

# Mobility Constraints and Labor Market Outcomes - Evidence from Credit Lotteries\*

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*The views expressed in the paper are those of the authors and should not be cited to reflect the view of the Banco Central do Brasil.*

## Abstract

This paper assesses the role of vehicle ownership in reducing spatial mismatch between employers and employees. We exploit random time-series variation in the allocation of motorcycles through lotteries among participants in a financial product in Brazil. We find that individuals exhibit higher employment, earnings, and business ownership, and commute further after obtaining a motorcycle compared to participants who did not yet win a motorcycle. Early lottery winners still exhibit superior outcomes five years after all participants have been awarded a motorcycle. Consistent with a reduction in spatial mismatch, the effects are strongest for individuals residing in areas with sparse public transportation and local labor markets. A lower incidence of job separations and a higher probability to be employed on a permanent contract after winning a motorcycle suggest that expanding the number and scope of potential employment opportunities through motorcycle ownership leads to more stable employer-employee matches.

JEL Codes: D14, G23, J62, R20, R23.

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# 1 Introduction

In a seminal paper, Kain (1968) introduced the idea that spatial mismatch between employers and employees adversely affects labor markets. While the theory emerged as a potential explanation for inferior labor market outcomes for African-Americans, it is applicable more generally with important implications for housing, transportation, and labor market policies. If workers are unable or unwilling to move or commute to areas with employment opportunities, they may experience inferior labor market outcomes and optimal employer-employee matches may be prevented. In this paper, we assess the labor market implications of enabling workers to commute longer distances through motorcycle ownership, taken their choice of residence as given. If spatial mismatch is an important friction, commuting longer distances expands the number and scope of employment opportunities available to individuals. We find that access to a motorcycle leads to longer commuting distances, higher earnings, and more business ownership. Higher earnings through (earlier) access to a motorcycle are persistent in the long-run for at least ten years. Consistent with spacial mismatch theories, the effect of motorcycle ownership on labor market outcomes is strongest for individuals residing in areas with underdeveloped public transportation and sparse local labor markets.

Identifying a causal effect of vehicle ownership on labor market outcomes is hampered by severe endogeneity problems. Vehicle ownership results from endogenous decisions and depends on individual characteristics that are likely correlated with other economic variables. For example, individuals with higher earnings are more likely to be able to acquire a motorcycle, and financing may be more readily available to individuals with better labor market prospects. To address these empirical challenges, we exploit random time-series variation in the allocation of motorcycles to individuals in Brazil through a financial product - Consorcio. Consorcio participants pool funds to obtain access to a pre-specified durable good, in our case a motorcycle. Once a consorcio group accumulates enough funds a lottery is held to allocate the first motorcycle. This process is repeated until all participants are awarded a motorcycle.<sup>1</sup> Importantly, all participants of a consorcio group apply for participation and are selected based on the same criteria at the same point in time. Additionally, since the timing of access to the good is purely random, and therefore orthogonal to individuals' characteristics.<sup>2</sup>

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<sup>1</sup>Following the purchase, the good serves as collateral to ensure that the individual continues to make payments to the group. See Section 2 for details.

<sup>2</sup>Participation in consorcios is widespread in Brazil. Over the seven-year period from 2009 to 2016, more than 10 million people, or 6.6 percent of the working age population participate in a motorcycle consorcio,

We start by examining changes in labor market outcomes following access to a motorcycle. Specifically, we compare labor market outcomes for consorcio participants that obtain a motorcycle through a lottery to participants of the same consorcio group that have not yet won a lottery. Gaining access to a motorcycle has a positive impact on individuals' labor market outcomes. In our strictest specification, we find that participants are 1.48 percentage points more likely to be formally employed after winning a motorcycle, experience a 2.47 percent increase in wages, and are 0.94 percentage points more likely to own a business compared to other participants, who did yet not win a motorcycle. Consistent with access to a motorcycle allowing individuals to conduct a geographically broader job search, we observe a 5.08 percent relative increase in the average commuting distance (about 0.5 kilometers) of individuals after winning a motorcycle.

Our data and empirical setting allow us to assess whether changes in employment and wages are persistent in the long-run. We observe that individuals that gain access to a motorcycle earlier still exhibit better labor market outcomes five years after the termination of a consorcio group. Since all consorcio participants ultimately obtain a motorcycle, we cannot compare the long-term implications of owning a motorcycle compared to not owning a motorcycle. Instead, we assess the implications of earlier access to a motorcycle by comparing labor market outcomes for early lottery winners (winning the first half of lotteries in a consorcio group) and late winners (winning the second half of lotteries) in the long-run. While differences in formal employment dissipate after late winners obtain access to a motorcycle, we observe that early winners continue to earn 4.16 percent higher wages, and are 5.61 percentage points more likely to own a business five years after all participants have received a motorcycle. Over the ten year period after the start of the consorcio group, early winners earn 53.33 percent of the annual pre-participation earnings more than late winners.<sup>3</sup> This suggests that policies that allow individuals easier access to mobility through motorcycle ownership may have a significant impact on earnings. The dynamics of commuting distance show that after early winners gain access to a motorcycle, their average commuting distance increases by about nine percent (about 0.9 kilometers) compared to later winners. Once late winners start to gain access to motorcycles as well this difference starts to decline and disappears once all later winners have access to a motorcycle.

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4.8 million of which obtain a motorcycle during this time period. This ensures that the effects we observe are representative of a large fraction of the population.

<sup>3</sup>Since we compare early winners with late winners, the estimate is likely conservative relative to the value of motorcycle ownership compared to not gaining access to a motorcycle at all.

While we observe persistently higher earnings for early winners in the long-term, we do not observe differences in their earnings path relative to the time of being allocated a motorcycle. Put differently, when we compare commuting distances, employment, and earning patterns in the five years before and after an individual gains access to a motorcycle for early and late winners, we observe identical patterns. Thus, better long-run labor market outcomes for early winners are driven by earlier access to mobility giving them a “head start” on a positive earnings trajectory.

We complement our analysis with cross-sectional tests in which we examine whether the effects of motorcycle ownership are larger in areas in which we would expect spatial mismatch to matter more. Specifically, we examine whether access to a motorcycle has a stronger impact on individuals’ labor market outcomes when public transportation is less developed and when job opportunities are more sparse in the vicinity of an individual’s residence. We find that motorcycle ownership leads to a higher increase in commuting distances and has a larger impact on formal employment, earnings, and business ownership for individuals living in areas with less developed public transport. Similarly, commuting distances and labor market outcomes increase more when there are fewer employment opportunities per capita in the zip code of residence, in particular when the ratio of potential employment opportunities three to twenty kilometers around the zip code of residence to the number of employment opportunities within the zip code is high.

Finally, we document that expanding the set of potential employment opportunities through motorcycle ownership affects employer-employee matches. In addition to the higher wages that workers earn after winning a motorcycle, which is indicative of higher productivity, we observe patterns consistent with improved job matches. First, when individuals start a new job after winning a motorcycle, they are more than ten percentage points more likely to be employed by the same firm after six to twenty-four months, compared to when they enter a new job before winning a motorcycle. Second, when individuals start a new job after winning a motorcycle, they are between five to eight percentage points more likely to be on a permanent contract at the time of hiring and up to twelve months later. Finally, expanding the scope of available employment opportunities is reflected in a twelve percentage points higher probability of switching to a new occupation when starting a new job after winning a motorcycle.

While random time-series variation in the allocation of motorcycles through lotteries among identically selected members of a consorcio group provides an almost ideal experiment

to assess the labor market implications of mobility constraints, we carefully examine potential confounding effects. Most notably, we ensure that the results are not affected by changes in participants' behavior after signing up for a consorcio group in anticipation of motorcycle ownership, exclude individuals that do not obtain a motorcycle due to missed payments, and individuals that join an existing consorcio group or participate in one than one group at a time in robustness tests. Additionally, we verify that the results we obtain in the smaller main sample of about 20,000 individuals that participate in all-lottery consorcios also holds for the full sample of more than 1.3 million lottery winners in mixed lottery and auction consorcio groups.

The results in the paper touch on several strands of literature. The paper is most closely related to the literature assessing the relevance of mobility constraints for labor market outcomes.<sup>4</sup> While there is broad evidence that individuals have a strong distaste for commuting long distances (Bonhomme and Jolivet 2009; Krueger, Kahnemann, Schkade, Schwarz, and Stone 2009; Guglielminetti, Lalive, Ruh, and Wasmer 2014; Marinescu and Rathelot 2016; Manning and Petrongolo 2017), there is no clear consensus on whether commuting constraints are important for labor market outcomes. For example, Marinescu and Rathelot (2016) argue that spatial mismatch explains only 5.3 percent of total unemployment in the U.S., because job seekers live close enough to potential vacancies. In contrast, other studies argue that reducing mobility constraints leads to better labor market outcomes (e.g., Holzer, Quigley, and Raphael 2003; Phillips 2014; Abebe, Caria, Fafchamps, Falco, Franklin, and Quinn 2017).

We contribute to this literature by documenting that reducing mobility constraints through motorcycle ownership improves individuals' labor market outcomes, including higher earnings. The advantage of our setting is that the time-series variation of motorcycle ownership is uncorrelated with individual characteristics allowing us to measure the effect of mobility through vehicle ownership on labor market outcomes free from confounding factors that plague existing studies.<sup>5</sup> Additionally, detailed employer-employee matched data allows us to examine the dynamics and long-run effects of mobility on labor market outcomes.

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<sup>4</sup>While there is a significant literature on regional migration (e.g., McKenzie 2012; Bryan, Chowdhury, and Mobarak 2014), our paper is rather related to the literature on commuting constraints.

<sup>5</sup>Ong (1996, 2002), Cervero, Sandoval, and Landis (2002), Raphael and Rice (2002), Gurley and Bruce 2005, Ong and Miller (2005), Baum (2009), and Le Gallo, L'Horty, and Petit (2017) examine the effect of car ownership on employment and earnings, whereas Phillips (2014) and Abebe, Caria, Fafchamps, Falco, Franklin, and Quinn (2017) assess how different forms of access to transportation affect employment.

Our results also relate to the literature on spatial mismatch, which encompasses mobility constraints, and has attracted extensive attention in labor and urban economics (Kain 1968; Ihlanfeldt and Sjoquist 1998; Manning and Petrongolo 2017).<sup>6</sup> Consistent with Kain (1968)’s initial conjecture, several studies provide empirical evidence consistent with spatial mismatch contributing to deteriorating labor market outcomes for African-Americans (e.g., Stoll and Raphael 2000; Holzer, Quigley, and Raphael 2003; Boustan and Margo 2009). Other studies examine the relevance of spatial mismatch on labor market outcomes in different contexts, finding evidence consistent with spatial mismatch (Aslund, Osth, and Zenou 2010).

The most important obstacle to identifying a causal effect of spatial mismatch on labor market outcomes is that individuals that are less attached to the labor market may sort into neighborhoods that are further away from job opportunities. Our paper contributes to the literature on spatial mismatch by exploiting an institutional setting that provides random time-series variation in enabling individuals to overcome spatial mismatch through mobility. Documenting that a reduction in commuting constraints leads to better labor market outcomes provides implicit evidence that spatial mismatch leads to adverse labor market outcomes for individuals. Longer commuting distances following access to a motorcycle, in combination with the observed increase in wages, suggests that increasing households’ mobility allows them to find jobs that yield higher wages. This implies that policies to improve household mobility may have positive effects on household income (Fan 2012).

The results in the paper also lend support to a strand of literature arguing that labor market shocks can have a lasting impact on workers’ income (Farber 1993; Jacobson, LaLonde, and Sullivan 1993; Davis and von Wachter 2011; Jung and Kuhn 2014; Jarosch 2015). Consorcio participants experience an identical “shock” when they win the motorcycle in a lottery, but at different points in time. This allows us to assess differences in long-term labor market outcomes that are purely driven by the timing of the shock. Documenting persistent differences in wages for individuals that experience a positive labor market shock on average about two to three years earlier suggests that shocks to individuals’ labor market outcomes can have long-term effects. In our case, earlier access to mobility has long-run implications for individuals’ labor market outcomes consistent with models of human capital accumulation and continued job search in combination with competition among employers that predict a positive wage trajectory (Postel-Vinay and Robin 2002; Burdett and Coles 2003; Rubinstein and Weiss 2006; Bagger, Fontaine, Postel-Vinay, and Robin 2014).

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<sup>6</sup>See Chapple (2006) for a review from the urban planning perspective.

The results in the paper also contribute to the literature on labor market implications of households' financial constraints.<sup>7</sup> Empirical evidence is surprisingly scant in this literature. Karlan and Zinman (2010) run a controlled field experiment with a lender in South Africa to extend credit to marginal borrowers and show that relaxing credit constraints affects a wide range of outcomes, including measures of employment and income. Herkenhoff, Phillips, and Cohen-Cole (2016) exploit the removal of bankruptcy flags from credit reports and document that formal sector employment rates are 0.32% higher for people whose flags are removed from their record, and these workers earn 1.8k dollars more when flowing into employment. Using the same experiment, Dobbie, Goldsmith-Pinkham, Mahoney, and Song (2017) find precise zero effects on employment and earnings.<sup>8</sup> The credit lotteries in consorcios provide random time-series variation in turning savers to borrowers.<sup>9</sup> The results suggest that for the self-selected group of consorcio participants that intent to invest in mobility, delayed access to mobility through motorcycle ownership due to credit constraints leads to lower employment, earnings, and business ownership. Additionally, given the persistence of the labor market effects, our results suggest that temporary financial distress or limited access to capital can have long-term effects on individuals' labor market outcomes and household income.

## 2 Consorcios

This section describes the structure of consorcio contracts and the allocation process of durable goods within a consorcio group through lotteries.<sup>10</sup>

Consorcios are a financial product in which participants act as lenders and borrowers to each other. Consorcios cover the acquisition of a wide range of durable goods, including

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<sup>7</sup>Investment in mobility is one of the most common forms of investment after relaxing households' credit constraints (Karlan and Zinman 2010; Kaboski and Townsend 2012). For example, Karlan and Zinman 2010 document that transportation expenses experience the second highest increase (19.3 percent) following food expenses (26 percent) after the relaxation of borrowing constraints for low-income households.

<sup>8</sup>Due to the nature of the experiment in these papers, it is unclear whether potential differences in employment and earnings are driven by credit constraints, or more directly through discrimination against previously bankrupt workers, as documented by Clifford and Shoag (2016), Bos, Breza, and Liberman (2017) and Cortes, Glover, and Tasci (2017).

<sup>9</sup>Credit groups to pool funds similar to consorcios exist not only in Brazil, although they tend to be less sophisticated and less regulated elsewhere. For example, credit groups, known as Tuanhui, exist in China as an alternative way of financing investment and consumption for households with limited access to traditional financing sources.

<sup>10</sup>A more thorough and detailed description of consorcios is available in Addison (2006).

different types of vehicles and real estate. At the start of the sample period, over three million individuals are registered participants in consorcios in Brazil. In general, consorcios allocate goods to participants through auctions and random lotteries. For the main sample of this paper, we only focus on consorcio groups in which participants obtain motorcycles exclusively through random lotteries to eliminate endogeneity concerns related to auctions. In robustness tests, we include the full sample of all lotteries in pure lottery groups and mixed lottery and auction groups.<sup>11</sup>

Consorcio groups are typically administered by the finance division of the manufacturer who provides the good that individuals save towards, a bank, or a specialty finance company. The administrator is in charge of marketing the consorcio, selecting the applicants, managing payments as well as the payment and the allocation of the good, and enforcing contracts. The administrator is compensated for these services through an administrative fee levied on all consorcio participants. In selecting the participants, administrators mainly consider income and savings criteria. The administrator carries only operational risk, while credit risk is borne by participants. Due to the organization of the group through a central and independent administrator, personal relations between Consorcio participants are uncommon and participants may reside in distant areas.

Consorcio participants contribute pre-determined payments in regular intervals, typically monthly. These payments are adjusted for inflation and changes in the price of the good. The payments cover, besides the purchase of the good, administrative fees as well as flowing into a guarantee fund that covers losses from defaults of individual participants.<sup>12</sup> Once funds are sufficient to buy one unit of the good, the recipient of the is determined through a random lottery.<sup>13</sup>

Lottery winners are required to continue their contributions to the consorcio. In case of default, the good is repossessed by the administrator and resold with the proceeds from the sale flowing back into the consorcio's funds. The ability to repossess the good is crucial for the functioning of consorcios, since different from other contracting arrangements that rely on social capital to enforce continued payments (e.g., ROSCAs) participants in consorcios typically do not share social ties. Due to this feature, consorcios groups are mostly limited to

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<sup>11</sup>By law, each consorcio needs to allocate at least one good each period through a lottery.

<sup>12</sup>In some consorcios, a fraction of the payments is used to insure the good against damage to preserve its value as collateral.

<sup>13</sup>The lottery ("sorteio") is determined through the distance between a participant's identification number and the number drawn by the national lottery according to a pre-specified formula to guarantee impartiality.



durable goods that serve as physical collateral. A supporting feature for the sustainability of consorcios is the ease and speed of recovery in the Brazilian system that allows administrators to recover the motorcycle within a few weeks of default. If a participant defaults before receiving the good, her past payments are kept in the consorcio until the person wins a lottery, in which case she is repaid her initial payments minus a penalty instead of receiving the good. Defaults of participants do not affect the required payments of other participants, as long as the losses that results from a default are covered through the guarantee fund. If losses exceed the capacity of the guarantee fund, participants absorb the losses through higher contributions. In practice, however, losses from defaults rarely exceed the capacity of the guarantee fund. At the termination date of the consorcio, any remaining funds are repaid to the participants.

### 3 Data

The data for this paper stems from three main sources. Data on consorcios in from the Sistema de Administracao de Grupos/Cotas de Consorcio (SAG) database, which is maintained by the Banco Central do Brasil (BCB). Information on labor markets outcomes is available through RAIS (Relacao Anual de Informacoes Sociais), which provides an employer-employee matched database that includes employment information and wages for all formally employed workers in Brazil. Data on business ownership comes from Receita Federal, the Brazilian equivalent of the IRS.

The database on consorcios provides information on the consorcio administrator, the number of participants in a given consorcio group, the good that is being allocated to participants, and the dates when the goods are awarded and delivered to participants. Besides allocating goods through lotteries, consorcios can also hold auctions to allocate the good across participants. For the main analysis in this paper, we restrict the data to consorcios that allocate all motorcycles through random lottery. The BCB collects data on all consorcios since October 15, 2008, including consorcios that started earlier, but have not completed by October 2008. The earliest starting date of a consorcio group in our sample is 2006. The sample ends in December 2015 to coincide with the availability of RAIS data when we extracted the data in September 2016. The database provides additional information on consorcio participants, including their social security number, which allows us to match them to the RAIS database.

The RAIS database records information on all formally employed workers in a given year and is maintained by the Labor Ministry of Brazil. All formally-registered firms in Brazil are legally required to report annual information on each worker that the firm employs. RAIS includes detailed information on the employer (tax number, sector of activity, establishment size, geographical location), the employee (social security number, age, gender, education), and the employment relationship (wage, tenure, type of employment, hiring date, layoff date, reason for layoff, etc.). Consistent with the data on consorcios, we use data from RAIS for the period from 2006–2015, which provides us with ten years of panel data on workers’ labor market outcomes. By the end of 2015, the database covers about 50 million formal employees. The datasets allows us to trace formal employment and wages for all individual.

Finally, the Receita Federal maintains a register of all business establishments including the social security number of the business owner, which allows us to match business ownership data with the other datasets.

Table 1 provides descriptive statistics on the consorcio groups (Panel A) and individuals (Panel B) in the data. The data contains 487 consorcio groups that allocate all motorcycles through random lottery between 2006-2016, which are organized by 25 different administrators. The average group has 43.79 participants, with a median number of 34 participants. Thus, the total number of participants in the 487 consorcios is 21,326. The average duration between the first and the last lottery of a consorcio group is 53.11, with a median duration of 57 months, and the average gap between the allocation of two motorcycles within a consorcio group is 2.38 months.

The average monthly salary across all participants in motorcycle consorcios is 1494 BRL, and 1440 BRL for pure lottery consorcios. This compares to an average salary of 1784 BRL in the working-age population. The average consorcio participant is similar to the average person in the population along many characteristics, such as the propensity to own a business or the industries they are employed in. Notable differences include gender, with consorcio participants being about twenty percentage points more likely to be male, and education with pure lottery consorcio participants being about half as likely to have graduated from university than the general population.

We compute commuting distance as the actual commuting distance (not air-line distance) between an individual’s residence and workplace using geocoding provided by google. We cap commuting distances at 100 kilometers, as commuting distances above 100 km are likely

to be mistakes due to misreporting of individuals' address. For example, they may still report their parents' address or previous address before moving. Excluding individuals that work and live in the same zipcode, the average commuting distance before gaining access to a motorcycle is 10.42 kilometers, the median commuting distance is 5.80 km. If we assign a commuting distance of zero to individuals living and working in the same zip code, the average commuting distance is 8.59 km, with a median of 4.26 km.

## 4 Empirical Strategy

This section outlines the empirical strategy employed in this paper to assess the effect of access to a motorcycle on individuals' labor market outcomes and entrepreneurship.

### 4.1 Short-Run Effects

Estimating the impact of commuting constraints on labor market outcomes, for example wages, implies the following basic regression equation:

$$\log(wage)_{it} = \alpha + \alpha_i + \beta \cdot mobility_{it} + \eta_{it} + \epsilon_{it}$$

where  $\log(wage)_{it}$  is the log of individual  $i$ 's wage in month  $t$ ,  $mobility_{it}$  is a measure of mobility for individual  $i$  in month  $t$ ,  $\eta_{it}$  are unobservable time-variant worker characteristics, and  $\alpha_i$  denotes time-invariant individual fixed effects.<sup>14</sup> Changes in mobility are likely to be correlated with changes in time-variant individual characteristics that predict changes in labor market outcomes (i.e.,  $corr(mobility_{it}, \eta_{it}) \neq 0$ ). For example, a bank may be more likely to provide financing to an individual whom it expects to earn higher wages in the future. In this case, the estimate  $\hat{\beta}_{OLS}$  will be biased:  $\hat{\beta}_{OLS} = \beta + [cov(mobility_{it}, \eta_{it})/var(\eta_{it})]$ .

To eliminate the estimation bias in  $\hat{\beta}_{OLS}$  requires to explore variation in  $mobility_{it}$  that is uncorrelated with unobserved individual characteristics  $\eta_{it}$ , such that  $cov(mobility_{it}, \eta_{it}) = 0$ . Consorcios, a unique credit product in Brazil, provide such exogenous variation in  $mobility_{it}$ , by allocating credit to participants to acquire motorcycles through random lotteries. This provides time-series variation in mobility orthogonal to individual characteristics.

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<sup>14</sup>In addition to wages, we examine the effect of mobility constraints on formal employment, business creation, and commuting distance.

Importantly, while the timing of credit allocation *within* a consorcio group is randomized through lotteries, selection into a given consorcio group is likely to be endogenous and may therefore be correlated with individual characteristics  $\eta_{it}$ . Thus, it is necessary to saturate the estimation with consorcio group-time fixed effects ( $\alpha_{ct}$ ) to control for characteristics of individuals that select and are selected into a specific consorcio group that may be related to changes in labor market outcomes. Together, this implies the following regression specification:

$$\log(wage)_{it} = \alpha + \alpha_i + \alpha_{ct} + \beta \cdot win_{it} + \eta_{it} + \epsilon_{it} \quad (1)$$

where  $win_{it}$  is a dummy variable that takes the value of one from the month in which individual  $i$  wins the lottery, and zero up until the winning month. Due to the random nature of credit allocation through lotteries within a consorcio, we get that  $cov(win_{it}, \eta_{it}) = 0$ , which allows us to recover an unbiased estimate of  $\hat{\beta}$ .

## 4.2 Long-Run Effects

To examine whether earlier access to mobility has an effect on labor market outcomes in the long-run, we examine differences in labor market outcomes for early lottery winners (i.e., workers that win the first half of lotteries in a given group), and late winners (i.e., workers that win the second half of lotteries in a given group). Specifically, we compare differences in labor market outcomes at different points in time for early and late winners:

$$\log(wage)_i^{s+m} - \log(wage)_i^s = \alpha + \alpha_c + \beta \cdot early\ winner_i + \epsilon_i \quad (2)$$

where  $s$  indicates the year when a consorcio group is initiated, and  $\log(wage)_i^{s+m} - \log(wage)_i^s$  is the change in worker  $i$ 's wage  $m$  years after the consorcio started. The dummy variable  $early\ winner_i$  takes the value of one for all workers that win in the first half of lotteries, and zero for workers that win the second half of lotteries. Consorcio-group fixed effects are denoted by  $\alpha_c$ . Since the dependent variable in this specification is the change in wage for the same worker, this is equivalent to including individual fixed effects ( $\alpha_i$ ) and consorcio group-time fixed effects ( $\alpha_{ct}$ ) in the non-differenced specification in equation (1). Since the timing of winning a lottery is random and uncorrelated with  $\eta_i$ , this specification provides us with an unbiased estimate of  $\hat{\beta}$ , where a positive value for beta indicates that earlier access to mobility has a positive impact on labor market outcomes.

### 4.3 Employer-Employee Matches

In the final set of tests, we examine differences in outcomes for a given employer-employee match established before and after winning a motorcycle through a lottery to assess whether mobility constraints have an effect on job match, by estimating:

$$match_{ijt,t+s} = \alpha + \alpha_{ct} + \beta \cdot win_{it} + \epsilon_{ijt} \quad (3)$$

where  $match_{ijt,t+s}$  is a measure of different outcomes  $s$  months after individual  $i$  joins firm  $j$  in month  $t$ , the other variables are defined as before. Specifically, we examine whether workers are more likely to remain employed by the same firm for a longer period of time after being hired after winning a motorcycle in a consorcio lottery, or whether workers are more likely to be on a permanent contract when they start a new job after winning a motorcycle. Additionally, we examine whether workers are more likely to transition to new occupations after winning a motorcycle. To ensure that our results are not affected by censoring, we only consider hirings that start more than  $x$  months before the end of the sample period, and more than  $x$  months before individuals win a motorcycle in a lottery when examining outcomes  $x$  months after starting a new job.

## 5 Results

This section presents the empirical results from estimating equations (1) to (3) complemented by cross-sectional tests that support the interpretation of the results.

### 5.1 Formal Employment

We start by examining the effect of mobility constraints on formal employment. Figure 1 depicts the coefficient from estimating equation (2) with 95% confidence bounds from year  $s - 3$  to  $s + 5$ , and from  $T$  to  $T + 5$ . Since the median consorcio group runs for 57 months, after about two and a half years all early winners have received a motorcycle and late winners start to receive motorcycles. While there is no trend in the difference of formal employment of early and late winners before the start of the consorcio, early winners are more likely to be formally employed from one year after the start of the consorcio when the first motorcycles have been allocated to early winners. The difference in formal employment

remains significant until three years after the start of the consorcio group. From the fourth year after the start of the consorcio late winners start to catch up with earlier winners, and in the long-run differences in formal employment probabilities for early and late winners become insignificant.

Column I in Table 2 depicts the results from estimating equation (1) with a dummy variable that takes the value of one if worker  $i$  is formally employed in month  $t$ , and zero otherwise, as the dependent variable. We observe a 1.48 percentage points increase in the probability of an individual being formally employed after winning a motorcycle through a lottery compared to other participants in the same consorcio group who have not yet won a motorcycle. Columns II to VII compare the differences in formal employment for individuals who win the first half of lotteries (early winners) and workers who win the second half of lotteries (late winners) by estimating equation (2) for different values of  $t$ . The results in columns II and III indicate that the difference in formal employment between early and late winners follows a similar trend before the start of the consorcio group ( $t < s$ ). Three years into the consorcio, which is roughly the time when early winners won a lottery, whereas late winners just started to win motorcycles, the difference in formal employment between early and late winners is about 1.33 percentage points (column IV). The difference in formal employment drops once late winners start to be allocated motorcycles and becomes insignificant by the end of the consorcio ( $t = T$ ) when all workers won a motorcycle (column V). In the long-run early and late winners show no significant differences in formal employment probabilities although the point estimate is still positive (columns VI and VII). Overall, the results in Figure 1 and Table 2 suggest that the effect of access to a motorcycle on formal employment are positive, but rather small.

## 5.2 Wages

We continue by examining the effect of motorcycle ownership on wages. Figure 2 depicts the coefficients from estimating equation (2) with 95% confidence bounds from year  $s - 3$  to  $s + 5$ , and from  $T$  to  $T + 5$ . While there is no trend in the difference of wages for early and late winners before the start of the consorcio group, wages of early winners start to relatively increase from one year after the start of the consorcio group when the first motorcycles have been allocated to early winners. Since the average consorcio group duration is about five years, late winners start to win motorcycles from around two and a half years after the start of the group. This suggests that the increase in wages continues after the receipt of the

motorcycle, as wages of early winners continue to increase relative to late winners until the end of the consorcio group at time  $T$ . The difference in wages declines only slowly after the end of the consorcio group, which suggests that the “head start” that early winners obtain through receiving a motorcycle on average around two and a half years earlier than late winners still affects wages in the long-run.

Column I in Table 3 depicts the results from estimating equation (1). After winning a motorcycle through a lottery, individuals’ wages increase by 2.47 percent more than for other participants in the same consorcio group, who have not yet won a motorcycle in a lottery. Columns II to VII compare the wages of early winners to the wages of late winners at different points in time by estimating equation (2) for different values of  $t$ . The results in columns II and III indicate that the difference in wages between early and late winners follows a similar trend before the start of the consorcio group ( $t < s$ ). Three years into the consorcio group, the difference in wages between early and late winners has increased by 4.64 percent (column IV). At the end of the consorcio group ( $t = T$ ) when all workers won a motorcycle, the wages of early winner are 6.21 percent higher than for later winners (column V). The results in columns VI and VII suggest that while the difference in wages narrows over time, early winners still earn higher wages than late winners three years after the end of the consorcio group by 5.31 percent (column VI), and five years after the end of the consorcio group by 4.16 percent (column VII).

When we aggregate the wage differentials for early and late winners over the ten years from  $t = s$  to  $t = T + 5$ , early winners’ aggregate earnings are 53.33 percent of annual the pre-consorcio wage higher than the aggregate earnings of late winners, which amount to an additional BRL 9561 over ten years. Since all participants obtain a motorcycle at some point and wage differentials are likely to continue beyond year  $T + 5$ , this is a conservative estimate of the effect of motorcycle ownership on aggregate wages.

### 5.3 Business Ownership

Next, we examine how access to a motorcycle affects business ownership. The allocation of motorcycles through consorcios may affect business ownership in several ways. On the one hand, higher wages may increase individuals’ ability start a new business by increasing available funds, either directly through the higher income, or by facilitating access to outside financing. Additionally, individuals may use the motorcycle directly in a new business ven-

ture. On the other hand, access to a motorcycle may improve individuals' outside option by expanding the set of potential employment opportunities, discouraging them from starting a new business or continuing an existing one.

Figure 3 depicts the coefficient from estimating equation (2) with 95% confidence bounds with business ownership as dependent variable from year  $s - 3$  to  $s + 5$ , and from  $T$  to  $T + 5$ . While there is no trend in differences in business ownership for early and late winners before the start of the consorcio group, early winners' business ownership starts to relatively increase after the start of the consorcio group and continues to increase maintaining a higher level even five years after the end of the consorcio group when all participants were awarded a motorcycle. This suggests that an earlier improvement in labor market outcomes, including higher wages have a persistent effect on business ownership.

The results in Table 4 column I, show the estimates from equation (1) with the number of business owned by individual  $i$  in month  $t$ . The probability of running a new business increases by 0.94 percentage points after winning a motorcycle in a consorcio lottery relative to other participants in the same consorcio group, who have not yet won a motorcycle in a lottery. Columns II to VII compare differences in business ownership for early winners and late winners by estimating equation (2) for different values of  $t$ . The results in columns II and III show that differences in business ownership follows a similar trend before the start of the consorcio for early and late winners. Three years after the start of the consorcio group, the difference in business ownership between early and late winners is 3.30 percentage points (column IV). At the end of the consorcio ( $t = T$ ), early winners are 4.49 percentage points more likely to own a business than later winners (column V). Business ownership continues to be higher for early winners three years after the end of the consorcio by 5.51 percentage points (column VI), and five years after the end of the consorcio by 5.61 percentage points (column VII).

## 5.4 Commuting Distance

Next, we turn to examining the underlying mobility channel. To shed light on whether motorcycle ownership leads to better labor market outcomes through increasing individuals' mobility, we examine changes in commuting distances between individuals' home and their



workplace.<sup>15</sup>

Figure 4 depicts the coefficient from estimating equation (2) with 90% confidence bounds with the log distance between an individual’s home and workplace as the dependent variable from year  $s - 3$  to  $s + 5$ , and from  $T$  to  $T + 5$ .<sup>16</sup> While there are no different trends in commuting distance for early and late winners before the start of the consorcio group, early winners’ commuting distance starts to increase once the first motorcycles are allocated. The difference in commuting distance increases by nine percent (about 0.9 kilometers) for early winner after they obtain their motorcycles compared to late winners and starts to decline after late winners receive their motorcycles and ultimately becomes insignificant. Thus, access to motorcycles allows later winners to “catch up” in terms of commuting distance. This also implies that differences in wages continue to persist even after late winners catch up in terms of mobility, which implies that earlier access to mobility provided early winners with a “head start” in more distant labor markets putting them on a career path that leads to long-term improvements in their labor market outcomes that late winners cannot match even five years after late winners received access to a motorcycle.

In Table 5, we examine changes in commuting distance following access to a motorcycle through consorcio lotteries. Column I shows the results from estimating equation (1) with the log of the distance between an individual’s home and workplace in month  $t$  as the dependent variable. We find that commuting distance increases by 5.04 percent for individuals after winning a motorcycle in a lottery, compared to other individuals in the same consorcio group, who have not yet won a motorcycle. Column II replaces the dependent variable with the log of commuting distance plus one to include cases in which individuals live and work in the same zip code. Including these cases, gaining access to a motorcycle leads to an increase in commuting distance by 3.57 percent. Columns III to VIII compare changes in commuting distance for early winners and late winners by estimating equation (2) for different values of  $t$ . Columns III and IV show that there is no relative change in commuting distance for early winners compared to late winners before the start of the consorcio group. Three years after the start of the group, commuting distance relatively increases for early winners by 8.82 percent, which equals about 0.9 kilometers (column V). The difference in commuting distance for early and late winners starts to decline towards the end of the consorcio to 2.22

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<sup>15</sup>Investment in mobility is often a high priority for individuals when financial constraints are relaxed (Karlán and Zinman 2010; Kaboski and Townsend 2012).

<sup>16</sup>We geocode locations of firms and individuals provided in RAIS using google and compute actual travel distances rather than airline distances.

percent (column VI), and remains insignificant after the end of the consorcio group (columns VII and VIII).

## 5.5 Mobility Constraints and Local Conditions

In this section, we examine whether increased mobility through access to a motorcycle has differential effects on individuals' labor market outcomes depending on local conditions. In Table 7, columns I to IV, we assess whether access to a motorcycle is more valuable in areas with less developed public transportation. For each municipality, we compute the ratio of bus lines per square kilometers to proxy for the quality of public transportation.<sup>17</sup> We find that the effect of winning a motorcycle on formal employment (column I), wages (column II), and commuting distance (column IV) decreases with more public transportation. This suggests that in some cases motorcycles function as a substitute for public transportation, and access to motorcycles is more valuable when individuals' mobility constraints are tighter due to less developed public transportation.

In columns V to VIII, we examine whether expanding the set of potential employment opportunities through motorcycle ownership is more valuable when individuals are faced with sparser local labor markets. For each zip code, we compute the number of firms per square kilometer as a proxy for the size of the local labor market.<sup>18</sup> We find that the increase in formal employment (column V), wages (column VI), and commuting distance (column VIII) is stronger for workers living in zip codes with sparser labor markets. This suggests that individuals that are faced with fewer local employment opportunities benefit more from access to a motorcycle and the associated increase in mobility.

We strengthen this interpretation of the results by assessing whether motorcycle ownership has a stronger impact when local labor market are sparse, relative to surrounding labor markets. In Table 8, we list the number of firms, jobs, and different occupations within a distance of one to one hundred kilometers from the center of the average zip code. The descriptive statistics show that the number of firms and jobs about doubles from 74 to 143 and 867 to 1863, respectively, when the distance from a zip code increases from one to three kilometers, and almost doubles again when increasing the distance to five kilometers, and again when increasing it to ten and twenty kilometers. The number of distinct occupations

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<sup>17</sup>We find qualitatively identical results when we scale the number of bus lines by population.

<sup>18</sup>We find qualitatively identical results when we scale the number of firms by population.

increases more slowly, increasing from 60 to 80 when increases distance from the zipcode from one to five kilometers, and to 91 at a distance of 91 kilometers.

In Table 9, we examine whether motorcycle ownership has a larger impact when higher commuting distance expands the number and scope of employment opportunities more by comparing the effect of gaining access to a motorcycle through a lottery for zipcodes with more employment opportunities within three, ten, or twenty kilometers normalized by the employment opportunities in the zipcode. We find strong evidence that formal employment increases more after gaining access to a motorcycle when commuting longer distances increases the number of employment opportunities (columns I to III, number of firms in Panel A and number of jobs in Panel B), and if longer commuting distance increases the scope of available employment opportunities by increasing the number of different occupations (columns I to III, Panel C). For wages, we find that a higher increase in the quantity and scope of employment opportunities within three to twenty kilometers around the zipcode in which an individual resides leads to a higher increase in wages after obtaining a motorcycle (columns IV to VI). Interestingly, business ownership increases relatively less for individuals that gain access to a motorcycle when there are more employment opportunities three to twenty kilometers around their zipcode (columns VII to IX). This suggests that while access to a motorcycle increases business ownership, expanding the set of potential employment opportunities through mobility can also be a substitute to business ownership. Consistent with the previous results, commuting distance increases more on average when individuals gain access to a motorcycle and there are relatively more employment opportunities around an individual's zipcode.

Overall, the results in this section show that motorcycle ownership is particularly valuable for individuals that live in areas with poor public transportation and a limited number of available local employment opportunities. Additionally, motorcycle ownership is most valuable when an increase in commuting distance leads to a higher increase in the amount and scope of potential employment opportunities.

## 5.6 Employer-Employee Matches

In this section, we examine whether higher mobility through motorcycle ownership has an effect on employer-employee matches. Specifically, we examine whether individuals stay longer with the same employer if they start a job after obtaining access to a motorcycle, are

more likely to be on a permanent contract, and differences in the probability to find a job in a different occupation.

We start by examining whether individuals are more likely to stay at the same firm for longer after winning a motorcycle compared to workers that start a job before winning a motorcycle in columns I to III of Table 10. We find that individuals are 10.70 percentage points more likely to remain employed by the same firm for at least six months when they start a job after winning a motorcycle compared to individuals that start a job before winning a motorcycle (column I). The effect is even stronger when examining differences in continued employment for at least twelve months with 14.11 percentage points (column II), and for continued employment for at least 24 months with 17.60 percentage points (column III). These results are consistent with relaxing mobility constraints leading to more stable employer-employee matches.

Next, we examine whether individuals are more likely to be on a permanent contract when they start a new job after winning a motorcycle, compared to when they start a new job before winning a motorcycle in columns IV to VII. We find that individuals are ten percentage points more likely to be hired on a permanent contract after winning a motorcycle (column IV). Individuals are still 6.77 percentage points more likely to be on a permanent contract three months after being hired (column V), if they won a motorcycle before starting a new job. We find similar results at longer horizons with individuals being about eight percentage points more likely to be on a permanent contract six months after being hired (column VI), and five percentage points more likely to be on a permanent contract one year after being hired (column VII) after winning a motorcycle. Finally, we examine whether workers are more or less likely to transfer to a different occupation when starting a job after winning a motorcycle in columns VIII. We find that workers are about twelve percentage points more likely to transfer to a new occupation after winning a motorcycle when they start a new job.

Together these results suggest that increasing individuals' mobility not only benefits individuals, but also affects employer-employee matches making them more stable and allowing individuals to transition to a different occupation.

## 6 Robustness Tests

In this section, we assess the robustness of our results to aspects of the institutional setting that may affect our estimates.

### 6.1 Anticipation of Motorcycle Ownership and Labor Market Outcomes

The random allocation of motorcycles to consorcio participants through lotteries comes close to an ideal experiment to study the effect of motorcycle ownership on labor market outcomes. The main concern with using consorcios as a laboratory is that participation in the consorcio itself affects individuals' labor market outcomes. In anticipation of experiencing an increase in mobility through motorcycle ownership individuals may exert less effort to find or maintain employment while waiting for the motorcycle. Conversely, late winners may experience a more positive change in labor market outcomes, for example if they accumulate additional human capital allowing them to transition to a better job immediately upon obtaining a motorcycle.

Since all individuals in our sample participate in a consorcio group, comparing those that already won a motorcycle to those that did not yet win a motorcycle controls for general effects of participation in a consorcio on labor market outcomes. Thus, the main concern is that employment trends differ for earlier winners, who obtain a motorcycle shortly after signing up to a consorcio group, and for later winners, for whom the conditional expectation of the waiting time to win a motorcycle declines every month. To assess this possibility, we examine trends in employment, commuting distance, earnings, and business ownership before winning a motorcycle for early winners and late winners. If anticipation of motorcycle ownership with different expected waiting times differentially affects individuals' labor market outcomes, we would expect late winners to exhibit different trends in labor market outcomes before winning a motorcycle than early winners.

In Figure 6, we explore whether winning a motorcycle earlier or later has a differential effect on labor market outcomes around the time of winning the motorcycle. The top plot compares the change in formal employment for early and late winners around the year in which they win a motorcycle. We observe no differences in the trend in formal employment in the five years before and after winning a motorcycle for early and late winners. The second

plot shows that early and late winners do not experience different trends in wages before or after winning a motorcycle. Moreover, we observe that individuals are equally likely to start a new business if they win the motorcycle earlier or later in the third plot, and the bottom plot indicates that winning a motorcycle earlier or later has no differential impact on individuals' commuting distance in the five years before and after winning a motorcycle. These similar trends suggest that winning a motorcycle earlier or later has no effect on labor market outcomes through other channels, such as late winners exerting lower effort with respect to finding or maintaining employment while waiting for motorcycle ownership.

Besides mitigating concerns about estimation bias due to anticipation effects, the results in this section also suggest that superior labor market outcomes exhibited by early winners are not driven by being put on a different trajectory, for example if individuals sign up for a consorcio group when they face specific labor market opportunities that expire over time. Instead, winning a motorcycle has the same effect on early and late winners. All differences are driven by the fact that early winners get a "head start" on the same positive trajectory, which late winners do not catch up with even five years after gaining access to a motorcycle.

## 6.2 Institutional Design

In this subsection, we assess whether aspects of the institutional design that avert full randomness of the timing of access to a motorcycle across participants affect our results. From the outset it should be noted that only a small number of individuals is subject to characteristics that may distort randomness in time-series variation in motorcycle access. We identify three potential threats to fully random allocation.

First, individuals may participate in more than one consorcio. The ability to participate in more than one consorcio increases the probability to obtain a motorcycle early and could be related to individual characteristics that predict better labor market outcomes. While this is a valid concern, less than one percent of participants participate in more than one consorcio group at a time. In Table 11, Panel A, we exclude all participants that are members of more than one consorcio group at a time and re-estimate equation (refeqn:identification). The results are virtually unaffected by excluding these participants.

Second, in some cases consorcio groups start before the full number of participants is reached or participants fail to make one of the first payments and are replaced by new

participants. While participants joining later may differ in their individual characteristics or labor market opportunity set, the vast majority of these cases occurs in the first three months of a consorcio group mitigating concerns about large differences in individual characteristics. Nevertheless, in Panel B of Table 11, we exclude all participants that join later than three months after the initial opening date of the consorcio group.<sup>19</sup> The results are qualitatively unaffected with similar magnitudes when excluding late joiners.

Third, some participants fail to make payments leading them not to be awarded a motorcycle when their number is drawn in the lottery. Instead, they receive their prior contributions minus a penalty (about 40 percent on average) when they win the lottery. Receiving a lower sum of cash rather than a motorcycle may lead to different labor market effects. In Table 11, we exclude all participants who default before receiving a motorcycle and find similar results as for the main sample.

Together the results in Panel A to C of Table 11 suggest that the deviations from random time-series variation in the allocation of motorcycles affecting a small number of individuals does not affect our results.<sup>20</sup>

### 6.3 External Validity

Our main empirical analysis focuses on the 21,326 individuals that participate in pure lottery consorcios, in which each motorcycle is awarded through a random lottery. In this subsection, we replicate our main tests for the full sample of lotteries in all consorcio groups, including those groups in which lotteries and auctions are held simultaneously. This ensures that our results are valid outside the smaller sample of individuals in pure lottery consorcios.<sup>21</sup> The full sample of lottery winners in all consorcio groups comprises 1,352,096 participants. Due to computational constraints, we randomly select a subsample of 25 percent of all participants, comprising 8,415 groups with 338,024 participants.

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<sup>19</sup>As a further robustness test, we exclude all lotteries in the first three or six months of a consorcio group, which does not affect the results.

<sup>20</sup>We also confirm that the dynamics and long-run effects of motorcycle ownership are unaffected by participation in multiple consorcio groups, late entries, or missed payments.

<sup>21</sup>We refrain from using the full sample of lotteries as our main sample, as awarding motorcycles through auctions is endogenous and the pool of participants that has not been awarded a motorcycle through auction may differ from the initial set of participants that participates in the first lottery. For example, later winners may have less liquid funds or worse job prospects since individuals with better job prospects may be more likely to successfully bid in an earlier auction.

The results are gathered in Panel D of Table 11. We find results that are qualitatively identical to the main sample with similar magnitudes. In the full sample, winning a motorcycle is associated with a 1.85 percentage points increase in formal employment (column I), a 2.09 percent increase in wages (column II), a 58 basis points increase in the probability of owning a business (column III), and a 5.51 percent increase in commuting distance (column IV). These results suggest that the effects of vehicle ownership on labor market outcomes are not confined to the small group of participants of all-lottery consorcios, but applies to a more representative sample of more than 1.3 million participants.

## 7 Conclusion

Exploiting randomized time-series variation in access to motorcycles through a unique financial product in Brazil (Consortio), we document that mobility has a significant impact on individuals' labor market outcomes. While all participants in a consorcio group receive a motorcycle at some point in time over a period of about five years, the order in which motorcycles are allocated is determined by lotteries. We find that participants that win a lottery experience a higher increase in formal employment by 1.48, an increase in wages by 2.47 percent, and are 0.94 percentage points more likely to own a business compared to participants who have not yet won a lottery. Consistent with motorcycles increasing individuals' mobility, we find that the average commuting distance of individuals that win a motorcycle increases by about 0.5 to 0.9 kilometers. Moreover, the effect of motorcycle ownership on individuals' labor market outcomes is stronger in areas with less developed public transport and scarce local labor markets.

The effects of mobility on wages are persistent in the long-run. Even five years after all members of a consorcio group were awarded a motorcycle, early winners (individuals winning in the first half of lotteries) earn 4.16 percent higher wages than late winners (individuals winning the second half of lotteries). This implies that earlier access to a motorcycle and the associated increase in mobility have long-term effects on individuals' labor market outcomes. Additionally, we find that individuals are more likely to stay employed with the same firm, to be on a permanent contract, and more likely to switch to a new occupation when they are hired after winning a motorcycle, suggesting that expanding the number and scope of potential employment opportunities affects the quality of employer-employee matches. Overall, our results resonate with theories of spatial mismatch (Kain 1968) and suggest that



policies to increase individuals' mobility (Fan 2012) may have important implications for the labor market.

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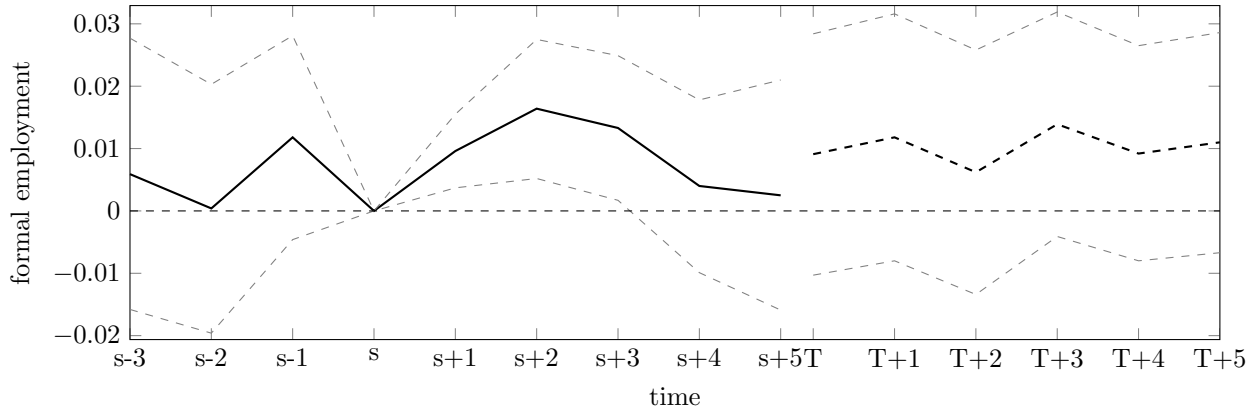
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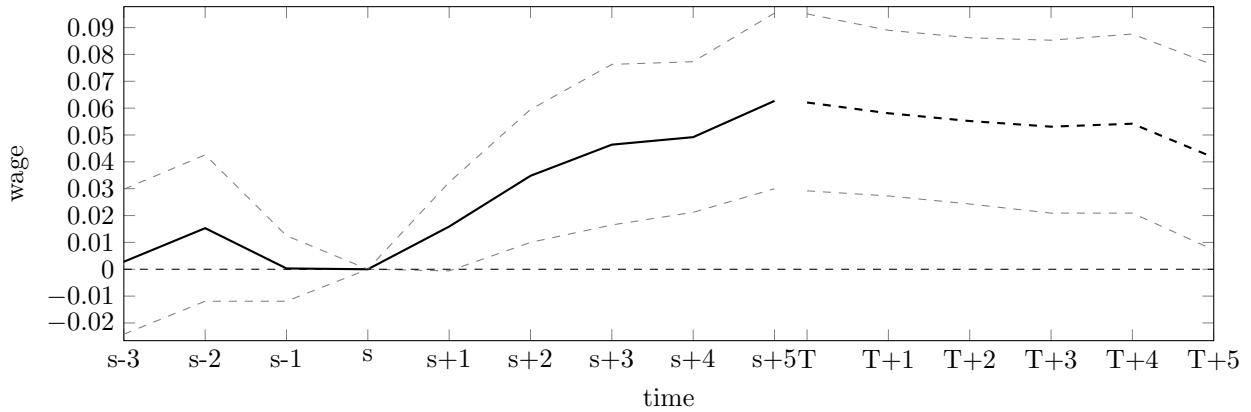
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Figure 1: Credit Lotteries and Formal Employment



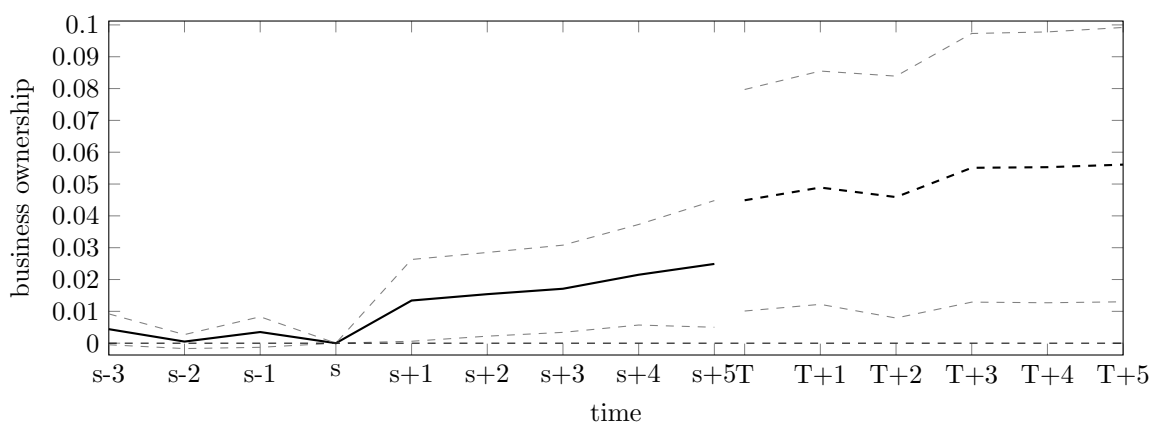
This figure depicts the difference in formal employment between below and above median lottery winners within a given consortium. The x-axis lists the year, where  $s$  indicates the starting year of a consortium, and  $T$  indicates the ending year of a consortium. The y-axis lists the fraction of formally employed workers for below and above median winners across all consortiums in the sample. The gray dashed lines depict 95 percent confidence bounds.

Figure 2: Credit Lotteries and Wages



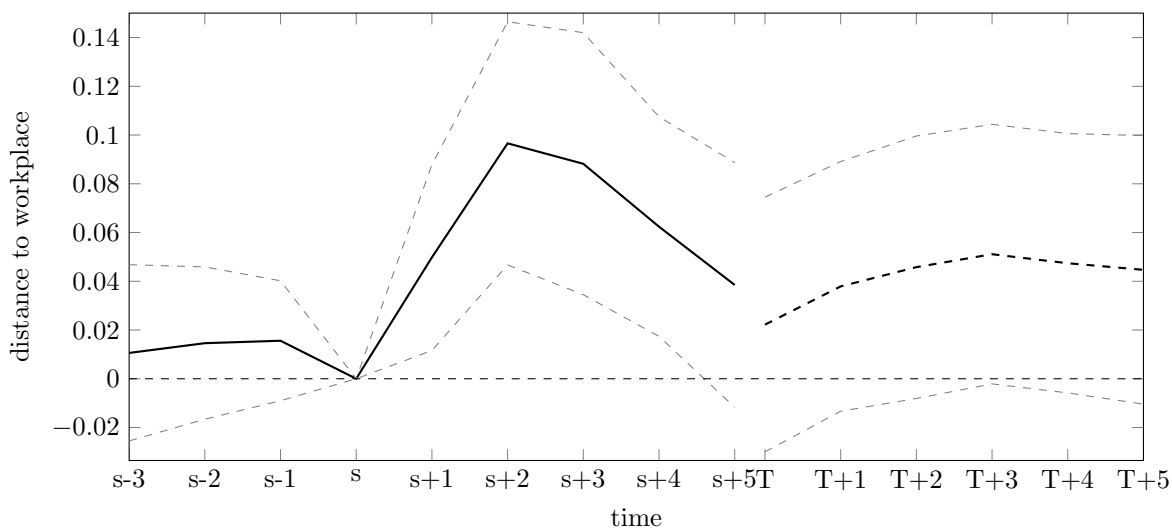
This figure depicts the average difference in wages between below and above median lottery winners within a given consortium. The x-axis lists the year, where  $s$  indicates the starting year of a consortium, and  $T$  indicates the ending year of a consortium. The y-axis lists the average log differences in wages of below and above median winners across all consortiums in the sample. The gray dashed lines depict 95 percent confidence bounds.

Figure 3: Credit Lotteries and Business Ownership



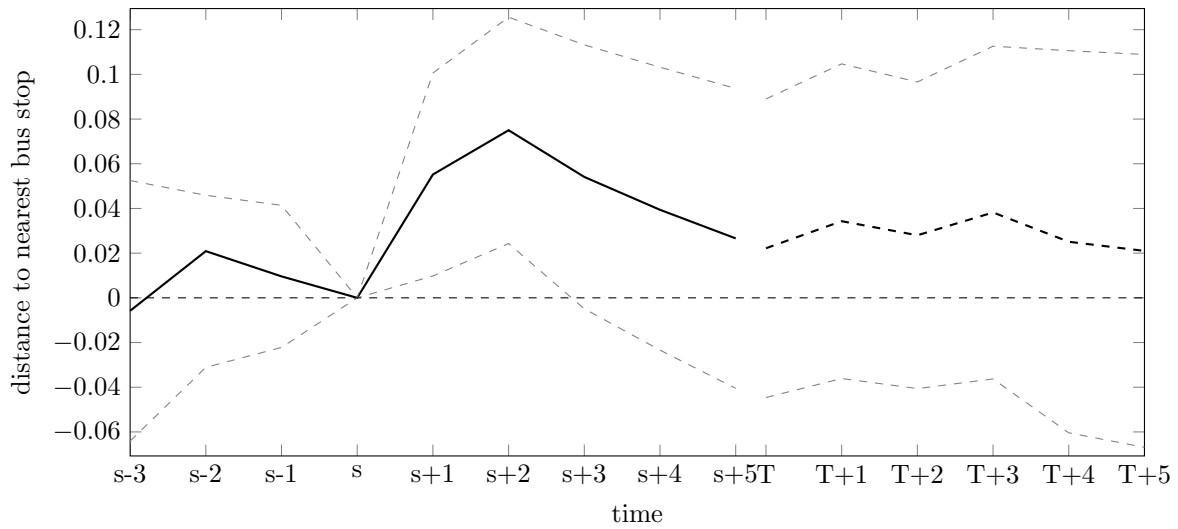
This figure depicts the average difference in business ownership between below and above median lottery winners within a given consortium. The x-axis lists the year, where  $s$  indicates the starting year of a consortium, and  $T$  indicates the ending year of a consortium. The y-axis lists the average difference in business ownership of below and above median winners across all consortiums in the sample. The gray dashed lines depict 95 percent confidence bounds.

Figure 4: Credit Lotteries and Commuting Distance



This figure depicts the average difference in commuting distance between below and above median lottery winners within a given consortium. The x-axis lists the year, where  $s$  indicates the starting year of a consortium, and  $T$  indicates the ending year of a consortium. The y-axis lists the average difference in commuting distance of below and above median winners across all consortiums in the sample. The gray dashed lines depict 90 percent confidence bounds.

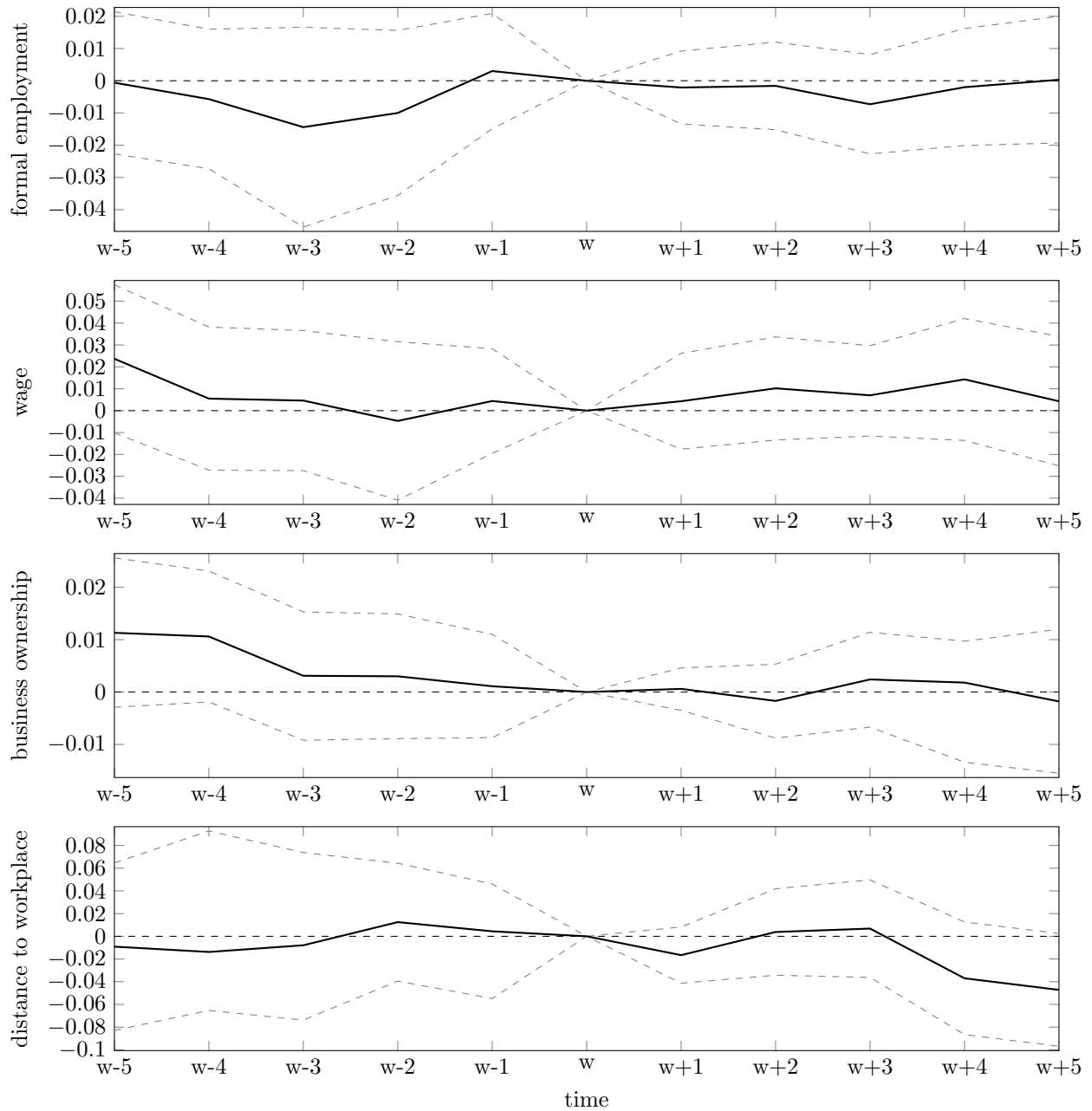
Figure 5: Credit Lotteries and Distance from Public Transport



This figure depicts the average difference in the distance between a worker’s job location and the nearest bus stop between below and above median lottery winners within a given consortio. The x-axis lists the year, where  $s$  indicates the starting year of a consortio, and  $T$  indicates the ending year of a consortio. The y-axis lists the average difference in job location to nearest bus stop distance of below and above median winners across all consorcios in the sample. The gray dashed lines depict 90 percent confidence bounds.



Figure 6: Differences in Treatment Effect - Early vs. Late Winners



This figure depicts the difference in formal employment, wages, business ownership, and distance to workplace between below and above median lottery winners within a given consortium. The x-axis lists the year, where  $w$  indicates the year of a lottery. The y-axis lists the fraction of formally employed workers, the log of workers' monthly wage, the number of businesses owned by an individual, and the distance for between home and workplace across all consortiums in the sample. The gray dashed lines depict 95 percent confidence bounds.

Table 1: **Descriptive Statistics**

Panel A: Consorcios	Mean	Median	Std.			
Administrators	25					
Groups	487					
Members per group	43.79	34.00	63.63			
Duration (months)	53.11	57.00	17.61			
Gap between wins (months)	2.38	1.62	8.15			
Panel B: Individual Characteristics (means)	Working-Age Population	Formally Employed	Consorcios	Pure Lottery	Consorcios	Vehicle Loans
Formal Employment Share	0.37	1.00	0.54	0.79	0.60	
Salary	1784	1596	1494	1440	2748	
Age	39.92	34.69	35.01	35.22	39.68	
Male	0.51	0.59	0.69	0.72	0.68	
University Education	0.15	0.15	0.11	0.08	0.25	
Business Ownership	0.10	0.00	0.15	0.13	0.23	
Agriculture & Fishing	0.05	0.04	0.05	0.05	0.03	
Construction	0.08	0.07	0.09	0.08	0.06	
Government	0.17	0.16	0.21	0.15	0.21	
Health & Education	0.07	0.06	0.05	0.05	0.08	
Hotel & Transport	0.10	0.09	0.08	0.11	0.10	
Manufacturing	0.17	0.15	0.15	0.18	0.18	
Real Estate & Finance	0.17	0.16	0.12	0.13	0.16	
Repairs	0.22	0.20	0.28	0.25	0.20	

This table provides descriptive statistics on the data used in this paper. Panel A provides descriptive statistics on the consorcios, including the number of different consorcio organizers, the number of consorcio groups, the number of winners in the first and last lotteries, the number of members per group, the duration of the groups, and the gap between the lotteries within a group. Panel B depicts descriptive statistics from other variables used in the empirical analysis in the paper.

Table 2: Credit Lotteries and Formal Employment

	I	II	III	IV	V	VI	VII
Dep. Var.:	$formal_{it}$	$formal_i^t - formal_i^s$					
		t=s-3	t=s-1	t=s+3	t=T	t=T+3	t=T+5
$win_{it}$	0.0148*** [0.0040]						
$early\ winner_i$		0.0059 [0.0110]	0.0118 [0.0083]	0.0133** [0.0059]	0.0091 [0.0099]	0.0139 [0.0091]	0.0110 [0.0090]
Group FE	-	yes	yes	yes	yes	yes	yes
Group-Year FE	yes	-	-	-	-	-	-
Individual FE	yes	-	-	-	-	-	-
Clustered SE	group	group	group	group	group	group	group
Observations	2,563,680	9,865	10,464	19,382	13,390	11,453	10,933
$R^2$	0.474	0.024	0.029	0.029	0.028	0.030	0.029

This table depicts the results from estimating equation (1) in column I, and equation (2) in columns II to VII. The dependent variable in column I is a dummy variable that takes the value of one if worker  $i$  is formally employed in month  $t$ , and zero otherwise. In columns II to VII, the dependent variable is the difference between worker  $i$ 's employment status in period  $t$  at the start ( $t = s$ ) of the consortio group. The variable  $win_{it}$  is a dummy variable that takes the value of one from the month when worker  $i$  wins the lottery and zero for the months before. The dummy variable  $early\ winner_i$  takes the value of one for all workers who win within the first half of lotteries and zero for all workers winning in the second half of lotteries. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. \*\*\* and \*\* denote statistical significance at the 1% and 5% levels, respectively.

Table 3: Credit Lotteries and Wages

	I	II	III	IV	V	VI	VII
Dep. Var.:	$\log(wage)_{it}$	$\log(wage)_i^t - \log(wage)_i^s$					
		t=s-3	t=s-1	t=s+3	t=T	t=T+3	t=T+5
$win_{it}$	0.0247*** [0.0038]						
$early\ winner_i$		0.0028 [0.0137]	0.0003 [0.0062]	0.0464*** [0.0152]	0.0621*** [0.0167]	0.0531*** [0.0164]	0.0416** [0.0175]
Group FE	-	yes	yes	yes	yes	yes	yes
Group-Year FE	yes	-	-	-	-	-	-
Individual FE	yes	-	-	-	-	-	-
Clustered SE	group	group	group	group	group	group	group
Observations	1,608,348	4,450	5,888	12,998	10,220	9,408	8,039
$R^2$	0.883	0.045	0.044	0.101	0.117	0.115	0.106

This table depicts the results from estimating equation (1) in column I, and equation (2) in columns II to VII. The dependent variable in column I is the log of worker  $i$ 's wage in month  $t$ . In columns II to VII, the dependent variable is the log difference between worker  $i$ 's wage in period  $t$  and worker  $i$ 's wage at the start ( $t = s$ ) of the consortio group. The variable  $win_{it}$  is a dummy variable that takes the value of one from the month when worker  $i$  wins the lottery and zero for the months before. The dummy variable  $early\ winner_i$  takes the value of one for all workers who win within the first half of lotteries and zero for all workers winning in the second half of lotteries. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Credit Lotteries and Business Creation

	I	II	III	IV	V	VI	VII
Dep. Var.:	$business_{it}$	$business_i^t - business_i^s$					
		t=s-3	t=s-1	t=s+3	t=T	t=T+3	t=T+5
$win_{it}$	0.0094*** [0.0027]						
$early\ winner_i$		-0.0020 [0.0038]	0.0020 [0.0022]	0.0330*** [0.0075]	0.0449** [0.0177]	0.0551** [0.0214]	0.0561** [0.0219]
Group FE	-	yes	yes	yes	yes	yes	yes
Group-Year FE	yes	-	-	-	-	-	-
Individual FE	yes	-	-	-	-	-	-
Clustered SE	group	group	group	group	group	group	group
Observations	2,563,680	9,840	10,464	19,572	13,724	11,453	11,343
$R^2$	0.912	0.029	0.003	0.045	0.071	0.068	0.065

This table depicts the results from estimating equation (1) in column I, and equation (2) in column II to VII. The dependent variable in column I is the number of businesses owned by worker  $i$  in month  $t$ . In columns II to VII, the dependent variable is the difference in the number of businesses owned by worker  $i$  in period  $t$  and at the start ( $t = s$ ) of the consortio group. The variable  $win_{it}$  is a dummy variable that takes the value of one from the month when worker  $i$  wins the lottery and zero for the months before. The dummy variable  $early\ winner_i$  takes the value of one for all workers who win within the first half of lotteries and zero for all workers winning in the second half of lotteries. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Credit Lotteries and Commuting Distance

	I	II	III	IV	V	VI	VII	VIII
Dep. Var.:	$\log(\text{distance})_{it}$	$\log(\text{distance} + 1)_{it}$	$\log(\text{distance})_i^t - \log(\text{distance})_i^s$					
			t=s-3	t=s-1	t=s+3	t=T	t=T+3	t=T+5
$\text{win}_{it}$	0.0508*** [0.0156]	0.0357** [0.0148]						
$\text{early winner}_i$			0.0106 [0.0218]	0.0156 [0.0149]	0.0882*** [0.0326]	0.0222 [0.0317]	0.0511 [0.0323]	0.0447 [0.0334]
Group FE	-	-	yes	yes	yes	yes	yes	yes
Group-Year FE	yes	yes	-	-	-	-	-	-
Individual FE	yes	yes	-	-	-	-	-	-
Clustered SE	group	group	group	group	group	group	group	group
Observations	619,435	650,714	2,489	3,109	4,712	4,154	3,824	3,733
$R^2$	0.875	0.877	0.077	0.061	0.123	0.105	0.116	0.107

This table depicts the results from estimating equation (1) in columns I and II, and equation (2) in columns III to VIII. The dependent variable in column I is the log distance between worker  $i$ 's home and workplace zip codes in month  $t$ , the dependent variable in column II is the log distance between worker  $i$ 's home and workplace zip codes plus one in month  $t$ . In columns III to VIII, the dependent variable is the difference between the log distances of worker  $i$ 's home and workplace zip codes in period  $t$  and at the start ( $t = s$ ) of the consortium group. The variable  $\text{win}_{it}$  is a dummy variable that takes the value of one from the month when worker  $i$  wins the lottery and zero for the months before. The dummy variable  $\text{early winner}_i$  takes the value of one for all workers who win within the first half of lotteries and zero for all workers winning in the second half of lotteries. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. \*\*\* and \*\* denote statistical significance at the 1% and 5% levels, respectively.

Table 6: Credit Lotteries and Distance to Nearest Bus Stop

	I	II	III	IV	V	VI	VII
Dep. Var.:	$\log(\text{bus distance})_{it}$	$\log(\text{bus distance})_i^t - \log(\text{bus distance})_i^s$					
		t=s-3	t=s-1	t=s+3	t=T	t=T+3	t=T+5
$win_{it}$	0.0664*** [0.0270]						
$early\ winner_i$		-0.0058 [0.0353]	0.0095 [0.0192]	0.0541 [0.0358]	0.0222 [0.0405]	0.0382 [0.0451]	0.0210 [0.0533]
Group FE	-	yes	yes	yes	yes	yes	yes
Group-Year FE	yes	-	-	-	-	-	-
Individual FE	yes	-	-	-	-	-	-
Clustered SE	group	group	group	group	group	group	group
Observations	878,654	2,489	3,109	7,338	6,345	5,222	4,283
$R^2$	0.858	0.062	0.061	0.100	0.103	0.101	0.111

This table depicts the results from estimating equation (1) in column I, and equation (2) in columns II to VII. The dependent variable in column I is the log distance between worker  $i$ 's workplace and the bus stop closets to the workplace in month  $t$ . In columns II to VII, the dependent variable is the difference between the log distances of worker  $i$ 's workplace and the nearest bus stop in period  $t$  and at the start ( $t = s$ ) of the consortio group. The variable  $win_{it}$  is a dummy variable that takes the value of one from the month when worker  $i$  wins the lottery and zero for the months before. The dummy variable  $early\ winner_i$  takes the value of one for all workers who win within the first half of lotteries and zero for all workers winning in the second half of lotteries. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. \*\*\* denotes statistical significance at the 1%.

Table 7: Mobility Constraints and Local Conditions

	I	II	III	IV	V	VI	VII	VIII
	Public Transport				Local Labor Market Size			
Dep. Var.:	$formal_{it}$	$\log(wage)_{it}$	$business_{it}$	$\log(distance)_{it}$	$formal_{it}$	$\log(wage)_{it}$	$business_{it}$	$\log(distance)_{it}$
$win_{it}$	0.0316*** [0.0046]	0.0314*** [0.0046]	0.0106** [0.0030]	0.0816*** [0.0183]	0.0320*** [0.0043]	0.0314*** [0.0049]	0.0111*** [0.0029]	0.0732*** [0.0179]
$transport\ density_{mt}$	0.0211*** [0.0009]	0.0053*** [0.0009]	-0.0008* [0.0005]	0.0304*** [0.0056]				
$win_{it} * transport\ density_{mt}$	-0.0072*** [0.0007]	-0.0019** [0.0008]	-0.0002 [0.0005]	-0.0103*** [0.0026]				
$labor\ market\ density_{mt}$					0.0011*** [0.0000]	0.0003*** [0.0000]	-0.0001* [0.0000]	0.0016*** [0.0003]
$win_{it} * labor\ market\ density_{mt}$					-0.0004*** [0.0000]	-0.0001** [0.0000]	-0.0000 [0.0000]	-0.0004*** [0.0001]
Group-Year FE	yes	yes	yes	yes	yes	yes	yes	yes
Individual FE	yes	yes	yes	yes	yes	yes	yes	yes
Clustered SE	group	group	group	group	group	group	group	group
Observations	2,406,942	1,511,735	2,406,942	581,407	2,406,942	1,511,735	2,406,942	581,407
$R^2$	0.481	0.882	0.911	0.877	0.483	0.882	0.911	0.877

This table depicts the results from estimating equation (1) adding a measure of public transportation  $transport\ density_{mt}$  at the municipality level, defined as the ratio of buses divided by the surface area (square kilometers), in columns I to III, and a measure of local labor market density  $labor\ market\ density_{mt}$ , defined as the number of firms per square kilometer. The dependent variable in columns I and IV is a dummy variable that takes the value of one if worker  $i$  is formally employed in month  $t$ , and zero otherwise. In columns II and V, the dependent variable is the log of worker  $i$ 's wage in month  $t$ . In columns III and VI, the dependent variable is the number of businesses owned by worker  $i$  in month  $t$ , and in columns IV and VIII, the dependent variable is the log distance between worker  $i$ 's home and workplace zip codes in month  $t$ . The variable  $win_{it}$  is a dummy variable that takes the value of one from the month when worker  $i$  wins the lottery and zero for the months before. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Commuting Distance and Employment Opportunities

Commuting Distance	1 km	3 km	5 km	10 km	20 km	50 km	100 km
Number of Firms	74	143	224	431	802	1399	2342
Number of Jobs	867	1863	3089	6400	12522	22100	36336
Number of Occupations	60	73	80	87	91	96	101

This table depicts the average number of firms, jobs, and alternative occupations within different distances from a given zipcode location in Brazil.

Table 9: Mobility Constraints and Employment Opportunities

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Dep. var.:	<i>formal<sub>it</sub></i>			<i>log(wage)<sub>it</sub></i>			<i>business<sub>it</sub></i>			<i>log(distance)<sub>it</sub></i>		
Commuting Distance	3km	10km	20km	3km	10km	20km	3km	10km	20km	3km	10km	20km
Panel A: Number of Firms												
<i>win<sub>it</sub></i>	-0.0239**	0.0232**	-0.0238**	0.0190***	0.0231***	0.0244***	0.0114***	0.100***	0.0090***	0.0248	0.0270	0.0263
	[0.0100]	[0.0104]	[0.0102]	[0.0052]	[0.0050]	[0.0047]	[0.0030]	[0.0029]	[0.0029]	[0.0243]	[0.0239]	[0.0238]
<i>win<sub>it</sub> * opportunities<sub>mt</sub></i>	0.0577***	0.0313***	0.0302***	0.2125***	0.0397*	0.0189	-0.0049***	-0.0011**	-0.0005*	0.0107**	0.0040*	0.0035**
	[0.0125]	[0.0072]	[0.0067]	[0.0764]	[0.0233]	[0.0125]	[0.0015]	[0.0005]	[0.0003]	[0.0054]	[0.0021]	[0.0017]
Observations	1,776,840	1,776,840	1,776,840	1,112,297	1,112,297	1,112,297	1,776,840	1,776,840	1,776,840	344,907	344,907	344,907
<i>R</i> <sup>2</sup>	0.476	0.476	0.476	0.881	0.881	0.881	0.905	0.905	0.905	0.878	0.878	0.878
Panel B: Number of Jobs												
<i>win<sub>it</sub></i>	-0.0218*	-0.0151	-0.0186	0.0173***	0.0223***	0.0239***	0.0108***	0.0099***	0.0091***	0.0249	0.0244	0.0240
	[0.0116]	[0.0112]	[0.0115]	[0.0051]	[0.0049]	[0.0047]	[0.0029]	[0.0028]	[0.0029]	[0.0238]	[0.0237]	[0.0237]
<i>win<sub>it</sub> * opportunities<sub>mt</sub></i>	0.0483***	0.0204***	0.0225***	0.1924***	0.0307**	0.0132*	-0.0026***	-0.0006***	-0.0003**	0.0045**	0.0020**	0.0017**
	[0.0143]	[0.0075]	[0.0074]	[0.0487]	[0.0134]	[0.0069]	[0.0081]	[0.0002]	[0.0001]	[0.0021]	[0.0008]	[0.0007]
Observations	1,776,840	1,776,840	1,776,840	1,112,297	1,112,297	1,112,297	1,776,840	1,776,840	1,776,840	344,907	344,907	344,907
<i>R</i> <sup>2</sup>	0.476	0.476	0.476	0.881	0.881	0.881	0.905	0.905	0.905	0.878	0.878	0.878
Panel C: Number of Occupations												
<i>win<sub>it</sub></i>	-0.0209**	-0.0204**	-0.0202**	0.0123	0.0170**	0.0181***	0.0116***	0.0107***	0.0105***	0.0226	0.0211	0.0211
	[0.0096]	[0.0098]	[0.0098]	[0.0075]	[0.0067]	[0.0065]	[0.0031]	[0.0030]	[0.0030]	[0.0239]	[0.0239]	[0.0239]
<i>win<sub>it</sub> * opportunities<sub>mt</sub></i>	0.0505***	0.0480***	0.0471***	0.8527**	0.4711**	0.4065**	-0.0170***	-0.0098**	-0.0089**	0.0923**	0.0839***	0.0817***
	[0.0116]	[0.0117]	[0.0118]	[0.3373]	[0.2176]	[0.1977]	[0.0059]	[0.0041]	[0.0039]	[0.0389]	[0.0307]	[0.0296]
Observations	1,776,840	1,776,840	1,776,840	1,112,297	1,112,297	1,112,297	1,776,840	1,776,840	1,776,840	344,907	344,907	344,907
<i>R</i> <sup>2</sup>	0.476	0.476	0.476	0.881	0.881	0.881	0.905	0.905	0.905	0.878	0.878	0.878
Group-Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Individual FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustered SE	group	group	group	group	group	group	group	group	group	group	group	group

This table depicts the results from estimating equation (1) adding a measure *opportunities<sub>mt</sub>* of the number of firms, jobs, or occupations in a three, ten, or twenty kilometer radius around an individual's home zip code, normalized by the number of firms, jobs, or occupations in the individual's zip code. The dependent variable in columns I to III is a dummy variable that takes the value of one if worker *i* is formally employed in month *t*, and zero otherwise. In columns IV to VI, the dependent variable is the log of worker *i*'s wage in month *t*. In columns VII to IX, the dependent variable is the number of businesses owned by worker *i* in month *t*, and in columns X to XII, the dependent variable is the log distance between worker *i*'s home and workplace zip codes in month *t*. The variable *win<sub>it</sub>* is a dummy variable that takes the value of one from the month when worker *i* wins the lottery and zero for the months before. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively.



Table 10: **Employer-Employee Matches**

	I	II	III	IV	V	VI	VII	VIII
Dep. Var.:	Separation <i>employed<sub>ijt,t+s</sub></i>			Permanent Contracts <i>permanent<sub>ijt,t+s</sub></i>				Occupation Change <i>new_occupation<sub>ijt,t+s</sub></i>
	s=6	s=12	s=24	s=0	s=3	s=6	s=12	s=0
<i>win<sub>it</sub></i>	0.1070*** [0.0096]	0.1411*** [0.0094]	0.1760*** [0.0104]	0.1035*** [0.0054]	0.0677*** [0.0059]	0.0784*** [0.0066]	0.0514*** [0.0090]	0.1198*** [0.0096]
Group FE	yes	yes	yes	yes	yes	yes	yes	yes
Clustered SE	group	group	group	group	group	group	group	group
Observations	45,576	43,323	38,683	54,103	46,403	45,576	43,323	54,103
$R^2$	0.062	0.088	0.116	0.031	0.018	0.021	0.028	0.028

This table depicts the results from estimating equation (3). In columns I to III, the dependent variable is a dummy variable that takes the value of one if worker  $i$  continues to be employed by firm  $j$  6, 12, or 24 months after hiring, and zero otherwise. In columns V to VIII, the dependent variable is a dummy variable that takes the value of one if a worker is on a permanent contract 3, 6, 12, or 24 months after being hired, and zero otherwise. In columns VIII to X, the dependent variable is a dummy variable that takes the value of one if a worker is hired a different profession compared to the previous job, or moved to a different occupation within 12, or 24 months after being hired, and zero otherwise. The variable  $win_{it}$  is a dummy variable that takes the value of one from the month when worker  $i$  wins the lottery and zero for the months before. Standard errors are reported in parentheses. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 11: **Robustness Tests**

	I	II	III	IV	V
Dep. Var.:	$formal_{it}$	$\log(wage)_{it}$	$business_{it}$	$\log(distance)_{it}$	$\log(bus\ distance)_{it}$
Panel A: Single-group Participants					
$win_{it}$	0.0139*** [0.0042]	0.0245*** [0.0039]	0.0088*** [0.0026]	0.0416** [0.0198]	0.0653** [0.0271]
Observations	2,558,280	1,604,992	2,558,280	608,196	877,935
$R^2$	0.474	0.883	0.912	0.876	0.858
Panel B: Full-time Participants					
$win_{it}$	0.0158*** [0.0052]	0.0253*** [0.0036]	0.0098*** [0.0027]	0.0600*** [0.0229]	0.0994*** [0.0360]
Observations	2,504,640	1,576,996	2,504,640	590,352	837,495
$R^2$	0.473	0.883	0.914	0.874	0.860
Panel C: Successful Participants					
$win_{it}$	0.0143*** [0.0043]	0.0233*** [0.0039]	0.0112*** [0.0027]	0.0522*** [0.0166]	0.0611** [0.0275]
Observations	2,529,000	1,590,900	2,529,000	612,090	868,820
$R^2$	0.473	0.883	0.912	0.875	0.858
Panel D: Full Lottery Sample					
$win_{it}$	0.0117*** [0.0012]	0.0282*** [0.0014]	0.0046*** [0.0010]	0.0577*** [0.0025]	0.0586*** [0.0030]
Observations	38,845,570	23,086,466	38,845,570	7,663,727	5,571,736
$R^2$	0.492	0.886	0.931	0.905	0.944
Group-Year FE	yes	yes	yes	yes	yes
Individual FE	yes	yes	yes	yes	yes
Clustered SE	group	group	group	group	group

This table depicts the results from estimating equation (1) for different samples. The sample in Panel A excludes all individuals that participate in two consorcio groups at a time, the sample in Panel B excludes individuals that join an existing consorcio group more than three months after it start, the sample in Panel C excludes individuals that do not obtain a motorcycle due to missed payments, in Panel D the sample includes all participants that win a lottery in pure lottery and mixed lottery/auction groups. The dependent variable is a dummy variable that takes the value of one if individual  $i$  is formally employed in month  $t$ , and zero otherwise in column I, the log of individual  $i$ 's wage in month  $t$  in column II, a dummy variable that takes the value of one if individual  $i$  own a business in month  $t$ , and zero otherwise in column III, and the log distance between individual  $i$ 's home and workplace in month  $t$  in column IV. The variable  $win_{it}$  is a dummy variable that takes the value of one from the month when worker  $i$  wins the lottery and zero for the months before. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. \*\*\* and \*\* denote statistical significance at the 1% and 5% levels, respectively.