Examining the implementation and labor market outcomes of targeted transit subsidies: SISBEN Subsidy for Bogota's Urban Poor

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ABSTRACT

In order to meet the challenges of providing affordable public transit services without compromising the financial sustainability of the system, many transit systems are setting fares at cost-recovery. However, in order to offer affordable transport services for the urban poor, cities can provide target subsidies. Bogotá has implemented a pro-poor public transit subsidy scheme that leverages the adoption of smartcards in its new public transit system and the country's poverty targeting instruments. This paper presents a critical analysis of the rationale, design and implementation of Bogota's public transit subsidy. Based on this experience, we explore two research questions: What are the determinants of user's "self-selection"? What are the causal links between the subsidy and labor market outcomes: employment and income? Two regressions, (linear and probabilistic) were used to identify the characteristics of individuals who choose to request the subsidized fare. A quasi-experimental technique was used for the impact assessment of the subsidy on labor market outcomes. This research allows us to being to understand how to design targeted subsidies for maximum labor market outcomes.

Keywords: transit subsidies, targeted subsidies, impact evaluation, labor outcomes, Bogota

INTRODUCTION

Public transport is an important mode of transport, especially for low-income populations. Cities, however, struggle to provide public transport services for fares that are both affordable and financially sustainable. Since meeting both goals is quite difficult, transport systems, either end up relying on high levels of subsidies or charging transit fares that are too expensive for the city's poor.

As a result, some city's transport systems use low fare levels (examples are Buenos Aires or the Mexico City subway), which require high amounts of public subsidy. Other cities use higher and thus more sustainable fares, but risk excluding the poor from public transport. The latter is the case in Bogotá, Colombia, where fares for its new public transit system are set high, close to cost-recovery levels, which may be unaffordable for part of the population.

Bogotá is currently implementing its Integrated Public Transport System (*Sistema Integrado de Transporte Publico,* SITP), which will integrate under a single fare, operation, and infrastructure all its Transmilenio's Bus Rapid Transit (BRT) corridors with the traditional bus system, the bike network and, in the future, Bogotá's first subway line. One of the prominent features of this public transit reform process has been the profound change in the business model and incentive structure for public transport service provision. These new incentives are embedded in the concession contracts for service provision, and are linked to the underlying concept of a tariff policy set at "cost recovery". Against this backdrop, Bogotá has tried to balance the needs for financial and social sustainability by setting fares at cost-recovery but then offering targeted subsidies for specific segments of the population.

This paper presents a critical analysis of Bogotá's experience with the implementation of targeted demand side subsidies for public transit, and describes the results of an impact evaluation recently carried out to assess what determines potential beneficiaries from opting into the subsidy and if the subsidy had any effect on labor market outcomes, namely hourly earnings and employment status. The paper describes how Bogota leveraged the country's poverty targeting system and database, and the progressive adoption of smartcards in its public transit system to design a pro-poor targeted subsidy scheme. The impact evaluation uses two regression models (linear and probabilistic) to examine the probability of opting for the transport subsidy ("self-selection") given a number of socioeconomic and geographic conditions, and accessibility to the new bus system. A difference-in-difference methodology was used to examine if there were any causal links between the use of the public transit subsidy and user's labor market conditions, income and employment status. The impact evaluation focused on analyzing changes in labor market outcomes; other outcomes related to changes in travel patterns were not examined because of data availability constraints, but are the focus of further research.

. The first section of this paper provides a literature review on the case for supply and demand side subsidies in public transit, particularly for a developing country context. The second section describes the design and implementation of Bogota's pro-poor subsidy scheme. The following sections present the results of the impact evaluation— the determinants of opting to request the smartcard with the subsidy and the subsidy's impact on user's labor market outcomes. The paper concludes with some recommendations in terms of the pro-poor subsidy design and areas of future research.

SUBSIDIES IN PUBLIC TRANSIT—THE CASE FOR SUPPLY AND DEMAND SIDE SUBSIDIES

Traditionally, the arguments for public transit subsidies have included the following: reducing the costs of environmental externalities, making efficient use of modes with different cost structures, and taking advantage of user economies of scale (1). In terms of environmental externalities, the case for supply-side subsidies indicates that subsidies might be a "second best" alternative to marginal social cost pricing of road use, as they have the potential to reduce congestion by shifting users from automobiles to public transport modes; however, the effect is subject to the ability to attract car users, for which the cross-elasticity of demand is typically low. The cost efficiency argument indicates that supply-side subsidies might be merited to reduce total system costs, generated through greater economies of scale in rail-based systems and transport system inter-modality (2). Finally, a case for subsidies can be made whereby these are used to increase level of service (i.e. increase frequencies and reduce waiting and transfer times) for users, generating user economies of scale in excess of the financial costs of the subsidy which produces them. This is also known as the "Mohring" effect (3), and has been widely discussed in the literature. This research (4,5,6,7,8,9,10) shows that under certain conditions, subsidies that help improve the quality of service by increasing service frequency are socially desirable.

However, there are some that disagree that providing supply side subsidies are favorable. Goldman and Wachs(11) have shown that in the United States, transit subsidies have resulted in system inefficiencies because of inadequate allocation mechanisms and incentives for cost-efficiency and failure to improve level of service via increased frequencies or fare reduction. Other research (12) found that transport subsidies are inadequately used, and points to the inefficiencies and risks associated with supply-side subsidies.

In developing country contexts, the arguments against supply-side subsidies can further be extended by the need to limit the fiscal burden, given limited resources and competing needs; and the need to focus subsidies where they are most needed socially (1, 13). Hence, to balance the needs for economic and social sustainability, ideally cities should try to set fares for cost-recovery, but offer targeted demand-side subsidies for specific segments of the population that face an affordability constraint. However, most of the experience thus far with demand-side subsidies has been inconclusive; these subsidies have not always lead to the intended results because of difficulties with accurately identifying the target population (especially if not employed in the formal sector), potential abuse of the subsidy, and large errors of exclusion or inclusion of the target population (Box 1).

BOX 1 Lessons from "first generation" demand-side subsidy programs

Several types of subsidies have been used to support low-income users of public transport. While well-intended, these "first generation" subsidy programs do not always reach the target audience and may even have unintended outcomes. The following are four types of subsidy programs and lessons learned from their implementation:

- **Vale-Transporte.** This subsidy program in Brazil caps commuting expenses for workers in the formal economy to 6% of their wages, with employers paying for the rest as a tax-deductible expense. This makes formal workers somewhat immune to higher transit tariffs, while providing no relief to workers in the informal sector (who constitute about 57% of nationwide labor force).
- **Cable cars *(teleferico*s) and feeder lines.** *Teleferico* services in Rio de Janeiro (Brazil) and Medellin (Colombia) provide free transport for poorer neighborhoods using cable cars. In Bogotá (Colombia), free "feeder lines" connect certain neighborhoods to the city's Transmilenio BRT system. While providing free services to poorer neighborhoods increases access, this kind of subsidy has significant exclusion errors in that it excludes a large number of low-income households living elsewhere in the city and may exacerbate a city's already existing spatial segregation.
- **The *Bilete Unico* and Integrated Fares that subsidize transfers.** The *Bilete Unico* system in Brazil, and integrated fare systems in Bogotá and Santiago, use a card to cap the fare for multi-modal trips. The program subsidizes transfers, which (in an urban structure with most of the poor living in the city's periphery and often needing to transfer) overwhelmingly supports low-income households. It however also reinforces tendencies for urban sprawl and is characterized by errors of inclusion.
- **Subsidized fares for the elderly, students, war veterans, and other categories**. While an important way to improve transport access for target groups, this kind of subsidy suffers from both inclusion and exclusion errors: many poor might not fall into one of these categories and people who do may not be poor.

Source: Mehndiratta et al(19)

Building on the experiences of these "first generation" subsidies, Bogota has recently innovated in targeted demand-side subsidies for the poor. The following section explains the design and implementation of the policy.

BOGOTA'S PRO POOR SUBSIDY SCHEME

Until the development of the Transmilenio system in 2000, all public transportation in Bogotá was operated under a system characterized by an inadequate incentive structure that led to an oversupply of buses, increased congestion, reduced vehicle safety and low-quality service. Bus companies owned the routes granted to them by the city government but were not required to own the bus fleet. Individual investors owned buses, and bus companies rented out to bus owners the right to operate a certain route. This arrangement induced bus owners to compete against other buses, irrespective of demand patterns, as their revenue and the wage of the bus driver was directly related to the number of passengers carried. Bus companies' main assets were their routes as they rent them out to bus owners, so they had the incentive to lure as many buses as possible to operate their routes. The incorporation of

a number of buses beyond those required to serve the market led to excessive competition, locally known as "the penny war" (*guerra del centavo*) because drivers literally fought for each prospective passenger (14).

In response to these shortcomings, by the end of the 1990s, the government of Bogotá began to explore alternative ownership models and incentive structures that maintained the benefits of privatization but improved service provision. One such ownership model was concession contracts for service provision. In this system, a competitive bidding process is used to determine which bus operators will have the right to operate a route or a number of buses. The concession is for a limited period of time, which ideally coincides with the useful lifespan of the fleet, as opposed to the lifetime permits offered in the traditional model. Bus operators, in turn, need to own the bus fleet and operate it under close supervision and regulation from the public sector, which determines whether operators supply the scheduled service. On the infrastructure side, the system uses exclusive bus ways, high-capacity buses, a centralized fare collection system based on the use of smartcards and a fleet control system (15). This new ownership model, incentive structure and infrastructure provision was at the crux of the Transmilenio BRT system, implemented in Bogotá in December 2000.

There are several features of the basic tariff model developed in the context of Transmilenio and used subsequently in Bogotá's SITP and in all of the other Colombian BRT systems that are worth highlighting. The systems were designed to be operationally self-sufficient with fares set at "cost recovery" levels. At present, Colombian law (Law 86 of 1989, Article 14) requires that public transport systems operate in this manner and that city government does not subsidize the system. In fact, the law mandates that fares charged should be sufficient to cover the costs of operation, management, maintenance and replacement of the bus fleet. In order to determine the appropriate cost-recovery fare, the national government developed a structured process that incorporated incentives for efficiency. The process is as follows, first, the public sector administrator designs the system and the operating plan. The public sector is also responsible for developing and maintaining the system infrastructure. The cost elements included are those associated with bus operations, fare collection and management, a trust agent (in charge of collecting revenue and then distributing payments to all agents) and a public sector system administrator in charge of planning and managing the system.. Each of these elements (except the public sector administrator costs which are estimated and added to the other costs) is then bid out separately. In the case of bus operations, there is a strong focus on keeping in the new system as far as possible, drivers and operators who were participating in the old traditional system. As such owners and drivers are encouraged to organize into formal companies that then bid against each other (often with partners that could include operators from outside the city) for a share of the service. Lastly, a notional "technical tariff" is then estimated by summing up the winning-low bids for each cost element (plus the per ticket costs estimated for the administrator) and dividing that by the expected ridership. In other words, the "technical tariff" or the tariff that allows for cost recovery, is an indicative tariff that captures the required average revenue per ticket sold that is needed to guarantee that the remuneration of all of the system's service providers (bus operators, fare collectors, trust agent, planning agency) is covered, given a predetermined level of service.

Hence, one of the challenges of setting user fares close to cost recovery is that Bogotá's lower income population may be priced-out from using the system. According to Bogotá's 2014 Multi-Purpose Survey, which provides welfare and socioeconomic indicators

for the city, households in the poorest areas of the city spend a greater percentage of their income on transport, between 16% to 27%, compared to a maximum of 4% in areas that are relatively richer (see Figure 1). Bogotá's 2011 Mobility Survey also corroborates this—the population in the lowest income strata usually travels less, and walks or bikes for longer trips.

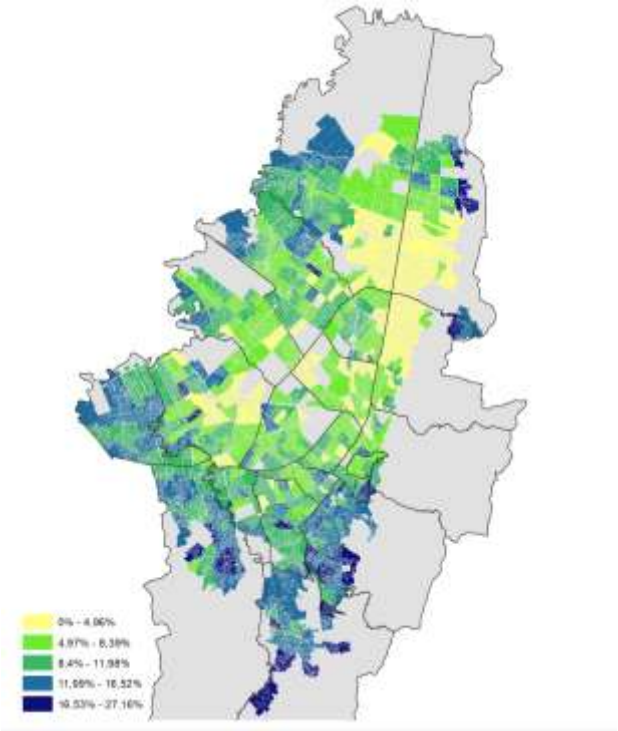

FIGURE 1 Public transportation spending as a Proportion of total household expenditure --Source: Bogotá Multi-Purpose Survey, 2014.

In order to meet the challenge of improving affordability to public transit for the poorest, Bogotá rolled-out in early 2014 a "pro-poor" public transit subsidy based on recent technical assistance provided by the World Bank (16). This work provided a better understanding of the poor´s travel patterns, the alternatives for targeting the subsidy, the implications on the system´s costs, and alternatives on how to implement the scheme. Since one of the authors of this paper was part of the World Bank team who helped design the subsidy, there is a need to clarify upfront this collaboration. However, this paper critically analyses the way Bogota implemented the scheme, and provides recommendations on how targeted subsidies in public transit can be implemented.

The subsidy program builds on two key aspects. First, the progressive adoption of electronic fare media (smart cards) in Bogotá's public transit system, which provides a means to distribute the subsidy to target beneficiaries, can be personalized to store the user's information, and be programmed with different subsidies. Second, Bogotá leveraged the country's experience with other poverty targeting initiatives, such as conditional cash transfer programs, that use the country's poverty targeting system and database (the *Sistema Nacional de Selección de Beneficiarios* or SISBEN). The SISBEN is a proxy-means tested index that uses several socio-economic indicators (household demographic composition and marital status, education, employment, income, possession of goods and assets, and dwelling

characteristics) to categorize potential beneficiaries of social programs. Each individual is given an identification card with its index score (ranging from 0 to 100) based on its socioeconomic characteristics, and is classified in one of SISBEN's six poverty levels, with level 1 being the poorest. Both SISBEN 1 and 2 household have incomes below Colombia's the official poverty line (17).

Citizens that live in Bogotá, that do not receive other concessional fares and have a SISBEN score of 40 or less can opt to request a public transit subsidy of COP$900 (equivalent to USD0.35) capped at 40 trips per month (on average this represents 50% discount for trunk services, and 60% discount for feeder services at peak hour). The card is also programmed with one free "credited" trip that can be used when the card is loaded, and once validated in a station, cannot be reused within a 30-minute window. Thus, people who are eligible have to request the subsidy, and the card is programmed with certain features to prevent subsidy abuse. Although the SISBEN dataset has the address of the potential beneficiary and in theory cards could be mailed to the entire potential beneficiary universe, Bogota decided to opt for the mechanism of self- selection during initial subsidy roll-out to manage potential subsidy abuse, get a better sense of the resources needed and mitigate fiscal impacts, as every card that is issued needs to be paid to the fare collection concessionaire. Potential beneficiaries can obtain the personalized subidy card in the local government's city centers, Transmilenio Terminal depots, or using the mobile (minivans) points of sales. Once a potential beneficiary ID is validated against the SISBEN database, the beneficiary receives the smartcard in about three business days.

As of April 2015, 250 thousand people had obtained the smartcard with the subsidy, and almost 150 thousand had actually used it. However, subsidized smart card use has been substantially lower than the potential beneficiary population (nearly 900,000 people). Hence, the remaining of the paper discusses what appears to determine that someone opts for the subsidized card, and what have been some of the subsidy impacts on labor market outcomes for those who have used it.

DATA

In order to analyze the determinants of obtaining the public transit subsidy and its impact on labor market outcomes, three sources of data were used.

First, the SISBEN database—this database provided the list of potential subsidy beneficiaries, those with a score of 40 points or less as of April 2015, including all the SISBEN variables for those individuals. Second, the Transmilenio and *Recaudo Bogotá* database contains information on the use of the transit smartcard for 2015, including the use of smartcards with subsidized trips. With this data we can identify the transit system use, determine the time of day used for entry or transfers, as well as the use generated by the subsidized trips. This information was geo-referenced using the location of the stops. This database provided the information on whether the potential beneficiary had a smartcard, and whether it was linked to an anonymous, personalized or subsidized profile. Using both of these databases, we were able to geo-reference and locate potential users, as well as the people who had requested the subsidized card and those who had actually used it.

We found that potential beneficiaries, as well as people who have requested the card concentrate in the city outskirts, predominantly in the south and some north outlying areas, which are correlated with the areas of highest spending on public transport in Figure 1. These areas are isolated from the central business district, where employment opportunities

concentrate; this further concentrates poverty and forces a higher proportion of income to be spent in transport.

Finally, in order to calculate the labor outcomes of the subsidy, namely hourly earnings and employment status, we used the information from socio-economic and labor characterization of the Integrated Household Survey (*Gran Encuesta Integrada de Hogares*, GEIH) for 2015, which we geo-referred at the block level. This data allows us to observe the socioeconomic indicators of the city over time. This was used in order to find a causal link between the implementation of the subsidy and changes in the socio-economic and employment status of its recipients.

DETERMINANTS OF OPTING INTO THE SUBSIDIZED FARE

As previously mentioned, not all potential beneficiaries opted to receive the subsidized card. There is a significant gap between the target population and the "self-selected" population that requested the subsidy. About 900,000 people were eligible to enter the program, but only 260,000 had done so as of April 2015.

We therefore, explored what factors lead to the self-selection of some of the eligible population to the subsidy program, which would allow the city to implement the subsidy better in the future. Two regressions, (linear and probabilistic) were used to identify the causal elements that explain the behavior of individuals who choose not to request the subsidized fare.

Methodology

Using the SISBÉN Bogota 2015 and the potential beneficiaries of the program—796.437 people in the city of Bogota per SISBEN dataset--, we created a cross-sectional analysis, which examined the probability of opting for the transport subsidy, given the potential beneficiaries geographical location, socio-economic conditions, and employment status, among others. We created a series of cluster groups, based on individual controls, family structure, socioeconomic conditions, employment status, proportion of neighboring people who have the subsidy and access to the system (proximity to card issuing point, bus station, etc.).

The models calculated are as follows:

$$\text{Linear Model: } 1(y_{ir} = beneficiario) = X_{ir}\beta + \alpha_r + \varepsilon_{ir} \quad (1)$$

$$\text{Probabilistic: } Pr(y_{ir} = beneficary) = F(X_{ir}\beta + \alpha_r + \varepsilon_{ir}) \quad (2)$$

Where:

$y_{ir} = 1$ if the individual, i, in the location, r, has a subsidized public transport smart card.

X_{ir} is a vector of individual characteristics, household structure, socio-economic condition, labor status and neighborhood in which the individual resides, as indicated in the SISBEN

α_r is a vector of fixed neighborhood effects

β is the parameter of interest, which relates variables to the likelihood of opting into the subsidy scheme.

Results

Table 1, shows the results of the aforementioned models. First, at the individual level, being a woman increases the likelihood of opting into the subsidy by 10%. There seems to be a clear relationship between educational level and the probability of obtaining the subsidy.

Furthermore, people who are married or living with a partner are less likely to obtain the subsidy, as compared to people who are single.

At a household level, not being the head of the household, either being a child, relative or non-relative reduces the probability of obtaining the subsidy by 4%, 8% and 9% respectively. However, having a member of the household who is attending an educational institution increases the likelihood of opting in by 4%.

Socioeconomic controls show that higher per-capita household income reduces the probability of obtaining the subsidy. People who are in the lowest income quartile are 7% more likely to use the subsidy. Within the eligible population, the SISBÉN score, which measures the socio-economic condition of households in addition to income, is also negatively correlated to the likelihood of obtaining the subsidy, i.e., people with a higher SISBEN score are less likely to opt in (although the magnitude of the correlation is quite low). Moreover, people who are employed, or looking for employment, have a higher probability of opting for the subsidy.

Finally, we found that the proximity to a service center where the card can be issued is not significantly associated with the probability of obtaining the card. However, there seems to be a 'stickiness effect' within the neighborhoods, since the proportion of residents who have requested the subsidized card is positively correlated with the individual's probability of obtaining it. Hence word of mouth appears to be a strong determinant of obtaining the subsidy—an increase in the proportion of cards in a neighborhood of 10%, generates an increase in the probability of obtaining the card by 11.5%.

TABLE 1 Regression model, Probability of Opting into Targeted Subsidy Scheme

Variables	**Probabilistic Model**			**Linear Model**		
	(1)	(2)	(3)	(4)	(5)	(6)
	Individual controls					
Logarithm Age	0.043***	0.043***	0.043***	0.036***	0.040***	0.040***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Sex (Female)	0.102***	0.102***	0.102***	0.101***	0.101***	0.101***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Marital status (base: single)						
Married	-0.020***	-0.020***	-0.020***	-0.020***	-0.022***	-0.022***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Separated or widows	-0.004**	-0.004**	-0.004**	-0.001	-0.005**	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Educational attainment (base: none)						
Primary	0.082***	0.081***	0.081***	0.071***	0.071***	0.071***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Secondary	0.076***	0.076***	0.076***	0.065***	0.068***	0.068***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Technical Degree	0.110***	0.110***	0.110***	0.087***	0.092***	0.091***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Some University	0.080***	0.080***	0.080***	0.059***	0.066***	0.066***

	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Bachelor's degree	0.018	0.018	0.018	0.011	0.017	0.017
	(0.024)	(0.024)	(0.024)	(0.018)	(0.018)	(0.018)
	Family structure controls					
Household size	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Role in the home (Base: Head)						
Spouse	0.001	0.001	0.001	0.002	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Children	-0.044***	-0.044***	-0.044***	-0.044***	-0.045***	-0.045***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Other relatives	-0.083***	-0.083***	-0.083***	-0.086***	-0.086***	-0.086***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Other non-relatives	-0.089***	-0.089***	-0.089***	-0.092***	-0.093***	-0.093***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Number of students in the household	0.043***	0.043***	0.043***	0.044***	0.043***	0.043***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Household dependents	-0.001	-0.001	-0.001	0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	Socio-economic Controls					
Income	-0.012***	-0.012***	-0.012***	-0.010***	-0.012***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Household income per capita (base: first quartile)						
2nd Quartile	-0.011***	-0.011***	-0.011***	-0.012***	-0.012***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
3rd Quartile	-0.036***	-0.036***	-0.036***	-0.038***	-0.037***	-0.037***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
4th Quartile	-0.068***	-0.068***	-0.068***	-0.073***	-0.069***	-0.070***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
SISBÉN Score	-0.012***	-0.012***	-0.012***	-0.005**	-0.012***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	Activity Controls					
Activity (Base: work)						
Seeking employment	0.006**	0.006**	0.006**	0.007**	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Studying	-0.001	-0.001	-0.001	-0.006**	-0.007***	-0.007***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Home-based tasks	-0.035***	-0.035***	-0.035***	-0.036***	-0.038***	-0.038***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Other activities	-0.094***	-0.094***	-0.095***	-0.089***	-0.092***	-0.092***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	System Access Controls					
Card Customization point less than 1000 m	-0.001	-0.001	-0.001	-0.010**	-0.001	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Smart Card use in neighborhood	1.158***	1.162***	1.159***	1.472***	1.172***	1.169***
	(0.064)	(0.064)	(0.063)	(0.061)	(0.063)	(0.062)
Distance (m) to transit stop		-2.249*			-2.173*	
		(1.236)			(1.230)	
Stops within 200 m			0.001**			0.001**
			(0.000)			(0.000)
Location controls	YES	YES	YES	YES	YES	YES
Observations	796,437	796,437	796,437	796,437	796,437	796,437
Pseudo R2	0.038	0.038	0.038	0.040	0.044	0.044

Standard errors in parentheses ***p<0.01, ** p<0.05, * p<0.1. To avoid problems of heteroscedasticity standard errors are estimated by cluster neighborhood.

The analysis shows that there are three main factors that influence an individual's "self-selection" to the subsidy: gender, employment status and word of mouth. Across the board, women are more likely to enroll to use the subsidy than men are. People who are working are more likely to apply for the subsidy. Lastly, people who had a large number of neighbors in the program were more likely to enroll in it as well.

SUBSIDY IMPACTS ON LABOR OUTCOMES

Secondly, we explored what were the labor outcomes of the subsidy for those who had chosen to take advantage of it. The main characteristic analyzed was the impact on hourly income and employment status. One hypothesis that arose at the beginning of the research was the possibility that the beneficiaries of the policy had very low employment accessibility, which would reduce their chances of getting jobs. If this were the case, we would expect to see an increase in labor force participation since the subsidy might increase the formal employment accessibility of unemployed or informal workers.

A quasi-experimental technique was used for the impact assessment methodology to account for the fact that the program design was not a randomized experiment. The subsidy targeted a specific subset of the population, and recipients had to self-select to enter the program, both of which can reflect socio-economic differences among recipients and those who chose not to enroll.

The labor market variables of interest in the GEIH are those primarily related to income: income per hour of workers, income per hour of informal workers, aggregate income at the household level and income normalized by the amount of household members. We defined informality through the Colombian standard set by the National Statistics

Department (DANE), which is built from information of the work performed and the size of the firm (18). In addition, we included in our analysis several variables on employment status, such as participation, unemployment and informality. Finally, since a transport subsidy may affect time management, we included in our analysis also the number of hours worked.

Methodology

In order to assess labor market outcomes, a difference in differences model was used. Two different models were calculated using different treatment variables, one defined as percentage of subsidized smart cards issued and the other as the percentage of subsidized trips. We sought to examine whether people living in blocks with greater use of the subsidy have consistently better employment outcomes than those living in blocks with a lower frequency of trips.

The smartcard validation database records every time a subsidized card is used in a SITP station. The station is used to geo-reference card validations. In order to cross-reference the smartcard validation information (provides information of the stations used) with the GEIH (which is at a block level), we assumed that people live within a 200m radius of the stations. Although this is slightly shorter than the average walking distance, it provided a good measure of the local supply of the service. Thus, we distributed the total validations between the blocks within 200m of the stations, weighted by the population in order to calculate the total trips in each block. Similarly, trips made with the subsidized card where distributed using the subsidized population as weights in order to calculate the amount of subsidized trips per block.

From this information, two variables were generated that determined the 'intensity of treatment', and used to determine the treatment and non-treatment areas. One of the variables used in order to measure the effect of the subsidy was the total number of subsidized smartcards in use as a percentage of total smartcards. Thus, we are measuring the effect of being a program beneficiary, but with the added refinement of effectively using the card.

$$\pi_m^T = \frac{Subsidized\ Cards\ in\ Use}{Total\ Fare\ cards\ in\ use\ in\ SITP} \quad (3)$$

The second variable is defined as the total subsidized trips as a percentage of total SITP trips.

$$\pi_m^V = \frac{Subsidized\ Trips}{Total\ Trips} \quad (4)$$

For both models, the treatment variable takes a value of 1 if the proportion of the previously defined variable is larger than a reference value – which was defined as the median of the sample.

$$T_m = 1[\pi_m > \bar{\pi}_m] \quad (5)$$

Thus, the econometric model is as follows:

$$Y_{imt} = \alpha_t + \alpha_m + \beta\ D_t\ T_m + \gamma X_{imt} + \varepsilon_{mt} \quad (6)$$

Y_{mj} is the outcome variable (employment, income, etc.) for person i in the block m in month t; α is a vector of fixed time, t, and location, m, effects; D_t identifies the time of the observation, whether it was before the widespread implementation of the subsidy (January, February and December) or after (September, October and November); T_m identifies whether the population is in a treatment block; X_{mj} is a vector of socio-economic controls (gender, age, education); and β is the impact of the subsidy. It is important to note that the interpretation of these results must be made geographically, given the definition of the

independent variable— this means that β does not measure the individual effect of the subsidy, but the average effect of the subsidy on blocks that have a greater proportion of beneficiaries.

Results

Table 2 shows the results of the estimated difference-in-difference model with fixed effects at a block level, which filter unobserved heterogeneity. The results show that the largest positive and significant effect of the subsidy is on the hourly income of informal workers. There are no significant effects in terms of hourly income for formal workers, households, worker participation level, nor evidence that the subsidy has had any impact on variables associated with employment status.

TABLE 2 Estimated impact of the subsidy on income variables

	Subsidized Trips/Total Trips	Subsidized Cards/Total Cards	Obs.
Hourly income	0.014	0.045	2,897
	(0.062)	(0.061)	
	[0.16]	[0.16]	
Informal hourly income	0.220**	0.241**	1,109
	(0.106)	(0.105)	
	[0.07]	[0.07]	
Family income per capita	-0.059	-0.017	4,007
	(0.083)	(0.083)	
	[0.10]	[0.10]	
Labor Participation	-0.009	-0.011	4,404
	(0.027)	(0.027)	
	[0.31]	[0.31]	
Unemployment	0.002	0.006	3,384
	(0.020)	(0.020)	
	[0.03]	[0.03]	
Formality	0.013	0.011	3,106
	(0.038)	(0.038)	
	[0.18]	[0.18]	
Hours worked	-0.395	-0.446	3,106
	(1.270)	(1.263)	
	[0.07]	[0.07]	
Block Fixed Effects	Yes	Yes	

Standard errors in parentheses R2 in brackets; *** p<0.01, ** p<0.05, * p<0.1. To avoid problems of heteroscedasticity standard errors are estimated by cluster neighborhood.

The results demonstrate that the subsidy had a significant increase on the hourly earnings of informal workers. The coefficients of other labor outcomes variables have the expected effects; however, we could not determine that there was a significant effect.

The results found highlight the complementarity between mobility and productivity of informal activities. The subsidy would improve the labor remuneration of the most vulnerable workers. Another explanation is that individuals using the subsidy have such mounting constraints in terms of mobility and spatial segregation to employment and income-generating opportunities that somehow, the subsidy manages to counteract this phenomenon.

Robustness

The aforementioned results are dependent on the definition of the treatment variable—that is, the threshold used to consider blocks as treatment or non-treatment areas. The results presented thus far define this thresholds (both for trips or cards), as the median use of smartcards with subsidized trips in public transport. In order to test the sensitivity to the thresholds, we also considered two different alternatives: a sensitivity analysis by setting the threshold in different percentiles and a difference-in-difference with a continuous treatment variable.

For the first sensitivity analysis, we set the threshold in the median, and then increased it 10 percentile points, until the threshold reached the 90th percentile. This would mean that the block under consideration would only be considered a treatment block if the proportion of subsidized smart cards or trips is in the top 90th percentile.

The second sensitivity analysis implied applying a difference-in-difference with a continuous treatment variable. Rather than dividing the sample into treated and untreated blocks, we use a continuous variable, defined as the standardized percentage of subsidized trips (or cards) as treatment variable. The model is similar to that described previously in the methodology but instead of using the indicator of a binary definition for a treatment block (T_m), the proportion of subsidized (P_m) is used

$$Y_{imt} = \alpha_t + \alpha_t + \alpha_m + \beta\ D_t\ P_m + \gamma X_{imt} + \varepsilon_{mt} \quad (7)$$

The results for both of these analyses are shown in Table 3.

TABLE 3 Estimated impact of the subsidy on the hourly income of informal workers

Treatment threshold	Subsidized Trips/Total Trips	Subsidized Cards/Total Cards	Obs.
Median	0.190*	0.109	1109
	(0.108)	(0.112)	
	[0.07]	[0.07]	
60th Percentile	0.220**	0.285***	1109
	(0.106)	(0.103)	
	[0.07]	[0.07]	
70th Percentile	0.157	0.157	1109
	(0.112)	(0.112)	
	[0.07]	[0.07]	
80th Percentile	0.243**	0.252**	1109
	(0.113)	(0.113)	
	[0.07]	[0.07]	
90th Percentile	0.160	0.155	1109

	(0.138)	(0.165)	
	[0.07]	[0.07]	
Continuous	0.151***	0.147**	1109
	(0.061)	(0.061)	
	[0.07]	[0.07]	
Block FE	Yes	Yes	

Standard errors in parentheses R2 in brackets; *** p<0.01, ** p<0.05, * p<0.1

As seen on Table 3, in most cases we found the results are consistent with pervious findings. Most of the analyses show a positive and significant effect of the subsidy on the hourly income of informal workers.

Heterogeneous effects

Since informal workers can be either self-employed or have an informal labor relationship with an employer, perhaps the program had a different impact between these two groups. Thus, we also explored the subsidy impact based on the type of informal labor relationship. The results show that the subsidy particularly favors informal workers who have an employment relationship with an employer, and are therefore most likely to be subject to a work schedule with limited flexibility.

We also hypothesized that the effect of the subsidy may be different depending on the worker's relative income; that is, that the subsidy may have greater impact on certain parts of the income distribution. The results from this test showed that that the effects vary among different income distributions, with the smallest effect on the bottom of the distribution (10th percentile) and at the upper end (the 50th percentile and above). The strongest correlation between the subsidy and increases in income is in the lower middle part of the income distribution.

CONCLUSIONS

In order to meet the challenges of providing affordable public transit services for the urban poor and at a cost that doesn't impinge on the system's financial sustainability, cities can consider setting fares at cost recovery levels for the majority of the population and target subsidies to those who need them most. To this end, Bogotá has designed and implemented a pro-poor public transit subsidy scheme that leverages the country's experience with poverty targeting instruments and the gradual adoption of smartcards in its new public transit system. This paper presented a critical analysis of the rationale, design and implementation of this public transit subsidy, explored the determinants of user's "self-selection" and assessed the causal links between the subsidy and labor market outcomes such as hourly income and employment status.

In terms of the determinants of "self-selection", the analysis points to three important elements that affect the probability of obtaining the subsidized cards: word of mouth, employment status and gender. People who had a large number of neighbors in the program were more likely to enroll; therefore a dissemination campaign that focused at the neighborhood level (significant resources have been used by the administration to do mass media campaigns), and expands the opportunities for individuals to obtain smartcard for the

first time (scaling up for instance the minivan strategy in very poor neighborhoods, with low accessibility) are likely to increase the percentage of the target population that enrolls. Furthermore, people who are working are more likely to apply for the subsidy, this may reflect that those that are unemployed have other binding labor market conditions (eg. lack of proper skills), or that the subsidy is not sufficient (higher percentage of the fare needs to be subsidized) to deal with their mobility constraint. Women seem to be more resourceful The fact that women are more likely to opt for the subsidy also might corroborate the argument that women have different travel patterns, and generally travel more due to other household and non-employment duties, and thus would benefit more from subsidized travel.

In terms of the effects of the subsidy on labor market outcomes, the results demonstrate that the subsidy had a significant increase on the hourly earnings of informal workers. The increase in income is not associated with an increase in the number of hours worked per week; in other words, the effect is not, related to timesaving that allowed the individual to work for longer hours. Rather, it points to the complementarity between mobility and productivity of informal activities—the subsidy appears to be increasing productivity by allowing informal workers to have better mobility and accessibility to economic opportunities, and thus higher earnings. Several exercises were performed to verify and further understand these results; these exercises corroborated the effect of the subsidy on informal workers' hourly income. Heterogeneous effects show that the effect on income of informal workers is particularly high for those who, despite being informal, have a hierarchical working relationship with an employee. This may be an indication that the channel through which the subsidy has an effect is through the increased ease of time management.

This research allows us to begin to understand how to design targeted subsidies for maximum labor market outcomes. However, further research on this topic, including analyzing the impacts on mobility patterns and quality of life of the target population is needed. A randomized impact evaluation is being considered to assess the impact of different subsidy schemes (increasing the percentage of the fare being subsidized and number of trips). A randomized trial will allow us to have further understanding of labor outcomes, and design optimal subsidies for the future.

Furthermore, this research shows that there are other binding constraints to employment that have to be examined. While we have focused on analyzing the impacts of increasing affordability, we have not explored the location of housing and employment opportunities, issues concerning an individual's employment accessibility. This dimension should also be integrated in further research in order to more fully understand the impact of transport demand-side subsidies.

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