ESTUDIO DE EVALUACIÓN EXTERNA AL SISTEMA DE TRANSPORTE PÚBLICO REMUNERADO DE PASAJEROS DE LA PROVINCIA DE SANTIAGO Y DE LAS COMUNAS DE SAN BERNARDO Y PUENTE ALTO

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INTRODUCCIÓN

La Ley N° 20.378 crea un subsidio nacional destinado a compensar los menores pagos que realizan los estudiantes en los servicios de transporte público remunerado de pasajeros. El subsidio establecido tiene un monto máximo de $380,000,000 miles de 2013. En sus disposiciones transitorias la Ley complementa este monto hasta en $360,000,000 miles de 2013 entre los años 2012 y 2022[1]. Ambos montos son ajustados anualmente de acuerdo con la variación del índice de precios del consumidor.

Tanto el monto del subsidio como el aporte establecido en las disposiciones transitorias de la Ley se divide en partes iguales entre 1) la Provincia de Santiago y las Comunas de San Bernardo y Puente Alto, y 2) las demás regiones del país[2].

La Ley crea un Panel de Expertos encargado de determinar el ajuste de tarifas para el transporte público remunerado de pasajeros.

Este informe, dirigido al Panel de Expertos, busca evaluar el funcionamiento del Sistema de Transporte remunerado de pasajeros de la Provincia de Santiago y de las Comunas de San Bernardo y Puente Alto. El objetivo es determinar su eficiencia, sus costos y la pertinencia y montos de los subsidios y aportes establecidos en la Ley N° 20.378, y proponer un ajuste a los montos de subsidio, para su consideración en la discusión del proyecto de Ley de Presupuestos del Sector Público.

Santiago de Chile cuenta con el sistema de transporte público con mayor nivel de integración tarifaria en América Latina

El alto nivel de integración ha sido posible en forma importante gracias al establecimiento del subsidio al transporte público.

El subsidio al transporte público es una política eficiente. El análisis de bienestar justifica subsidios para mantener frecuencias de los buses y dar menores tiempos de espera a los pasajeros, al tiempo que se reduce el uso de automóviles, generando externalidades positivas.

El monto del subsidio definido en 2013 obedece a las condiciones de operación observadas hasta ese momento. Las principales variables de cálculo han crecido más allá del índice de precios del consumidor por lo cual se recomienda cubrir el déficit de 2014, ajustar el monto de los subsidios para 2015 y modificar la metodología de indexación.

Las observaciones y comentarios contenidos en este informe son entera responsabilidad de los autores y no reflejan la opinión de las personas entrevistadas y las instituciones a las que éstas pertenecen.

[1] El monto complementario se reduce en 1% anual a partir de 2018.

[2] El término "las demás regiones" incluye la Región Metropolitana excluyendo la Provincia de Santiago y las Comunas de San Bernardo y Puente Alto.

El informe se realizó con base en información provista por la Dirección de Transporte Público Metropolitano DTPM, revisión de literatura sobre la eficiencia de subsidios al transporte público y entrevistas a personal y asesores del Ministerio de Transporte y Ministerio de Hacienda.

El informe incluye un resumen ejecutivo (en español) y un análisis más detallado de las condiciones y evolución del subsidio (en inglés).

RESUMEN EJECUTIVO

Lo Planificado

El sistema de transporte público remunerado de pasajeros de Santiago (que recibió el nombre de Transantiago) fue planeado como un sistema integrado multimodal, con una estructura tronco-alimentada. Los servicios troncales serían proporcionados por el metro y nuevos corredores de buses con segregación del resto del tráfico, intercambios bien diseñados, y redes de buses alimentadores. Los servicios reestructurados se otorgarían por licitación, para cambiar la competencia en la vía por competencia por el mercado. La operación se realizaría con un número reducido de buses, ambientalmente superiores y con mayor rendimiento operacional, de forma que se reduciría substancialmente el impacto ambiental, los accidentes y la congestión vial. Las tarifas serían totalmente integradas y su recaudo sería administrado por un operador separado. En teoría, la eficiencia del sistema permitiría el cubrimiento total de los costos de operación y adquisición de buses con tarifas a los usuarios –no existirían aportes públicos (subsidios).

¿Qué pasó?

La operación de nuevos servicios e integración tarifaria se puso en marcha sin contar con infraestructura suficiente para segregación de buses troncales y para integración entre distintos servicios (buses alimentadores, buses troncales y metro). En estas condiciones las velocidades de operación fueron menores a las previstas. Al mismo tiempo el control de la operación inicial fue insuficiente. En estas condiciones la oferta real de servicio fue menor a la esperada (fallas de cubrimiento, frecuencia y confiabilidad).

La oportunidad de integración con el metro y la baja calidad de servicios en la superficie hicieron que muchos usuarios usaran el metro, que tuvo que soportar ocupaciones extremas. Al mismo tiempo se generó una fuerte evasión de tarifas. Para superar la crisis se ordenó incrementar la flota (1000 buses adicionales). Con el tiempo se realizó un ajuste a los servicios, alejándose del concepto tronco-alimentador, en la medida que no se realizaron las inversiones en facilidades de intercambio. Al mismo tiempo, se ajustaron incentivos contractuales para mejorar el control operativo y trasladar riesgos comerciales a los operadores (al menos parcialmente).

¿Qué estuvo bien?

El nuevo sistema permitió la renovación de la flota de buses por equipos de mejores características técnicas y desempeño ambiental. El número de unidades final fue menor al total inicial, incluso después del ajuste para mejorar oferta.

Como consecuencia de estos dos efectos, las emisiones de contaminantes del transporte público y los accidentes de tráfico son mucho menores, generando impactos sociales significativos. Las condiciones laborales de los conductores son mejores que en el sistema

desregulado que se reemplazó. El sistema integrado de recaudo funciona bien, aunque persisten quejas por puntos de recarga insuficiente.

¿Qué estuvo mal?

La insuficiencia del servicio de bus en la puesta en marcha de Transantiago en 2007 fue inmediata y evidente. A pesar de las medidas correctivas adoptadas a lo largo del tiempo (mayor flota, mayor control y mejores incentivos), se mantiene una mala percepción de los usuarios y el público en general, como consecuencia de las precarias condiciones iniciales.

El efecto inmediato de la crisis de oferta fue un cambio de modo: de buses a automóvil, taxi colectivo y metro. El mayor número de automóviles y taxis colectivos aumentó la congestión, con una consecuente reducción en la velocidad del tráfico (afectando también la eficiencia en la operación de los buses). Al mismo tiempo se dio una sobrecarga excesiva en el sistema de metro.

A pesar que es posible observar buses con alta ocupación en algunos segmentos y algunas ocasiones, la productividad general de los buses (pasajeros que abordan por kilómetro recorrido o IPK) es baja en promedio. Esto sugiere oportunidades de mejora en la estructura de los servicios.

La expectativa inicial de auto-suficiencia financiera no se cumplió. En este marco, el Congreso autorizó un subsidio permanente, principalmente dirigido a la población estudiantil.

Más recientemente la situación financiera se ha deteriorado aún más, como resultado de ampliaciones al subsidio estudiantil, incrementos a los precios del combustible, deterioro de la tasa de cambio, y aumentos de flota (consecuencia de menores velocidades por congestión del tráfico). Por otra parte la evasión de tarifa se ha mantenido alta en comparación con otros sistemas de transporte público.

¿Qué hacer de forma inmediata?

En el muy corto plazo existen tres opciones principales – aumentar las tarifas, reducir el servicio ofrecido, o aumentar el subsidio.

Aumentar las tarifas es inaceptable en las condiciones actuales (la calidad del servicio percibido es bajo, y aumentos de tarifa han resultado en mayor evasión).

La reducción de servicios es inconveniente en el corto y mediano plazo. En corto plazo agrava la percepción de calidad; en mediano plazo incentiva el cambio de modo a autos y taxi colectivo, aumentado la congestión, contaminación y niveles de accidentes. Para población de bajos ingresos significa dificultades de acceso y aumento de la segregación social.

Nuestra opinión es que el análisis del bienestar general justifica importantes subvenciones para mantener la oferta; en particular alta frecuencia de servicio. Esto genera menores tiempos de espera para los pasajeros, y desincentiva su paso a vehículos privados. Como consecuencia se reduce la congestión y externalidades asociadas: contaminación y accidentalidad.

En el corto plazo, consideramos necesario el aumento del nivel de subsidio. De acuerdo con la revisión de información disponible el efecto agregado de incremento de combustible Diesel, tasa de cambio y costos del Metro, el déficit adicional de 2014 es de $75,133 millones comparado con el de 2013.

Este valor debe cubrirse con recursos de presupuesto adicional.

Para evitar esta situación de déficit en el futuro, sugerimos modificar el mecanismo de ajuste de tarifas y subsidio estabilizador relacionado con el **verdadero costo de las variables clave –costo de combustibles, tasa de cambio, tamaño de flota, e inversiones del Metro.** Esto porque la revisión anual del valor del subsidio sólo se realiza con índice de precios al consumidor y resulta incorrecto.

Adicionalmente y en la medida de lo posible, recomendamos se busque que:

1) La carga del subsidio que compensa los menores pagos que realizan los estudiantes en los servicios de transporte público remunerado de pasajeros quede en el presupuesto del Ministerio de Educación;
2) Se realice una revisión adicional a los incentivos contractuales a los operadores para manejar la evasión de tarifas, buscando aumentar su manejo del riesgo comercial. Esto porque los operadores concesionados no tienen control sobre la definición de tarifas.

¿Qué hacer en el mediano plazo?

En el mediano plazo sugerimos medidas para:

1) Optimizar la eficiencia operativa del sistema
2) Mejorar el destino del subsidio (actualmente el subsidio no es necesariamente redistributivo), y
3) Explotar nuevas fuentes de ingresos que no generen distorsiones (por ejemplo, mayores cargos por estacionamiento, introducción de cargos por congestión, y mayor aprovechamiento de valor inmobiliario generado por mejor acceso)

Para la optimización del sistema, creemos que el concepto de tronco y alimentador que se propuso originalmente para Transantiago sigue siendo válido, pero que **necesita una inversión sustancial para mejorar la segregación de los buses troncales y en las instalaciones de intercambio entre metro, buses troncales y buses alimentadores**. Entendemos que este es el principal enfoque del programa de inversión ya anunciado[3], cuyos efectos serán visibles en la medida que avancen las inversiones en los próximos cinco años.

Así mismo sugerimos revisar las estructuras de servicios (posiblemente con el uso de vehículos más pequeños para mantener frecuencias para servicios de alimentación), en la medida que se avance en infraestructura de intercambio y se mejoren las condiciones de operación de servicios troncales.

Para mejor eficiencia y focalización de subsidios se recomienda revisar el sistema de tarifa plana. Se sugiere evaluar la adopción de un sistema zonal acompañado de subsidios a la demanda de los grupos de menores ingresos en lugares remotos (por ejemplo mediante el Sistema Chile solidario). Un esquema de este tipo puede mejorar la eficiencia del sistema (atrayendo viajes cortos, actualmente más caros) y aumentar los efectos redistributivos y el acceso a la población más pobre.

[3] Ver https://www.mtt.gob.cl/archivos/7358.html

INTRODUCTION

The purpose of this exploratory review is to give an opinion on what policies might be appropriate to handle the increasing deficits being incurred by the Santiago public transport system (Transantiago) in a context where it is perceived to be politically very difficult to increase fares so soon after the recent substantial fare increases.

While increases in subsidy are not the only alternative policy available (for example the deficit could be reduced by reducing fare evasion, increasing vehicle speeds through investment in bus segregation or selective adjustment of frequencies and bus sizes) it is on the issue of the acceptability of increased subsidy that the focus seems bound to rest in the short term. Still deficit reduction strategies are required in the medium and long term.

We would therefore start by exploring what are the relevant benefits and costs of subsidies to public transport, referring to international experience, and then attempting to elicit the implications of those arguments and that experience for Santiago.

> **Increases in subsidy are not the only alternative policy but it is the focus on the short term. Other policies to improve efficiency shall be adopted in the medium term**

HOW IS SUBSIDY MEASURED?

In purely formal – and legal – terms, a subsidy is usually defined as any payment made to a producing agency to cover a deficit of its full revenues compared to its full costs of producing its product. In practice this is complicated by two important issues on which international practice varies greatly.

The first concerns what costs should be included in the measurement of public transport subsidy. In many cases, particularly with metros, capital costs are carried entirely on central government budget, and not on that of the operator. For that reason it is common to calculate the rate of recovery of operating costs alone, rather than coverage of full costs including the servicing of the infrastructure, which can be up to double the operating costs.

With the requirement that the Santiago metro company finances one third of the capital costs of expansion with the user fare, it appears that the apparent operating costs of Santiago are substantially inflated compared with those of other metro companies. In a contrary sense it has been suggested to us that the real costs of metro are understated by the absence of any provision for depreciation. While that, in itself is just an accounting matter, the absence of a corresponding provision of a replacement reserve would certainly threaten the need to return eventually to government for support of rolling stock and other fixed asset renewal in the future.

It has been suggested to us that a similar issue arises in respect of the terminals (garaging and repair facilities) of the bus contractors. This seems to us to be a slightly different issue. In most (but not all) bus franchising systems the operators maintain their vehicles in facilities which they own, the costs of which are included in their franchise bid prices, and viewed as part of operating costs. In our view the problem in Santiago is not that this inflates the apparent amount of subsidy compared with other cities, but that given the small number of franchises and the large size of the contracts ownership of the garaging facilities by the operators gives a very large advantage to the incumbent in the retendering process, so that effective competition, and its effects on efficiency, are reduced.

> **Capital costs of metro and garages for bus operators are currently included in the operational cost of the system and thus in the current level of subsidy**

The second concerns what revenues should be included in calculating public transport subsidy levels. As in Chile, many countries provide, and often legislate for, concessionary fares for various categories of traveler – most notably children, students and old people. However, in many cases it is required that the public transport operator should be directly compensated for the costs of such discounts on the full fare by the agency mandating them. For example, in the United Kingdom the statutory provisions of concessionary fares for pensioners are financed directly by central government.

We understand that the rationale for the initial subsidy law was to compensate Transantiago for the costs of the student subsidy so that the burden would not be carried by other passengers. However, the availability of student fare card has been expanded considerably since that time, without any subsequent analysis of the impacts of this on the appropriate compensating subsidy. There is believed to be a substantial misuse of the student fare cards, though there is little direct evidence of this. Furthermore, the administration of the student fare cards by the Ministry of Education, which has no financial responsibility for the costs of its actions means that there is little incentive to control the costs of the arrangement.

It has been suggested to us that, as the revenue losses (from misuse of student cards) fall predominantly to the operators, this abuse does not directly affect the financial balance of Transantiago. While this may be true in the short run, in the longer term it creates financial difficulties for the operators and will certainly be reflected in the bids in subsequent rounds of tendering. Taken together these arguments suggest to us the need to consider

1) the need for a further comprehensive review of the impact of student subsidy arrangements on the financial balance of Transantiago
2) transfer of the estimated cost and responsibility for it to the budget of the Ministry of Education, with payments from that ministry to Transantiago then appearing transparently as fare revenue for the transport system.

In many international cases it is required that the public transport operator should be directly compensated for the costs of discounts on the full fare by the agency mandating them

INTERNATIONAL COMPARISONS

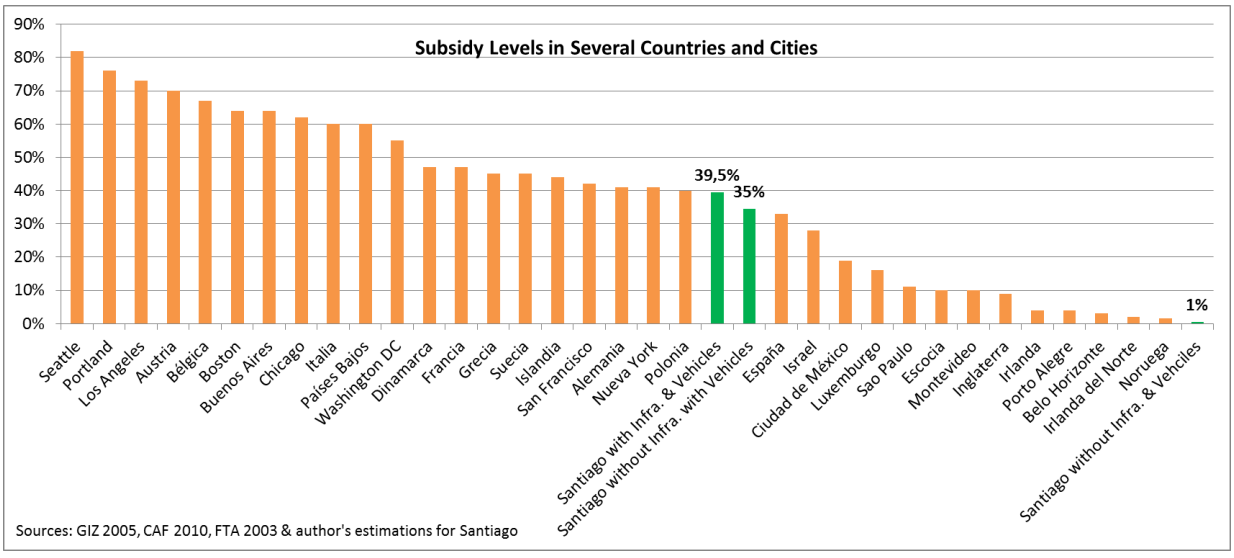
Subsidies to public transport systems are large in the developed world; for example, they reach around 70 percent of operational cost on average for the largest 20 cities in the US (Parry and Small 2009). Similar figures are found in other developed nations (see Kenworthy and Laube 2001, Elgar and Kennedy 2005). The reality is quite different in the developing world. In Latin America, for example, subsidies are zero in most cities, with the only exceptions of Buenos Aires (65 percent), Montevideo (10 percent) and Brazilian cities (CAF, 2010).

The coverage of operating costs from fares is shown in the table below for a number of urban public transport systems in the world, and compared with the presently reported deficits of Transantiago. We present the full deficit (39.5% in 2013) and two corrected values: 1) excluding infrastructure (35% in 2013) and 2) excluding infrastructure and vehicles (many properties exclude capital cost of vehicles or its replacement form the operational costs).

What can be seen from this table is that the level of deficit currently being experienced by Transantiago, while high by Latin American standards is not high by world standards.

Of course, the fact that other countries subsidize urban public transport does not, of itself justify the pursuit of such a policy by Chile. What is important, however, is that these other countries believe that there are benefits from subsidization of urban public transport, of a magnitude to justify their level of subsidy. It is therefore appropriate to examine what these benefits are and whether they also apply to Santiago.

The level of deficit experienced by Transantiago is not high when compared with world standards



Sources: GIZ 2005, CAF 2010, FTA 2003 & author's estimations for Santiago

SUBSIDY IN THE SANTIAGO PUBLIC TRANSPORT SYSTEM

The system

The Santiago Integrated Public Transport System (known as Transantiago) is a combination of metro (own by the government) and bus services (owned by private operators) offering coverage in 32 comunas in the Santiago Metropolitan Region. Main characteristics are presented in the table below.

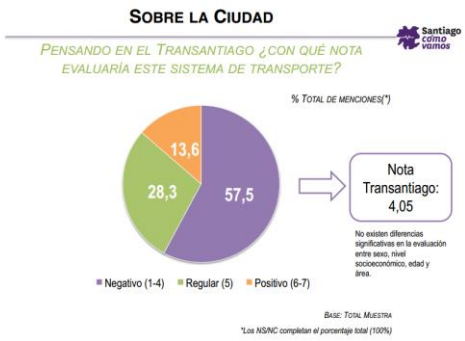
Bus services were originally structured into a trunk and feeder network in which nine feeder operators enjoyed the exclusive provision of services in an area of the city, while five trunk operators enjoyed the exclusive provision of services in a set of corridors. Contract modifications reduced the number of operators to seven in 2012.

Initially, a private consortium composed by the most important banks in Chile and a technological operator composed the Technological and Financial Administrator of Transantiago (AFT) which provided the magnetic payment card, its charging network and the card validating devices in all of the buses, as well as management of the funds gathered through the fares. The fare collection services are now offered by Metro de Santiago.

The system captured worldwide attention after its premature implementation in February 2007, before most of the infrastructural and systems conditions required by its designers were in operation. For a thorough revision of the design and implementation of Transantiago we refer to Munoz et al, 2008.

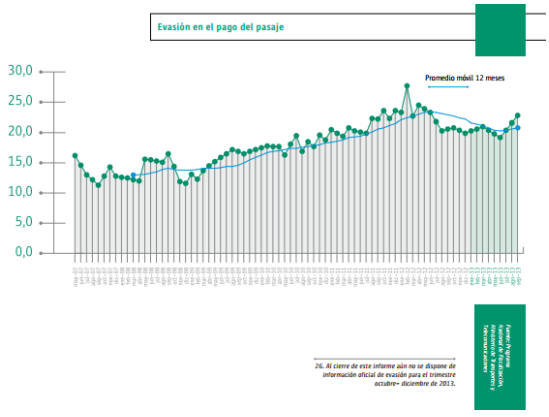
Over the last seven years the system has evolved, and now is the most advanced integrated public transport service in Latin America (Munoz, et al. 2013). Still it has many issues outstanding reflecting the initial difficulties, the contractual scheme (which has been modified based on direct negotiations with the private operators), and the lack of investment in facilities for bus priority and passenger interchange.

User perception remains a strong issue, with an overall rating of 3.1/7.0 according (ICCOM, 2014) and 4.05/7.00, according to (Santiago Como Vamos, 2013).



Source: Santiago Como Vamos (2013)

Fare evasion has remained an issue despite great efforts to curb it down, probably still reflecting the initial difficulties and lack of incentives for the private operators to control it (Torres-Montoya, 2014). Renegotiation of contracts in 2012 resulted in better alignment of incentives.



Source: DPTM (2013) Informe de Gestión

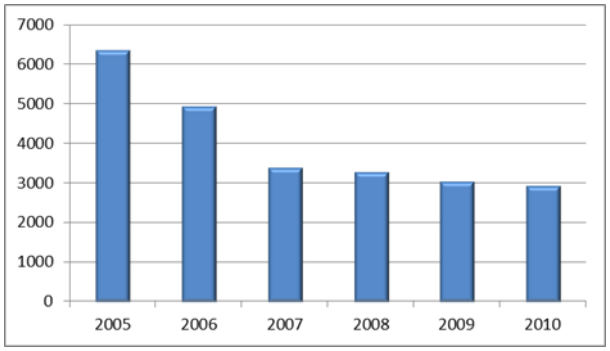
Transporte Público Santiago 2013	Fuente: http://www.dtpm.gob.cl/archivos/Memoria%202013-Web_Final%20(1).pdf
Área de Cobertura	34 comunas Región Metropolitana 1680 km2
Sistema Tarifario	100% integrado
Sistema de pago	Tarjeta sin Contacto/Tiquetes Magnéticos (M)
No. De Tarjetas	4,906,630
Transacciones	1,678 millones por año 5.6 millones/día laboral
No. Operadores	7 operadores de buses, 1 operador metro
Intercambiadores	6 estaciones de intercambio modal
Recaudo bip!	1,492 puntos de recarga, 75 centros bip!
	108 cajas Metro, 535 totems, 5 centros atención
Transacciones Buses	1,010 millones por año 3.3 millones/día laboral
Oferta Buses	6,493 buses, 368 servicios, 464 millones km por año
Red vial cubierta buses	2,770 km, 11,271 paradas
	68 km segregados, 31 km exclusivos, 119 km pistas
Transacciones Metro	668 millones por año 2.3 millones/día laboral
Equipos Metro	186 trenes, 1093 coches, 194429 plazas, 143 millones km/año
Infraestructura Metro	5 líneas, 104 km, 108 estaciones,

System Impacts

Despite the initial difficulties, the implementation of the integrated public transport system has resulted in reduced accidents and improved air quality in the metropolitan region.

According to the statistics by CONASET the number of crashes involving public buses in Santiago has reduced from more than 6,000 in 2005 to less than 3,000 in 2010. Similar reductions have been reported for fatalities and injuries.

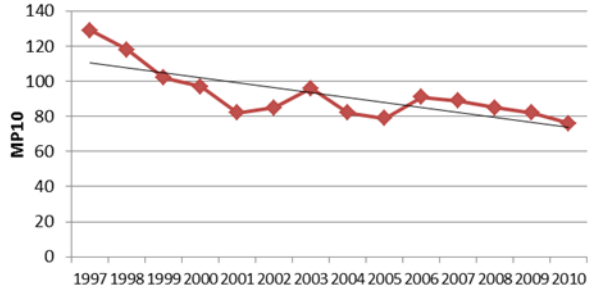
Traffic Crashes in Santiago 2005-2010



Source: CONASET, 2012

Air quality has also improved as a result of reduced emissions from public transport buses. The total fleet and the total mileage have reduced, but also the fleet has steadily improved.

Average Concentrations PM10



Fuente: Elaboración propia, en base a datos de la Seremi de Salud RM

Source: Figueroa et al. 2012

Costs

Total system costs, as reported by DPTM were $909,052 million pesos. This includes costs of the seven private bus operators, the AFT and Metro.

Tabla 2-e: Costos totales del Sistema
(Expresados en millones de pesos de diciembre de 2013)

	2009	2010	2011	2012	2013
Trim.1	173.613	180.695	192.838	202.894	200.675
Trim.2	206.495	231.009	239.802	232.705	233.564
Trim.3	209.852	223.680	227.527	223.408	231.458
Trim.4	213.756	228.693	241.895	232.110	243.356
	803.717	864.077	902.062	891.118	909.052

Revenues and Deficit

System operational revenues were $550.366 million. Total deficit in 2013 was $358,686 million.

Tabla 1: Ingresos operacionales totales
(Expresados en millones de pesos de diciembre de 2013[i])

	2009	2010	2011	2012	2013
Trim.1	95.540	96.180	127.277	129.712	129.419
Trim.2	102.554	119.889	138.306	138.827	140.480
Trim.3	103.900	132.388	134.190	139.050	137.251
Trim.4	106.471	133.830	136.105	143.234	143.216
	408.465	482.287	535.877	550.823	550.366

Cost Dynamics

The drivers of the bus costs, according to the established methodology, are Fuel (Diesel), Labor, Consumer Price Index, Lubricants, Tires, Exchange Rate (US and Euro), Imported Price Index Industrial Sector. There have been important changes in two of these indexes between 2013 and 2014: Fuel and Exchange Rate.

In addition, the increased congestion in Santiago has resulted in decrease in bus speeds and the need to expand the bus fleet to keep the bus frequency constant.

Finally, the introduction of air conditioning in Metro and the construction of Lines 3 and 6, results in additional costs per passenger.

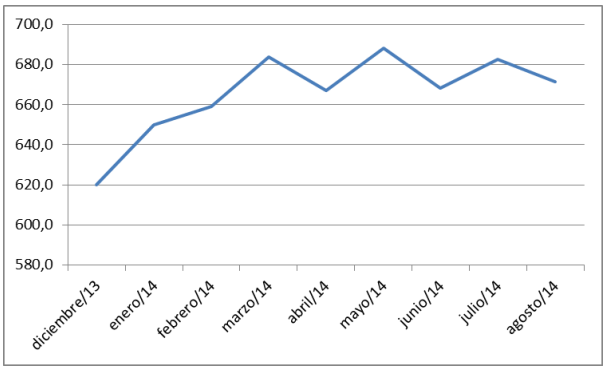
The following subsections provide further information regarding these issues.

Fuel

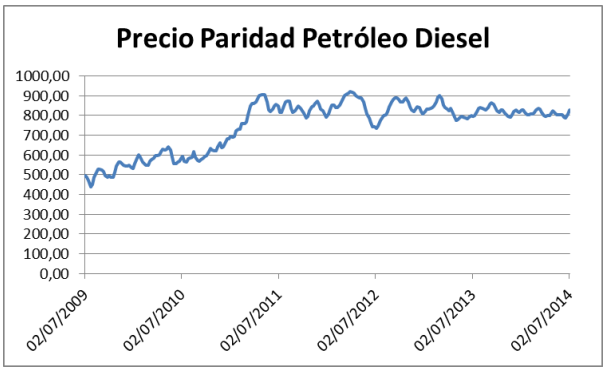
According to the formulas established in the concession contracts, Diesel fuel represents between 14% and 25% (average 22%) of the total costs per kilometer (DPTM).

Diesel cost has increased 8,28% between December 2013 and August 2014 (http://www.cne.cl/estadisticas/energia/hidrocarburos), which result in a 1,16%-2,07% increase in the total cost (depending on the type of vehicle).

Diesel Price per Liter Dec 2013-Aug 2014



Source: http://www.cne.cl/estadisticas/energia/hidrocarburos



Source: http://www.cne.cl/estadisticas/energia/hidrocarburos

Exchange Rate

The USD exchange rate represents 12,33% of the costs and the Euro exchange rate represents 2,46% of the costs (DPTM, Decreto 140).

According to the Central Bank of Chile statistics, the USD exchange rate has observed a variation of 10,54% between July 2013 and July 2014.

This represents an increase of 1,30% in the total cost of buses.

Source: http://si3.bcentral.cl/Siete/secure/cuadros/arboles.aspx

Fleet size

To keep bus frequency at the current levels in an environment of increased congestion it is required to expand the bus fleet.

According to estimations by DPTM, the contribution of bus fleet increase, results in an additional $19,415 million in costs from 2013 to 2014 (5,47%).

Metro Costs

Cost per passanger (transaction) in 2013 was $302,06 (DPTM).

The introduction of Air Conditioning increased the cost in $9,12 (3,01%).

The construction of Lines 3 and 6 increase the cost per passenger in $55,50 (18,37%). This increase corresponds to the third of the capital costs which is charged to the operation (passengers).

The construction of Lines 3 and 6 also increases air conditioning, by $7,78 (2,58%).

As a result the total increase in passenger cost is $62,28 (20,61%).

Aggregate Effect

The combined effect of the different drivers in the cost per passenger has a direct effect in the level of subsidy.

The subsidy law does not account for these different effects. The level of subsidy is only increased with the consumer price index.

As a result there is a **structural deficit** in the level of subsidy.

According to estimations by DPTM reviewed by the consultant team, the aggregate effect of increases in Diesel Fuel, Exchange Rate, Fleet Increase and Metro Costs, results in about $75,133 million additional deficit in 2014 as compared with 2013.

This is a 21,15% increase in the system deficit while the consumer price index grew 4,73% between July 2013 and July 2014 (http://si3.bcentral.cl/Siete/secure/cuadros/arboles.aspx).

Options

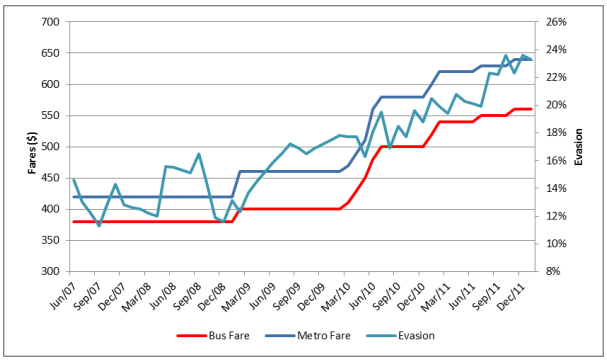
To face the increased costs of provision of the public transport service, government has three options: increase fares, reduce costs or increase subsidy. A combination of the three measures may be also applicable.

Increase Fares

Fare increase places the burden of increased costs in the passengers. In 2010 due to the end of the previous subsidy authorization, fares were increased to cover the growing deficit.

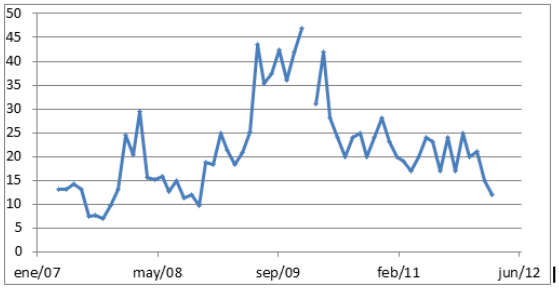
The result was a reduction in passenger demand (further eroding the system finance), an increase in fare evasion, and a reduction in passenger satisfaction.

System Fares and Evasion in 2007-2011



Source: Transantiago 2012

Transantiago Approval Rates 2007-2012



Soruce: Adimark 2010; 2012, Cited by Munoz et al. 2013

If fares are increased again as they were in 2010, one can expect a negative reaction by the public given the current low level of approval of the system (53%, ICCOM, 2014). An increase in evasion is also likely; further eroding the system revenues (the improved

control in fare evasion observed in 2012 and 2013 can be lost).

Cost Reductions

Costs can be reduced by reducing service (coverage or frequency) or by increasing productivity.

Reducing service (vehicle-km) under the current routing may result in increased walking and waiting times. As these are critical variables for passenger attraction, one can expect a demand reduction.

Reducing service results in a negative spiral and is not advised, as passengers will reduce their welfare or shift to unsustainable modes (shared taxi, motorcycle or private car).

Productivity can be increased from the current relatively low levels (IPK is around 2 passengers boarding per kilometer). Nevertheless this may require a reorganization of services, going back to the feeder-trunk scheme.

This also requires substantial investment in infrastructure for dedicated bus lanes (Bus Rapid Transit) and interchange facilities (to make passenger transfers seamless and convenient). These capital investments have been announced, but they will take time to complete.

As a result productivity increases are not possible in the short term; but they are important in the medium and long terms.

Increased Subsidy

Subsidy is currently increased by the consumer price index. This has proven insufficient as the cost drivers have increased 5 times faster.

Rather than placing the burden of cost increases on the passengers (which they are not able to control), government may consider adapting the subsidy level to external shocks. The formula for adjusting subsidy levels may include the cost of fuel, the exchange rate, the impact of congestion in bus speeds (and thus increased bus fleet) and the costs of metro capital improvements.

Furthermore, it would be important to make transparent the capital costs of metro currently included in the subsidy, as they are not covered fully covered by passengers (as initially intended) but from the system subsidy.

Recommendations

Our view is that general welfare analysis justifies subsidies to maintain frequency, providing lower waiting times for passengers and lower road congestion for car users (see analysis in the following sections).

We suggest that subsidy increases should be accompanied by (a) shifting the burden of student subsidies to the Ministry of Education budget, (b) introduction of a stabilizing fare and subsidy adjustment mechanism related to the real cost drivers of the system, and (c) adjustment of the incentive mechanisms within the contracts. We suggest increasing penalties to operators for tolerating fare evasion, without forcing them to assume the majority of revenue risk over which they have relatively little control (as fares and frequencies are fixed for them in the contracts).

In the longer term it is suggested that measures should be taken (i) to optimize both the operational efficiency of the system (ii) to better target of subsidies and (iii) to exploit new non-distortionary revenue sources.

For system optimization, we believe that the original trunk and feeder concept is still valid, but that it needs **substantial investment in increased and improved segregation of**

buses on the trunk routes and in interchange facilities between trunk and feeders.

We would recommend that this be the focus of the large investment program already announced. Route structures should be revised (possibly with use of smaller vehicles to maintain frequency for feeder services) only as the infrastructure becomes ready to support it.

For better targeting of subsidies we recommend that the flat fare system be replaced by a zonal system with the "Chile Solidario" system used to give direct subsidies to lower income groups and those in remote locations (see discussion in the sections "Distributional Effects" and "Quantifying the Issues").

For financing we recommend that consideration be given to designing developer contributions to the capital cost of metro extensions and more generally the introduction of a road congestion charging system as a source of finance for bus services (see discussion in the sections "Distributional Effects" and "Quantifying the Issues").

THE BENEFITS OF PUBLIC TRANSPORT SUBSIDIES

Any subsidy instrument in public transport may have benefits in three dimensions – the efficiency of the transport system, the environmental impact of the system and the distribution of costs and benefits of the system.

Efficiency impacts

In assessing the efficiency impact three types of effect have traditionally been examined:

1) ***The effect on road congestion achieved through transfer of passengers from car to public transport.*** It is presumed that a general transport model will be capable of assessing the time and cost saving effects of different levels of private car demand. But it also requires estimation of the cross elasticity of demand between car usage and public transport fares. This has usually been found to be relatively low (around 0.1). While it may be possible to obtain an estimate of this elasticity from the calibration of the general demand forecasting model, it is probably more efficiently (and economically) estimated through a free standing stated preference analysis.

   Peak costs raised some special problems in this respect. The "second best argument" for public transport subsidy depends critically on the gap between price and marginal social cost of movement being greater for private than for public transport. With congestion and without congestion pricing, it is clear that there is a gap for private transport. But it has also been shown that, because of the need for extra vehicles and crew to be employed specifically to meet peak demand, the same is also true for public transport.

   That would appear to make the case for urban transport peak subsidy depend on the level of congestion and on the level of peak/off-peak demand disparities in each particular situation. However, it was also suggested that for all U.K. municipal undertakings providing for the peak had a deleterious effect on the finances of the supplying company, so that, given the under-pricing of road use, the case for urban transport peak subsidy was robust (Tyson, 1972).

> Given the under-pricing of road use, the case for urban transport peak subsidy was robust

   Similarly, a study of Belgian cities, concluded that while optimal prices for private transport would rise by 150% in the peak period, those for public transport would also rise by 22%. By implication, however, if private transport prices were not raised a compensating subsidy of public transport would be appropriate (de Borger, Mayeres, Proost and Wouters, 1996).

2) ***The effect on passenger waiting times (the "Mohring" effect).*** The increased use of public transport generated by subsidies may justify increased frequencies which reduce passenger waiting times (Mohring, 1972). This generates beneficial time savings to users. Where frequencies are high and arrivals at stations random the time savings per passenger may be

simply estimated as half the reduction in headway.

This benefit can then easily be estimated in a general transport model. But where headways are large the user response may be to reschedule activities to minimize wasted time. If this occurs, the "optimal deficit per passenger" may be higher for urban high frequency services than for lower frequency services.

An interesting parallel may be drawn here between the conventions for appraisal of road investments and the appraisal of public transport subsidies which increase service frequencies. Both involve the expenditure of public funds to yield uncharged for benefits in time savings to users, though with different distributions of benefit. The relation between optimal price and service frequency was discussed by Jansson (1979). More recently, Jara Diaz and Geschwender (2009) have shown that a self-funding requirement will result in a transit system with lower frequencies and larger buses than is optimal.

Conventional appraisal of road investments involves expenditure of public funds to yield uncharged benefits in time savings to users. But distribution of these benefits is different than the case of public transport subsidy

3) ***Economies of scale.*** Where costs are decreasing with scale, marginal cost is less than average cost, and short term welfare maximization appears to justify a subsidy to allow prices to be set equal to marginal cost.

   The weakness of this argument is that there may be many public utilities for which a subsidy might be justified on these grounds, yielding an unsustainable burden on the public budget. In these circumstances there would need to be some other arguments as to why the subsidy should be applied to transport rather than to other products or services.

   However, the argument may have some greater significance if applied within the sector. In multi-modal systems there may be greater economies of scale in rail than in road based modes. Train (1977) argued that this might imply cross-subsidy from the mode with the greater returns to scale, and showed, with reference to the San Francisco Bay area, how the optimum level of cross subsidy could be estimated. This is directly relevant to the case of Santiago, with the implication being that the metro should be subsidized to perform the trunk carriage role within the multi-modal system.

Environmental impacts

A range of impacts of transport affecting Santiago can be classed as environmental:

1) ***Global warming*** is now widely recognized as being not only real but also anthropomorphic. While there is a range of gases which contribute to the effect, the production of carbon dioxide in the burning of carboniferous fuels is the most important contributor associated with the transport sector.

The extent of the impact is thus fairly directly related to the total consumption of carboniferous fuel in the sector

2) ***Local air pollution*** is the most directly perceived impact. As with global warming there is a range of emissions contributing to local air pollution, with differing health effects in terms of morbidity and mortality. In developing countries, and certainly in Chile, the most significant impacts come from suspended particulate matter, PM10 and particularly from the fine particulate matter PM2.5. The extent of the local air pollution impact is generally believed to be a function of the amount of traffic, but to depend most critically on a combination of the vehicle technologies adopted, the quality of fuel used.

3) ***Noise*** is also of growing concern in some situations, but seems unlikely to be effected significantly at the margin by the changes resulting from any general transport subsidy scheme. It is a function of the amount of traffic and the vehicle technologies used.

4) ***Traffic accidents*** were a great concern in Santiago in the pre-Transantiago period, associated particularly with aggressive driving behavior resulting from an excessive number of buses engaged in direct competition for passengers on the road.

These impacts have without doubt been reduced in various ways by the implementation of Transantiago. Shift of trips from private to public transport – often thought of as the primary objective of public transport support – appears to have played a relatively small role.

Transantiago has been effective in reducing greenhouse gas emissions, air pollution and accidents. These impacts were part of the initial plan

This is partly because reductions in real fares have little leverage because of the low cross price elasticity of demand, and partly because there has been little perceived improvement of the quality of public transport. What has happened, however, is that there has been an increase of use of the metro, a sharp reduction in the number of buses on the street, the elimination of predatory driving practice and a substantial improvement of bus technology.

Despite the well documented defects in initial implementation, which has a continued adverse effect on consumer perception of the system, it should be noted that all of these contributions to the improvement of the environment were part of the initial plan.

In assessing whether the environmental impacts should form part of a case for subsidy, the critical questions are:

- the extent to which these beneficial effects can be attributed to subsidy of the system, and,
- the extent to which the benefits will be lost if the increasing costs which are driving the increased operational deficit are not covered by an increase in subsidy.

On the first issue, subsidy appears to have had no initial role. The reform in the franchising system which reduced the number of buses, increased their quality, and increased the use of metro within an integrated fare system, was designed to operate without subsidy.

As will be discussed later, the deficits appeared not as a design feature of the system but as a consequence of the expanding student concessions, the inclusion of a proportion of the capital charges of the metro extension within the Transantiago account, and, particularly, the failure of the fare and subsidy system to adjust to adverse movements in the external factors of fuel prices and the dollar exchange rate.

On the second issue, despite the absence of subsidy as an initial driver of the features of environmental improvement, it is not at all certain what would happen without an increase of subsidy to cover the deficits driven by the external pressures. If, in the short run, neither fares nor subsidy can be increased some other expedients would be required.

While in the longer term we believe that there is scope for improved efficiency in the use of vehicles (see below), in the short term it is likely that there would need to be reductions in vehicle kilometers operated which would further damage the perception of the quality and validity of the system, and contribute to increased private car use. But it does not seem likely that it would roll back the improvement in vehicle quality.

Distributional effects

Income distribution is clearly a serious issue in Chile. In terms of the most common measure, the Gini coefficient (see below for further discussion), with a post-tax and redistribution measure of 0.50, Chile is about the median amongst Latin American countries, but had the most unequal distribution of income among 38 OECD member countries in 2009.

Reducing costs by shortening supply would further damage the perception of quality and contribute to increases in private car use.

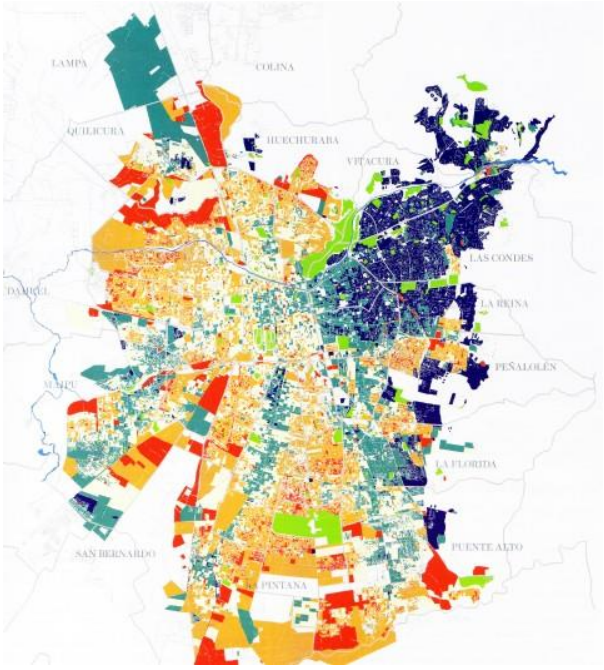
While the inequality appears to have been declining slowly in recent years the difference between its "before tax and transfers" and its "after tax and transfers" value (0.52 to 0.50) is also the lowest of all the OECD countries. Given this position, the possibility of securing a significant advantage for the poor through public transport policy has clear attraction.

In Santiago there is a clear belief that the present flat fare structure does this, and that the greater the overall level of subsidy the greater will be the redistribution effect of urban transport policy. But we have observed, but not been able to analyze in depth, several factors militate against that. First, the very large subsidy for students is very unlikely to be progressive in its effects – particularly when it applies to all trips, whether concerned with education or not.

Second, there is an increasing "gentrification" of locations with good access to the metro suggesting that the middle classes are significant users of what could be the most heavily subsidized parts of the system (See map below in which medium-

high socioeconomic class coinciding with metro line alignment)

Socioeconomic Distribution Greater Santiago 2009



Source: Max Zambra, Geo Adimark GFK. Revista Foco, Ideas de Ciudad nº10, Agosto 2009. http://www.plataformaurbana.cl/archive/2009/08/29/dime-donde-vives-y-te-dire-quien-eres-una-radiografia-a-la-sociedad-santiaguina/

Third, if there are substantial "leakages" of subsidy to the middle classes, then the redistribution characteristics of the tax system which finances subsidies comes into play. The relatively small difference between the "with" and "without" tax and transfers Gini coefficient for the country as a whole suggests that this may not be very progressive.

If any of these factors is significant, then the progressiveness of the Santiago subsidy arrangement may be much less than supposed. If that were the case, then it would be sensible to look for some alternative demand side targeted subsidy arrangement.

If any of these factors is significant, then the progressiveness of the Santiago subsidy arrangement may be much less than supposed

THE DISBENEFITS OF SUBSIDY

Induced inefficiency

There has traditionally been a concern about the effects of the availability of subsidy on firm efficiency in producing transit services.

The potential availability of subsidy strengthened the hand of trade unions by attenuating the effect of wage increases or less efficient use of labor on employment levels. An early study in the UK suggested that up to half of subsidy payments "leaked" to increased wages or slacker operating arrangements (Bly and Oldfield, 1985).

Similar effects were estimated in the United States, where the emphasis was put on the lack of efficiency incentives in deficit financing systems which was accentuated when taxes were earmarked for transit subsidies or shifted to Federal sources of funding (Pucher, Markstedt and Hirschman. 1985).

However, these studies applied essentially to deficit funding of monopoly supply agencies. In recent years reconciliation of subsidy with the maintenance of competitive pressure to maintain efficiency has been achieved through the competitive tendering of service franchises.

This would appear to be the solution implicit in the Transantiago arrangements. However, it would appear that with the reduction of the number of contracts, and their long duration, that the competitive pressure may be diminished and the strength of the suppliers increased. In the light of that we would recommend that as the current contracts terminate, consideration should be given to returning to smaller and shorter contract packages to ensure continued competitive pressure.

Poor targeting

The "net" redistribution effect of transit subsidies depends on:

- the type of subsidy, or use of subsidy funding;
- the sources from which the subsidy is funded;
- longer term "capitalization effects, such as changes in land and property prices; and
- longer term effects on transit efficiency.

For Canada, Frankena (1973) found that the direct effects of subsidies to commuter rail services and bus services to outlying areas, were regressive. A similarly mixed, but generally skeptical, assessment of the income distributional effects of the more extreme case of free transit in West Germany was reached by Baum (1973).

The general response that is now being taken on distributionally directed subsidies is that it is best for them to be targeted at users rather than suppliers.

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Most countries are familiar with reduced fares for school children and senior citizens. However, even person type targeted subsidies have not always had positive income re-distributional effects results; for example in Canada those to the elderly and a uniform reduction in transit fares were found to be progressive while those to children were found to be regressive.

Student concessions are less obviously distributionally effective. If the objective is to assist the poor, then direct targeting of the poor would appear to be the appropriate basis for subsidy

In practice, targeting subsidies at lower incomes has often proved difficult to achieve, though there have been some well-known successes in achieving specific (not necessarily noble) objectives.

In apartheid South Africa the sale of highly subsidized weekly coupons for ten journeys from the black townships to the areas of industrial employment, effectively targeted not only poor black workers but also limited the availability of the subsidy to workers for the journey to work. Approved bus operators who accepted the tokens were then able to cash them in with the authorities for the full "economic fare".

Somewhat similarly in Brazil, the "vale transporte" (VT) system requires all formal sector employers to offer tickets for the journey to work at a deduction of six per cent of the nominal income of the worker. As only lower income workers would find it attractive to accept the tickets rather than the cash, it did effectively target lower income workers. While there were defects in this system (particularly the fact that it was not available to the very poorest of the poor who were either unemployed or employed in the informal sector) it had reasonable distributional efficiency and shared the cost between employers and government (through the allowance of VT expenditures of the firm as a cost to set against corporate taxation).

Where there are already well established registers of low income families for other purposes, it may be possible to piggy back a specific transport subsidy on the existing mechanisms. This is an approach now being attempted in Bogota.

Low leverage

It is well established in the literature that there is a relatively low cross-elasticity of demand between private care use and public transport prices. This means that fare subsidies have little leverage in securing the changes of mode choice which are at the heart of the presumed benefits in terms of reduced congestion and environmental impacts. What this suggests is that careful attention needs to be given to the question of whether public transport subsidy is the most effective use of funds in attempting to improve performance of the urban transport system.

Subsidies have little leverage in securing changes of mode choice

Perverse impacts

There are a range of perverse impacts which may occur as a result of public transport subsidies. In particular the operation of a flat fare regime over a very large area, as in Santiago, while having favorable income redistribution properties provides an undesirable incentive to urban sprawl as well as increasing the real cost (as opposed to the fare) per passenger trip. While in the short term it may not be possible to change the fare structure, we think that consideration should be given to finding policy packages other than the present simple flat fare regime for securing any desired income redistribution objective.

The shadow cost of public funds

At a more theoretical level it has been argued that because of non-optimality of tax systems which impose an excess welfare burden, the public budget dollar should be valued more highly than the private benefit dollar. Certainly public resources are thought to be scarce in a number of sectors – exemplified by the fact that the cost/benefit rate of return to marginal projects exceed 1 at currently adopted discount rates – so that a premium should be applied to those funds wherever they are used.

Flat fare regime over a very large area provides an undesirable incentive to urban sprawl and increasing the real cost per passenger trip

QUANTIFYING THE ISSUES

In general there are two different types of indicators suggested – those founded in traditional cost benefit analysis and those based on recent developments in the welfare distribution literature.

Efficiency effects and cost benefit appraisal

The efficiency effects can be incorporated, with the fiscal cost of a subsidy in a general Cost Benefit Analysis (CBA). CBA normally considers the effect of an intervention (usually a capital investment) over a period of years, using whatever time discount rate is considered appropriate in the national context.

In the case of a public transport subsidy, however, as both the costs and benefits are primarily in current rather than capital terms, the outcome is only likely to be sensitive to the choice of a discount rate insofar as the costs of the subsidy and the benefits of the subsidy change at different rates over time.

This may occur either because of demand side changes such road congestion increasing over time as incomes increase or because of cost side changes occurring either for exogenous reasons or because of increasing inefficiency resulting from the subsidy instrument.

A further consideration, already mentioned above, is that as the costs accrue to the public budget while the benefits accrue primarily to transport users, and given a general scarcity of public funds it may be appropriate to require a benefit cost ratio exceeding whatever shadow price of public funds is considered appropriate in the national context.

There are many examples of this approach. For example, Glaister (2001) assessed the economic impact of local transport subsidies under a liberalized market regime in the United Kingdom.

The results of such studies vary substantially, not only according to the precise models used but also, more significantly by location. Proost and Van Dender (2008) find that the optimal transit fare in the peak-period in Brussels may be close to zero, while the recent analysis by Parry and Small (2009) for London, Washington DC, and Los Angeles shows that extending subsidies far beyond two-thirds of operating costs is in usually welfare improving.

Winston and Shirley (1998), on the other hand, find that for many major US cities, with a larger stock of road space and higher car ownership, an efficient policy would sharply increase all bus fares and substantially cut frequency of service everywhere. The critical question in the Santiago context is whether the conditions of the city are more like those of London. Washington and New York or like those of the other US cities cited.

Most recently Basso and Silva (n.d.) have undertaken a model based assessment of the efficiency and desirability of transit subsidies in London and Santiago using a transport mode choice model that considers substitution between private and public transport, inter-temporal and total transport demand elasticities, and enables consumer surplus calculations in a theoretically sound manner.

Their model captures congestion interactions between cars and transit while vehicles are in motion, and at bus stops, and allows transit system design to adapt to new conditions, incorporating vehicle size, frequency and design of bus stops as variables.

Interestingly Basso and Silva come to similar conclusions about London to other studies ranging from that of Glaister, and recently to that of Parry and Small. That suggests that the approach adopted may also give a reasonable estimate for Santiago.

Perhaps their most important contribution, however, is that they analyze the performance of alternative policy instruments, such as congestion pricing and dedicated bus lanes, using their modeled welfare measures for the comparisons, both applied separately and in various combinations.

Their main results show that the benefit that each stand-alone measure induces is different between locations. In London, congestion pricing and bus lanes increase social welfare significantly and by similar amounts, while optimal subsidization (free buses) achieves much less. In Santiago, on the other hand, bus lanes yield a much higher benefit than congestion pricing and optimal subsidization.

However, in both cities there is a large degree of substitutability among the three policies. Once one is implemented, adding another does not increase welfare as much. In particular, the marginal contribution to welfare of transit subsidies is large only when none of the other urban policies considered in this paper are in place.

In the model of Santiago segregating traffic through bus achieves large welfare improvements without subsidies or cumbersome car congestion tolling, affecting generalized prices through quality of service (speeds) instead of monetary prices. Moreover, the bus lane policy induces the largest increase in frequency for both cities, and it does so without the use of subsidies.

In Santiago, Basso and Silva, show that bus lanes yield a much higher benefit than congestion pricing and optimal subsidization

The results of Basso and Silva appear to have the important policy implication that there might be ways to reduce transit deficits without attracting losses of welfare or consumer surplus, but this requires careful planning of the order in which policies are implemented, because there is a clear best stand-alone measure for each application and substitutability between policies is high.

We recommend that in the medium term a strategy should be developed for Santiago which recognizes and incorporates these interactions between policy instruments.

Environmental effects

The World Health Organization and/or national and regional jurisdictions set standards for the ambient air quality level for six "criteria pollutants, namely: (1) carbon monoxide, (2) lead, (3) nitrogen dioxide, (4) particulate matter, (5) ozone, and (6) sulfur oxides (USEPA, 2011).

Economic analysis of these environmental impacts has usually focused on attempting to identify the marginal social cost of each pollutant in money terms based on the general prescription that "the proper corrective device is a Pigovian tax to the

marginal social damage levied on the generator of the externality" (Baumol and Oates, 1988). Similar approaches can be applied to evaluation of morbidity and mortality impacts of road traffic accidents and, with more difficulty to noise pollution (Nelthorpe et al 2007). A review of the approaches to evaluation in these cases is given in Gwilliam (2011).

When considering the environmental impacts of a policy or policy reform which take place over a period of time one of the greatest difficulties is to separate out the effects of the policy from other changes which are occurring simultaneously.

Such an analysis has been applied by Figueroa et al (2011) to the reduction of the most damaging pollutant – MP10 – brought about by Transantiago. They conclude that the concentration of MP10 had been reduced by 5.8 micrograms per cubic meter of air, and that this corresponded to a value of $384,270 million pesos of which $47,931million pesos were savings in health care costs.

Figueroa et al (2011) estimate that Transantiago has reduced the concentration of MP10 by 5.8 micrograms per cubic meter of air. They estimate a monetary equivalent of $384,270 million per year.

Distributional Impact indicators

Much of the resistance to increases in fares in Santiago is associated with the belief that there would be great opposition because of the effect on the poor, based on an observation that it is the poor who are most dependent on public transport.

The distributional impact of fare and subsidy levels and structures is thus central to the political issue. Four different types of indicators of distributional effects have been developed in recent years, focusing on slightly different aspects of the distributional issue.

Weighting Benefits in Cost Benefit Analyses

Assessment of the distributional effects of a transport subsidy is not directly commensurate with the efficiency and environmental effects, which can both be estimated in aggregate monetary form. This does not mean, however, that they should be ignored in a general modeling exercise. For example, a general model should be capable of showing average incomes, the distribution of incomes and the changes in transport travel times and costs by zone.

This form of disaggregation will give some general indication of the distribution effects of different policy interventions, including fare interventions. These issues were all incorporated in a generalization of the cost benefit appraisal of subsidies by Dodgson and Topham (1987), which identified the data requirements for a full analysis and also addressed the factors determining the preference between fare reduction and frequency enhancement. In assessing the distributional effects for policy purposes a number of different specific indicators are available, discussed below.

If the benefits and costs estimated in the kind of transport model discussed above can be assigned to different income groups, then the application of benefit weighting inverse to incomes is one way of integrating distributional considerations within a primarily efficiency based criterion. Even without weighting to get an aggregate result, the distribution of costs and benefits can be examined.

For the case of Santiago, where such data enables a full distributional analysis, Basso and Silva find that congestion pricing turns out to be a progressive measure so long as the transit system improves to cover the new demand.

This is an important refutation of the conventional view that congestion charging is regressive because it drives off the roads those with lower income who benefit least from the speed increase due to low values of time (see Hau 2005a, Hau 2005b).

Basso and Silva find that dedicated bus lanes are also progressive, while optimal transit subsidization is also a Pareto-improving measure. Indeed, if the distributional concerns are sufficiently high, optimal subsidization can be the best stand-alone measure and a complement for bus lanes and congestion pricing.

The affordability index

The problem with integrating distributional concerns within an optimized efficiency model, as discussed above, is that it does not make the equity implications explicit. For this reason attempts have been made to develop specific distributional indicators to be used either in conjunction with a general efficiency model or as a free-standing analytical device.

The affordability index, originally suggested by Armstrong Wright and Thiriez (1987) and more recently developed by Carruthers et al (2005) measures the proportion of monthly income required to make 60 single journeys to work per month[4].

An affordability target has been adopted in the national urban transport strategy in South Africa (South Africa DoT, 1996). The raw index is easy to construct. Table 1 shows international data for 2005. A rough current estimate for Santiago would show an average value of about 6, but a value of 24 for the poorest 5th quintile.

There are several difficulties in interpreting this indicator. First, and most important, because it does not include walking time, and the very poor rely most on walking, it may give the false impression that there is no problem for groups which are in practice the most disadvantaged by the level of public transport fares.

To replace the nominal expenditure on public transport by the actual expenditures and including walking time in a generalized cost of transport to work would make it a better indicator of deprivation but would require additional sources of information as well as a contentious monetary evaluation of walking time.

[4] The number 60 is selected to be consistent with the application of this indicator in other countries. If used as an indicator specifically to compare cities in Chile, or to trace the change in the burden of transport fares in Santiago over time a different number of trips could be used as the base.

Table 1. Affordability index for different cities assuming 60 ten-km trips per person per month

City		Affordability index	
		Average (%)	Bottom quintile (%)
1	Sao Paulo	11	107
2	Rio de Janeiro	6	63
3	Brasilia	6	59
4	Cape Town	4	38
5	Buenos Aires	4	26
6	Mumbai	9	23
7	Kuala Lumpur	5	22
8	Mexico City	3	19
9	Chennai	8	19
10	Manila	5	17
11	Krakow	6	17
12	Ámsterdam	6	16
13	Moscow	4	15
14	Guangzhou	4	14
15	Warsaw	4	11
16	New York	3	10
17	Los Angeles	3	10
18	Chicago	3	10
19	Singapore	2	10
20	Beijing	3	9
21	Seoul	4	9
22	Shanghai	2	6
23	Cairo	3	6
24	Budapest	3	6
25	London	2	5
26	Prague	2	4
27	Bangkok	1	4

Source: Carruthers *et al*. (2005)

Moreover, in situations of multiple deprivation, where the poor have inadequate health, education, and housing, as well as "unaffordable" transport, the adoption of an arbitrary threshold for a transport affordability index may direct public resources in directions which are not the best uses of funds to assist the poor.

Despite the difficulties in interpreting the affordability index as a justification for subsidy, it can be used as an instrument in assessing impacts of specific schemes and on specific groups or locations.

It is therefore recommended that the use of the data from Household Expenditure Survey data should be explored to create such an index which could be applied to compare both different income groups and different locations in the metropolitan region.

The inclusion and exclusion indicators

One of the dangers of using general public transport subsidies (as opposed to demand side subsidies targeted on specific groups) is that the subsidies, primarily intended to help poor people are actually paid to a disproportionate extent to richer groups.

Unless the tax system which yields the revenues to finance the subsidy is extremely progressive (which does not appear to be the case in Chile) the outcome may be perverse, with richer groups obtaining a positive rather than negative benefit from the redistribution. It is therefore important to pay particular attention to the focusing effect of the subsidy instrument.

In Santiago it appears to be generally believed that because the poor generally live in the outlying parts of the city a subsidized flat fare system has desirable redistribution properties. In fact, examination of the map of average incomes of sub-districts through the city shows not only the expected concentration of poor districts in the periphery but also a distinct, though less pronounced, axis of high income districts on some of the metro lines. This suggests that a substantial part of the benefits of the subsidy are going to richer groups. Through a process of gentrification of highly more highly metro accessible locations this may be increasing over time. And, without more detailed investigation of the effective distribution of subsidy between modes in the integrated fare system, we are not able to be sure that the metro is not the major recipient mode for the subsidies. We consider that the issue of the real redistribution impact of the existing arrangements needs more careful examination to justify its continued acceptance as the primary justification of extended subsidy support.

The inclusions and exclusion approach looks specifically at the accuracy of the focus of any subsidy on a predetermined sub-set of the population defined as poor. The exclusion index is the proportion of those defined as poor who do not benefit from a particular subsidy; the inclusion index is the proportion of the total number of people benefitting from any particular subsidy who fall outside the defined category of poor. This is shown diagrammatically in figure 1. If the objective is to redistribute welfare from the define non-poor to the defined poor group, the ideal, once a target population group has been defined, is that both exclusion and inclusion indicators should be close to zero.

Figure 1. Errors of inclusion and exclusion (source; Foster, 2004)

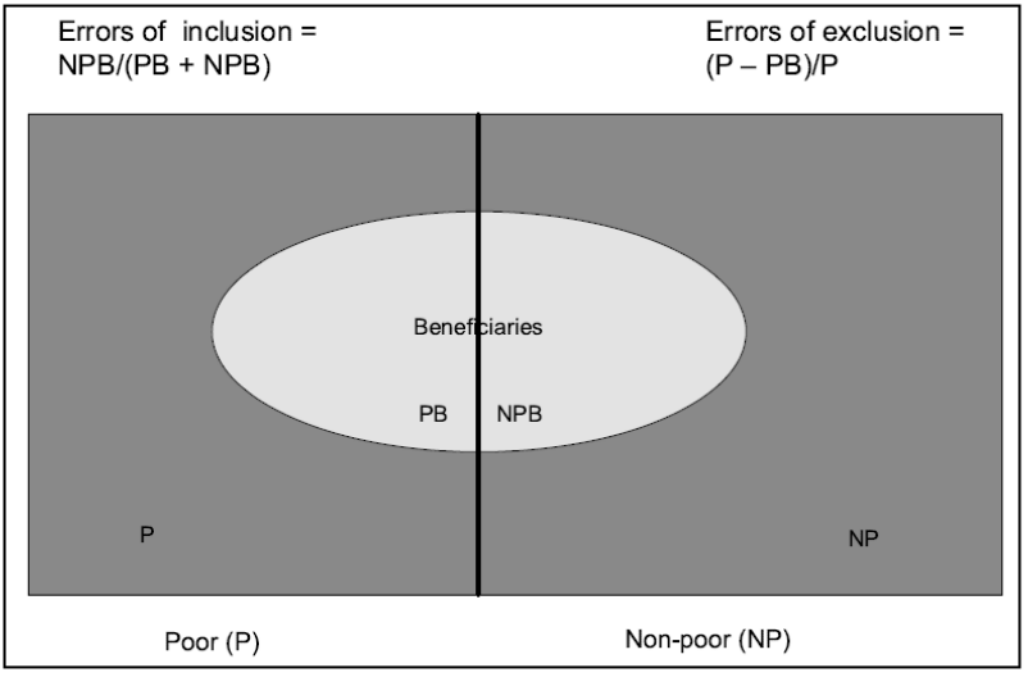
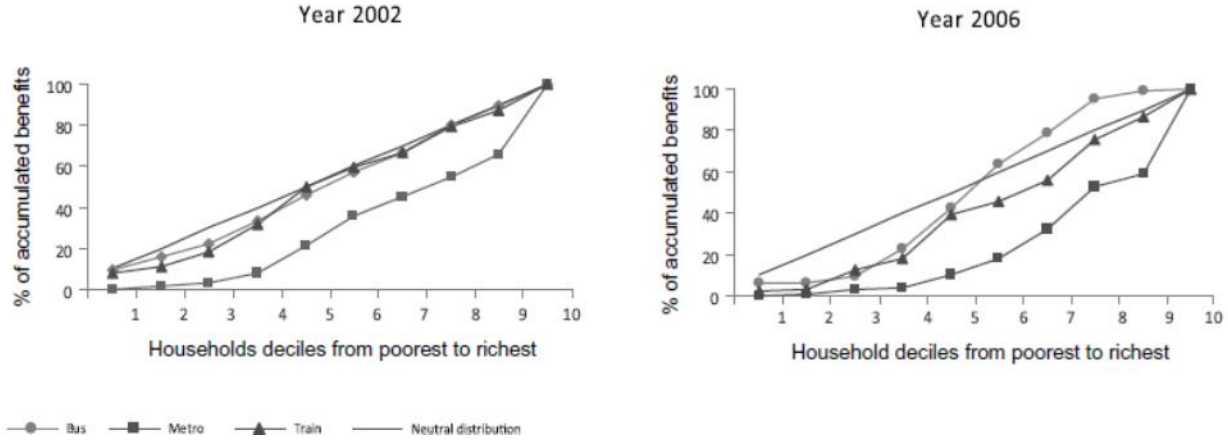


Figure 3 The distributional impact of different modal subsidies in Buenos Aires



The advantage of this measure is that it can easily be estimated from household survey data which shows whether a subsidized product or service is consumed or not. This may be very important in the design of subsidies. It can be readily applied to the assessment of the likely focus of any specific new subsidy instrument, as well as to the assessment of the change in accuracy of focus over time.

It has been applied to the focus of public transport services in Buenos Aires. It can also be applied to the comparative assessment of different types of subsidy, including geographically focused supply side subsidies if the income composition of different areas is well recorded and understood.

The disadvantage of this indicator is that it does not distinguish between cases where a household gets some minor advantage from a subsidy (for example because they made an occasional emergency trip on a mode which they could not normally afford to use) and those where a household is a regular and large consumer of the subsidized service. This could be addressed by redefining use as requiring some minimum number of trips per month by a subsidized mode, but doing so would make the index less easy to interpret.

The Gini and Omega coefficients

An approach which overcomes the limitation of the inclusion and exclusion indices is that based on the construction of a Lorenz curve and the calculation of the associated Gini and Omega coefficients. The relative benefit distribution curve (or Lorenz curve) graphs the percentage of a subsidy accruing to the first jth rank of households, according to some measurement of income, expenditure or wealth distribution. More formally, the graph of a relative distribution curve can be defined as:

$$r(j) = \sum_{h=1}^{j} \frac{S_h}{S} \times 100$$

where h indexes all households below the jth ranked household from the lowest to the highest, r(j) is the value of the graph at the household ranked j, sh is the benefit accruing to household h and S is the total benefit distributed by the policy.

A curve above a diagonal straight line shows a progressive distribution of benefits, while a curve below the diagonal line shows a regressive distribution of benefits. This approach has been applied to public transport in Buenos Aires for 2002 and 2006 by Bondarevsky, 2007 (see figure 3, above).

Associated with the relative distribution curve is the Quasi-Gini coefficient which gives a summary measurement of the progressive or regressive nature of the policy in question. This coefficient is calculated as the area between the diagonal and the actual distribution curve (with a negative value when the actual distribution curve is above the diagonal.

The closer the Quasi-Gini coefficient is to –1, the more progressive is the distribution of impacts. It can be used not only to compare alternative fare and subsidy structures at a single point in time but also to understand how the distributional impact of a specific fare and subsidy system changes over time.

Besides the Quasi-Gini coefficient, another summary measurement of the distributive incidence of a subsidy is the Ω statistic which, with a poverty line defined in terms of a proportion of the population of households, is the percentage of the subsidy accruing to

poor households over the percentage of the population represented by poor households. It will be above 1 for a progressive subsidy and below 1 for a regressive one.

The redistributive implications of various subsides to transport in Santiago were discussed by Gomez-Lobo (2009). He analysed the impacts of student preferential fars separately in the bus and metro systems, metro infrastructure subsidy, general gasoline subsidy, general bus subsidy and direct monetary transfers.

He found that direct monetary transfers, now embodied in the "Chile Solidario" mechanism, were by far the most progressive, with a Gini coefficient of -0.33, while general bus fare and student bus fare subsidies were mildly progressive (Gini coefficients -0.11 and -0.16). However, as the latter were financed by internal cross-subsidy from general bus fares, the net effect was that the majority of poor households suffered from the student bus fare subsidies while the top quintile of incomes received a net benefit on average. Metro student farfe and metro capital subsidies, as well as general fuel subsidies were found to be substantially regressive.

These results were pre-Transantiago. Since the date of the study there has been a direct subsidy aimed at offsetting the need for internal cross-subsidy of student fare subsidies, and hence making the system more progressive. But other changes, such as the integration of the fare systems taken together with the extension of the metro, make any estimate of the overall distibutional impact of Transantiago somewhat speculative. What does not change, however, is the large difference in progressiveness between the direct monetary transfers to the poor through "Chile Solidario" and the indirect transfers through transport prices.

Monetary transfers embodied in the "Chile Solidario" mechanism may be more progressive than general bus fare and student bus fare subsidies.

Who pays

Subsidies to public transport may be financed in three main ways:

- from general taxation, direct or indirect,
- from taxes on specific persons, goods or activities earmarked for the purpose, or
- by cross subsidy within the public transport sector, which effectively means some public transport users subsidizing others.

The most common situation is for external subsidies (as opposed to internal cross-subsidy within a sector) to be financed from general taxation (as opposed to earmarking of specific taxes).

The net distributional effect of a change in subsidy therefore depends on the characteristics of the tax system with which it is associated. Some general observations can be made arising from this. It is generally the case that direct taxes on income are, by design, more progressive than indirect taxation on commodities (though there can be significant differences in progressiveness within the category of indirect taxes).

The progressiveness of taxation may also vary significantly between local and national taxation regimes. Typically national tax revenues depend more heavily on the more progressive income tax that local taxes, which tend to be indirect taxes on commodities, services or property, all of which tend to be regressive.

For Chile, Engel (1999) concluded that the overall tax system was basically distributionally neutral in 1996. Assuming that there has been no significant change in this structure since then the implication is that for any subsidy financed from general taxation the distribution impact is determined by the distribution of benefits.

Specific earmarked taxation

The distributional effects of an earmarked tax on consumption goods such as alcohol or tobacco may be traced through expenditure surveys (and may actually turn out to be very regressive).

Taxes on producer goods such as fuel are more difficult to estimate as the distribution of their ultimate impact will depend on the effect of a tax increase on the prices of different final consumer goods. But the converse of the Gomez-Lobo finding that fuel tax subsidy had a regressive distributional effect is that funding transport improvements or fare policies through earmarked fuel taxation would be generally progressive in its impact.

The objection to this would appear to be a resistance in Chile (for good fiscal management reasons) to earmarking of tax revenues.

An alternative might be to use direct charges for road use – such as the London congestion charge – as a source for public transport funding. These have a double benefit. Not only do they encourage modal shift (and other cost reducing adaptations of behavior) but they generate revenues without the usual excess burden of taxation.

Their distributional effects may be complicated to assess as they impact on final consumption both directly (believed to be progressive where use of the private car is viewed as a consumption good) and indirectly, through increases in the embodied freight transport cost of final consumption goods.

Their distributional impacts also depend on the cross-elasticities of demand between modes by income group. It is noticeable, however, that in the case of London – after a prolonged campaign of information - much of the business community supported the introduction of road pricing as they judged that it would yield benefits to them through increased travel speed within the priced area in excess of the direct monetary costs that they would incur in congestion charges.

Similar complications arise in estimating the ultimate distributional effect of earmarked taxes on employers – such as the Brazilian "vale transporte" or the French "versement transport". Moreover, such taxes may carry the danger of reducing employment, which is almost certain to be regressive in impact.

However, we recommended that a thorough review of the potential of new tax and charge revenue sources to contribute to the achievement of a more efficient urban transport system.

We recommend that a thorough review of potential new taxes and charge revenue sources

As far as capital costs of network extension is concerned it might be worthwhile re-examining the possibility of using impact fees negotiated with developers as was attempted for financing the external development costs of the metropolitan extension of Santiago in Chacabuca province, though only about 40% of the total costs were raised in this way (Zegras,2003).

Internal cross-subsidy

Internal cross-subsidy within a public transport mode may be used to generate income from potentially remunerative services to support commercially unremunerative services.

In practical terms this means cross-subsidy:

- by location,
- by time of day,
- by class of travel, or
- by mode.

The most relevant of these in the Santiago context is cross-subsidy by location, achieved through the flat fare system.

As in many South American cities this may be an effective cross subsidy from short trips to long trips. But it means that fares are higher for shorter trips than they might be with a graduated fares scale so that poorer groups living in inner areas suffer a corresponding disadvantage. More importantly it seems to us that flat fares involve an efficiency loss which increases with city size and may encourage undesirable urban sprawl.

Flat fares involve an efficiency loss which increases the city size and may encourage urban sprawl

Hence it would be sensible to continue to review the costs and benefits of the flat fare system as the city spreads, and particularly to consider its replacement by other demand side targeted subsidy mechanisms

Cross-subsidy by time of day has also been used in some cities for example in London in the 1950' s to encourage travel before the morning peak. The economic efficiency of this depends on the assumption of a relatively high cross elasticity between times of travel, and the distributional progressiveness on the assumption that the poor are more likely to be travelling before the peak than higher income groups.

Neither assumption may in the event be well founded so it is critical in the assessment of this type of instrument that the relevant elasticities and characteristics are well researched.

More generally, it is often argued that peak public transport travel should be subsidized by off-peak travel because of the congestion and environmental advantage of shifting passengers from car to public transport.

In practice the economic argument might militate in the opposite direction if high peak usage involves high capacity costs (as is certainly the case for buses and also true for rail systems as they approach capacity), because the excess of marginal over average cost for public transport in those circumstances might approach or exceed the excess of marginal over average cost for the private car.

In this case the estimation of the efficiency effects requires careful analysis not only of demand elasticities and cross-elasticities between times of travel and modes but also supply elasticities by time of day.

Cross-subsidy by class of travel is a third possibility. Insofar as higher income passengers are willing to pay more for more comfortable (or in the case of express services, quicker) travel it may be possible to use product differentiation as a basis for yielding surpluses to support lower income passengers on the basic service.

In order for this to be possible, however, a single supply agency must be providing both. Again, this form of cross –subsidy appears to be much more feasible in the case of a system with a single supply manager, but does not appear to offer significant potential in Santiago.

Cross-subsidy by mode has been given an economic theoretical in the work of Train (1977) on multi-modal systems, the argument being for the subsidy of modes with higher fixed and lower marginal costs by those with lower fixed and higher marginal costs.

Typically this is interpreted as an economic case for the subsidy of metros from bus systems, and gains extra credence from the possibility of reduced congestion and environmental cost by transfer of traffic from road to rail modes. A possible implication of this in the Santiago context is that the assumption of the capital costs of metro development on the Transantiago budget can be attributed a positive efficiency benefit.

CONCLUSIONS ON SUBSIDY ANALYSIS

We note that there is a general belief (probably well justified) that in Santiago the combination of flat fares and overall public transport subsidy with the actual distribution of population by income group (with the poorest living in more peripheral locations) has a positive redistribution effect.

While we agree that the distributional effects of subsidy are of great importance, we would argue that they need to be assessed in a comprehensive framework which takes into account:

1) Efficiency and environmental as well as distributional effects of any subsidy
2) A wide range of forms of user adjustment to subsidies.
3) The impacts of who pays for the subsidy as well as who receives it.

Comprehensive evaluation (point 1 above) is in principle best done through a comprehensive cost-benefit analysis framework which will highlight any efficiency losses, while the distribution of the net effect can be shown identification of effects among income based zones.

The range of adjustments to be addressed (point 2 above) should, in principle include changes in residential and activity location, as well as changes in mode or time of travel. This would be addressed through a progressively refined multi-modal transport demand model, supplemented where necessary by specific disaggregate choice modeling.

The taxation effects (point 3 above) should in principle be addressed through detailed analysis of the incidence of different tax instruments by income level. While for direct taxes this can be done directly from the analysis of tax schedules, assessing the impacts for indirect taxation and specific earmarked tax financing of subsidy requires a deeper analysis of effects on final consumer good prices as well as the income profile of consumption of different goods.

Satisfying the above requirements raises practical problems of differing degrees of tractability. The easiest step is to examine the immediate user side effects of particular subsidies or proposed subsidy structures in terms of their effect on the affordability of transport for specifically defined income groups (using the affordability index), the effectiveness of targeting (using the inclusion and exclusion error statistics) and on their income distribution effects (using the Lorenz curve, Gini and Ω statistics).

Putting the analysis of distributional impacts in the broader context of a cost benefit analysis of alternative policies, comprehending efficiency and environmental objectives requires a much more comprehensive development of a demand forecasting model. Given the pre-eminence of Santiago academics in the world of transport modelling we would expect that its application as a central policy tool in evaluation of public transport subsidy policies could proceed very rapidly.

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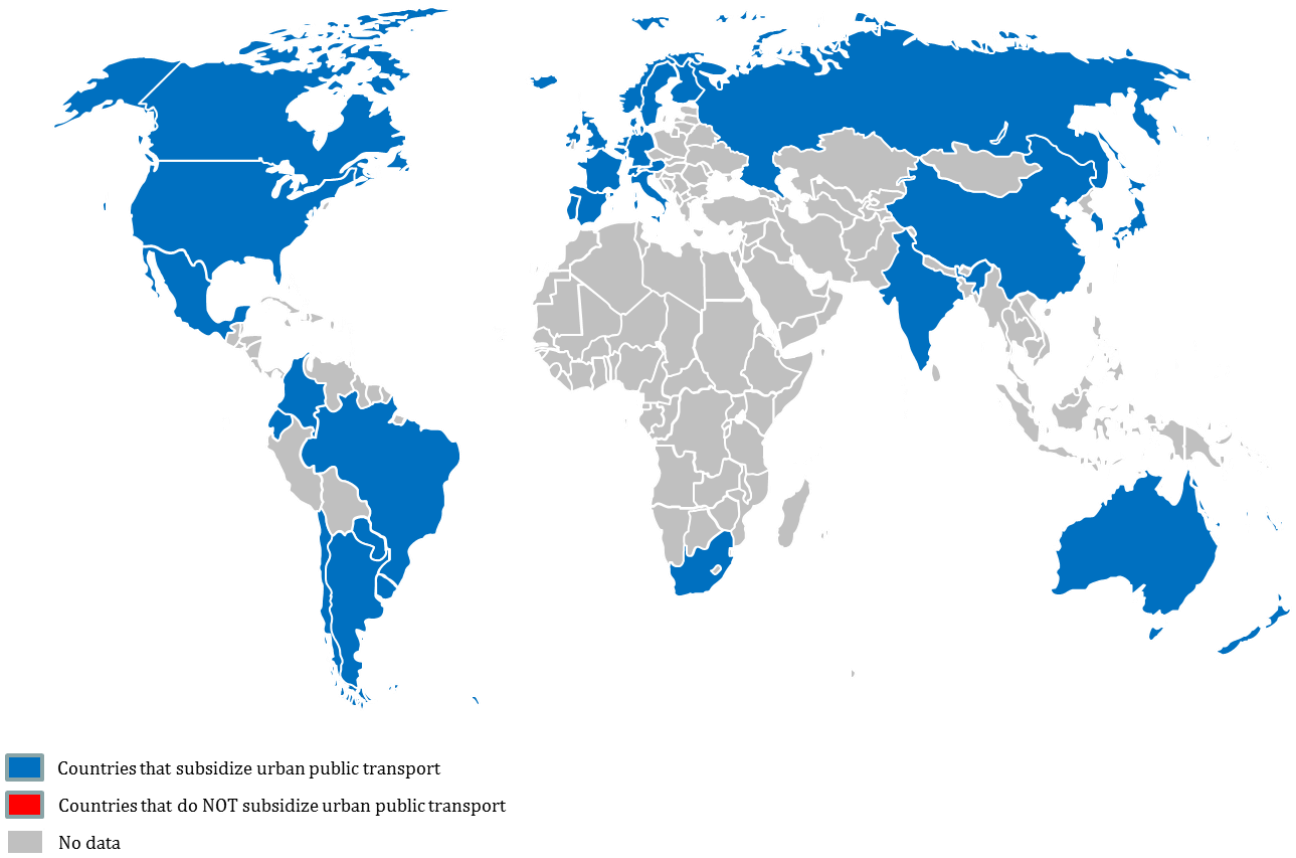
Subsidies around the World



Source: EMBARQ (2014), preliminary