Leisure and effort at work: incorporating self-employment into urban markets

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Abstract

In this paper, we study self-employment in a theoretical setting derived from urban efficiency wages spatial models, where leisure and effort at work are complementary. Our model shows that unemployment tends to concentrate far from business districts, in contrast to employment and self-employment. The self-employed tend to live closer to workplaces than do the employed, as commuting has relatively negative effects, given that it affects productivity and thus earnings. We use data from the American Time Use Survey 2003-2014 to analyze the spatial distribution of self-employment, employment, and unemployment across metropolitan areas in the US, focusing on the relationship between commuting time and the probability of employment and self-employment. Our results show that employment and self-employment are negatively related to commuting, in comparison to unemployment, while self-employment is associated with shorter commutes, in contrast to those of employees, giving support to the theoretical background.

Keywords: employment, self-employment, commuting, leisure, shirking, American Time Use Survey.

JEL Codes: J21, J22, R12, R41.

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1. Introduction

In this paper, we analyze the distribution of employment and unemployment, with a focus on self-employment, in a framework based on urban efficiency wages theory. According to the efficiency wages models, employed workers may receive a higher wage than that of the labor market equilibrium in order to discourage or forestall shirking (Brueckner, Thisse and Zenou, 1997; Zax and Kain, 1991; Kain, 1968,Brueckner and Zenou, 2003; Gobillon, Selod and Zenou, 2007; Ross and Zenou, 2008) with prior evidence showing that shirking is not eliminated, but only ameliorated, by efficiency wages (Albrecht and Vroman, 1992).However, efficiency wages focus on wage earners or firms, and self-employed workers have been largely overlooked (Campbell III, 1993; Walsh, 1999).We go a step further and include a spatial pattern to study the distribution of employment, self-employment, and unemployment across cities, in a framework based on the efficiency wage model of Ross and Zenou (2008), where leisure and shirking are considered to be substitutes. According to this model, behavioral substitution between leisure time at home and effort at work is allowed, and more commuting time is related to less time in leisure.[1]This increases the incentives to shirk and decreases the effort at work and ultimately the level of productivity. As a consequence, commuting time is related to unemployment and wages.

Efficiency wages theories do not incorporate self-employed workers in their analyses, because self-employed workers are not paid a wage but receive income from their own business, and thus are not compensated for longer commuting times. Self-employment earnings are determined by a production function whose elements are capital investment, time, and personal (managerial and technical) abilities (Blau, 1985; Taiwo, 2011), and productivity (i.e., effort at work) affects the production function that measures self-employment earnings. Within this framework, since commuting and effort at work are negatively related (Gimenez-Nadal, Molina and Velilla, 2016), self-employed workers who devote comparatively more time to commuting have comparatively less time to devote to leisure activities and thus decrease their effort at work, which reduces their productivity and ultimately their earnings. Under these circumstances, the probability of self-employment is lower when commuting times are longer, as expected earnings are lower.

[1] The relationship between commuting and income has also been analyzed in Manning (2003), White (1999), and Zax (1991).

The relationship between self-employment and commuting has only rarely been studied (van Ommeren and van der Straaten, 2008; Gimenez-Nadal, Molina and Velilla, 2015). Against this background, the primary goals of this paper are twofold. First, we develop an analytical model based on efficiency wages with a spatial pattern that incorporates self-employed workers. Commuting and effort at work are endogenously determined, leisure time is negatively related to commuting and positively to effort, and thus we hypothesize that workers who devote comparatively less time to leisure will not be as productive as they could otherwise be. We theoretically obtain that shirking and unemployment are characterized by residential locations far from the business districts, in contrast with effort at work (i.e., employment and self-employment). Furthermore, the efficiency wage mechanism cannot be extended to self-employment, and thus the self-employed tend to live nearer to urban cores than do employees. As a consequence, commuting time is positively related to the probability of unemployment (in contrast to employment and self-employment).Comparing employment and self-employment, the probability of self-employment is lower in comparison to the probability of employment in the relationship with commuting (e.g., longer commuting times reduce the probability of self-employment towards a higher probability of employment).

We empirically check the predictions of the model using the American Time Use Survey (ATUS) for the years 2003-2014, which includes information on commuting time, leisure, labor force status, and other individual characteristics. We find that the probability of being employed or self-employed is negatively related to expected commuting times, which may be interpreted as that those who are employed or self-employed tend to live closer to the business districts than do the unemployed. When we compare the probability of being employed and being self-employed, we find that longer commuting is related to a lower probability of self-employment in favor of the probability of being employed. The efficiency wage mechanism cannot be extended to self-employment, and thus the self-employed tend to live nearer to urban cores than do employees, in order to reduce their commutes.

We contribute to the literature by analyzing the spatial distribution of employment and self-employment, developing a theoretical urban model where productivity, commuting, and leisure are of major importance, in an efficiency wage setting. To the best of our knowledge, prior research has not included self-employed workers in such an analysis. We use time-use data from the US to test the adequacy of our theoretical

model. Time-use databases have been underused in this field, although the ATUS has been used in the past in commuting analyses (Gimenez-Nadal et al., 2015, 2016). Our theoretical results indicate that the self-employed and employees live nearer than the unemployed to the urban business districts (with the self-employed being the closest). Our empirical analysis points toward the validity of the model.

The rest of the paper is organized as follows. In Section 2, we propose the theoretical model. Section 3 describes our data, and Section 4 presents our empirical results. Section 5 sets out our main conclusions.

2. Theoretical model

The aim of this Section is to include self-employment in the Ross and Zenou (2008) urban efficiency wages model, based on the substitutability of leisure and shirking. To that end, we assume that self-employed workers are not paid a wage, but receive income from their own business. Blau (1985) and Taiwo (2011) develop a model where self-employment is determined by a production function whose elements are capital investment, time, and personal (managerial and technical) abilities. Within this framework, we assume that productivity (i.e., effort at work) affects the production function that measures self-employment outcomes, primarily earnings. We develop a model for employment and self-employment decisions (i.e., being employed, self-employed, or unemployed) in a context where certain of the main hypotheses are taken from urban wage-efficiency theory with urban components, and with location of business and residence, commuting, leisure, and effort at work having primary importance. In our context, the main deviation from the traditional urban efficiency wages model is that we cannot talk about high *wages* as compensation for commuting (and leisure loss), and to discourage shirking of self-employed workers, because self-employment income depends directly on effort. Furthermore, there is no external supervision in self-employment, which also plays a major role in urban wage-efficiency models.

2.1. Hypotheses of the model

We consider a linear, monocentric and closed city where the Central District, CD, is located at one end ($x = 0$), and the city fringe, x_f, at the other ($x = 1$). The city is fully

centralized, i.e., all jobs and places of business are located at one point, the Business District, BD, which is located in the CD at $x = 0$.

There are two types of individuals in our model, workers and landlords. Landlords own all the available land and play no role in the development of the model. Workers are risk-neutral, do not have inter-temporal preferences, and can be unemployed, employees, or self-employed. We assume that workers can endogenously decide their residential location, x, such that $BD < x < x_f$,and their effort at work, e. There are infinite moving costs, i.e., once workers choose their residential location, it remains invariable over time. We consider a population of workers normalized to 1, implying that unemployment, employment, and self-employment levels coincide with the respective rates.

It must be noted that an opposite scenario can be posed, where the BD is located in the city fringe (a completely decentralized city). However, as explained in Ross and Zenou (2008), the key point is not the location of the BD, but the distance between residential locations and the BD. All these assumptions are general in urban models (Fujita, 1989; Ross and Zenou, 2008). Although new models have generalized the concept of the monocentric city to multi-centric employment, the main results arising from the monocentric model are invariable to the type of city modeled (Ross and Zenou, 2008).

2.2. Indirect utilities of workers

The process behind the transitions between the three conditions of worker, employed, self-employed, or unemployed, is governed by a Markovian time process. We assume a rate $\theta > 0$ of abandoning unemployment. Then, individuals go to a fictitious intermediate state that immediately leave to become self-employed, with a probability $p_1 > 0$, or finding an employer, with probability $p_2 > 0$, such that $p_1 + p_2 = 1$. The self-employed decide to give up their business and become unemployed at a rate $\delta_1 > 0$, and employees are fired at a rate $\delta_2 > 0$. We maintain that there are no direct transitions from self-employment to employment, and the reverse, allowing frictional unemployment.

Under these hypotheses, we have that the expected time that an individual will be unemployed until he/she becomes employed or self-employed is $1/\theta$, and the expected

time workers will be self-employed or employees until they become unemployed are $1/\delta_1$ and $1/\delta_2$, respectively. Then, we can obtain the percentage of life that workers will be unemployed(u), self-employed (se), and employed(we):

$$u = \frac{\frac{1}{\theta}}{\frac{1}{\theta} + \frac{1}{\delta_1} + \frac{1}{\delta_2}} = \frac{\delta_1 \delta_2}{\alpha}, \tag{1}$$

$$se = \frac{\frac{1}{\delta_1}}{\frac{1}{\theta} + \frac{1}{\delta_1} + \frac{1}{\delta_2}} = \frac{\theta \delta_2}{\alpha}, \tag{2}$$

$$we = \frac{\frac{1}{\delta_2}}{\frac{1}{\theta} + \frac{1}{\delta_1} + \frac{1}{\delta_2}} = \frac{\theta \delta_1}{\alpha}, \tag{3}$$

with $\alpha \coloneqq \delta_1 \delta_2 + \theta \delta_2 + \theta \delta_1$.

Note that, since the population is normalized to 1, *u*, *se* and *we* coincide with the levels, and rates, of unemployment, self-employment, and employment, respectively. Further, it must be that $u = P(\text{being unemployed} | \, s.s.)$, $se = P(\text{being self-employed} \, | \, s.s.)$, and $we = P(\text{being employed} | \, s.s.)$ with *s.s.* denoting the steady state.

Now, we define, for each type of worker, the instant utility and the indirect utility that will allow us to develop the equilibrium.

2.2.i. Indirect utility of employees

Following Ross and Zenou (2008), we define an instant utility

$$z + V(l, e) \tag{4}$$

where *z* is the consumption of goods (at unitary prices), and $V(l, e)$ is the instant utility from leisure and effort at work, *l* and e, respectively.

We assume that $l = l(x)$, i.e., the availability of leisure depends on the commute from home to work or, in our setting, on the residential location. For instance, $l'(x) < 0$ and the more commuting, the less time available for leisure (Gimenez-Nadal et al., 2016). Further, we maintain that effort at work and leisure are not independent activities: the extent to which individuals benefit from shirking, and not putting effort into work, arises from the availability of leisure time (Ross and Zenou, 2008).

$V(l,e)$ has the following properties: it increases with leisure and, consequently, decreases with commuting), $\frac{\partial V(l,e)}{\partial l} > 0$, and it decreases with effort at work, $\frac{\partial V(l,e)}{\partial e} < 0$.In both cases, there are decreasing returns to scale, $\frac{\partial^2 V(l,e)}{\partial l^2} < 0$ and $\frac{\partial^2 V(l,e)}{\partial e^2} < 0$. These hypotheses are the same as in Ross and Zenou (2008). However, a key theoretical and empirical ambiguity emerges in that work, since it is unknown whether leisure and effort are complementary or substitutes, and it is also unknown whether $\frac{\partial^2 V(l,e)}{\partial l \partial e}$ is positive or negative. Despite that their results point to the first option, no empirical test is done. Gimenez-Nadal et al. (2016) empirically test that hypothesis, giving robustness to the Ross and Zenou (2008) results and directly finding a negative association between leisure and shirking, defined as the opposite to effort at work, $-e$. Then, we maintain that $\frac{\partial^2 V(l,e)}{\partial l \partial e} > 0$, and less time devoted to leisure (i.e., less time for rest and relaxation) has as a consequence an increase in the benefits derived from leisure at work (i.e., from shirking).

We assume fixed and exogenous wages,w, and working times, T. When we normalize the total available time to 1, we have the following budgetary and time constraints:

$$wT = z + R(x) + \tau x, \tag{5}$$

$$1 - T = l + tx, \tag{6}$$

where $R(x)$ represents the living costs in x, and τ and t represent the relationship between commuting costs and distance, and commuting time and distance, respectively. With these, we can now define the indirect utility, in terms of the endogenous variables e and x, of the employed workers:

$$I_{we} = I_{we}(x,e) = wT + V(1 - T - tx, e) - R(x) - \tau x, \tag{7}$$

which measures income, plus utility from leisure and effort, minus living costs and commuting costs.

2.2.ii. Indirect utility of the unemployed

The instant utility of the unemployed also depends on the unitary consumption of goods, although it cannot depend on leisure and effort at work because, on the one hand,

unemployed workers cannot make effort at work, and, on the other, the unemployed do not work, nor do they commute, and thus$l = 1$. We can assume that their instant utility can be expressed as a constant

$$z_0 + V_0, \tag{8}$$

with $z_0 < z$ (Ross and Zenou, 2008). Because $l = 1$, the unemployed do not have a temporal constraint, but only a budgetary one. If we assume that the unemployed receive a benefit *b* from unemployment, normalized to 0, we can write:

$$0 = z_0 + R(x). \tag{9}$$

Oppositely to Ross and Zenou (2008), we drop commuting costs from the unemployed. Those authors argue that the commuting of the unemployed is represented by the daily costs of searching for a job and going to interviews, but we consider that this assumption is too strong, because the search for work, and even job interviews, are mainly done on the internet, and thus entails no commuting cost.[2] The instant utility of the unemployed workers results as the fixed utility from leisure, minus the living costs, and can be written as follows:

$$I_u = I_u(x) = V_0 - R(x). \tag{10}$$

2.2.iii. Indirect utility of the self-employed

The self-employed receive no wage from an employer, but income from an individual production function. Then, there is no theoretical background supporting the existence of efficiency wages, or any similar mechanism, for these workers. Despite that, the main idea of substitutability between leisure and shirking (or complementarity between leisure and effort at work) is invariable to the type of work. Hence, we maintain that the self-employed can be added to the model. Their instant utility is the same as that for employees, and is given by Equation (4), and their time constraint is given by Equation (6).

We assume that self-employed income is given by a production function $F = F(T, k, e)$, where T is the time input, k the capital input, and e the personal input, i.e., the personal effort at work (Blau, 1985; Taiwo, 2011; Molina, Velilla and Ortega,

[2] The exclusion of the unemployed commuting costs does not suppose any qualitative change in the model. Results do not significantly vary.

2016). In the current setting, we assume that T is fixed (as for the employees), and k is exogenous. Thus, $F = F(e)$, and self-employmentoutcomes directly depend on personal effort at work. We assume that $F'(e) > 0$ and $F''(e) < 0$. The budgetary constraint is then:

$$F(e) = z + R(x) + \tau x, \tag{11}$$

and we can write the indirect utility of the self-employed as follows:

$$I_{we} = I_{we}(x, e) = F(e) + V(1 - T - tx, e) - R(x) - \tau x. \tag{12}$$

2.2.iv. Life-cycle utility

By weighting each indirect utility by the corresponding probability, in the steady state, of being employed, self-employed, or unemployed, we can obtain the expected life-cycle utility of workers, as a function of e and x:

$$I = I(x, e) = P(\, u \mid s.s.)\, I_u + (\, we \mid s.s.)\, I_{we} + (\, se \mid s.s.)\, I_{se} =$$

$$= \frac{\theta\delta_1}{\alpha} wT + \frac{\theta\delta_2}{\alpha} F(e) + \frac{\theta(\delta_1 + \delta_2)}{\alpha} V(1 - T - tx, e) + \frac{\delta_1\delta_2}{\alpha} I_u - \frac{\theta(\delta_1 + \delta_2)}{\alpha} \tau x - R(x). \tag{13}$$

2.3. Equilibrium

2.3.i. Two levels of effort and efficiency wages theory

We define the equilibrium of the model as the point where all workers have the same expected life-cycle utility, in terms of their effort at work and their residential location. To that end, we propose two levels of effort, in terms of the idiosyncrasy of workers regarding their level of effort: effort at work,e_1, and shirking at work,e_0, with$e_1 > e_0$ (Ross and Zenou, 2008).

Here, efficiency wages theory plays a major role, since shirking behavior implies, against an efficiency wage background where firms pay higher wages to discourage shirking, an increase in the probability of being fired. We can consider a process where workers are monitored by firms. Then, if a worker is caught shirking, which can occur with a probability $m > 0$, he/she will be automatically fired. While this has no effect on the Markovian process for the non-shirkers, and then Equations (1), (2) and (3) remain unchanged (i.e., $u_1 = u$, $we_1 = we$ and $se_1 = se$), the transition rates of the shirker

workers are affected by the monitoring process. Now, employees are fired with a probability $\delta_2 + m > \delta_2 > 0$, and thus the expected time that a worker is employed until he/she is fired is $\frac{1}{\delta_2+m} < \frac{1}{\delta_2}$.

For the case of the self-employed, there is no mechanism of monitoring because they do not have an employer. However, here *F* plays a major role. Shirker workers will have lower income than the non-shirkers, $F(e_1) > F(e_0)$, since $F' > 0$. Then, we can suppose that the productive self-employed will have a greater probability of not giving up their business, in contrast to shirkers. This can be due not only to income, but also to other individual characteristics, such as the 'entrepreneurial spirit', optimism, or the family and financial environment (Cueto *et* al., 2015; Dawson *et* al., 2015; Molina et al., 2016). We assume the same change in the probability of giving up a business as for the employees, $\delta_1 + m > \delta_1 > 0$, so the expected time that a worker will be self-employed until he/she leaves is $\frac{1}{\delta_1+m} < \frac{1}{\delta_1}$. Hence, the differentiation between the two types of workers has two different implications for the self-employed, directly, regarding their income, and indirectly, the rate of giving-up.

We now calculate the rate of shirker workers being unemployed, employed, and self-employed:

$$u_0 = \frac{\frac{1}{\theta}}{\frac{1}{\theta} + \frac{1}{\delta_1+m} + \frac{1}{\delta_2+m}} = \frac{(\delta_1 + m)(\delta_2 + m)}{\beta}, \tag{14}$$

$$we_0 = \frac{\frac{1}{\delta_2+m}}{\frac{1}{\theta} + \frac{1}{\delta_1+m} + \frac{1}{\delta_2+m}} = \frac{\theta(\delta_1 + m)}{\beta}, \tag{15}$$

$$se_0 = \frac{\frac{1}{\delta_1+m}}{\frac{1}{\theta} + \frac{1}{\delta_1+m} + \frac{1}{\delta_2+m}} = \frac{\theta(\delta_2 + m)}{\beta}, \tag{16}$$

with$\beta = (\delta_1 + m)(\delta_2 + m) + \theta(\delta_2 + m) + \theta(\delta_1 + m) > \alpha$, since $m > 0$.When we compare these with the corresponding rates of the non-shirkers, we find that:

Proposition 1. *Non-shirker workers tend to spend less time unemployed during their life-cycle*.

Dem: We must check if $u_0 > u_1$. Since all arguments are positive: $u_0 > u_1 \Leftrightarrow \frac{(\delta_2+m)(\delta_1+m)}{(\delta_1+m)(\delta_2+m)+\theta(\delta_2+m)+\theta(\delta_1+m)} > \frac{\delta_2\delta_1}{\delta_1\delta_2+\theta\delta_2+\theta\delta_1} \Leftrightarrow \frac{\theta}{\delta_2+m} + \frac{\theta}{\delta_1+m} < \frac{\theta}{\delta_1} + \frac{\theta}{\delta_2}$,which is trivial.

As a consequence of Proposition 1, we obtain that non-shirker workers spend more time, during their expected life-cycle, employed and self-employed than their shirker counterparts. Since the variations of *we* and *se* from non-shirkers to shirkers are analogous, $we_0 < we_1 \Leftrightarrow se_0 < se_1$, and while$u + we + se = 1$in both cases, the result follows. That is to say, among non-shirkers, employees and the self-employed will predominate in comparison with non-shirkers, where the rate of unemployment will be higher than among the non-shirkers.

2.3.ii. Workers' location within the city

In the steady state, all workers, non-shirkers and shirkers, will have the same life-cycle utility,I_{eq}, as a function of the remaining endogenous variable, the residential location *x*. While for the former group the life-cycle utility, I_1, is given by Equation (13) evaluated in e_1, the different transition rates of the shirkers change their life-cycle utility to

$$I_2 = \frac{\theta(\delta_1+m)}{\beta} wT + \frac{\theta(\delta_2+m)}{\beta} F(e_0) + \frac{\theta(\delta_1+\delta_2+2m)}{\beta} V(1-T-tx, e_0) +$$

$$+ \frac{(\delta_1+m)(\delta_2+m)}{\beta} I_u - \frac{\theta(\delta_1+\delta_2+2m)}{\beta} \tau x - R(x). \qquad (17)$$

We now obtain an expression of the bid rent functions of workers, in terms of *x* and *I*. Bid rents represent workers' demand for land, i.e., the amount that they are willing to pay, in the equilibrium, for a unit of land in *x*. When we clear $R(x)$ in equations (13) and (17), we obtain an expression of the bid rents of non-shirker and shirker workers, respectively:

$$\psi_1(x, I_{eq}) = \frac{\theta\delta_1}{\alpha} wT + \frac{\theta\delta_2}{\alpha} F(e_1) + \frac{\theta(\delta_1+\delta_2)}{\alpha} V(1-T-tx, e_1) +$$

$$+ \frac{\delta_1\delta_2}{\alpha} I_u - \frac{\theta(\delta_1+\delta_2)}{\alpha} \tau x - I_{eq}, \qquad 18)$$

$$\psi_0(x, I_{eq}) = \frac{\theta(\delta_1+m)}{\beta} wT + \frac{\theta(\delta_2+m)}{\beta} F(e_0) + \frac{\theta(\delta_1+\delta_2+2m)}{\beta} V(1-T-tx, e_0) +$$

$$+\frac{(\delta_1+m)(\delta_2+m)}{\beta}I_u-\frac{\theta(\delta_1+\delta_2+2m)}{\beta}\tau x-I_{eq}. \qquad 19)$$

Note that $\frac{\partial\psi_1}{\partial x}$ and $\frac{\partial\psi_2}{\partial x}$ are always negative: $\frac{\partial\psi_i}{\partial x}=A_i\frac{\partial V}{\partial l}\frac{\partial l}{\partial x}-A_i\tau$, and$A_i>0,i=1,2,\frac{\partial V}{\partial l}>0$, $\frac{\partial l}{\partial x}<0$, $\tau>0$. That is to say, both groups prefer to live as near as possible to the BD, since the closer the location is to the BD, the more workers are willing to pay for it. However, the group with the greater demand for land *nearer* the BD will live there, since they are willing to pay more for the land than the other group, which will be relegated to the outskirts. Further, there must be a point, $\tilde{x}$, that separates the areas where both groups choose to locate their residences. Then, the group with the steepest slope bid rent will choose to reside in the city (BD $<x<\tilde{x}$), and the group with the lesser slope will reside in the outskirts ($\tilde{x}<x<x_f$).

Proposition 2. *Non-shirkers and the productive self-employed will live in the city.*

Dem: Since $\frac{\partial\psi_1}{\partial x}$, $\frac{\partial\psi_2}{\partial x}<0$, we need to see whether $\frac{\partial\psi_1}{\partial x}<\frac{\partial\psi_2}{\partial x}$ or, equivalently, $-\frac{\partial\psi_1}{\partial x}>-\frac{\partial\psi_2}{\partial x}$.

$$-\frac{\partial\psi_1}{\partial x}=-\frac{\theta(\delta_1+\delta_2)}{\alpha}\frac{\partial V(l,e_1)}{\partial l}\frac{\partial l(x)}{\partial x}+\frac{\theta(\delta_1+\delta_2)}{\alpha}\tau,$$

$$-\frac{\partial\psi_2}{\partial x}=-\frac{\theta(\delta_1+\delta_2+2m)}{\beta}\frac{\partial V(l,e_0)}{\partial l}\frac{\partial l(x)}{\partial x}+\frac{\theta(\delta_1+\delta_2+2m)}{\beta}\tau.$$

When we assume that$\frac{\partial V(l,e_1)}{\partial l}\approx\frac{\partial V(l,e_0)}{\partial l}$, i.e., the variation of *V* when *l* varies is similar for non-shirkers and shirkers, then the result follows, since $\frac{\partial l(x)}{\partial x}<0$, and $\frac{\theta(\delta_1+\delta_2)}{\alpha}=1-u_1$, $\frac{\theta(\delta_1+\delta_2+2m)}{\beta}=1-u_0$, and $1-u_1>1-u_0\Leftrightarrow u_1<u_0$, which is Proposition 1.

Note that this result indicates that individuals who idiosyncratically are prone to shirk will reside in the outskirts, and individuals who make effort at work will live near the BD. Under the same conditions of agreed working hours, non-shirkers will devote less time to commuting and will have more time for leisure. Then, even when they personally tend not to shirk, their endogenously-chosen residential locations encourage effort at work, under the key assumption of substitution between leisure and shirking,

empirically demonstrated in Gimenez-Nadal et al. (2016). On the other hand, the residential location of shirkers additionally promotes shirking, since they have longer commutes and thus less leisure time. These patterns promote the formation of clusters in urban areas, with productive workers living in the surroundings of business districts. This would mean that, if firms can detect shirking and observe workers' residential location, centralized cities would concentrate the employed population near the city center, while decentralized and polycentric ones would concentrate the employed population in the outskirts, or in the surroundings of the corresponding employment cores, favoring the polarization of urban areas.

2.3.iii. Relationships between income, effort, and shirking: Self-employed versus employees' residential location

The existing literature suggests that the self-employed belong to a different labor-search market than employees, since they in fact look for places where they can establish a business, rather than for job vacancies, leading them to less-imperfect information and shorter commutes (e.g., Zax, 1991; Holzer, 1994; Stutzer and Frey, 2008).

We try to find differences in a scenario where such variations are not considered, and the only difference is that income is exogenous for the employees, but endogenous for the self-employed. We limit our analysis to those individuals who do not shirk, although it would be analogous for shirkers.

Increases in w would discourage shirking and increase e among employees, under the efficiency wages theory. Then, when wages increase, the percentage of shirkers in the city would decrease and $\tilde{x}$would increase: $\frac{\partial \tilde{x}}{\partial w} > 0$ (Ross and Zenou, 2008).

When we analyze the corresponding relationship among the self-employed, we cannot develop an analogous argument. On the one hand, if there is an increase in F due to a general increase of e among all workers, the causal relationship between income and effort at work would be opposite to that for employees: income increases because individuals devote, in general, more effort at work, but there is no reason to consider an increase of e due to increases in self-employment outcomes.

Let us suppose that there is an increase in F that is due to an external shock, and it is independent of e. Then, what would be the effect on$e$? Conceptually, it can be that: a)

Workers reduce their effort, keeping F and x invariable, b) Workers maintain their levels of effort and adjust their commuting behavior, or c) Workers increase their level of effort, analogous to the efficiency wage mechanism.

Proposition 3: $0 < |\frac{\partial F}{\partial \tilde{x}}| < \frac{\partial w}{\partial \tilde{x}}$ and there is no clear mechanism analogous to efficiency wages for the self-employed. Further, if this mechanism existed, it would be smaller than that for efficiency wages.

Dem: let us suppose that F increases, what would be the effect on$\tilde{x}$? We know that

$$\begin{aligned}\psi_1(I_{eq}, \tilde{x}) = \psi_2(I_{eq}, \tilde{x}) \Leftrightarrow (1-u_s)V_s - (1-u_{ns})V_{ns} \\ = (we_{ns} - we_s)wT + \left(se_{ns}F(e_1) - se_sF(e_0)\right) - \tau\tilde{x}(u_s - u_{ns}) \\ + I_u(u_{ns} - u_s).\end{aligned}$$

When we differentiate with respect to$\tilde{x}$, assuming that$\frac{\partial V(l,e_1)}{\partial l} \approx \frac{\partial V(l,e_0)}{\partial l}$ and $\frac{\partial F(e_1)}{\partial \tilde{x}} \approx \frac{\partial F(e_0)}{\partial \tilde{x}}$, we find that

$$\frac{\partial w}{\partial \tilde{x}} = \frac{\left(t\frac{\partial V}{\partial l} + \tau\right)(u_s - u_{ns}) + \frac{\partial F}{\partial \tilde{x}}(se_s - se_{ns})}{T(we_{ns} - we_s)} > 0 \Longrightarrow \quad (20)$$

$$\frac{\partial F}{\partial \tilde{x}} < \frac{u_s - u_{ns}}{se_{ns} - se_s}\left(t\frac{\partial V}{\partial l} + \tau\right) > 0.$$

Then, we find a superior bound for$\frac{\partial F}{\partial \tilde{x}}$, indicating that, whether it would be negative or positive, it would be bounded by a function of the marginal variation of the associated utility, the commuting constants, and the relationship between unemployment and self-employment trade-offs between shirkers and non-shirkers.

From Equation (20), using the Reverse Triangle Inequality, it also follows that

$$\frac{\partial w}{\partial x} > \frac{\partial w}{\partial x}T(we_{ns} - we_s) = \left(\tau + t\frac{\partial V}{\partial l}\right)(u_s - u_{ns}) + \frac{\partial F}{\partial x}(se_s - se_{ns}) > 0 \Longrightarrow$$

$$\frac{\partial w}{\partial x} > \frac{\partial w}{\partial x}T(we_{ns} - we_s) \geq \left|\left(\tau + t\frac{\partial V}{\partial l}\right)(u_s - u_{ns}) - \left|\frac{\partial F}{\partial x}(se_s - se_{ns})\right|\right| \Longrightarrow$$

$$\frac{\partial w}{\partial x} > \frac{\partial w}{\partial x}T(we_{ns} - we_s) \geq -\left|\frac{\partial F}{\partial x}(se_s - se_{ns})\right| = (se_{ns} - se_s)\left|\frac{\partial F}{\partial x}\right|.$$

Since the variation of self-employment and employment from shirkers to non-shirkers is given by an analogous mechanism, we can assume$\frac{se_{ns} - se_s}{we_{ns} - we_s} \approx 1$. It follows that

$$\frac{\partial w}{\partial x} > \left|\frac{\partial F}{\partial x}\right|.$$

The latter result is of special interest, since it indicates that employees have greater incentives to live far from the BD, since commuting is directly related to wages more strongly than to self-employment outcomes. For instance, it is theoretically ambiguous whether self-employment outcomes are positive or negatively related to commuting.

Corollary 1: *the self-employed would live nearer the BD than their employed counterparts.*

Dem: the proof of this Corollary is immediate, given Proposition 3. Employees have greater incentives to live far from the BD, since this gives them a higher marginal increase of wages than the corresponding marginal effect of self-employment outcomes, independently of whether this effect is positive or negative.

3. Data and variables

We use the American Time Use Survey (ATUS) for the years 2003-2014 to analyze the relationship between employment, self-employment, unemployment, and commuting. The ATUS provides us with information on individual time use, collected from the diaries of the respondents, and the survey includes a set of 'primary' activities, including commuting. The database also covers certain personal, family, demographic, and labor variables. The ATUS is administered by the Bureau of Labor Statistics, and is considered the official time-use survey of the United States. More information can be found athttp://www.bls.gov/tus/. The advantage of our data over micro-data surveys based on stylized questions is that diary-based estimates are more accurate (Juster and Stafford, 1985; Robinson, 1985; Bianchi et al., 2000; Bonke, 2005; Yee-Kan, 2008).

We restrict our sample to those individuals between the ages of 16 and 65 who are not retired or students, in order to minimize the role of time-allocation decisions that have a strong inter-temporal component over the life cycle, such as education or retirement (Aguiar and Hurst, 2007; Gimenez-Nadal and Sevilla, 2012). Figure 1 shows the evolution of employment, self-employment, and unemployment rates in the US, using ATUS, and we observe that both employment and self-employment decreased until 2010, but increased afterwards, while unemployment grew over the period, with a

clear increase during 2009-2011 – due to the economic crisis – and a decrease afterwards, consistent with the US Bureau of Labor Statistics data (BLS, 2016).

To test the model, we additionally restrict the sample to individuals who are unemployed, on the one hand, and to employed or self-employed in the private sector during working days(e.g., days where individuals spend more than 60 minutes working), on the other. This allows us to avoid computing zero minutes of commuting to any employed or self-employed worker who filled out the time-use diary on a non-working day, which would affect our computation of expected commuting. These restrictions leave us with 41,329 individuals, of whom 31,343 are private sector employees, 5,290 are self-employed, and 4,696 are unemployed. For the restriction to working days, we define the variable market work time as the time devoted to the sum of work, main job not at home, work-related activities not at home, and waiting work related activities not at home. Figure 2 shows the evolution of the average commuting time in minutes per day for the employed and self-employed workers in our sample, and we note that trends are constant for the former, but have increased for the latter, consistent with the predictions of our model: longer commuting is negatively related to employment and self-employment, and positively related to unemployment rates. Additionally, the reported increase in commuting time is in line with Kirby and LeSage (2009) and Gimenez-Nadal and Molina (2014).We define commuting time as the time of commuting to/from work, coded with the activity code "180501" in the ATUS.[3]

Table 1 shows a descriptive analysis of the variables, by group (self-employed vs. employees vs. unemployed).We show the average and standard deviations of the original commuting of the employed and the self-employed, and the average and standard deviation of the expected (e.g., predicted) commuting predicted from the commuting models. We observe that the self-employed devote, on average, 29.2minutes to daily commuting, and their coefficient of variance is 1.5, considering reported commuting times, in contrast with 39.0 minutes and 1.05 for employees, respectively. Figure 3 shows k-densities of commuting time for employees and the self-employed. We can see how zero and low commuting times concentrate the mass. In the case of expected commuting, because these are expected values, standard deviations and

[3]We have repeated the analysis with a generalized definition of commuting times(Commuting timebis),defined as commuting time, pluswork-related travel (180502), travel related to income-generating activity (180503), and travel related to work (180599). Results using this alternative definition of commuting time are shown in Appendix B, and are robust to our main results

variance coefficients decrease considerably, but we still observe that the average expected commuting time is shorter for the self-employed in comparison with employees and the unemployed, in all cases. These results are consistent with the theoretical model, where we establish a negative relationship between commuting time and self-employment (vs. employment).

We have defined other variables that may affect employment status, such as gender (being male), *potential* years in labor market (age minus number of education years and minus a fixed value, taken as 3), education level, living in couple, partner's labor-force status (a dummy variable that indicates whether or not the partner works), number of children, being white, and being American, Asian, or Pacific Islander. For education, we consider three levels: basic education (less than high school diploma), secondary education (high school diploma), and university education (more than high school diploma). We have also included the years in the labor market squared to measure non-linear effects.

According to Table 1, there are more male employees and self-employed than female (52.7% vs. 47.3%, and 63.8% vs. 36.2%, respectively) and there are more female unemployed (56.3%, vs. 43.7% of males). The self-employed have had more years in the labor market than employees and the unemployed (24.6 vs. 20.5 vs. 19.4 years on average, respectively). This relationship is consistent with Blanchflower (2000) and Molina et al. (2015), who find that age is positively related to the fact of being an entrepreneur. For education variables, we observe that 5% of the self-employed have only basic education, 24% have secondary education, and 71% have University education, versus 8%, 28% and 63% of employees, and 19%, 34% and 47% of the unemployed, respectively. Thus, we find that a University education appears to be positively related to employment and, especially, to self-employment. Regarding the family variables, we show that 70% and 60% (46%) of the self-employed and employed(unemployed) live in couple, 53% and 45% (33%) have a couple who both work,53% and 54% (57%) of them have children, and family sizes are, on average, 3 and 2.9 (3.1) members. Furthermore, 89% and 82% (70%) are whites, and 86% and 82% (82%) are American.

4. Econometric analysis and results

We first analyze the probability of being employed or self-employed in comparison to being unemployed, with a focus on the commuting time of individuals. The theoretical framework developed in Section 3 establishes in Proposition 2 that the longer the commute, the higher the unemployment rate, and thus we estimate the probability of being unemployed vs. employed/self-employed, on the commuting time of individuals. One important issue is that commuting time is not observed for the unemployed. To overcome this problem, we follow Ross and Zenou (2008), who identify commuting using cross-metropolitan variation. In particular, Ross and Zenou (2008) identify the effect of commuting time by the exclusion from the labor market equation of certain factors that can explain commuting time differences. With this approach, the source of variation for identification comes from cross-metropolitan area differences in commuting times (see Ross and Zenou (2008) for a discussion of this approach).

But in comparison with Ross and Zenou (2008), who estimate commuting models for each statistical area included in their data, we cannot estimate specific models of commuting time for Metropolitan Statistical Areas (MSA) individually, as there are several MSA with less than 30 observations, and we must be cautious in making estimates for specific metropolitan areas.[4]Alternatively, we interact the housing stock variables with the region variables included in the ATUS, exploiting systematic differences between the structures of metro areas in different regions of the country. In particular, we interact the information regarding residence ownership (i.e., Owned or being bought by a household member, Rented for cash, Occupied without payment of cash rent) with the information on census region of residence (i.e., Northeast, Midwest, South, West), and thus the model is identified by the exclusion from the labor market equation of the interaction of region fixed effects with the housing stock variables. We estimate an OLS model on commuting time, and then predict commuting times for the employed, the self-employed, and the unemployed.[5]

Once we have predicted (expected) commuting time, we estimate the following

[4]The geographic information in the ATUS data includes identification of the MSA of residence of individuals. Metropolitan areas are counties or groups of counties centering on a substantial urban area. While the Census Bureau's terminology for metropolitan areas and the classification of specific areas changes over time, the general concept is consistent: a metropolitan area consists of a large population center and adjacent communities that have a high degree of economic and social interaction. Metropolitan areas often cross state lines. Information on the coding of this variable con be found athttps://www.atusdata.org/atus-action/variables/METAREA#description_section. For some MSAs, there are very few observations and, then, we must be cautious when making estimates for specific MSAs.

[5]Sum stats of the housing and census region variables, and the results of the commuting model, can be found in Tables A1 and A2 of the Appendix A, respectively.

Probit model:

$$\text{probit}(Y_{is}) = \alpha_0 + +\alpha_1 C_{is} + \alpha_2 X_{is} + \alpha_3 W_{is} + \alpha_s + \varepsilon_{is} (21)$$

where Y_{is} represents a dummy variable for employment status (i.e., employed/self-employed vs. unemployed) of a given individual "i" living in Metropolitan Statistical Area (MSA) area "s", and C_{is} represents the(log) expected commuting time of that individual. X_{is} includes the set of socio-demographic variables described in Section 3,W_{is} represent housing attributes, α_s represents MSA fixed effects, and ε_{is} represents random variables capturing unmeasured factors and measurement errors.This specification resembles that of Ross and Zenou (2008). Given that we are using generated regressors, we follow Pagan (1984), Murphy and Topel (1985), and Gimenez-Nadal and Molina (2013) and bootstrap the standard errors of the regressions (500 replications). Given our theoretical model (Proposition 2), we would expect that commuting time has a negative relationship to the probability of not being unemployed, i.e., $\beta_1 < 0$.

Column (1) in Table 2 shows the results of estimating Equation (21) on the probability of being employed/self-employed. We find that one more minute of commuting is significantly associated, on average, with increases in the probability of being unemployed of 3.9%. These results are in line with prior works of Ross and Zenou (2008)and Gimenez-Nadal et al. (2016) for employees vs. unemployed workers (i.e., higher commuting time is related to higher unemployment rates), and they also provide empirical support to Proposition 2. The implication of this proposition is that the employed and the self-employed live closer to the business centers, in comparison to the unemployed.

Further, males have a higher probability of not being unemployed, while years working follows an inverted-U relationship with the probability of being employed. Education is positively related to being employed or self-employed, since the higher the education level, the lower the probability of being unemployed, in line with Autor and Handel (2013) and Cortes (2016). Americans have a lower probability of being employed than their Asian counterparts, while being white is strongly and positively related to employment. Regarding family features, it is observed that workers who live in couple have a higher probability of being employed. The partner's labor status and

the presence of children have no significant effect, but heads of larger families have higher probabilities of being unemployed.

We next analyze the probability of being self-employed in comparison to being employed, dropping the unemployed from the analysis. The model developed in the previous section establishes (Corollary 1) that, comparing employed and self-employed workers, the higher the commuting time the higher the probability of being employed (vs. self-employed).Given that this relationship is obtained in the market equilibrium, we do not attempt to estimate causal effects, but we are interested in an equilibrium relationship instead, and the estimation of a conditional correlation using an OLS model is sufficient to test for the relationship predicted by the model.

We estimate a linear probability model analogous to Equation (21), where the only two changes are thatY_{is} is now the dummy variable being self-employed, that takes value 1 if individual 'i' is self-employed, and value 0 if individual 'i' is employed, and $C_{is}$is now the reported commuting times of the employees and self-employed workers. We expect a negative relationship between reported commuting and self-employment, i.e., $\beta_1 < 0$, indicating that the self-employed live nearer the urban cores than do employees.

Column (2) of Table2 shows the results of estimating Equation (21), where our outcome of interest is the probability of being self-employed, in comparison to being employed. It is observed that, according to reported commutes, one additional minute of expected commuting is associated with a decrease of 4.2% in the probability of being self-employed (vs. being employed). This result indicates that there exists a negative relationship between (expected) commuting and the probability of being self-employed, in comparison with being employed, consistent with our model. The implication of this result is that the self-employed live closer to their respective workplaces, in comparison to the employed. This parameter is in line with the existing literature, consistent with the idea that self-employed workers devote, on average, less time to commuting than do employed workers (Giuliano, 1998; Stutzer and Frey, 2008; van Ommeren and van der Straaten, 2008; Gimenez-Nadal et al., 2015).

We also find that males have a higher probability of being self-employed, while age is linear and also positively related to self-employment in the US, in line with Blanchflower (2000), for the OECD, and Molina et al. (2016), for Spain. Secondary

education does not have a significant effect, in comparison with Primary, but workers who have gone to University do have a higher probability of being self-employed, showing the effect of acquired entrepreneurial and managerial skills (Kotsova, 1997; Minniti, 2009; Levie and Autio, 2013). Being American, Asian, or Pacific Islander is not significantly associated with being either self-employed or an employee, but white workers have higher probabilities of being self-employed. Finally, the effect of living in couple, the active labor status of the partner, and the presence of children are all positively related to being self-employed, but the total family size appears to have no significant effect.

5. Conclusions

This paper analyzes urban employment and self-employment in a context derived from efficiency wages theory, with a spatial pattern, where leisure and effort at work are complementary concepts. We propose a new theoretical model that includes self-employment, indexed by commuting and efficiency at work, and we find that, although the productive self-employed tend to live near their work-places, as happens with employees, commuting does not have a clear relationship with earnings for the self-employed. Thus, there is no clear mechanism, similar to that for efficiency wages, for self-employment. Making use of the ATUS for the years 2003-2014, we present an employment and self-employment empirical micro-econometric model.

Our empirical results show that employment and self-employment are negatively related to commuting, in comparison to unemployment. Furthermore, self-employment is associated with shorter commutes, in comparison to wage employment. The results presented in this paper give support to our theoretical model. Our results contribute to the literature by not only complementing urban efficiency wage models, but also offering a new theoretical study of self-employment in the United States with a spatial pattern, which has been underappreciated in this field.

However, our analysis does have certain limitations: by using cross-sectional data, we cannot establish causal effects. Furthermore, unobserved heterogeneity also has a strong impact on our empirical modeling, where non-controllable variables could potentially determine commuting patterns (van Ommeren and van der Straaten, 2008).However, the relationships are obtained in the market equilibrium, and the

estimation of conditional correlations using OLS models is sufficient to test for the relationships predicted by the model. The results are consistent with the theoretical model. Second, and more important, we do not have data on self-employment earnings, and we cannot analyze their relationship with commuting times, i.e., we cannot empirically check Proposition 3. More research on this topic is needed.

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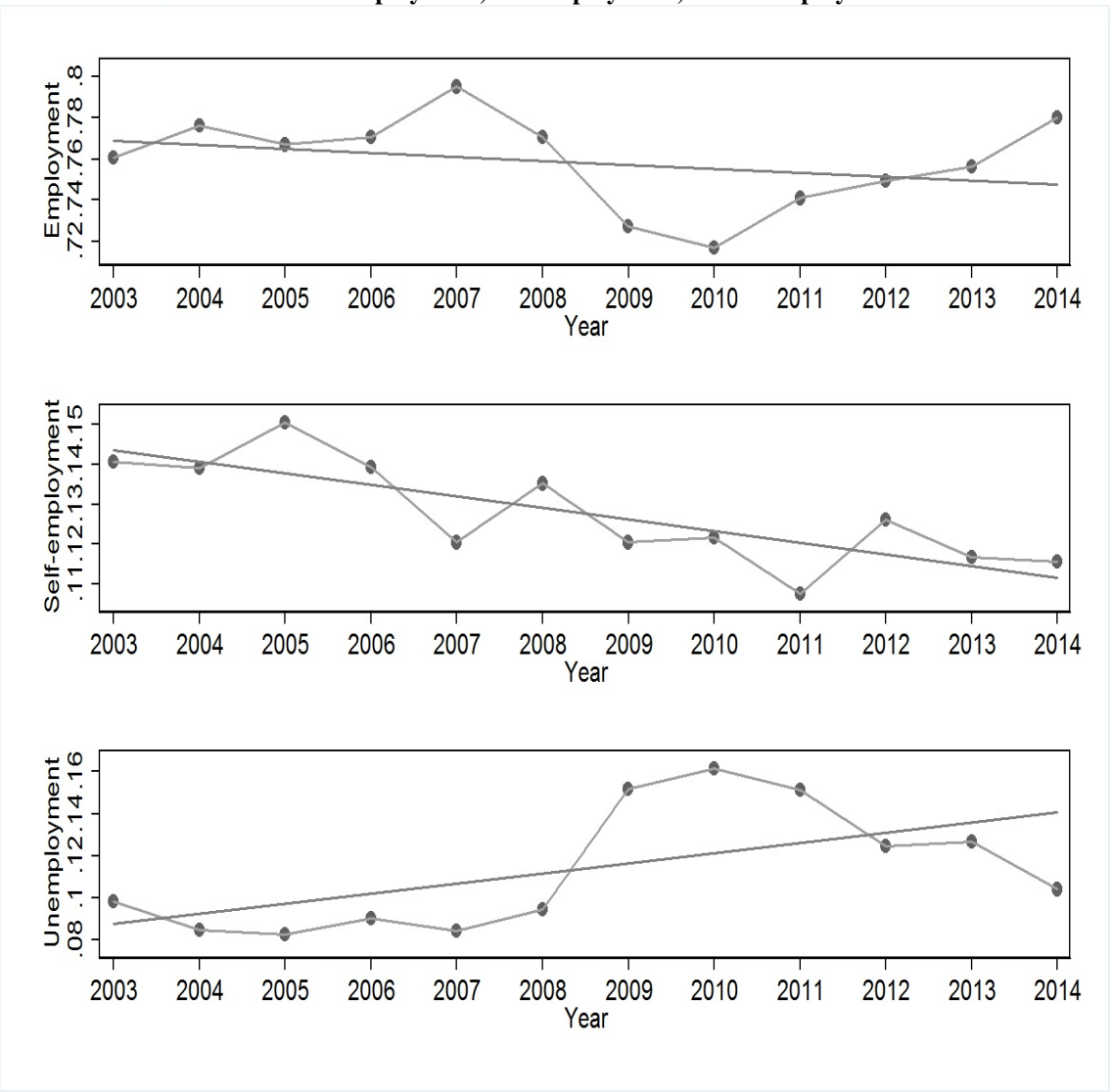
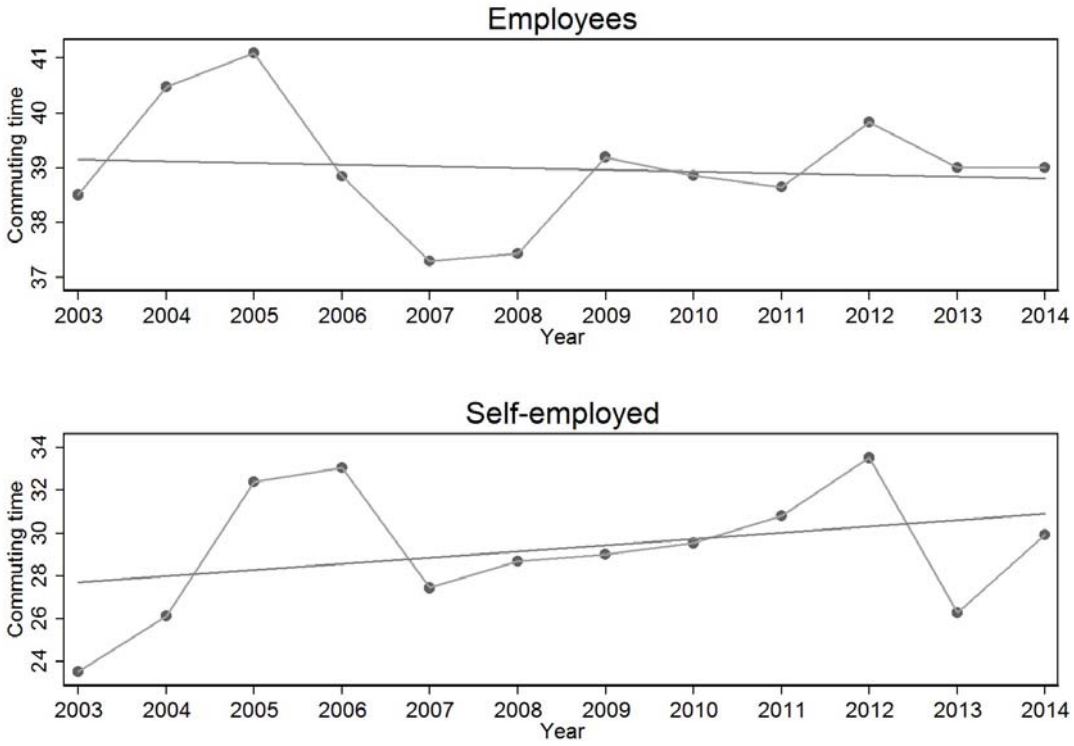
Figure 1
Evolution of employment, self-employment, and unemployment



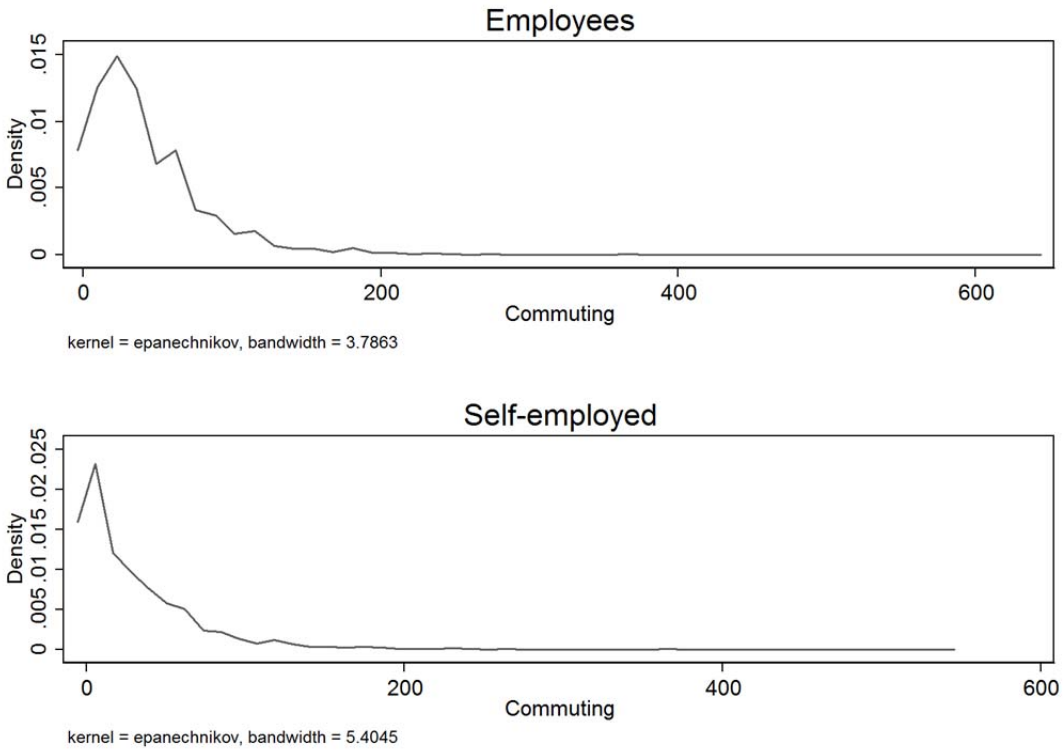
Note: the sample (ATUS 2003-2014) is restricted to private sector employees, self-employed, and unemployed, respectively.

Figure 2
Evolution of commuting times



Note: the sample (ATUS 2003-2014) is restricted to private sector employees and self-employed, respectively.

Figure 3
K-densities of commuting times



Note: the sample (ATUS 2003-2014) is restricted to private sector employees and self-employed, respectively.

Table 1
Summary statistics

Variables	(1) Employed		(2) Self-employed		(3) Unemployed	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Commuting time	38.983	41.024	29.203	44.134	-	-
Expected commuting (1)	40.060	3.384	40.062	3.183	40.133	3.479
Male	0.527	0.499	0.637	0.481	0.437	0.496
Years in labor market	20.450	11.566	24.640	10.532	18.854	12.751
Years in labor market sq.	55.199	51.251	71.802	52.137	51.803	53.697
Primary education	0.082	0.275	0.054	0.226	0.194	0.395
Secondary education	0.284	0.451	0.237	0.426	0.335	0.472
University education	0.634	0.482	0.709	0.454	0.471	0.499
Live in couple	0.602	0.490	0.702	0.457	0.443	0.497
Partner's labor force status	0.448	0.497	0.533	0.499	0.319	0.466
Have children	0.538	0.499	0.533	0.499	0.570	0.495
Family size	2.944	1.490	2.972	1.519	3.101	1.594
White	0.822	0.382	0.886	0.318	0.696	0.460
American	0.821	0.383	0.854	0.353	0.815	0.388
Asian	0.042	0.200	0.032	0.176	0.030	0.169
Pacific/Islander	0.002	0.043	0.002	0.050	0.003	0.056
Tenure: owned	0.702	0.457	0.827	0.378	0.541	0.498
Tenure: rented	0.286	0.451	0.163	0.369	0.441	0.496
Other type of tenure	0.012	0.110	0.010	0.100	0.018	0.134
Observations	31,343		5,290		4,696	

Note: the sample (ATUS 2013-2014) is restricted to private sector employees, self-employed, and unemployed individuals. Commuting time is measured in minutes. Years working is measured in years. Expected commuting (1) is estimated from Column (1) of Table A1. Expected commuting (2) is estimated from Column (2) of Table A1.

Table 2
Model estimates

VARIABLES	(1) Employed/self-employedvsunemployed	(2) Self-employed vs paid employed
Male	0.032***	0.055***
	(0.003)	(0.004)
Years working	0.005***	0.005***
	(0.001)	(0.001)
Years working squared	-0.001***	-0.000
	(0.000)	(0.000)
Secondary education	0.088***	-0.000
	(0.008)	(0.009)
University education	0.125***	0.040***
	(0.008)	(0.009)
American	-0.025***	-0.003
	(0.005)	(0.007)
Asian	0.076***	0.009
	(0.009)	(0.013)
Pacific/Islander	0.035	0.055
	(0.041)	(0.043)
White	0.089***	0.027***
	(0.006)	(0.006)
Live in couple	0.054***	0.017**
	(0.006)	(0.007)
Partner working	0.001	0.011*
	(0.004)	(0.006)
Number of children	0.000	0.012*
	(0.005)	(0.006)
Number of household members	-0.017***	-0.002
	(0.002)	(0.002)
***Expected c*ommuting**	-0.039*	
	(0.020)	
***Reported* commuting**		-0.042***
		(0.002)
Constant	0.775***	0.047**
	(0.069)	(0.022)
Housing characteristics	Yes	Yes
Observations	41,329	36,633
R-squared	0.058	0.069

Note: the sample (ATUS 2013-2014) is restricted to private sector employees, self-employed, and unemployed individuals in Column (1), and to private sector employees and self-employed in Column (2). Bootstrapped errors in Column (1), and robust standard errors in Column (2), in parentheses. Dependent variable is the dummy working (employees plus self-employed) in Column (1), and the dummy self-employed in Column (2). Expected and reported commuting times are measured in minutes (expected commutes estimated in Table A1, Columns (1)). Years working is measured in years. * Significant at the 90% level. ** Significant at the 95% level. *** Significant at the 99% level.

Appendix A: Commuting model

Table A1
Summary statistics of housing and census region variables

Variables	(1) Employed		(2) Self-employed		(3) Unemployed	
	Mean	SD	Mean	SD	Mean	SD
Tenure: owned	0.702	0.458	0.827	0.378	0.541	0.498
Tenure: rented	0.286	0.452	0.163	0.369	0.441	0.497
Other type of tenure	0.012	0.110	0.010	0.101	0.018	0.134
Region: North East	0.184	0.387	0.170	0.376	0.176	0.381
Region: Mid West	0.260	0.439	0.246	0.431	0.231	0.421
Region: South	0.341	0.474	0.319	0.466	0.346	0.476
Region: West	0.216	0.411	0.265	0.441	0.247	0.431
Observations	31,343		5,290		4,696	

Note: the sample (ATUS 2013-2014) is restricted to private sector employees, self-employed, and unemployed individuals.

Table A2
Commuting model

VARIABLES	(1) Commuting	(2) Commuting bis
Tenure: owned *		
Region: North East	22.893***	23.220***
	(3.724)	(3.723)
Region: Mid West	14.170***	14.428***
	(3.662)	(3.659)
Region: South	18.196***	18.445***
	(3.661)	(3.658)
Region: West	18.458***	18.777***
	(3.694)	(3.691)
Tenure: rented *		
Region: North East	24.178***	24.380***
	(3.886)	(3.885)
Region: Mid West	13.159***	13.143***
	(3.770)	(3.767)
Region: South	18.546***	18.669***
	(3.745)	(3.744)
Region: West	19.127***	19.297***
	(3.800)	(3.798)
Other type of tenure *		
Region: North East	9.936*	9.651
	(5.953)	(5.951)
Region: South	8.660*	9.024*
	(4.653)	(4.702)
Region: West	5.815	5.879
	(8.829)	(8.847)
Constant	22.042***	22.326***
	(3.617)	(3.613)
Observations	36,633	36,633
R-squared	0.006	0.006

Note the sample (ATUS 2003-2014) is restricted to private sector employees and self-employed. Robust standard errors in parentheses. Dependent variables are "commuting time" in Column (1) and "commuting time (bis)" in Column (2). Commuting times are measured in minutes. * Significant at the 90% level. ** Significant at the 95% level. *** Significant at the 99% level.

Appendix 2: Empirical results using the alternative definition of commuting

Table B1
Alternative econometric model estimates

VARIABLES	(1) Employed/self-employedvsunemployed	(2) Self-employed vs paid employed
Male	0.032***	0.055***
	(0.003)	(0.004)
Years working	0.005***	0.005***
	(0.001)	(0.001)
Years working squared	-0.001***	-0.000
	(0.000)	(0.000)
Secondary education	0.088***	0.000
	(0.008)	(0.009)
University education	0.125***	0.040***
	(0.008)	(0.009)
American	-0.025***	-0.002
	(0.005)	(0.007)
Asian	0.076***	0.009
	(0.009)	(0.013)
Pacific/Islander	0.035	0.054
	(0.041)	(0.043)
White	0.089***	0.027***
	(0.006)	(0.006)
Live in couple	0.054***	0.017**
	(0.006)	(0.007)
Partner working	0.001	0.011*
	(0.004)	(0.006)
Number of children	0.000	0.012**
	(0.005)	(0.006)
Number of household members	-0.017***	-0.002
	(0.002)	(0.002)
***Expected* commuting (bis)**	-0.039*	
	(0.020)	
***Reported* commuting (bis)**		-0.041***
		(0.002)
Constant	0.777***	0.045**
	(0.069)	(0.022)
Housing characteristics	Yes	Yes
Observations	41,329	36,633
R-squared	0.058	0.068

Note: the sample (ATUS 2013-2014) is restricted to private sector employees, self-employed, and unemployed individuals in Column (1), and to private sector employees and self-employed in Column (2). Bootstrapped errors in Column (1), and robust standard errors in Column (2), in parentheses. Dependent variable is the dummy working (employees plus self-employed) in Column (1), and the dummy self-employed in Column (2). Expected and reported commuting (bis) times are measured in minutes (expected commutes estimated in Table A1, Column (2)). Years working is measured in years. * Significant at the 90% level. ** Significant at the 95% level. *** Significant at the 99% level.