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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. The empirical results suggest that shirking and leisure are complementary with the marginal benefit of shirking increasing with an individual's net time endowment.

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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. In fact, a considerable body of research has developed documenting the impact of residential location on employment outcomes; a few recent examples include Bayer, Ross, and Topa (2004) and Topa (2001) on social interactions, Weinberg, Reagan and Yankow (In Press) and Katz, Kling, and Liebman (2001) on neighborhood quality, and Weinberg (2000) on job access.

Recently, a body of theoretical work has developed that explores the spatial distribution of urban unemployment. A common approach in the literature is to use the efficiency wage model as the mechanism by which unemployment arises in the urban economy. For example, Zenou and Smith (1995) develop a model in which housing prices and workers' location (land market), as well as wages and unemployment (labor market) are determined in equilibrium, and Brueckner and Zenou (2003) examine the impact of job decentralization or spatial mismatch on unemployment using a similar efficiency wage model.[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 economies. 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 wage models to the spatial distribution 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.

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

Previous research especially concerning the spatial mismatch hypothesis has examined the empirical relationship between commutes and labor market outcomes. A substantial number of studies use average commute time as a proxy for employment access and sometimes find a positive relationship between commutes and employment, but studies employing more precise measures of employment access tend to find a more robust relationship (Ihlanfeldt and Sjoquist, 1998). In a related, Zax and Kain (1991) examined the quit rates of white and black employees following the relocation of their current employer from downtown Detroit to the suburbs. While they find that the change in commute times affected black quit rates, these changes had no effect on white employees who presumably faced less location constraints in the housing market. In terms of the relationship between commutes and wages, Manning (2003) using British data (the Labour force Survey for 1993-2001 and the British Household Panel Survey for 1991-2000) shows that an extra hour of commuting each day is associated, on average, with an increase in wages of between 3 and 28 percent depending upon the sample and the specification. These results are consistent with a number of U.S. studies on urban wage gradients (White, 1999). For instance, Madden (1985) using the PSID finds a positive relationship between wage change and change in commute for workers who changed job, and Timothy and Wheaton (2001) using PUMS data from the U.S. Census find that average commutes in an employment location can explain across location wage differences. Finally, Zax (1991) also finds a positive relationship between commutes and wages using the Detroit firm relocation sample.

In the empirical section of the paper, models of employment and labor market earnings are estimated that include a proxy for a worker's expected commute. The model includes a measure of expected employment access, as well as other neighborhood controls, in order to avoid confounding the influence of commutes on employment through shirking behavior with employment access and neighborhood effects on employment. In addition, the effect of expected commute and other location variables are identified by across metropolitan variation in order to address concerns that workers are likely to sort across locations based on their quality. This focus on an individual's expected commute rather than the actual or expected commute associated with a particular job distinguishes our paper from studies of urban wage gradients that test for a compensating relationship between firm wages and commutes. The analysis is conducted for the eleven metropolitan samples of the 1985 Metropolitan Area (Metro) sample of the American Housing Survey (AHS). The empirical results suggest that shirking and leisure are complementary with the marginal benefit of shirking increasing with an individual's net time endowment. In terms of magnitude, these effects are substantial with a two and a half minute increase in predicted commute time (about one standard deviation) leading to between a 1.2 and 2.3 percent increase in employment presumably due to lower rates of shirking. No evidence is found to suggest that firms wage discriminate based on a worker's commute.

This approach should be contrasted against traditional attempts to test efficiency 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. These studies directly examine the firm-worker relationship while our study attempts to isolate one aspect of the complex, equilibrium effect of efficiency wages on labor market outcomes.

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 and 6 are devoted to the empirical part of the paper that tests the two models using the American Housing Survey. Finally, section 7 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 (employed

[2] All theses assumptions are very standard in urban economics, see Fujita (1989). The key assumption

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 benefits arising from additional *leisure activity on the job* is obviously related to the extent of *leisure activity at home* and visa-versa.

that might give readers pause is the concentration of employment in one location. Many urban models have generalized the classic monocentric model to allow for decentralized or multi-centric employment, see Ross and Yinger (1995) for example. The main behavioral results arising from the monocentric urban model invariably hold in these more general model with individuals who face the same commuting costs making similar decisions regardless of their employment location.

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

Alternatively, 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. While this model does not incorporate a full home production model as in Becker (1965), leisure time at home might reasonably be viewed as a composite good that encompasses a variety of home activities. The traditional home production model implies that changes in the wage rate will cause substitution between home and market production (Baxter and Jerman, 1999). It also seems reasonable that changes in the time available at home, possibly due to a long commute, is likely to influence the distribution of personal activities between home and work.

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

[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.

[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.

is thus equal to that worker's average utility over the job cycle and is given by

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

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:

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

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] Neither sign can be ruled out using reasonable restrictions on

[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

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

preferences. Low leisure at home may imply that the worker has less time for rest and relaxation and more pressed for time at home (less time for relaxation or errands), and as a result the benefit of taking leisure or conducting home production (relaxation or errands) while at work rises. This story is consistent with increasing disutility from e as leisure falls or $\partial^2 V(l, e) / \partial l \partial e > 0$, and the level of e will fall as commutes increase. If this assumption holds, workers residing close to jobs will provide more effort than those residing further away from jobs because they have lower commuting time and thus more leisure time at home.

On the other hand, if someone's leisure time at home l is reduced, social life may suffer substantially, which in turn reduces the benefits derived from leisure and leads to less planned activities at home. This decline in quality of social life is likely to reduce the overall demand for personal time and activities. 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 activities 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 his/her time at home is spent watching TV and relaxing, which is consistent with $\partial^2 V(l, e) / \partial l \partial e < 0$. 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.

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:

[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.

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

showing a clear trade off between shirking (higher utility $V(\cdot)$ when employed since less effort but more unemployment spells during the lifetime) and nonshirking. 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:

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

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

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

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 $F''(\cdot) < 0$.

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:

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

[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.

$$-w\frac{\partial \widetilde{x}}{\partial w}(u^S - u^{NS}) = 0$$

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

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.

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

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

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

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

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

Inspection of this equation shows that

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

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:

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

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]

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

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

which implies that:

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

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

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

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 (43) in the Appendix, this can be written as:

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

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 market earnings are estimated that include a proxy for a worker's expected commute. The analysis is conducted for the eleven metropolitan samples of the 1985 Metropolitan Area (Metro) sample of the American Housing Survey (AHS),[14] and the effect of expected commute and other location

[14]The eleven metropolitan areas in the sample are Boston, Dallas, Detroit, Fort Worth, Los Angeles, Minneapolis, Philadelphia, Phoenix, San Antonio, Tampa, and Washington D.C

variables are identified by across metropolitan variation. 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 6 and 44 zones with population of approximately 100,000 each. 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 publicly available data set that provides information on employment and residential location at this level of spatial detail.[16]

A base sample of prime-age adults 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 37,920 prime-age adults across 7,535 census tracts in the eleven metropolitan areas. For the analysis of labor market earnings, the sample is further reduced to 30,076 by deleting all prime-age adults with less than $1,000 of labor earnings. Standard control variables for experience, educational attainment, race/ethnicity, and family structure are available in the Metro AHS. The means and standard errors of employment, earnings in $1,000's, and these control variables are shown in Table 1 for the full adult sample, the sample of employed adults, and the sample of adults with labor earnings. The adult with labor earnings subsample naturally exhibit higher employment rates, and both the employed and with labor earnings subsamples have higher earnings. In addition, both subsamples are older, contain more college graduates, and contain less females especially less married females with children.

[*Insert Table* 1 *here*]

[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 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.

A set of variables is created to describe each tract that is represented by at least five households in the Metro AHS samples. These variables include mean adult commute time in hours, mean family income in $1,000's, share of population that is African-American or Hispanic, as well as a proxy for employment access. It should be noted that no adult influences the value of the mean or share variables for their neighborhood. Specifically, an adult's own commute, family income, race, and ethnicity is eliminated from the calculation of the averages.[17] The employment access variable is included 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 adult's zone of work. Specifically, the flow of commuters between each tract and work zone is regressed 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 using a log-log specification. The employment access 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.[19] The direct inclusion of these location variables in the employment and earnings models would lead to two significant biases. First, since households choose their residential location or at least choose not to move from their current location, unobservables that affect this sorting choice are likely to be correlated with both the location attributes and labor market

[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.

[18] It should be noted that mean commute time is sometimes used in this literature as a proxy for employment access. In practice, however, the correlation between gravity based measures of employment access and mean commute time is small. Furthermore, mean commute time is often insignificant in those studies while gravity based measures are typically found to be significant in the same or similar samples. See Ihlanfeldt and Sjoquist (1998) for a recent survey of the spatial mismatch literature.

[19] 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.

outcomes. Second, the small number of households in many tracts implies that the location variables are measured with considerable error, which is likely to bias the resulting estimates towards zero.

Cutler and Glaeser (1997) argue that an appropriate solution to the sorting bias problem is to identify the effect of location using across metropolitan variation.[20] Such an approach also addresses the measurement error problem present in this sample because across metropolitan differences are based on large metropolitan specific samples. The specific approach used here involves the calculation of predicted exposure levels for each location attribute that only vary over observable individual attributes and across metropolitan areas. The effect of exposure is identified using only across metropolitan differences in exposure for observationally equivalent individuals because the same individual attributes that are used to create predicted exposure levels are included in the employment and earnings models.

Specifically, metropolitan specific models of exposure are estimated based on individual attributes

$$Z_{ils} = \beta_s X_{ils} + \varepsilon_{ils} \tag{34}$$

where Z_{ils} is an individual i's actual location attribute in location l in metropolitan area s, X_{ils} is a vector of the individual's own attributes, β_s is an estimable parameter that describes the metropolitan specific conditional correlation between observable attributes and location attributes, and ε_{ils} is a random error term. The estimated parameters from the above equation ($\widehat{\beta}_s$) are used to create a predicted exposure rate, which can be interpreted as a conditional mean of the location attribute for each metropolitan area.

Finally, labor market outcomes (Y_{ils}) are modelled as

$$Y_{ils} = \gamma X_{ils} + \delta E[Z_{ils}|X_{ils}, \widehat{\beta}_s] + \alpha_s + \mu_{ils} \tag{35}$$

where Y_{ils} is a variable describing labor market outcomes, γ and δ are estimable parameters that describe the relationship between individual and location attributes and labor market outcomes, and μ_{ils} is a random error term. The mean and standard error of these predicted location attributes are shown in Table 1. Commute time and employment access do not vary much across the samples, but the employed adults and adults with labor earnings samples exhibit higher predicted mean family income and lower predicted fraction African-American.

A series of specifications are estimated using the above model. The first set of estimations involves varying the location attributes included starting with just variables to control for

[20] Also see Ross (1998) and Weinberg (2000) for recent examples of this approach in the spatial mismatch literature.

commute time and employment access and then adding additional controls for predicted tract income, percent African-America, and percent Hispanic. The second set of estimations varies the vector of individual attributes (X_{ils}) in both first and second stage models in order to examine whether the findings are robust. Specifically, the estimations assess the effect of adding additional controls based on the presence of children younger than six year old and the effect of adding controls for differential employment and earnings returns to education and experience by race and ethnicity. These controls are added to both the first and second stage models and as such may affect the identification of the coefficients on predicted location attributes.

Another set of estimations examine an alternative instrument to the one presented above. The predicted exposure rates described above have the advantage that they identify the effect of location based on cross-metropolitan variation in a model that controls for metropolitan level fixed effects. Nonetheless, the estimates may be biased if idiosyncratic metropolitan differences in the spatial allocation of adults are spuriously correlated with differences in labor market outcomes. For example, a metropolitan area that has experienced central city decline may exhibit both greater decentralization of high skill workers plus lower earnings for those high skill workers because the metropolitan area offers less agglomeration economies than metropolitan areas with more vibrant central cities. The example just discussed above describes a situation where the model of labor market outcomes varies across metropolitan areas. This finding violates the implicit identifying restriction in all across metropolitan studies that those models exclude the interaction between metropolitan identity and individual attributes. In order to address this concern, alternative predictions for location attribute exposure are created based on the individual's housing attributes, or in other words the effect of location attributes will be identified based on across metropolitan variation in the average exposure of different types of housing units rather than the average exposure of different types of workers.

Specifically, the first stage model is estimated as a function of housing attributes (W_{ils}) only

$$Z_{ils} = \beta_s W_{ils} + \varepsilon_{ils} \tag{36}$$

and labor market outcomes are regressed on these revised predictions

$$Y_{ils} = \gamma X_{ils} + \delta E[Z_{ils} | W_{ils}, \widehat{\beta}_s] + \alpha_s + \mu_{ils} \tag{37}$$

The key problem with this specification is that individuals may sort across housing units based on their unobserved attributes and these unobserved attributes may also be correlated with labor market outcomes. Accordingly, a final model is estimated that includes housing attributes in the labor market equation with the understanding that these variables are intended to capture unobservable labor market variables that happen to be correlated with housing market choices.

$$Y_{ils} = \gamma X_{ils} + \zeta W_{ils} + \delta E[Z_{ils}|W_{ils}, \hat{\beta}_s] + \alpha_s + \mu_{ils} \tag{38}$$

A final 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 also drop households based on any indication of an unemployment spell during the year since such 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 were either unemployed at the time of the survey or report receiving other non-labor income, which captures unemployment benefits and workman's compensation in the AHS are dropped from the sample. These criteria reduce the sample from 30,076 to 26,031 and 23,403, respectively.[21]

The employment model is estimated using a linear probability model where observations are deleted interatively whenever predicted probabilities from the estimated model fall above one or below zero. Horace and Oaxaca (2003) show that this iterative approach provides consistent estimates for binary dependent variable problems. The earnings model is estimated using standard ordinary least squares where the dependent variable is the logarithm of earnings. All standard errors are corrected for heteroskedasticity using standard techniques (White, 1978).

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

6 Estimation Results

Table 2 presents the estimation results for the baseline employment model. The estimated relationship between predicted commute time and employment is positive and statistically significant at just below the 10 percent level for the specification including only predicted commute time and employment access, at better than the 10 percent level when predicted mean income is included, and at better than 1 percent significance when race and ethnicity are included.[22] The results of the model suggest that shirking and leisure are complementary with the marginal benefit of shirking increasing with an individual's net time endowment. In terms of magnitude, these effects are substantial with a two and a half minute increase in predicted commute time (about one standard deviation) leading to between a 1.2 and 2.3 percent increase in employment presumably due to lower rates of shirking.[23] The other results are quite intuitive and comparable across all three specifications. 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. In terms of other predicted location attributes, employment access is positively correlated with employment status, and percent African-American lowers employment rates. The mean family income and fraction Hispanic have the expected signs, but are statistically insignificant. The F-test presented in the first column compares the model with commute time and employment access to a model that only contains individual attributes, in the second column compares the model with the mean income variable to one without, and in the third column compares the model with the fraction African-American and Hispanic added to the model with the mean income variable. These tests strongly support the full model presented in the third column.

[*Insert Table* 2 *here*]

Table 3 presents the estimation results for the baseline earnings model. In this case,

[22] It should be noted that the significance of the commute time variable does not arise from the inclusion of five predicted variables, which might cause some concern since all five variables are identified based on the same source of variation. Rather, the inclusion of percent black in the model leads to a significant parameter estimate on commute time even in a model with no other location attributes, which makes sense since commute time and racial composition tend to be correlated and a higher share black appears to lower employment rates even after controlling for the individual's race.

[23] These results differ from traditional findings in the spatial mismatch literature because those earlier studies did not separately control for employment access and commutes. Our findings for the employment access variable closely correspond to the existing literature.

the estimated relationship between predicted commute time and earnings is not statistically significant for any specification. These findings do not support the hypothesis that firms can wage discriminate based on a worker's commute.[24] It should be noted that the sign of the coefficient on commute time is negative, which is also consistent with complementarity between shirking and leisure since firms would be expected to pay higher wages to workers with a higher likelihood of shirking (shorter commutes). 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. It is worth noting, however, that the an individual's race and ethnicity continues to matter in the earnings equation even after controlling for the predicted location attributes for racial and ethnic neighborhood composition, while these individual race and ethnicity variables are statistically insignificant in the employment model. Mean tract income and percent African-American are both positively related to earnings, and percent Hispanic is associated with lower earnings. Employment access is consistent with higher earnings, but the estimated coefficient is not statistically significant. The F-tests presented for the earnings equations take the same form as the tests in Table 2 and support retaining the additional controls for mean income, fraction African-American, and fraction Hispanic.

[*Insert Table* 3 *here*]

Tables 4 and 5 present alternative estimations with additional control variables, which potentially may affect the identification of the parameters on the location attributes. The first column in these tables contains the baseline estimates from column three in Table 2. The second column presents the results for a model that adds controls for whether children less than six are present in the household and whether the adult is a married female with children less than six present. The third column presents the results for a model that interacts both adult race and ethnicity with years in labor market and the educational attainment variables. The key findings for predicted commute time, as well as employment access and fraction African-American, are robust to the alternative specifications. The magnitude of the commute time effect falls somewhat down to a 1.6 percent increase in employment for a two and a half minute increase in predicted commute, but the effect is still substantial in

[24] These negative findings differ from earlier studies that examine the relationship between commutes and wages. As discussed earlier, however, those studies either examine the effect of actual commutes that are tied to a specific job or focus on the expected commute for a specific employment location. Such studies are testing for whether firms whose workers need to commute longer receive compensation for that commute as opposed to our study which tests whether a workers wages is influenced by their residential location.

magnitude and statistically significant. The F-tests in columns two and three compare the extended employment models to the baseline model. These test suggest that both extensions are statistically justified. The reader should note that a complete model that incorporates both controls for young children and differential return to human capital yields results that are nearly identical to the results in column three. For the earnings models shown in Table 5, the sign of the commute time variable is unchanged, but the magnitude increases to represent a 2.0 percent decrease in earnings for a two and a half minute increase in predicted commute in column three and is approaching significance at the 10 percent level. As in Table 4, the F-tests support the inclusion of these additional variables.

[*Insert Tables* 4 *and* 5 *here*]

Tables 6 and 7 present the results where housing attributes are used to predict location attributes. As above, the first column contains the baseline results from Table 2. Columns two and three contain the estimates based on labor market models without and with housing attribute controls, respectively. The qualitative effect of commute time on employment is robust under the two new specifications, but the magnitude does fall from 2.3 in column 1 to 2.0 and 1.3 percent increase in employment for a two and a half minute increase in predicted commute for the models in columns two and three. The other location estimates are less robust across specifications, and the F-test supports the inclusion of housing attributes in the employment equation. In comparing column one to three, this analysis indicates that the positive effect of employment access is quite robust, but that the negative effect of fraction African-American is not. In addition, the effects of mean family income and percent Hispanic are larger in magnitude and now statistically significant. The F-test in Table 7 also supports the inclusion of the housing attributes into the earnings equation. A comparison of the estimates between the baseline model and the preferred model in column three shows that the effect of commute time changes sign, but is still statistically insignificant. All other findings are robust across the two models.

[*Insert Tables* 6 *and* 7 *here*]

The final two analyses focus on the earnings regression. Tables 8 and 9 present the results for the alternative samples based on excluding adults who had an unemployment spell during the survey period or in column three reported unemployment or workman compensation income. Table 8 presents the findings for the original specification in column three of Table 3. The exclusion of unemployed adults increases the magnitude of the negative relationship between earnings and predicted commute, but the parameter estimates are still statistically insignificant. Table 9 presents the findings for the model using alternative predicted location attributes that was presented in column three of Table 7. As in Table 7, the estimated effect between earnings and predicted commute time is positive, but statistically insignificant for both subsamples.

[*Insert Tables* 8 *and* 9 *here*]

7 Summary and conclusions

This paper extends the classic model of efficiency wages to allow for substitution between shirking and leisure. This model is set within an urban equilibrium. The paper shows that a worker's benefit from shirking will depend upon their time endowment net of commuting time and that some workers will shirk in equilibrium unless firms can set efficiency wages based on each worker's commute. The model implies an empirical relationship between commutes and either employment and/or wages and that relationship depends upon whether shirking and leisure are complementary or substitutable.

The paper uses a unique sample of households from the metropolitan area sample of the American Housing Survey 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 predicted commute time influences employment or labor market earnings. The analyses consistently find evidence to suggest that longer commutes lead to higher levels of employment. These findings suggest that shirking and leisure are complementary so that an increase in commutes reduces an individuals net time endowment leading to lower levels of both leisure and shirking. The analysis does not find either statistically significant or consistent evidence of a relationship between earnings and predicted commute, and so does not support the hypothesis that firms can establish a no shirking equilibrium by paying efficiency wages based on workers commutes.

This finding is quite significant given that many of the metropolitan areas studied are large, congested areas with an average one-way commute times over 20 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 strong 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.

In addition, the model and findings presented in this paper have broader implications for the efficiency wage literature. Traditional efficiency wage models suggest that firms can prevent shirking by paying efficiency wages, but this paper suggests a mechanism by which workers will differ in their likelihood of shirking even if their underlying preferences are the same. Specifically, workers that have a lower net endowment of time prior to making a work effort decision, either do to a longer commute or non-work related personal obligations, such as a disabled spouse, child, or parent, are likely to differ in their propensity to shirk. Accordingly, if firms are unable to distinguish between workers in different circumstances, they will rationally set wages so that some workers shirk in equilibrium. The evidence found in this paper is consistent with this form of equilibrium shirking.

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APPENDIX

Proof of Proposition 1

First observe that
$$-\frac{\partial \Psi^{NS}(x,\overline{I})}{\partial x}\mid_{x=\widetilde{x}} \gtreqless -\frac{\partial \Psi^{S}(x,\overline{I})}{\partial x}\mid_{x=\widetilde{x}}$$
This is equivalent to:
$$\tau + t(1-u^{NS})\frac{\partial V\left(1-T-tx,\overline{e}\right)}{\partial l}\mid_{x=\widetilde{x}} \gtreqless \tau + t(1-u^{S})\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\mid_{x=\widetilde{x}}$$
or
$$(1-u^{NS})\frac{\partial V\left(1-T-t\widetilde{x},\overline{e}\right)}{\partial l}\mid_{x=\widetilde{x}} \gtreqless (1-u^{S})\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\mid_{x=\widetilde{x}}$$
For (i), we want $>$ to holds. 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.
$$(1-u^{NS})\frac{\partial V\left(1-T-t\widetilde{x},\overline{e}\right)}{\partial l}\mid_{x=\widetilde{x}} < (1-u^{S})\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\mid_{x=\widetilde{x}}$$
Now, if
$$\frac{\partial^2 V\left(l,e\right)}{\partial l \partial e} < 0$$
then, using (7) and (8), this condition writes:
$$\left(\theta+m+\delta\right)\frac{\partial V\left(1-T-t\widetilde{x},\overline{e}\right)}{\partial l}\mid_{x=\widetilde{x}} < \left(\theta+\delta\right)\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\mid_{x=\widetilde{x}}$$
■

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:

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

(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

$$\begin{aligned}&\left(\frac{1}{\theta+m+\delta}\right)V\left(1-T-t\widetilde{x}^a,\underline{e}\right)-\left(\frac{1}{\theta+\delta}\right)V\left(1-T-t\widetilde{x}^a,\overline{e}\right)\\=&\left(\frac{1}{\theta+m+\delta}-\frac{1}{\theta+\delta}\right)\left(w^aT-V_0\right)\end{aligned}\tag{39}$$

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:

$$\overline{I}^a=\left(\frac{\theta}{\theta+m+\delta}\right)\left[w^aT+V\left(1-T-t,\underline{e}\right)\right]-\tau+\frac{\delta+m}{\theta+m+\delta}V_0\tag{40}$$

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:

$$\begin{aligned} & F'(\cdot)\frac{\partial \widetilde{x}^a}{\partial w}\left[(\frac{\theta}{\theta+\delta})\overline{e}-(\frac{\theta}{\theta+m+\delta})\underline{e}\right] \\ = & \left[(1-\widetilde{x}^a)(\frac{\theta}{\theta+m+\delta})+\widetilde{x}^a(\frac{\theta}{\theta+\delta})\right]+w^a\frac{\partial \widetilde{x}^a}{\partial w}\left(\frac{\delta+m}{\theta+m+\delta}-\frac{\delta}{\theta+\delta}\right) \end{aligned} \tag{41}$$

$$F'(\cdot)\left[(1-\widetilde{x}^a)(\frac{\theta}{\theta+m+\delta})\,\overline{e}+\widetilde{x}^a(\frac{\theta}{\theta+\delta})\,\underline{e}\right]=w^a\left[(1-\widetilde{x}^a)(\frac{\theta}{\theta+m+\delta})+\widetilde{x}(\frac{\theta}{\theta+\delta})\right] \tag{42}$$

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 (39), (41) and (42), we obtain a unique $\widetilde{x}^a, w^a$ and α^a. Finally, by plugging the value of w^a in (40), we obtain the unique $\overline{I}^a$. ■

Proof of Proposition 4

Using (11), we have:

$$\frac{\partial w(x)}{\partial x}=\frac{1}{T(u^S-u^{NS})}t\left[(1-u^{NS})\frac{\partial V\left(1-T-tx,\overline{e}\right)}{\partial l}-(1-u^S)\frac{\partial V\left(1-T-tx,\underline{e}\right)}{\partial l}\right] \tag{43}$$

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

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

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

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

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

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 $\overline{I}^k$. ■

Table 1: Means and Standard Errors[1]			
Variable Names	Adult Sample[2]	Employed Adults	Adults with Labor Earnings
Employment	0.729 (0.445)	1.000 (0.000)	0.866 (0.341)
Adult's Salary in \$1000's	18.4 (17.7)	22.6 (17.4)	23.2 (16.9)
Years in Labor Market [3]	19.00 (9.25)	18.53 (9.01)	18.52 (9.06)
Adult is High School Graduate	0.568 (0.495)	0.566 (0.496)	0.567 (0.495)
Adult is College Graduate	0.308 (0.462)	0.341 (0.474)	0.335 (0.472)
Adult is Hispanic	0.073 (0.261)	0.065 (0.247)	0.068 (0.251)
Adult is African-American	0.128 (0.334)	0.116 (0.320)	0.122 (0.327)
Adult is Male	0.483 (0.500)	0.562 (0.496)	0.544 (0.498)
Adult's Household Contains Children	0.546 (0.498)	0.523 (0.499)	0.521 (0.500)
Adult is Married	0.669 (0.470)	0.662 (0.473)	0.658 (0.475)
Adult is a Married Female	0.338 (0.473)	0.264 (0.441)	0.278 (0.448)
Adult is Married Female with Children	0.223 (0.416)	0.162 (0.368)	0.172 (0.377)
Commuting Time in Hours	0.379 (0.044)	0.379 (0.044)	0.379 (0.044)
Employment Access	0.929 (0.304)	0.938 (0.308)	0.938 (0.308)
Mean Family Income in \$1000's	33.42 (7.41)	33.89 (7.09)	33.73 (7.17)
Fraction African-American	0.124 (0.178)	0.115 (0.167)	0.119 (0.172)
Fraction Hispanic	0.063 (0.080)	0.060 (0.074)	0.061 (0.076)
Sample Size	37,920	27,641	30,076

1. Standard errors are shown in parentheses. The sample excludes any households located in census tracts that contain less that five sample households.

2. The adult sample contains all family members aged between 25 and 55. The employed adult excludes adults who were not working at the time of the survey, and the adults with earnings excludes adults with \$1,000 or less of labor earnings.

3. Years in labor market are calculated as age minus the sum of years of education and six years and represents potential experience.

Table 2: Parameter Estimates and T-Statistics for Employment Models[1]

Variable Names	Commute and Access	Plus Mean Income	Plus Race and Ethnicity
Years in Labor Market / 10	0.075 (6.89)	0.060 (4.34)	0.067 (4.82)
Square of Years in Labor Market	-0.023 (8.83)	-0.021 (6.95)	-0.022 (7.27)
Adult is High School Graduate	0.157 (19.66)	0.139 (11.05)	0.138 (10.75)
Adult is College Graduate	0.173 (19.21)	0.137 (6.59)	0.142 (6.71)
Adult is Hispanic	-0.044 (4.35)	-0.024 (1.65)	-0.013 (0.72)
Adult is African-American	-0.083 (8.85)	-0.052 (2.65)	0.008 (0.27)
Adult is Male	0.064 (8.47)	0.064 (8.52)	0.063 (8.35)
Household Contains Children	-0.016 (2.67)	-0.020 (3.17)	-0.017 (2.61)
Adult is Married	0.107 (14.79)	0.096 (10.28)	0.095 (10.09)
Adult is a Married Female	-0.163 (13.83)	-0.167 (13.96)	-0.164 (13.68)
Married Female with Children	-0.115 (11.05)	-0.112 (10.79)	-0.115 (10.97)
Commuting Time in Hours	0.292 (1.60)	0.320 (1.75)	0.550 (2.80)
Employment Access	0.347 (5.56)	0.352 (5.63)	0.363 (5.77)
Mean Family Income / $100,000		0.322 (1.89)	0.118 (0.64)
Fraction African-American			-0.181 (2.86)
Fraction Hispanic			-0.122 (1.36)
R-Square	0.1257	0.1258	0.1261
F-Test	17.12 [0.001]	3.66 [0.056]	4.98 [0.007]
Final Sample Size	37,870	37,868	37,901

1. T-statistics are shown in parentheses

Table 3: Parameter Estimates and T-Statistics for Models of Log Salary			
Variable Names	Commute and Access	Plus Mean Income	Plus Race and Ethnicity
Years in Labor Market / 10	0.417 (19.61)	0.388 (14.52)	0.376 (13.78)
Square of Years in Labor Market	-0.077 (15.18)	-0.072 (12.62)	-0.070 (12.22)
Adult is High School Graduate	0.360 (23.28)	0.327 (13.61)	0.310 (12.61)
Adult is College Graduate	0.705 (40.69)	0.640 (16.00)	0.609 (14.92)
Adult is Hispanic	-0.244 (12.44)	-0.208 (7.36)	-0.144 (4.12)
Adult is African-American	-0.128 (7.47)	-0.070 (1.90)	-0.176 (3.45)
Adult is Male	0.227 (16.46)	0.228 (16.52)	0.226 (16.37)
Household Contains Children	-0.025 (2.25)	-0.033 (2.75)	-0.032 (2.68)
Adult is Married	0.296 (21.17)	0.275 (15.23)	0.280 (15.50)
Adult is a Married Female	-0.425 (19.31)	-0.432 (19.32)	-0.440 (19.59)
Married Female with Children	0.186 (9.05)	-0.182 (8.84)	-0.180 (8.71)
Commuting Time in Hours	0.086 (0.26)	0.107 (0.32)	-0.247 (0.69)
Employment Access	0.145 (1.24)	0.146 (1.25)	0.157 (1.34)
Mean Family Income / $100,000		0.587 (1.79)	0.812 (2.29)
Fraction African-American			0.295 (2.62)
Fraction Hispanic			-0.488 (2.92)
R-Square	0.2671	0.2671	0.2676
F-Test	0.86 [0.421]	3.35 [0.067]	10.01 [0.001]

Table 4: Parameter Estimates for Alternative Employment Models			
Variable Names	Baseline	Controls for Young Children	Differential Return to Human Capital
Commuting Time in Hours	0.550 (2.80)	0.501 (2.65)	0.381 (2.22)
Employment Access	0.363 (5.77)	0.334 (5.43)	0.275 (4.86)
Mean Family Income / $100,000	0.118 (0.64)	0.150 (0.87)	0.094 (0.56)
Fraction African-American	-0.181 (2.86)	-0.180 (2.91)	-0.161 (2.66)
Fraction Hispanic	-0.122 (1.36)	-0.131 (1.48)	-0.144 (1.50)
R-Square	0.1261	0.1349	0.1280
F-Test		126.99 [0.001]	12.42 [0.001]
Final Sample Size	37,901	37,905	37,847

Table 5: Parameter Estimates for Alternative Models of Log Salary			
Variable Names	Baseline	Controls for Young Children	Differential Return to Human Capital
Commuting Time in Hours	-0.247 (0.69)	-0.418 (1.25)	-0.490 (1.60)
Employment Access	0.157 (1.34)	0.129 (1.16)	0.055 (0.55)
Mean Family Income / $100,000	0.812 (2.29)	0.881 (2.69)	0.986 (3.10)
Fraction African-American	0.295 (2.62)	0.281 (2.61)	0.252 (2.39)
Fraction Hispanic	-0.488 (2.92)	-0.538 (3.36)	-0.319 (1.83)
F-Test	0.2676	0.2765	0.2748
R-Square		31.58 [0.001]	4.15 [0.001]

Table 6: Employment Model with Housing Attribute based Exposure Proxies			
Variable Names	Baseline	Housing Based Instrument w/out Housing Controls	Housing Based Instrument with Housing Controls
Commuting Time in Hours	0.550 (2.80)	0.480 (3.38)	0.315 (2.04)
Employment Access	0.363 (5.77)	0.149 (3.53)	0.244 (5.07)
Mean Family Income / $100,000	0.118 (0.64)	-0.184 (3.24)	0.353 (2.29)
Fraction African-American	-0.181 (2.86)	-0.235 (5.96)	-0.030 (0.60)
Fraction Hispanic	-0.122 (1.36)	-0.394 (4.48)	-0.201 (2.09)
R-Square	0.1261	0.1264	0.1284
F-Test			11.04 [0.001]
Final Sample Size	37,901	37,845	37,758

Table 7: Models of Log Salary with Housing Attribute based Exposure Proxies			
Variable Names	Baseline	No Housing Control Variables	Housing Control Variables
Commuting Time in Hours	-0.247 (0.69)	0.761 (3.00)	0.348 (1.27)
Employment Access	0.157 (1.34)	0.127 (1.64)	0.077 (0.89)
Mean Family Income / $100,000	0.812 (2.29)	1.893 (17.92)	0.988 (3.44)
Fraction African-American	0.295 (2.62)	0.219 (3.12)	0.323 (3.60)
Fraction Hispanic	-0.488 (2.92)	-0.761 (4.45)	-0.934 (4.74)
F-Test			13.00 [0.001]
R-Square	0.2676	0.3029	0.3050

Table 8: Baseline Model of Log Salary for Alternative Samples			
Variable Names	Core Sample Adults with Labor Earnings	Exclude Unemployed Adults	Also Exclude Adults with Benefits
Commuting Time in Hours	-0.247 (0.69)	-0.509 (1.39)	-0.505 (1.33)
Employment Access	0.157 (1.34)	-0.024 (0.21)	-0.054 (0.44)
Mean Family Income / $100,000	0.812 (2.29)	0.816 (2.25)	0.696 (1.85)
Fraction African-American	0.295 (2.62)	0.306 (2.64)	0.313 (2.59)
Fraction Hispanic	-0.488 (2.92)	-0.514 (3.00)	-0.514 (-2.86)
R-Square	0.2676	0.2767	0.2848
Sample Size	30,076	26,031	23,403

Table 9: Housing Attribute based Exposure Proxies with Alternative Samples			
Variable Names	Core Sample Adults with Labor Earnings	Exclude Unemployed Adults	Also Exclude Adults with Benefits
Commuting Time in Hours	0.348 (1.27)	0.281 (1.00)	0.205 (0.70)
Employment Access	0.077 (0.89)	0.053 (0.60)	0.040 (0.44)
Mean Family Income / $100,000	0.988 (3.44)	0.940 (3.15)	0.899 (2.88)
Fraction African-American	0.323 (3.60)	0.288 (3.13)	0.267 (2.77)
Fraction Hispanic	-0.934 (4.74)	-1.021 (4.83)	-0.969 (4.31)
R-Square	0.3050	0.3156	0.3231