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Shirking, Commuting and Labor Market Outcomes

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Abstract

Recent theoretical work has examined the spatial distribution of unemployment using the efficiency wage model as the mechanism by which unemployment arises in the urban economy. This paper extends the standard efficiency wage model in order to allow for behavioral substitution between leisure time at home and effort at work. In equilibrium, residing at a location with a long commute affects the time available for leisure at home and therefore affects the trade-off between effort at work and risk of unemployment. This model implies an empirical relationship between expected commutes and labor market outcomes, which is tested using the metropolitan sample of the American Housing Survey. No evidence is found to suggest a consistent impact of efficiency wages on the spatial pattern of unemployment or earnings.

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1 Introduction

Many U.S. metropolitan areas as well as European cities are characterized by a concentration of poverty and unemployment in specific regions of their central cities and inner ring suburbs. The concentration of poverty and unemployment in a neighborhood may have external effects on other neighborhood residents leading to poor outcomes in education and family structure, and further exacerbating negative labor market outcomes.

Recent theoretical work has examined the spatial distribution of unemployment using the efficiency wage model as the mechanism by which unemployment arises in the urban economy. For example, Zenou and Smith (1995), who were the first to fully analyze the interaction between land and labor markets, develop a model in which housing prices and workers' location (land market), as well as wages and unemployment (labor market) are determined in equilibrium.[1] Most of this literature, however, has not allowed for any interaction between the shirking behavior, which is central in efficiency wage models, and commuting time costs, which are an essential feature of urban models. This omission seems problematic given the fact that shirking is a form of leisure and long commutes directly infringe upon the time available for leisure at home. Furthermore, up to this point, no empirical work has been conducted to compare the implications of efficiency wages model to the spatial distributions of unemployment and earnings.

This paper extends the standard efficiency wage model in order to allow for behavioral substitution between leisure time at home and effort or shirking at work. In equilibrium, residing at a location with a long commute affects the trade-off between effort at work and the frequency of unemployment spells by reducing the time available for leisure at home and by changing the commute savings that occur during unemployment spells. This model suggests that either workers segregate over space in terms of effort provided at work or wages vary based upon a worker's residential location depending upon whether firms can discriminate based on residential location. This model implies an empirical relationship between expected commutes and employment or between commutes and wages. Empirical analyses of three metropolitan areas based on the metropolitan sample of the American Housing Survey provide little evidence to suggest that efficiency wages can explain spatial variation in either unemployment or earnings.

This approach should be contrasted against traditional attempts to test ef-

[1] See Zenou (2000) for a survey on urban unemployment and efficiency wages.

ficiency wage theory, which focus on wage differentials across industries rather than across space (Kruger and Summers, 1987, 1988; Dickens and Katz, 1987; Murphy and Topel; 1987, 1990). Recent work in this area includes Chen and Edin (2002) who distinguish between jobs which have hourly and piece rate pay, Lazear (2000) and Paarsh and Shearer (2000) who examine the link between productivity and wages, Neal (1993) who examines the link between supervision and wages, and Gibbons and Katz (1992) who test whether unmeasured ability can explain interindustry wage differentials. The failure of our study to find evidence of efficiency wages over space in no way suggests that efficiency wages do not operate in labor markets, but instead suggests that even if efficiency wages are paid they do not appear to have a substantial influence on the spatial pattern of unemployment and earnings.

The remainder of the paper is organized as follows. The next section presents the basic model. In section 3, we develop a model in which firms cannot wage and hiring discriminate in terms of location whereas in section 4 we focus on a labor market where firms can on the contrary wage discriminate in terms of location. Sections 5, 6 and 7 are devoted to the empirical part of the paper that tests the two models using the American Housing Survey. Finally, section 8 concludes.

2 The basic model

There is a continuum of workers (employed or unemployed) uniformly distributed along a monocentric, linear and closed city who endogenously decide their effort level at work e and the optimal residential location between the business district and the city fringe. They all consume the same amount of land (normalized to 1 for simplicity) and the density of residential land parcels is taken to be unity so that there are exactly x units of housing within a distance x of the business district.

All firms are assumed to be exogenously located in the Business District (BD hereafter). The BD is a unique employment center located at one end of the linear city. In a centralized city, it corresponds to the central business district, whereas in a completely decentralized city, it represents suburban employment. As will be clear below, what is crucial here is not the location of the BD but the distance between workers' residential location and their workplace (i.e. the BD). All land is owned by absentee landlords.[2] Each worker

[2] All theses assumptions are very standard in urban economics. See Fujita (1989).

(employed or unemployed) who consumes one unit of land is assumed to be infinitely lived and risk neutral. Workers endogenously decide their optimal place of residence between the BD (i.e. 0) and the city fringe (x_f). The total population is normalized to 1 so that the unemployment rate is equal to the unemployment level and is given by u, Similarly, the employment rate is equal to the employment level and is given by $1 - u$.

At any moment, workers can either be employed or unemployed. If employed he/she obtains a wage w whereas if unemployed he/she gets an unemployment benefit b. We assume that changes in the employment status (employment versus unemployment) are governed by a continuous-time Markov process. Job contacts (that is the transition rate from unemployment to employment) randomly occur at an endogenous rate θ while the exogenous job separation rate is δ. In this context, the expected duration of employment is given by $1/\delta$ whereas the expected duration of unemployment amounts to $1/\theta$. It then follows that a worker spends a fraction $\theta/(\theta + \delta)$ of his/her lifetime employed and a fraction $\delta/(\theta + \delta)$ of his/her lifetime unemployed. In steady state, flows into and out of unemployment are equal. Therefore, we have:

$$u = \frac{\delta}{\theta + \delta} \tag{1}$$

Observe from (1) that the steady state unemployment and employment rates correspond to the respective fractions of time a worker remains unemployed and employed over his/her infinite lifetime. Equation (1) can also be interpreted as the probability a worker will be unemployed in steady state.

Let us now determine the instantaneous utilities of an employed and an unemployed worker. For the employed, the utility function is separable and is given by:[3] $z_1 + V(l, e)$, where z_1 is the quantity of a (non-spatial) composite good (taken as the numeraire) consumed by the employed and $V(.)$ is assumed to be increasing in l and decreasing in the effort e, and concave in both arguments. This choice of the utility function aims at capturing the fact that effort and leisure are not independent activities. Indeed, if one interprets $-e$ as the leisure activity on the job (shirking), then the *leisure activity on the job* can obviously influence the *leisure activity at home*. Similarly, if one interprets leisure at home as home production, individuals might shirk or choose low levels of work effort by shifting home production to work time, such as taking care of household errands during the work day.

We are now able to write the budget constraint of an employed worker.

[3] Subscripts '1' and '0' respectively refer to the employed and the unemployed groups.

Each worker purchases the good z produced and incurs τx in monetary commuting costs when he/she lives at distance x from the BD. Letting $R(x)$ denote rent per unit of land, the budget constraint of an employed worker at distance x can be written as follows:

$$wT = z_1 + R(x) + \tau x \tag{2}$$

where w is the per-hour wage and T denotes the amount of working hours. T is assumed to be the same and constant across workers, an assumption that agrees with most jobs in the vast majority of developed countries.

Each worker provides a fixed amount of labor time T so that the time available for leisure l depends solely on commuting time. Thus, denoting by tx the commuting time from distance x (where $t > 0$ is the time commuting cost per unit of distance), the time constraint of an employed worker at distance x can be written as:

$$1 - T = l + tx \tag{3}$$

in which the total amount of time is normalized to 1 without loss of generality.

By plugging (2) and (3) into the utility function, we obtain the following indirect utility for the employed:

$$I_1(x, e) = z_1 + V(l, e) = wT - R(x) - \tau x + V\left(1 - T - tx, e\right) \tag{4}$$

Let us now focus on the unemployed. Their budget constraint is given by:

$$b = z_0 + R(x) + \tau x \tag{5}$$

where b is the unemployment benefit. In this formulation, we assume for simplicity that employed and unemployed workers have the same monetary commuting costs. The former commute every day to work whereas the latter commute every day for interviews.

To keep the analysis manageable and to be consistent with the utility of the employed, we assume that the unemployed's utility function is given by: $z_0 + V_0$,[4] and, without loss of generality, we normalize b to zero. In this formulation, V_0 is a constant utility benefit arising to all who are unemployed. Basically, V_0 is introduced to recognize the inherent disutility to being at work

[4]This formulation assumes that there is no search behavior from the unemployed. They just obtain a job randomly. This is consistent with the standard assumptions of exogenous reemployment probability in the efficiency wage model. Observe that all our basic results go through if we allow for search with time and commuting costs for the unemployed. The analysis just gets messier.

and commuting to work since it assures that when people have exactly the same z, the one working can receive less utility.

By using (5), we obtain the following indirect utility function for the unemployed:

$$I_0(x) = z_0 + V_0 = -R(x) - \tau x + V_0$$

We are now able to calculate the expected utility of each worker. To do that, we assume perfect capital markets with a zero interest rate.[5] We also assume that there are very high mobility costs. This implies that *a worker's residential location remains fixed as he/she enters and leaves unemployment.* This is much more realistic than assuming that changes in employment status involve changes in residential location. In fact, for workers to stay in the same location and thus pay the same bid rent over their lifetime, it has to be that they adjust their composite consumption. It is easy to verify that

$$z_1 - z_0 = wT > 0$$

which means that workers consume less composite good when unemployed. This difference increases with wages since better paid workers consume more composite good only when employed.[6]

Since a worker spends a fraction $1 - u = \theta/(\theta + \delta)$ of his/her lifetime employed and a fraction $u = \delta/(\theta + \delta)$ unemployed, at any moment of time, the disposable utility of a worker is thus equal to that worker's average utility over the job cycle and is given by

$$\begin{aligned} I &= (1-u)I_1(x,e) + uI_0(x) \\ &= (1-u)\left[wT + V\left(1 - T - tx, e\right)\right] - R(x) - \tau x + u\,V_0 \end{aligned} \tag{6}$$

[5] When there is a zero interest rate, workers have no intrinsic preference for the present so that they only care about the fraction of time they spend employed and unemployed. Therefore, the expected utilities are not state dependent.

[6] Many intertemporal models recognize that households might engage in precautionary savings in order to protect against negative shocks, such as unemployment, and in those types of models consumption may not fall or at least will fall less during spells of unemployment. In this model, however, consumers have no incentive to smooth consumption because consumption of the composite commodity, z, enters utility in a linear fashion and interest and discount rates are both zero.

3 Firms cannot wage and hiring discriminate in terms of location

It is assumed in this section that, by law, firms cannot discriminate in wages or hiring and thus must give all workers the same wage w.

3.1 The urban land use equilibrium

Each individual supplies one unit of labor. There are only two possible effort levels: either the worker shirks, exerting effort $e^S = \underline{e} > 0$, and contributing $\underline{e}$ units to production, or he/she does not shirk, providing effort $e^{NS} = \overline{e} > \underline{e}$, and contributes $\overline{e}$ units to production. The implication of this efficiency model, which allows for substitution between leisure and shirking behavior, differs from the standard efficiency wage model (Shapiro and Stiglitz, 1984) in that some shirking is possible and can persist in equilibrium.

Using (6), and given that all workers obtain the same wage, this implies that the expected indirect utilities of non-shirker and shirker workers are respectively equal to:

$$I^{NS}(x,\overline{e}) = (1-u^{NS})\left[wT + V\left(1-T-tx,\overline{e}\right)\right] - R(x) - \tau x + u^{NS}\,V_0$$

$$I^{S}(x,\underline{e}) = (1-u^{S})\left[wT + V\left(1-T-tx,\underline{e}\right)\right] - R(x) - \tau x + u^{S}\,V_0$$

which are simply weighted averages of the utility levels when employed and unemployed where the share of time spent unemployed is used to form the weights.

Since shirking is not perfectly detected by firms, we assume that there is a monitoring technology m (probability of detecting shirking). Using (1), this implies that

$$u^{NS} = \frac{\delta}{\theta+\delta} \tag{7}$$

$$u^{S} = \frac{\delta+m}{\theta+m+\delta} \tag{8}$$

with $u^S > u^{NS}$, $\forall \delta, \theta, m > 0$. All workers (shirking or not shirking) must in equilibrium obtain the same utility level $\overline{I}$, which is location independent.

Since workers stay in the same location all their life, bid rents are given by:[7]

$$\Psi^{NS}(x,\overline{I}) = (1-u^{NS})\left[wT + V\left(1-T-tx,\overline{e}\right)\right] - \tau x + u^{NS}\,V_0 - \overline{I} \tag{9}$$

$$\Psi^{S}(x,\overline{I}) = (1-u^{S})\left[wT + V\left(1-T-tx,\underline{e}\right)\right] - \tau x + u^{S}\,V_0 - \overline{I} \tag{10}$$

Inspection of these two equations shows that, as usual, the bid-rent functions are decreasing in x, with $\partial\Psi^{NS}(x,\overline{I})/\partial x < 0$ and $\partial\Psi^{S}(x,\overline{I})/\partial x < 0$. In the present model, this reflects the combined influence of the time cost of commuting and the monetary cost. Let us denote by $\widetilde{x}$ the border between non-shirkers and shirkers. We have the following result.[8]

Proposition 1

(i) If

$$\frac{\partial^2 V\left(l,e\right)}{\partial l\partial e} > 0 \tag{11}$$

then, workers who reside close to jobs will choose not to shirk whereas workers located farther away will shirk.

(ii) If

$$\frac{\partial^2 V\left(l,e\right)}{\partial l\partial e} < 0 \tag{12}$$

then the location pattern of shirkers and non-shirkers is indeterminate. However, if we assume something stronger, that is:

$$\left(\theta+m+\delta\right)\frac{\partial V\left(1-T-t\widetilde{x},\overline{e}\right)}{\partial l}\,|_{x=\widetilde{x}} < \left(\theta+\delta\right)\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\,|_{x=\widetilde{x}} \tag{13}$$

then workers who reside close to jobs will choose to shirk whereas workers located farther away will not shirk.

As it can be seen from this proposition, the crucial assumption is whether $\partial^2 V\left(l,e\right)/\partial l\partial e$ is positive or negative.[9] Both assumptions make sense because

[7] The use of bid-rent curves are standard in models with land markets and commuting, and in these types of models rents are assumed to adjust so that in equilibrium consumers are indifferent between different locations.

[8] All proofs of propositions can be found in the Appendix.

[9] Observe that, for case *(ii)*, condition (13) implies (12). Indeed, since $\theta+m+\delta > \theta+\delta$, then if condition (13) holds, it has to be that

$$\frac{\partial^2 V\left(l,e\right)}{\partial l\partial e} < 0$$

the causality between e and l can go in both directions. Indeed, low leisure at home implies that the worker is more pressed for time at home (less time for errands or relaxation) and as a result the benefit of conducting home production (errands or relaxation) while at work rises. This means that the worker will rest on the job and will need to do errands on the job, both leading to a low e. In this case, we need to assume $\partial^2 V(l,e)/\partial l \partial e > 0$ so that the lower the effort level, the lower the (marginal) utility derived from leisure. If this assumption holds, then it is clear that workers residing close to jobs, because they have lower commuting time and thus more leisure time at home, will provide more effort than those residing further away from jobs.

On the other hand, if someone's leisure time at home l is reduced, social life may suffer substantially, which in turn leads to less planned activities at home and less overall demand for errands in someone's life. As a result, the benefit from doing home production at work falls because in the case of errands the worker has less overall demand for those and in the case of relaxation a substantial amount of time at home is already available for relaxation. Thus, the worker provides higher effort e at work. In the extreme case, the worker has less leisure time at home so his/her wife divorces him/her. Once the divorce goes through, the worker has less household errands to run and most of time at home is spent watching TV and relaxing. The assumption is now: $\partial^2 V(l,e)/\partial l \partial e < 0$, so that the lower the effort level, the higher the (marginal) utility derived from leisure. Now, the location pattern is less obvious. Indeed, workers residing close to jobs have lower commute time and thus more leisure time at home and, because $\partial^2 V(l,e)/\partial l \partial e < 0$, provide less effort. So they are more likely to be shirkers and spend a greater fraction of their time unemployed. On the other hand, unemployment offers the consumers a savings in terms of no commutes during the spell of unemployment, and the benefit of these savings are larger away from the BD. Accordingly, the overall unemployment cost of shirking is lower near the edge of the urban area, which implies less effort in those locations.[10] The net sign is thus ambiguous. If however (13) holds, which means that the unemployment spells are not too long (because for example the monitoring rate m is quite low), then the shirkers will live close to jobs.

[10] We can in fact generalize the model by allowing the unemployed to have a search effort, so that leisure will be affected by location even when unemployed. In this case, if the marginal utility of leisure in employment is assumed to be larger than the marginal utility of leisure in unemployment whether workers shirk or not, then it can be shown that Proposition 1 still holds.

Let us now determine $\widetilde{x}$, the boundary between shirking and non-shirking workers where a consumer is indifferent between high and low levels of effort at work. To obtain the value of $\widetilde{x}$, we have to solve: $\Psi^{NS}(\widetilde{x}, \overline{I}) = \Psi^{S}(\widetilde{x}, \overline{I})$, which is equivalent to:

$$(1-u^S)V\left(1-T-t\widetilde{x}, \underline{e}\right) - (1-u^{NS})V\left(1-T-t\widetilde{x}, \overline{e}\right) = \left(u^S - u^{NS}\right)\left(wT - V_0\right) \tag{14}$$

showing a clear trade off between shirking (higher utility $V(\cdot)$ when employed since less effort but more unemployment spells during the lifetime) and non-shirking. Adopting the following notations, $V\left(1-T-t\widetilde{x}, \overline{e}\right) \equiv \widetilde{V}^{NS}$ and $V\left(1-T-t\widetilde{x}, \underline{e}\right) \equiv \widetilde{V}^{S}$, we have:

$$\frac{\partial \widetilde{x}}{\partial w} = \frac{T(u^S - u^{NS})}{t\left[(1-u^{NS})\frac{\partial \widetilde{V}^{NS}}{\partial l} - (1-u^S)\frac{\partial \widetilde{V}^{S}}{\partial l}\right]} \tag{15}$$

In the Appendix, we have a Lemma (Lemma 1) that determines the sign of $\partial^2 \widetilde{x}/\partial w^2$. In fact, the main condition is

$$\frac{\partial^2 \widetilde{V}^{NS}}{\partial l^2} < \frac{\partial^2 \widetilde{V}^{S}}{\partial l^2} < 0 \tag{16}$$

because it guarantees an interior solution by separating workers over space. The intuition behind this assumption is quite reasonable and consistent with the intuition behind the assumption stated in equation (6). Consider a plot of the marginal utility of leisure $\partial V/\partial l$ against effort with effort on the horizontal axis, which is positively sloped by equation (6). For low levels of the marginal utility of leisure (high levels of leisure), effort at work probably has little impact on the marginal utility of leisure because the worker is well rested and his/her home is well ordered. The resulting plot of $\partial V/\partial l$ is fairly flat. On the other hand, for high levels of $\partial V/\partial l$ (low leisure), effort at work is probably quite important, and the plot of $\partial V/\partial l$ is likely to be quite steep. Under these conditions, the effect of a decrease in l on $\partial V/\partial l$ is larger in magnitude at high levels of effort, which is consistent with equation (16).

We have now the following result.

Proposition 2

(*i*) *If (11) holds, then, higher wages implies less shirking in the city, i.e.* $\partial \widetilde{x}/\partial w > 0$.

(ii) If (13) holds, then higher wages reduces shirking in the city, i.e. $\partial\widetilde{x}/\partial w < 0$.

This proposition states that wages affect $\widetilde{x}$ the border between shirkers and non-shirkers. Indeed, if (11) holds, i.e. effort and leisure are substitutes, then when wages are higher, less workers shirk (the fraction of shirkers $1-\widetilde{x}$ decreases) since there are more incentive not to shirk (the average wage difference $wT(u^S - u^{NS})$ between shirkers and non-shirkers increases). If effort and leisure are complements and the difference in employment rates between the shirkers and the nonshirkers is not too large (13), then shirkers outbid nonshirkers for central locations and higher wages reduce the faction of shirkers.

Let us determine the equilibrium. We consider an closed city model in which $\overline{I}$ is endogenous and the city fringe is equal to 1 (the size of the total population is 1 since land consumption is 1).

3.2 The labor market equilibrium

There are M firms in the economy. The profit function of a typical firm can be written as:

$$\Pi = F\left(\alpha\left[L^{NS}\,\overline{e} + L^S\,\underline{e}\right]\right) - w\alpha L$$

where α is the fraction of workers hired by each firm and where the total number of non-shirkers in the economy is given by

$$L^{NS} = \widetilde{x}(1-u^{NS}) \tag{17}$$

the total number of non-shirkers is

$$L^S = (1-\widetilde{x})(1-u^S) \tag{18}$$

and the total number of employed workers is $L = L^S + L^{NS}$. We impose here that there is no discrimination in wages which means that all workers, whatever their location, obtain the same wage. We also impose that firms employ the same fraction α of workers (shirkers and nonshirkers).[11] Thus, even if firms know that all workers residing beyond $\widetilde{x}$ will shirk, they have to pay them the same wage as the ones who live between 0 and $\widetilde{x}$ (nonshirkers). We assume that $F'(\cdot) > 0$ and $F''(\cdot) < 0$.

[11] This might seem unreasonable, but actually if the location of the workers at a given firm are distributed randomly then over time the firms share of shirking workers at any wage should mirror the economies share, and individual firms can directly effect their fraction of shirkers with their wage.

Let us now solve the firm's program. By taking $\overline{e}$, $\underline{e}$, u^S and u^{NS} as given, each firm chooses w and α that maximize its profit. When choosing w firms will face the following trade off. Because it affects $\widetilde{x}$, higher wages implies that the fraction of shirkers hired will be lower (Proposition 2) and thus total output increases but labor costs are also higher since the wage given to workers is the same. When choosing α firms face the following trade off. Higher α means that more workers are higher; thus higher output but also higher labor costs.

First order conditions yield:

$$\begin{aligned}\frac{\partial \Pi}{\partial w} = F'(\cdot)\frac{\partial \widetilde{x}}{\partial w}\left[(1-u^{NS})\overline{e}-(1-u^S)\underline{e}\right] - \left[(1-\widetilde{x})(1-u^S)+\widetilde{x}(1-u^{NS})\right] \\ -w\frac{\partial \widetilde{x}}{\partial w}(u^S-u^{NS}) = 0\end{aligned} \tag{19}$$

$$\frac{\partial \Pi}{\partial \alpha} = F'(\cdot)\ \left[(1-\widetilde{x})(1-u^S)\,\overline{e}+\widetilde{x}(1-u^{NS})\,\underline{e}\right] - w\left[(1-\widetilde{x})(1-u^S)+\widetilde{x}(1-u^{NS})\right] = 0 \tag{20}$$

Now by combining these two equations, we obtain the following equation that determines the wage setting:

$$w\frac{\partial \widetilde{x}}{\partial w} = \frac{L\left[(1-\widetilde{x})(1-u^S)\,\overline{e}+\widetilde{x}(1-u^{NS})\,\underline{e}\right]}{(\overline{e}-\underline{e})\left[(1-\widetilde{x})(1-u^S)^2+\widetilde{x}(1-u^{NS})^2\right]} \tag{21}$$

where $L=(1-\widetilde{x})(1-u^S)+\widetilde{x}(1-u^{NS})$, whereas the employment level in each firm is determined by (20). We have the following proposition.

Proposition 3

(*i*) *Assume (11) and (16). Then, firms always want to allow some shirking in equilibrium and all shirkers live at the periphery of the city.*

(*ii*) *Assume (13) and (16). Then, firms always want to allow some shirking in equilibrium and all shirkers live close to jobs.*

We have shown that it is optimal for each firm to set a wage given by (21). This wage is set by taking into account the fact that it affects $\widetilde{x}$, the fraction of non-shirkers in the each firm, via (14). Of course, one has to verify that the wage that maximizes profit and that is given by (21) corresponds to a strictly interior $\widetilde{x}$, i.e. $\widetilde{x} \in]0,1[$. We assume here a strictly interior solution for $\widetilde{x}$.

In equilibrium, it has to be that labor supply equals labor demand for nonshirkers and shirkers respectively. Since the total population of workers is equal to 1, these conditions can be written as:

$$\alpha M L^{NS} = (1 - u^{NS})\widetilde{x}$$

$$\alpha M L^{S} = (1 - \widetilde{x})(1 - u^{S})$$

Using (17) and (18), this implies that

$$M = \frac{1}{\alpha} \tag{22}$$

We are now able to define the equilibria in this economy. In fact, there are two equilibria, depending on the conditions on the parameters. Assume (16). If (11) holds, the nonshirkers are close to jobs whereas the shirkers are far away. This is referred to as Equilibrium A. If (13) holds, the shirkers are close to jobs whereas the nonshirkers are far away. This is referred to as Equilibrium B.

Let us give a formal definition of each equilibrium:[12]

Definition 1 *Consider the case when firms cannot wage and hiring discriminate in terms of location. Assume (16). Furthermore, assume (11) for Equilibrium A to hold and (13) for equilibrium B to hold. Then, Equilibrium* $k = A, B$ *is a vector* $(\widetilde{x}^k, w^k, \alpha^k, M^k, u^{NS}, u^S, \overline{I}^k)$ *such that (14), (19), (20), (22), (7), (8) hold plus*

$$\Psi^{Sa}(1, \overline{I}^a) = 0 \tag{23}$$

for equilibrium A and

$$\Psi^{NSb}(1, \overline{I}^b) = 0 \tag{24}$$

for equilibrium B.

Conditions of the land market equilibrium are given by (14) and (23) for Equilibrium A or (24) for Equilibrium B. These conditions guarantee that the equilibrium land rent has to be continuous over all the city, i.e. land rents of shirkers and nonshirkers have to be equal at the intersection location $\widetilde{x}$ and the land rent at the city fringe has to be equal to the agricultural land rent (here normalized to zero). Conditions of the labor market equilibrium are given by the five other equations. An equilibrium requires solving *simultaneously* these two equilibria. In the Appendix, we show that the equilibrium exists and is unique.

[12] Superscripts a and b refer respectively to equilibria A and B.

4 Firms can wage discriminate in terms of location

We now assume that firms can discriminate in wages or hiring and thus can give workers different wages.

4.1 Urban land use equilibrium

The utility of each worker is still given by (6). Now, as we will show in the labor market analysis, there will be no shirking in equilibrium. This implies that the unemployment rate of the economy is given by

$$u^{NS} = \frac{\delta}{\theta + \delta} \tag{25}$$

Furthermore, the bid rent of a (non-shirker) worker is equal to

$$\Psi(x, \overline{I}) = (1 - u^{NS})\,[w(x)T + V\,(1 - T - tx, \overline{e})] - \tau x + u^{NS}\,V_0 - \overline{I} \tag{26}$$

Inspection of this equation shows that

$$\frac{\partial \Psi(x, \overline{I})}{\partial x} = (1 - u^{NS}) \left[w'(x)T - \frac{\partial V\,(1 - T - tx, \overline{e})}{\partial l} t \right] - \tau \tag{27}$$

which can be positive or negative depending on the sign of $w'(x)$ (it will determined below in the labor market analysis).

Since all workers provide the same effort level and are identical in all respects, they just locate anywhere in the city and enjoy the same utility level $\overline{I}$, the land rent adjusting for commuting cost differences between different locations.

To close the urban equilibrium, we have to check that $\Psi(1, \overline{I}) = 0$, which is equivalent to:

$$\overline{I} = (1 - u^{NS})\,[w(1)T + V\,(1 - T - t, \overline{e})] - \tau + u^{NS}\,V_0 \tag{28}$$

4.2 Labor market equilibrium

At each location in the city ($0 \leq x < 1$), each firm has to set a NSC (that equates shirking and non-shirking utilities) to prevent shirking. At each x, we have to solve the following equation:[13]

$$(1 - u^{NS})\,[wT + V\,(1 - T - tx, \overline{e})] + u^{NS}\,V_0 = (1 - u^{S})\,[wT + V\,(1 - T - tx, \underline{e})] + u^{S}\,V_0$$

[13] Like in the previous model, we have here the assumption that firms receive an equal share of workers from each location.

$$+(1-u^S)V\left(1-T-tx,\underline{e}\right)-(1-u^{NS})V\left(1-T-tx,\overline{e}\right)$$

which implies that:

$$w(x)=\frac{(1-u^S)V\left(1-T-tx,\underline{e}\right)-(1-u^{NS})V\left(1-T-tx,\overline{e}\right)}{T(u^S-u^{NS})}+\frac{V_0}{T} \quad (29)$$

This is the standard Shapiro-Stiglitz style non-shirking condition evaluated in equilibrium for every residential location x. It should be clear here that, when firms can wage discriminate, it is optimal for them not to allow shirking in equilibrium. In the previous model, this was not possible since each firm had to give to all its workers the same wage and thus it was somehow optimal to let some workers shirk.

Proposition 4

(*i*) *Assume (11). Then,* $w'(x)>0$.

(*ii*) *Assume (13). Then,* $w'(x)<0$.

This result is quite intuitive. If leisure and effort are substitute (i.e. (11) holds), then wages have to compensate workers who live further away since they commute more and thus have less time for leisure at home. If this is not the case and (13) holds (which is more that leisure and effort are complement), then firms have to compensate workers who live closer to jobs for the time they spend employed because they value less leisure.

Using (27), Proposition 4 implies that when (11) holds, $w'(x)>0$ and thus the sign of $\partial\Psi(x,\overline{I})/\partial x$ is ambiguous. This is because there are two opposite effects. On the one hand, workers residing far away have higher wages. On the other, they have higher monetary commuting costs and also higher time costs and thus lower leisure. The compensation of the land rent is therefore not straightforward. Because we would like land rents to decrease from the center to the periphery, we assume that

$$(1-u^{NS})w'(x)T<(1-u^{NS})\frac{\partial V}{\partial l}t+\tau$$

i.e., the wage is lower than the commuting cost effect so that land rents compensate workers who reside further away. Using (7), (8) and (38) in the Appendix, this can be written as:

$$0<\frac{\partial V\left(1-T-tx,\overline{e}\right)}{\partial l}-\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}<\frac{\tau\, m}{t\theta} \quad (30)$$

which guarantees that bid rents are always decreasing. This condition encompasses (11).

Consider now the case when (13) holds, $w'(x) < 0$ and thus $\partial\Psi(x, \overline{I})/\partial x < 0$.

Let us now define the labor demand α of each firm. Firms solves the following program:

$$\max_{\alpha} \left[\Pi = F(\alpha L\overline{e}) - \alpha L \int_{0}^{1} w(x)dx \right]$$

First order condition yields

$$\overline{e}F'(\alpha L\overline{e}) = \int_{0}^{1} w(x)dx \tag{31}$$

Equilibrium condition (Labor demand equals labor supply):

$$L = 1 - u^{NS} = \frac{\theta}{\delta + \theta} \tag{32}$$

We focus on a symmetric labor market equilibrium in which each firm employs the same number of workers $\alpha L = L/M$ so that

$$M = \frac{1}{\alpha} \tag{33}$$

Definition 2 *Consider the case when firms can wage discriminate in terms of location. Assume (30) for Equilibrium A to hold and (13) for equilibrium B to hold. Then, Equilibrium $k = A, B$ is a vector $(w^k(x), \alpha^k, M^k, u^{NS}, u^S, \overline{I}^k)$ such that (29), (31), (20), (33), (7), (8) and (28).*

We show in the Appendix that there exists a unique equilibrium for each equilibrium.

5 Empirical Approach and Data Description

The theoretical models above suggest a empirical relationship between commuting time and either job separation and/or wages.

While the model does not provide an unambiguous prediction concerning sign of these relationships and other models might generate similar relationships, the model above does suggest that if efficiency wages are going to play an important role in the distribution of unemployment or wages this role should be directly related to the commutes faced by workers (since commutes and thus leisure, depending on (11) or (13), can have a positive or negative impact on effort and thus shirking). In this context, the tests offered in this paper can be viewed as necessary conditions, as opposed to sufficient, for efficiency wages to be important in the spatial distribution of labor market outcomes. Moreover, a finding that one of the variables, unemployment or earnings, are related to commutes, but not the other would provide evidence favoring the model where firms cannot or can discriminate over space when setting wages.

In the empirical section of the paper, models of employment and labor earnings are estimated that include a proxy for a worker's expected commute. These analyses are conducted for metropolitan specific samples and are identified by cross-sectional variation within each metropolitan area. Specifically, the sample for this analysis is drawn from the 1985 Metropolitan Area (Metro) samples of the American Housing Survey (AHS) for Boston, Philadelphia, and Washington D.C. The Metro samples of the AHS contain detailed housing characteristics and the location of the housing unit down to a census tract identifier, which identifies all housing units that belong to the same tract, but does not actually identify the tract itself. The location of the housing unit is described by its placement into one of between 23 and 35 zones with population of approximately 100,000 each.[14] It also contains information on family structure and family member demographics, such as age and education. The 1985 survey included a commuting supplement that collected limited information on the labor market outcomes of each family member including the employment location at the zone level for all family members who are currently employed and work at a fixed location.[15] To our knowledge, the 1985 AHS is the only publically available data set that provides information on employment and residential location at this level of spatial detail.[16]

[14] Boston is divided into 5 zones, and the rest of the metropolitan area is divided into 26 zones. Philadelphia is divided into 13 zones, and the rest of the metropolitan area is divided into 22 zones. Washington D.C. is divided into 6 zones, and the rest of the metropolitan area is divided into 17 zones.

[15] The commuting time supplement has not been administered as part of the metropolitan sample of the AHS since 1985, and therefore no information on work location, commuting, or mode choice is not available for later waves of the AHS.

[16] See Ross and Petitte (1999) and Deng, Ross and Wachter (In Press) for other recent studies that use the commuting supplement of the1985 AHS Metro sample. The 1990 Public Use Microdata Sample of the U.S. Census is often used for studies of this type. However, this sample uses zones of 100,000 people to report residential location, which does not provide enough spatial detail to represent individual neighborhoods, and employment location is

A base sample of prime-age adults for each metropolitan area is created including all individuals between ages 25 and 55 who belong to housing units that are located in census tracts that contain at least four other occupied housing units. This criteria leads to a sample of 2,312 adults in 302 census tracts for Boston, 4227 adults in 490 census tracts for Philadelphia, and 5760 adults in 503 census tracts for Washington D.C.

The means and standard errors for these samples are shown in Table One for all three metropolitan areas. The samples are comparable over most variables with Philadelphia having unusually low employment and college graduation rates, and Boston having a very small number of African-American adults. Table Two contains the means and standard errors for all adults who have at least $1,000 of labor earnings. Washington D.C. has substantially higher income levels than Boston and Philadelphia.

A set of variables is created to describe each tract that is represented in the three samples. The mean adult commute time for a tract is created as a proxy for the expected commute time for adults residing in that tract. The number of households in a tract must exceed five households based on our sample criteria and never exceeds 20 households. In order to limit the influence of outliers in these small samples, the tract mean commute time variable is calculated as a mean based on truncated tails. If the number of commutes from a tract is between five and nine, the highest and lowest values are dropped from the calculation of the average. The two highest and two lowest values are dropped if the number of commutes is between ten and nineteen, and the four highest and lowest values are dropped if the number is above twenty. Finally, no adult influences the value of this variables for specifying their own tract mean commute time. Specifically, adult's own commute is eliminated from the calculation of the averages. Next, two socio-economic variables, mean family income and percent African-American, are created based on averages from the original household sample in order to control for any empirical relationship between neighborhood quality and either employment or labor earnings. These variables are constructed following rules similar to mean commute time in that the outliers are truncated for mean family income and the household's actual race and family income do not enter their tract racial composition or mean

only provided at the level of central city or central county for this sample. As a result, the central zone often contains between 50 and 90 percent of the employment. Also, see Gabriel and Rosenthal (1999) for a study that uses the labor market information in the commute time supplement of the national sample of the American Housing Survey.

income.[17] A third control variable is created to measure employment access in order to distinguish between the effect of commutes and employment access on employment, which has been examined extensively in the spatial mismatch literature.[18] The measure of employment access is created by estimating a traditional gravity model based on commuting flows between census tracts and an adults zone of work.[19] These means are also shown in Tables One and Two.

The inclusion of these four tract variables into an employment or regression model creates the potential for heteroskedastic data. Heteroskedasticity biases the estimates of non-linear models, such as a logit or probit, and also biases the standard errors in the linear model. The employment equation is estimated using a probit with multiplicative standard errors by Full Information Maximum Likelihood Estimation (FIML).[20] The heterskedasticity associated

[17] Additional location variables, such as tract average education among adults and tract located in the central city based on the residential zone in which the housing unit is located, are calculated. These variables are colinear with other control variables and do not add much additional information. All results are robust to estimations that include these variables.

[18] See Ihlanfeldt and Sjoquist (1998) for a recent survey.

[19] The sample of employed prime age adults is used to estimate a gravity model in which the flow of commuters between each tract and work zone depends upon the number of prime age adults in the tract, the number of employed adults working in the zone, and the mean travel time between the tract and the zone. The gravity measure is based on weighted exponential average of zone employment totals, where the parameter estimates and the commute times between a tract and each zone are used to create the weighting scheme. The approach used in the paper differs slightly from the standard approach because the data on flows in the 1985 metro AHS is quite thin when considered at the tract level. In the standard gravity model, the sample is based on residential and work locations for which flows between these locations are observed because commute time is unobserved when there are no commuters traveling between the locations. In this paper, all possible residential and work locations are included in the sample and the commute time between the residential and employment zones is used as a proxy for the tract to employment zone commute time for routes that are not traveled by commuters in the AHS sample. Note that the final job access measure is based on a log-log specification in which the logarithm is taken of one plus the number of flows, but alternative flow models based on an ordered probit or a poison regression yield very similar results. See Ross (In Press) for an earlier use of this modified gravity measure.

[20] The multiplicative model of heteroskedasticity is based on the exponential of a linear function of control variables (Harvey, 1976). Note that in a binary dependent variable problem the variance intercept is not identified and initialized to zero. Ross (In Press) uses the same variable construction procedures, and Ross directly investigated the influence of tract sample size on the variance of the variable percent African-American. He then adjusted this variable to directly control for heteroskedasticity. These adjustments had no substantial effect on any of his estimations.

with an observation is assumed to depend upon the number of households as well as the number of commuters in a census tract since the household and commuter samples were used to create the tract level variables.[21] The earnings equation is estimated using ordinary least squares, but the standard errors are corrected for heteroskedasticity (White, 1978).

Finally, residential and employment location dummy variables are created using the spatial zones from the metro AHS. The residential dummy variables are included in the employment equation to control for location unobservables that may exist over fairly broad regions of the metropolitan area. The effect of including these residential location dummy variables is to identify the effect of commuting differences within broad, internally homogenous regions of the metropolitan area rather than by comparisons across those regions. Essentially, these variables provide a non-parametric control for heterogeneity over space and are comparable to the types of controls used by Gibbons (2003).[22] The employment location dummy variables are included in the earnings equation in order to control for spatial variation in wages so that the effect of commuting time only captures the direct relationship between residential location and earnings rather than an indirect effect through employment location. In principle, the earnings equation might also include the residential location zone variables, but in practice these variables had no explanatory power in the earnings equations.[23]

[21] In principle, any explanatory variable in the probit specification for employment can also be included in the heteroskedasticity specification. However, binary dependent variables do not provide any information on the variation, and the coefficients on any variables that are included in both the employment and heteroskedasticity specifications are only identified by functional form. Rather than rely on functional form restrictions, heteroskedasticity in this model is based soley on the tract sample size variables and identified by the exclusion of the sample size variables from the behavioral model.

[22] Gibbons (2003) estimates the effect of crime rates on English housing prices. He controls for the effect of neighborhood quality on property values using a non-parametric smoothing estimator to model the price of housing over space, and the unexplained variance is regressed on crime rates that are recorded at a very low level of aggregation. As with the AHS zone variables, the smoothing estimator removes variation that arises at a broader level of aggregation than the phenomenon being studied. In other words, if variation in crime rates or other variables of interest exist within broad, fairly homogenous neighborhoods, these types of corrections may mitigate bias by controlling for unobservables associated with these broad neighborhood types.

[23] Earlier work by Ihlanfeldt (1992) suggests that residential location does not explain wage differences after controlling for employment location.

6 Methodological Extensions and Robustness of Results

The theoretical model also suggests that an efficiency wage-based relationship between commute time and either employment or earnings is likely to depend upon factors that affect the household's demand for personal time. Marriage is a major life change that has an important impact on the demand for personal time. Intuitively, one might expect that marriage increases the demand for personal time, leads to substitution towards shirking, and as a result to higher unemployment rates or higher earnings if firms respond to shirking. In order to examine this possibility, separate models are estimated for two subsamples: all single prime-age adults, and all married prime-age males. Females are excluded from the married adult sample in order to avoid the complex issues surrounding female labor supply in married households. If the efficiency wage story holds, we would expect to see a positive relationship between mean commute time and either employment or earnings for married males. The married prime-age male samples contain 761, 1334, and 1856 for Boston, Philadelphia, and Washington D.C. respectively, and the single prime-age adult samples contain 739, 1491, and 1996.

A second issue involves the use of annual labor market earnings rather than wage rates in the test for a relationship between commuting time and wage. The American Housing Survey (AHS) does not contain information on hours worked and so periods of unemployment or underemployment during the year may not accurately capture an empirical relationship between commute time and wages. The initial earnings regressions simply dropped all prime-age adults with labor earnings below $1,000. As a robustness check, the earnings regressions are reestimated for samples that drop households based on any indication of an unemployment spell during the year since this spells would create a disconnect between earnings and wages. First, all adults who were unemployed at the time of the survey, but report labor earnings during the year are dropped. Second, all adults who report receiving other non-labor income, which captures unemployment benefits in the AHS, are dropped from the sample. These criteria result in samples of 1662 and 1545 for Boston, 2729 and 2446 for Philadelphia, and 4213 and 3917 Washington D.C.[24]

[24]This issue seems less critical in the employment equation. The model predicts that commute time affects shirking behavior leading to higher separation rates. In an equilibrium where firms cannot base wages on residential location, these higher separation rates are directly reflected in higher cross-sectional employment rates, and this paper uses a defintion

Finally, alternative specifications are considered to directly model potential simultaneities in the earnings equation. The first model uses mean tract commute time as an instrument in an earnings model that includes an adult's actual commute time as an endogenous right hand side variable. The commute time specification includes all right hand side variables in the earnings equation plus mean commute time so that the exclusion of mean commute time itself from the earnings model once actual commute time has been included identifies the model.[25] The second model corrects the earnings equation for sample selection into employment where earnings are only observed if the adult is employed. Employment access is excluded from the earnings equation and is assumed to only influence earnings through its influence on employment. As with the first model, the sample selection corrected earnings model is only identified by the exclusion of employment access.[26] Standard errors for both models are corrected using standard approaches.

7 Estimation Results

Table Three presents the estimation results for the baseline employment model. The estimated relationship between mean tract commute time and employment is not statistically significant for any metropolitan area. The other results are quite intuitive and comparable across all three metropolitan areas. Years in the labor market, often referred to as potential experience, and educational attainment lead to higher employment rates, but the year effect declines as the adult's time in the labor market increases. Males have higher employment rates, especially if married, and married females with children have especially low employment rates. Employment access is positively correlated with em-

of employment based on whether the adult was working at the time of the survey.

[25] In principle, commute time may also be explained by the residential zone dummy variables that are included in the employment equation. These variables are excluded in order to assure that identification arises from the exclusion of mean commute time from the employment equation. Alternative models in which zone dummies are also included as instruments yeild similar results.

[26] All other earnings regressions excluded residential zone dummy variables arguing that these residential fixed effects have little ability to explain earnings after controlling for employment location. Their exclusion, however, would provide identifying information in the sample selection model. In order to be precise concerning the identification of the model, residential location zone dummy variables are included in the sample selection corrected earnings model. Similar results arise if the residential zone variables are excluded from the earnings model.

ployment status. The only surprising result is that tract mean family income is negatively related to employment in Philadelphia and Washington D.C. One possible explanation is that neighborhood mean family income is correlated with housing equity or positive shocks to housing equity, and the observed negative relationship accounts for the effect of wealth on labor supply.[27] Finally, the estimates on number of households and number of commuters in tract are highly significant, except for number of commuters in Philadelphia, providing strong evidence of heteroskedastic errors.

Table Four presents the estimation results for the baseline earnings model. Again, the estimated relationship between tract commute time and earnings are not statistically significant for any metropolitan area. For the standard demographic variables like potential experience, educational attainment, gender and family structure, the empirical relationship between those variables and earnings is quite similar to the relationship with employment status. Mean tract income is always positively related to earnings. This variable certainly captures at least some omitted human capital variables due to the fact that households with high levels of human capital tend to sort into the same neighborhoods. Employment access is negatively related to earnings for Boston, and percent African-American is negatively related to earnings for Philadelphia and Washington.[28]

Table Five presents separate estimations for married males and single adults.[29]

[27] It should be noted that the mean family income results are less striking in the simple probit model that is not corrected for heteroskedasticity. Specifically, the negative relationship only remains for Washington D.C., and a positive relationship between mean family income and employment is found for Boston. While the points estimates change, the qualitative results for employment access and tract commuting time parameter estimates are the same for both the traditional probit and the probit with heteroskedastic errors.

[28] The fact that residential location is endogenous has been a continuing problem for studies of the spatial mismatch hypothesis and is clearly a concern here. The tract mean income, percent African-American, and employment access variables were included as an attempt to not only control for neighborhood effects, but also to capture omitted labor market variables that might influence household sorting. The questions is whether after controlling for a reasonable set of neighborhood characteristics are households with higher quality unobserved labor market attributes sorting systematically into tracts with unusually high or low expected commutes. If not, the estimation is consistent, but if sorting of this type takes place the question posed in this paper could only be answered by modelling the residential location choice problem, which raises many additional identification problems and is beyond the scope of this paper. See Ihlanfeldt (1998) and Glaeser (1996) for discussions of this problem in the context of the spatial mismatch hypothesis.

[29] Estimates of control variables are suppressed from this point forward, but are available upon request.

In the employment equation, mean commute time is only significant for married males in Philadelphia. The coefficient estimate takes the expected sign for Philadelphia, but the estimates for married males are very near to zero for the other two metropolitan areas. In the earnings equations, mean commute time is positive and significant for married adults in Washington D.C., which is expected if firms condition wages on residential location in order to address the potential for shirking. The mean commute time coefficient for single adults in Philadelphia, however, is positive and significant.

One possible explanation is that an efficiency wage operates differently across both metropolitan areas and groups so that in Boston, neither group adjusts shirking behavior as increased commutes erode leisure time; in Philadelphia both groups adjust shirking behavior and single adults are compensated by firms to prevent shirking, while married males are not compensated and shirk, and in Washington D.C. only married males adjust shirking behavior. In our opinion, however, this explanation is unconvincing because these three metropolitan areas are all centered on large, northeast cities and exhibit fairly comparable average commutes, see Table One.[30]

The final two analyses focus on the earnings regression. Table Six presents the results for the alternative samples based on excluding adults who had an unemployment spell during the survey period. These restrictions had no effect on the results. Mean commute time is still unrelated to earnings. Table Seven presents the estimation results for the instrumental variable and sample selection specifications. As above, no statistically significant relationship between mean commute time and earnings is found.

[30] The employment access variables have very little effect on the employment of married males, which might be expected due to their strong attachment to the labor market. However, the effect of employment access is also not robust for single adults. Employment access leads to higher employment among single adults in Philadelphia as expected, but leads to lower employment in Boston and has no effect in Washington D.C. This result is surprising since employment access had a positive effect in the pooled estimates. This anomaly appears to be a result of the heteroskedastic probit specification. Using a simple probit model, employment access does have a statistically significant, positive impact on employment for single adults in Philadelphia and Washington D.C. The effect in Boston is also positive and comparable in magnitude to the estimates for other metropolitan areas, but the estimate is insignificant potentially due to the smaller size of the Boston sample.

8 Summary and conclusions

This paper uses a unique sample of households within the Boston, Philadelphia, and Washington D.C. metropolitan areas to investigate whether the empirical implications of our efficiency wage-substitution model hold. The sample contains detailed information on residential and employment location, as well as standard demographic data, labor market outcomes, and commuting patterns. A variety of models are estimated to examine whether a household's expected or actual commute time influences employment or labor market earnings. Most analyses provide no evidence to suggest that employment or earnings are empirically related to a household's actual or expected commute time. The one exception arises in the analysis where separate estimations are conducted for married males and single adults. The results in this model, however, are not consistent across the three metropolitan areas. Commute time is unrelated to either employment or earnings in Boston, and the estimated relationship differs dramatically between Philadelphia and Washington D.C.

The only explanation for the married male and single adult results that is consistent with the efficiency wage-substitution model is that circumstances differ substantially between the groups and across the metropolitan areas leading to systematic differences in both firm and group behavior. These three metropolitan areas, however, are all centered on large, northeast cities and exhibit fairly comparable average commutes. A more reasonable explanation is that other, metropolitan area specific factors create a relationship mean tract commutes and employment or earnings. Therefore, while an efficiency wage model may operate in American labor markets, its effect on both earnings and employment appear to be small relative to other factors in these urban economies that influence the empirical relationship between commute times and labor market outcomes. A small or non-existence effect of efficiency wages on the spatial variation of employment and earnings may arise either because on average household preferences are described by a situation where the effect of substitution between leisure and shirking is exactly cancelled by the influence of commuting time savings during unemployment or because alternative theoretical models, such as search models, where unemployment depends upon local networks or spatial variation in search costs.

This finding is quite significant given that the metropolitan areas studied are large, congested areas with average one-way commute times between 23 and 28 minutes and containing some residents with one-way commutes that are well over two hours. A substantial, growing literature exists on the operation of efficiency wage models in urban economies (see e.g. Zenou and Smith, 1995, Smith and Zenou, 1997, Zenou, 2002, Brueckner and Zenou 2003), and prior to this paper no empirical evidence has been offered to suggest that efficiency wages are important in explaining outcomes over space. This paper offers a first attempt to test for the influence of efficiency wages on urban outcomes and finds very little evidence to support the relevance of this theory. Additional empirical work is needed investigating the role that efficiency wages or other models of unemployment can play in explaining spatial variation in employment and earnings.

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APPENDIX

Proof of Proposition 1

First observe that

$$-\frac{\partial\Psi^{NS}(x,\overline{I})}{\partial x}\,|_{x=\widetilde{x}} \gtrless -\frac{\partial\Psi^{S}(x,\overline{I})}{\partial x}\,|_{x=\widetilde{x}}$$

This is equivalent to:

$$\tau+t(1-u^{NS})\frac{\partial V\left(1-T-tx,\overline{e}\right)}{\partial l}\,|_{x=\widetilde{x}} \gtrless \tau+t(1-u^{S})\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\,|_{x=\widetilde{x}}$$

or

$$(1-u^{NS})\frac{\partial V\left(1-T-t\widetilde{x},\overline{e}\right)}{\partial l}\,|_{x=\widetilde{x}} \gtrless (1-u^{S})\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\,|_{x=\widetilde{x}}$$

For (i), we want this inequality to be always $>$. Since $1-u^{NS}>1-u^{S}$, it is easy to see that, if

$$\frac{\partial^2 V\left(l,e\right)}{\partial l\partial e}>0$$

then this inequality is always true.

For (ii), we need the contrary, i.e.

$$(1-u^{NS})\frac{\partial V\left(1-T-t\widetilde{x},\overline{e}\right)}{\partial l}\,|_{x=\widetilde{x}} < (1-u^{S})\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\,|_{x=\widetilde{x}}$$

Now, if

$$\frac{\partial^2 V\left(l,e\right)}{\partial l\partial e}<0$$

then, using (7) and (8), this condition writes:

$$\left(\theta+m+\delta\right)\frac{\partial V\left(1-T-t\widetilde{x},\overline{e}\right)}{\partial l}\,|_{x=\widetilde{x}} < \left(\theta+\delta\right)\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\,|_{x=\widetilde{x}}$$

■

Lemma 1 *Consider the case when firms cannot wage and hiring discriminate. Assume*

$$\frac{\partial^2\widetilde{V}^{NS}}{\partial l^2}<\frac{\partial^2\widetilde{V}^{S}}{\partial l^2}<0$$

(i) *If (11) holds, then* $\partial^2\widetilde{x}/\partial w^2<0$.

(ii) *If (13) holds, then* $\partial^2\widetilde{x}/\partial w^2>0$.

Proof. Differentiation of $\widetilde{x}$ yields:

$$\frac{\partial^2 \widetilde{x}}{\partial w^2} = \frac{T(u^S - u^{NS})}{t\left[(1-u^{NS})\frac{\partial \widetilde{V}^{NS}}{\partial l} - (1-u^S)\frac{\partial \widetilde{V}^S}{\partial l}\right]^2}\left[(1-u^{NS})\frac{\partial^2 \widetilde{V}^{NS}}{\partial l^2} - (1-u^S)\frac{\partial^2 \widetilde{V}^S}{\partial l^2}\right]\frac{\partial \widetilde{x}}{\partial w}$$

Thus, if (16) holds and since $1 - u^{NS} > 1 - u^{NS}$, we have:

$$(1-u^{NS})\frac{\partial^2 \widetilde{V}^{NS}}{\partial l^2} - (1-u^S)\frac{\partial^2 \widetilde{V}^S}{\partial l^2} < 0$$

As a result,

$$sgn\frac{\partial^2 \widetilde{x}}{\partial w^2} = sgn\frac{\partial \widetilde{x}}{\partial w}$$

Using Proposition 2, the results are straightforward. ■

Proof of Proposition 3

We would like to show that $\partial^2\Pi/\partial w^2 < 0$. By Differentiating (19) with respect to w, we easily obtain:

$$\begin{aligned}\frac{\partial^2 \Pi}{\partial w^2} &= \alpha\frac{\partial^2 \widetilde{x}}{\partial w^2}\left\{F'(\cdot)\left[(1-u^{NS})\overline{e} - (1-u^S)\underline{e}\right] - w(u^S - u^{NS})\right\} \\ &+\alpha\frac{\partial \widetilde{x}}{\partial w}\left\{\alpha\frac{\partial \widetilde{x}}{\partial w}F''(\cdot)\left[(1-u^{NS})\overline{e} - (1-u^S)\underline{e}\right]^2 - (u^S - u^{NS})\right\}\end{aligned}$$

(i) Consider first the case when (11) holds. Then, from Proposition 2, we know that $\partial\widetilde{x}/\partial w > 0$. Using the fact that $F''(\cdot) < 0$ and $u^S > u^{NS}$, we obtain:

$$\alpha\frac{\partial \widetilde{x}}{\partial w}\left\{\alpha\frac{\partial \widetilde{x}}{\partial w}F''(\cdot)\left[(1-u^{NS})\overline{e} - (1-u^S)\underline{e}\right]^2 - (u^S - u^{NS})\right\} < 0$$

Now, (19) can be written as:

$$\frac{\partial \widetilde{x}}{\partial w}\left[F'(\cdot)\left[(1-u^{NS})\overline{e} - (1-u^S)\underline{e}\right] - w(u^S - u^{NS})\right] = L$$

Since $\partial\widetilde{x}/\partial w > 0$, this implies that

$$F'(\cdot)\left[(1-u^{NS})\overline{e} - (1-u^S)\underline{e}\right] - w(u^S - u^{NS}) > 0$$

Finally, using Lemma 1, assuming (16) implies that $\partial^2\widetilde{x}/\partial w^2 < 0$ and thus

$$\alpha\frac{\partial^2 \widetilde{x}}{\partial w^2}\left\{F'(\cdot)\left[(1-u^{NS})\overline{e} - (1-u^S)\underline{e}\right] - w(u^S - u^{NS})\right\} < 0$$

Consequently, $\partial^2\Pi/\partial w^2 < 0$.

(ii) Consider now the case when (13) holds. Then, from Proposition 2, we know that $\partial\widetilde{x}/\partial w < 0$. Using the fact that $F''(\cdot) < 0$ and $u^S > u^{NS}$, we obtain:

$$\alpha\frac{\partial\widetilde{x}}{\partial w}\left\{\alpha\frac{\partial\widetilde{x}}{\partial w}F''(\cdot)\left[(1-u^{NS})\overline{e}-(1-u^S)\underline{e}\right]^2-(u^S-u^{NS})\right\}<0$$

Now, (19) can be written as:

$$\frac{\partial\widetilde{x}}{\partial w}\left[F'(\cdot)\left[(1-u^{NS})\overline{e}-(1-u^S)\underline{e}\right]-w(u^S-u^{NS})\right]=L$$

Since $\partial\widetilde{x}/\partial w < 0$, this implies that

$$F'(\cdot)\left[(1-u^{NS})\overline{e}-(1-u^S)\underline{e}\right]-w(u^S-u^{NS})<0$$

Finally, using Lemma 1, assuming (16) implies that $\partial^2\widetilde{x}/\partial w^2 > 0$. As a result,

$$\alpha\frac{\partial^2\widetilde{x}}{\partial w^2}\left\{F'(\cdot)\left[(1-u^{NS})\overline{e}-(1-u^S)\underline{e}\right]-w(u^S-u^{NS})\right\}<0$$

Consequently, $\partial^2\Pi/\partial w^2 < 0$. ■

Existence and uniqueness of equilibrium when firms cannot wage and hiring discriminate in terms of location

We will not prove formally that there exists a unique equilibrium (this is available unpon request) but give the main intuitions for the demonstration. We focus on Equilibrium A since the demonstration for Equilibrium B is exactly the same.

First, using (7) and (8), equation (14) can be written as

$$\begin{aligned}&\left(\frac{1}{\theta+m+\delta}\right)V\left(1-T-t\widetilde{x}^a,\underline{e}\right)-\left(\frac{1}{\theta+\delta}\right)V\left(1-T-t\widetilde{x}^a,\overline{e}\right)\\&=\left(\frac{1}{\theta+m+\delta}-\frac{1}{\theta+\delta}\right)(w^aT-V_0)\end{aligned}\tag{34}$$

It is easy to verify that this equation determines a unique relationship between $\widetilde{x}^a$ and w^a.

Second, using (7) and (8), equation (23) is equivalent to:

$$\overline{I}^a=\left(\frac{\theta}{\theta+m+\delta}\right)\left[w^aT+V\left(1-T-t,\underline{e}\right)\right]-\tau+\frac{\delta+m}{\theta+m+\delta}V_0\tag{35}$$

which determines a unique increasing relationship between $\overline{I}^a$ and and w^a.

Third, using (7) and (8), equations (19) and (20) are equal to:

$$F'(\cdot)\frac{\partial \widetilde{x}^a}{\partial w}\left[(\frac{\theta}{\theta+\delta})\overline{e}-(\frac{\theta}{\theta+m+\delta})\underline{e}\right] \tag{36}$$
$$= \left[(1-\widetilde{x}^a)(\frac{\theta}{\theta+m+\delta})+\widetilde{x}^a(\frac{\theta}{\theta+\delta})\right]+w^a\frac{\partial \widetilde{x}^a}{\partial w}\left(\frac{\delta+m}{\theta+m+\delta}-\frac{\delta}{\theta+\delta}\right)$$

$$F'(\cdot)\left[(1-\widetilde{x}^a)(\frac{\theta}{\theta+m+\delta})\,\overline{e}+\widetilde{x}^a(\frac{\theta}{\theta+\delta})\,\underline{e}\right]=w^a\left[(1-\widetilde{x}^a)(\frac{\theta}{\theta+m+\delta})+\widetilde{x}(\frac{\theta}{\theta+\delta})\right] \tag{37}$$

where $\partial\widetilde{x}^a/\partial w^a$ is given by (15) and α^a only appears in the production function. By combining these two equations, for each $\widetilde{x}^a$, we find a unique relationship between w^a and α^a.

By combining (34), (36) and (37), we obtain a unique $\widetilde{x}^a, w^a$ and α^a. Finally, by plugging the value of w^a in (35), we obtain the unique $\overline{I}^a$. ■

Proof of Proposition 4

Using (11), we have:

$$\frac{\partial w(x)}{\partial x}=\frac{1}{T(u^S-u^{NS})}t\left[(1-u^{NS})\frac{\partial V\left(1-T-tx,\overline{e}\right)}{\partial l}-(1-u^S)\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\right] \tag{38}$$

Since, $u^S > u^{NS}$, the when (11) holds, $w'(x)>0$. When (13) holds, then $w'(x)<0$. ■

Existence and Uniqueness of equilibrium when firms can wage discriminate in terms of location

We will not prove formally that there exists a unique equilibrium (this is available unpon request) but give the main intuitions for the demonstration.

The equilibrium is characterized by equations (29), (31) and (28). They can be respectively written as

$$w^k(x)=\frac{(\frac{\theta}{\theta+m+\delta})V\left(1-T-tx,\underline{e}\right)-(\frac{\theta}{\theta+\delta})V\left(1-T-tx,\overline{e}\right)}{T(\frac{\delta+m}{\theta+m+\delta}-\frac{\delta}{\theta+\delta})}+\frac{V_0}{T}$$

$$\overline{e}F'(\alpha^k L\overline{e})=\int_0^1 w^k(x)dx$$

$$\overline{I}^k = (\frac{\theta}{\theta + \delta}) \left[w^k(1)T + V\left(1 - T - t, \overline{e}\right)\right] - \tau + \frac{\delta}{\theta + \delta} V_0$$

and the three unknowns are $w^k(x), \alpha^k$ and $\overline{I}^k$.

The first equation determines a unique wage $w^k(x)$. Plugging this wage in the next equation gives a unique α^k. Plugging this wage in the last equation gives a unique $\overline{I}^k$. $\blacksquare$

Table One: Means and Standard Errors for Adult Sample[1]			
Variable Names	Boston	Philadelphia	Washington
Employed at Time of Survey	0.761 (0.426)	0.686 (0.464)	0.764 (0.424)
Years in Labor Market / 100[2]	1.883 (0.947)	1.957 (0.938)	1.872 (0.898)
Square of Years in Labor Market	4.444 (4.089)	4.710 (4.097)	4.312 (3.792)
Adult is High School Graduate	0.562 (0.496)	0.589 (0.491)	0.485 (0.499)
Adult is College Graduate	0.353 (0.478)	0.269 (0.444)	0.418 (0.493)
Adult is Hispanic	0.022 (0.146)	0.028 (0.166)	0.029 (0.168)
Adult is African-American	0.059 (0.236)	0.193 (0.395)	0.240 (0.427)
Adult is Male	0.481 (0.499)	0.470 (0.499)	0.476 (0.499)
Adult's Household Contains Children	0.529 (0.499)	0.554 (0.497)	0.544 (0.498)
Adult is Married	0.680 (0.466)	0.647 (0.477)	0.653 (0.475)
Adult is a Married Female	0.351 (0.477)	0.331 (0.470)	0.331 (0.470)
Adult is Married Female with Children	0.223 (0.416)	0.225 (0.417)	0.223 (0.416)
Mean Tract Commuting Time (Hours)	0.369 (0.130)	0.406 (0.165)	0.448 (0.142)
Employment Access (Gravity Measure)	0.192 (0.069)	0.229 (0.090)	0.409 (0.137)
Tract Fraction African-American	0.059 (0.191)	0.181 (0.305)	0.233 (0.313)
Tract Mean Family Income	0.322 (0.135)	0.275 (0.139)	0.387 (0.171)
Tract Number of Households	0.802 (0.293)	0.919 (0.333)	1.113 (0.398)
Tract Number to Report Commute Time	0.952 (0.464)	0.974 (0.541)	1.358 (0.628)
Sample Size	2312	4227	5760

1. Standard errors are shown in parentheses. The sample excludes any households located in census tracts that contain less that five sample households.
2. Years in labor market are calculated as age minus the sum of years of education and six years and represents potential experience.

Table Two: Means and Standard Errors for Working Adult Sample[1]			
Variable Names	Boston	Philadelphia	Washington
Adults Salary / 100,000	0.224 (0.160)	0.206 (0.148)	0.260 (0.180)
Years in Labor Market / 100	1.848 (0.930)	1.905 (0.923)	1.834 (0.880)
Square of Years in Labor Market	4.280 (3.929)	4.484 (3.951)	4.139 (3.659)
Adult is High School Graduate	0.558 (0.496)	0.595 (0.490)	0.483 (0.499)
Adult is College Graduate	0.374 (0.484)	0.302 (0.459)	0.437 (0.496)
Adult is Hispanic	0.017 (0.131)	0.021 (0.146)	0.029 (0.169)
Adult is African-American	0.058 (0.234)	0.181 (0.385)	0.242 (0.428)
Adult is Male	0.538 (0.498)	0.537 (0.498)	0.525 (0.499)
Adult's Household Contains Children	0.501 (0.500)	0.526 (0.499)	0.524 (0.499)
Adult is Married	0.675 (0.468)	0.646 (0.478)	0.637 (0.480)
Adult is a Married Female	0.302 (0.459)	0.272 (0.445)	0.275 (0.446)
Adult is Married Female with Children	0.178 (0.382)	0.171 (0.376)	0.176 (0.381)
Mean Tract Commuting Time (Hours)	0.371 (0.129)	0.404 (0.164)	0.447 (0.139)
Employment Access (Gravity Measure)	0.193 (0.068)	0.235 (0.091)	0.412 (0.137)
Tract Fraction African-American	0.057 (0.186)	0.166 (0.288)	0.230 (0.309)
Tract Mean Family Income	0.325 (0.134)	0.283 (0.132)	0.386 (0.167)
Sample Size	1879	3208	4826
1. Sample contains all family members aged between 25 and 55 with more than $1,000 of labor earnings.			

Table Three: Parameter Estimates and T-Statistics for Employment Model[1]			
Variable Names	Boston	Philadelphia	Washington
Years in Labor Market	0.644 (2.827)	0.375 (2.311)	0.449 (3.440)
Square of Years in Labor Market	-0.157 (2.982)	-0.108 (2.918)	-0.129 (4.153)
Adult is High School Graduate	0.531 (3.251)	0.668 (6.009)	0.477 (4.919)
Adult is College Graduate	0.778 (3.781)	0.975 (6.578)	0.540 (4.951)
Adult is Hispanic	-0.149 (0.531)	-0.149 (0.717)	0.037 (0.249)
Adult is African-American	0.455 (1.688)	-0.014 (0.126)	0.030 (0.370)
Adult is Male	0.343 (2.171)	0.215 (1.911)	0.266 (2.834)
Household Contains Children	-0.177 (1.368)	-0.355 (3.726)	-0.141 (1.837)
Adult is Married	0.646 (3.602)	0.807 (6.053)	0.310 (3.032)
Adult is a Married Female	-0.770 (3.062)	-1.012 (5.223)	-0.604 (3.960)
Married Female with Children	-0.393 (2.124)	-0.348 (2.458)	-0.469 (4.005)
Mean Tract Commuting Time	0.285 (0.755)	0.318 (1.448)	0.284 (1.383)
Employment Access	2.087 (2.091)	2.870 (4.332)	1.370 (3.901)
Tract Fraction African-American	-0.621 (1.638)	-0.202 (1.120)	-0.137 (0.819)
Tract Mean Family Income	-0.026 (0.061)	-0.663 (2.066)	-0.807 (3.834)
Tract Number of Households	0.926 (4.067)	0.516 (3.603)	0.697 (6.090)
Number to Report Commute Time	-0.517 (3.415)	-0.138 (1.663)	-0.374 (5.174)
Log-likelihood Value	-1088.11	-2246.57	-2791.26
1. T-statistics are shown in parentheses			

Table Four: Parameter Estimates and T-Statistics for Model of Log Salary

Variable Names	Boston	Philadelphia	Washington
Years in Labor Market	0.398 (4.700)	0.274 (4.128)	0.512 (9.835)
Square of Years in Labor Market	-0.078 (3.940)	-0.048 (3.115)	-0.100 (8.055)
Adult is High School Graduate	0.216 (3.349)	0.235 (5.165)	0.235 (6.322)
Adult is College Graduate	0.508 (7.229)	0.502 (9.663)	0.5251(2.909)
Adult is Hispanic	-0.243 (1.846)	-0.132 (1.539)	-0.193 (3.330)
Adult is African-American	-0.087 (0.976)	0.029 (0.665)	-0.271 (0.958)
Adult is Male	0.113 (2.184)	0.223 (5.261)	0.120 (3.784)
Household Contains Children	-0.086 (2.267)	-0.068 (2.218)	-0.760 (3.167)
Adult is Married	0.311 (6.010)	0.337 (8.278)	0.289 (8.883)
Adult is a Married Female	-0.712 (9.011)	-0.479 (7.128)	-0.478 (9.294)
Married Female with Children	-0.185 (2.412)	-0.151 (2.436)	-0.222 (4.520)
Mean Tract Commuting Time	-0.078 (0.640)	0.088 (1.070)	0.115 (1.634)
Employment Access	-0.777 (3.114)	-0.030 (0.206)	-0.852 (1.177)
Tract Fraction African-American	0.044 (0.344)	-0.194 (3.031)	-0.100 (2.339)
Tract Mean Family Income	1.189 (8.771)	1.091 (8.600)	0.670 (9.882)
R-Square	0.377	0.303	0.324

Table Five: Separate Model Estimates by Marital Status and Gender			
Variable Names	Boston	Philadelphia	Washington
Estimates for Employment Model			
Married Males: Mean Commute[1]	0.057 (0.092)	0.918 (2.126)	0.031 (0.084)
Married Males: Job Access	-0.979 (0.718)	-0.781 (2.013)	-0.617 (1.429)
Single Adults: Mean Commute[2]	0.249 (0.756)	-0.174 (0.578)	-0.247 (1.240)
Single Adults: Job Access	-1.410 (2.875)	3.556 (3.155)	-0.080 (0.272)
Estimates for Model of Log Salary			
Married Males: Mean Commute	-0.162 (0.917)	-0.043 (0.421)	0.193 (2.191)
Married Males: Job Access	-0.646 (1.912)	-0.231 (1.393)	-0.026 (0.285)
Single Adults: Mean Commute	-0.035 (0.178)	0.253 (2.216)	0.068 (0.543)
Single Adults: Job Access	-1.207 (2.704)	-0.343 (1.139)	-0.040 (0.330)

1. The estimates are based on a subsample containing only married, male household members.
2. The estimates are based on a subsample of male and female, single household members.

Table Six: Log Salary Estimates for Alternative Samples			
Variable Names	Boston	Philadelphia	Washington
Baseline Sample			
Mean Commute	-0.078 (0.640)	0.088 (1.070)	0.115 (1.634)
Employment Access	-0.777 (3.114)	-0.030 (0.206)	-0.085 (1.177)
No Observed Unemployment[1]			
Mean Commute	0.003 (0.024)	0.087 (1.059)	0.084 (1.183)
Employment Access	-0.773 (3.050)	-0.091 (0.618)	-0.075 (1.050)
No Reported Benefits[2]			
Mean Commute	0.006 (0.045)	0.122 (1.397)	0.072 (0.980)
Employment Access	-0.846 (3.179)	-0.009 (0.061)	-0.102 (1.362)

1. The estimates are based on the subsample that excludes all households that were unemployed at the time of the survey.

2. The estimates are based on the subsample that excludes all households that were unemployed at the time of the survey or reported non-labor income in the category that contains unemployment benefits.

Table Seven: Log Salary Estimates for Model Specifications			
Variable Names	Boston	Philadelphia	Washington
Instrument Variable Estimation for Adult's Commute			
Adult's Commute	-0.029 (0.061)	0.012 (1.055)	0.008 (0.506)
Employment Access	-1.722 (0.106)	0.112 (0.485)	0.539 (0.413)
Sample Selection Correction for Employed Sample			
Mean Commute	0.079 (0.494)	0.134 (1.367)	0.081 (0.981)