cost to total cost relationship of the U.S. is the same for the other 20 countries.

First, we use volume per capita for each country to approximate pieces per possible stop. We assume a direct linear relationship between volume per capita and pieces per possible stop:

$$PPS_i = (VC_i / VC_{u.s.}) * PPS_{u.s.} \qquad (5)$$

where,

PPS_i = Average pieces per possible stop for country i

$PPS_{u.s.}$ = Average pieces per possible stop for the U.S.

VC_i = Volume per capita for country i

$VC_{u.s.}$ = Volume per capita for the U.S.

For the United Kingdom, for example, we estimate an average of 1.8 pieces per possible stop (with a corresponding coverage of about 69 percent):

$$\begin{aligned} PPS_i &= (VC_i / VC_{u.s.}) * PPS_{u.s.} \qquad (5) \\ &= (264/536) * 3.66 \\ &= 0.49 * 3.66 \\ &= 1.8 \end{aligned}$$

[1]In contrast to the previous section, all data in this section are from the year 1988.

Using the estimates of pieces per possible stop for each country, we calculate the monopoly cost and the duopoly cost using equations (2), (3), and (4) based on the U.S. costs. For example, for the United Kingdom, equations (2), (3), and (4) would result in the following results:

$$SC_m = RC_m + EC_m + f_m * AC_m + v_m * AC_m \quad (2)$$
$$= 2.95 + 0.94 + 0.48\ (4.08) + 0.52\ (4.08)$$
$$= 7.98$$
$$SC_{firmi} = RC_m + 0.5 * EC_m + f * AC_{firmi} + v * AC_{firmi} \quad (3)$$
$$= 2.95 + 0.5\ (0.94) + 0.27\ (2.78) + 0.73\ (2.78)$$
$$= 6.22$$
$$SC_{duopoly} = 2\ SC_{firmi} \quad (4)$$
$$= 2 * 6.22$$
$$= 12.44$$
$$\text{Value of Scale} = SC_{duopoly} - SC_m$$
$$= 12.44 - 7.98$$
$$= 4.46$$

The value of scale is about $4.46 billion using the U.S. model. In 1988, the total cost for the Postal Service was about $36.5 billion. When we adjust the total cost for the United Kingdom's coverage level, the total cost would be about $26.7 billion. If we assume that all cost segments other than street delivery vary with volume, the value of scale is about 17 percent of the total cost at the United Kingdom's volume and coverage levels. We then apply the 17 percent estimate to the United Kingdom's actual total cost for 1988 ($6.58 billion) to calculate the value of scale. The value of scale for the United Kingdom is about $1.1 billion.