WORKFORCE HOUSING APP

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Executive Summary

Across the country, one of the main reasons commuter trip lengths are increasing and traffic conditions are deteriorating is because people do not live near their jobs. The physical distance between the location of jobs and appropriate housing can be significant and often the only "realistic alternative for workers who cannot work from home is to commute by car to their job location" (Weitz 2003). Congested freeways and rush hours provide ample evidence of this spatial separation.

When jobs and housing are located in close proximity, the need for long commutes can be reduced. Workers who live near their jobs may choose to take public transportation, bike, or walk as an alternative to driving. When all people in an area live in proximity to where they work, it is referred to as a job-worker balance.

A prerequisite for achieving a job-worker balance is an income-balance for an area. Income balance indicates that the yearly salary of residents is proportionate to the yearly salary of workers in the same area. A balance indicates that the jobs in the area are paying employees enough to afford housing in the area.

This study synthesizes research from across the U.S. on the causes, measurements, and benefits of a job-worker and income balance. We use journey-to-work data for metropolitan census tracts across the U.S. to derive models that estimate internal capture of trips within clusters. Internal capture refers to the number of people who live and work in the same area.

Our results demonstrate that the effect of achieving an income balance in a region does more to increase internal capture than numerical job-worker balance. Since the coefficients of our predictive models are elasticities, we can compare the effects on internal capture to job-worker balance and income balance. For every 1% increase in income balance, we expect internal capture to increase 2.13%.

This research is to our knowledge the first to create models to predict internal capture based on job-worker balance and income balance that can be applied anywhere in the nation. Unlike similar studies, we use data from across the country and the models derived from this research should be generalizable in any region of the country.

These models can be used as predictors of internal capture within the software package Envision Tomorrow Plus (ET+), based upon the job-worker and income balance in census tracts. ET+ is a state-of–the art scenario planning tool being developed by Fregonese Associates and the University of Utah under a HUD Sustainable Communities Grant.

Introduction

On a regional or metropolitan scale, there will always be rough equivalency between the number of jobs and workers. However, for smaller subareas, there may be numerical imbalances in so-called housing-rich or job-rich areas. In housing-rich areas, resident workers will have to commute to jobs outside the area. In job-rich areas, nonresident workers will have to commute in to fill the jobs.

There can be rough equivalence in numbers of jobs and workers in an area, and yet workers still have to commute significant distances to get to work. There may be the right number of job opportunities for resident workers, but a poor match of skills. This is the case in many central cities where the jobs require high skilled professionals and managers while the resident workforce is low skilled. Conversely, in the suburbs, the jobs are often predominantly low skilled retail and service jobs while the workers are high income and high skilled. If housing prices are high and earnings are low, workers cannot afford to live near their jobs. Conversely, if housing prices are low and earnings are high, workers may not find suitable housing near their jobs. We refer to this mismatch or match as income balance.

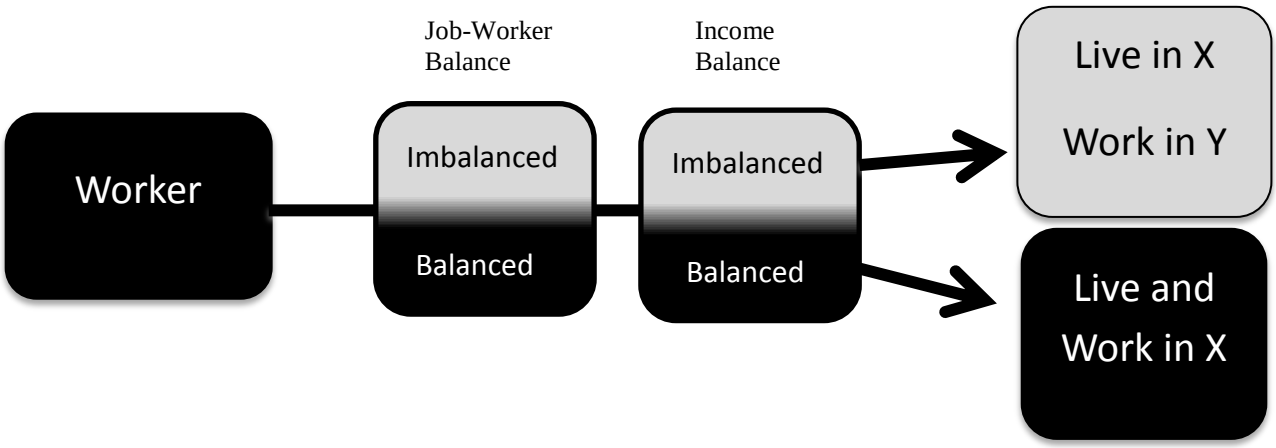
Housing appropriate to a workforce is termed workforce housing. Workforce housing refers to affordable housing for households with earned income that is sufficient to secure quality housing in reasonable proximity to the workplace. Workforce housing is a term that is increasingly used by planners, government, realtors, developers and lenders.

Workforce housing is closely related to another term in the planning literature, jobs-housing balance. This common term has several meanings. It can imply numerical balance between jobs and workers, what we will refer to as job-worker balance. Job-worker balance is the degree to which jobs within a subarea of a region are numerically equivalent to workers residing within the subarea. We use the term job-worker balance in place of jobs-housing balance for clarity: it is not the number of housing units that must have some relation to jobs, but rather number of resident workers living in those units.

Two leading planning researchers recently asked, "which reduces vehicle travel more, jobs/housing balance or retail/housing mixing?" (Cervero and Duncan 2006). Jobs-housing balance refers to the spatial separation of jobs and housing in a sub-region and retail/housing mixing refers to the mix of retail and housing. The answer—surprisingly, since work trips represent less than 20 percent of all trips—was jobs-housing balance. We ask, what matters more, job-worker balance or income balance?

Our research examines job-worker balance and income balance across 106,255 combinations of metropolitan census tracts in the U.S. We expect job-worker balance to increase internal capture of work trips within census tracts (Figure 1). Specifically, we hypothesize that the greater the numerical balance between jobs and workers, the higher the proportion of workers who will live and work in the same census tract. Likewise, the greater the income balance, the higher the proportion of workers who will live and work in the census tract.

Figure1. Conceptual Framework



Literature Review

Causes of Job-Worker Imbalance

Land-use patterns have increased travel distances between home and work, primarily because Euclidean zoning separates homes, jobs, and other destinations (Weitz 2003). Such zoning practically makes it impossible for jobs and housing to be located in close proximity. A quick scan of an aerial image of suburbia would reveal whether the subarea had a job-worker balance or imbalance. Miles and miles of uninterrupted cul-de-sacs is a likely sign of jobs-worker imbalance.

Some communities may be locked into a job-worker catch twenty-two: as communities add jobs, the demand increases for housing close to the jobs. If housing is not added in some reasonable proportion to jobs added, housing in the job-rich (unbalanced) areas becomes scarcer, and the market responds by driving up prices due to the increased demand (Giuliano and Small 1993; Weitz 2003). Expensive downtown housing exemplifies this negative feedback loop.

Other factors account for job-worker imbalance in our cities: "fiscal and exclusionary zoning that results in an undersupply of housing; rents and housing costs that price many service workers out of the local residential market; and several demographic trends, including the growth in dual wage earner households and career shifts" (Cervero 1989). A lack of regional land use planning is partly to blame as is lack of affordable housing near suburban job centers (ibid). These reasons are described in Table 1.

Table 1. Sources of Job-Worker- Imbalance (From Cervero 1989)

Causes of Job-worker Imbalance	Description
Fiscal and exclusionary zoning	The practice of zoning land predominantly for high-revenue-generating and low-services-demanding land uses, such as commercial and * industrial development, has limited the supply of housing in many areas and driven housing prices upward (Windsor 1979; Rolleston 1987).
Growth moratoria	Moratoria on building permits and downzoning also have depressed housing supplies in many suburbs.
Worker earnings housing cost mismatches.	By restricting housing supplies, fiscal zoning and growth ceilings have unavoidably increased suburban housing prices. Many moderate-salaried clerical and service industry workers cannot afford the executive- priced, single family homes near many office parks and centers.
Two wage-earner households	Unless a region has a large share of households where both wage-earners work in the same vicinity, a certain degree of job-worker imbalance is inevitable.
Job turnover	Even if someone is able to buy a home within walking distance of the office, that person may end up commuting long distances if he or she switches jobs, particularly given today's high cost of financing new home mortgages.

Income Imbalance

The necessity for income balance is demonstrated in research that found that San Francisco Bay Area workers in professional-managerial occupations enjoy the highest job and housing access because of the availability of high end jobs and housing. The high housing prices displace lower-paid employees to outlying neighborhoods and low paying jobs remain located in the city center (Cervero, Rood, & Appleyard, 1999). Those that aren't in professional-managerial occupations likely commute large distances between affordable housing and their jobs. These findings are similar to Horner's (2004) observation that job accessibility in Atlanta, Baltimore, and Wichita "tapers off" as one moves from the central urban area out toward peripheral locations.

Benefits of Balance

The primary goal of achieving a job-worker balance is to reduce motorized travel. The literature suggests that commutes in a balanced region would be shortened, and the share of non-motorized trips would likely increase (Cervero 1989; Frank and Pivo 1994; Guiliano & Small 1993; Ewing 1996; Sultana 2002; Rodriguez 2004). You can imagine why this would occur: if residents in a community have the opportunity to work close to home, many of them would. Not all of them would, of course, but if the conditions exists (a jobs-worker balance and income balance), the likelihood increases for shorter commutes where non-motorized travel is possible. Commuting stress would decrease, and workplace productivity would likely increase (Armstrong and Sears 2001).

A study by Cervero and Duncan (2006) suggests that a job-worker balance is one of the most important ways that land-use planning can contribute to reducing motorized travel. In San

Francisco, Cervero and Duncan (2006) analyze the results of 2000 Bay Area Travel Survey (BATS) and compare travel outcomes of respondents depending on job accessibility (a measure of jobs-housing balance) and retail and service accessibility (retail-housing balance). Their results suggest that occupational matched job accessibility (income balance) within four miles of the respondent significantly reduces their VMT.

A reduction of motorized travel results in lower tailpipe emissions and an improvement in air quality (Armstrong and Sears 2001). Air pollution is a problem in many cities: the haze above Salt Lake City, Los Angeles, and Atlanta among many others, detracts significantly from the resident's quality of life. Any step to reduce air pollution in metropolitan areas is worthwhile and while a job-worker balance wouldn't end all harmful emissions, it would contribute to regional strategies to reduce emissions.

A job-worker balance could also promote larger social objectives and goals (Cervero 1989). For example, the "provision of affordable housing closer to suburban job centers would vastly increase the residential opportunities of America's working class and would help reduce housing discrimination" (ibid). The lack of affordable housing near suburban job centers has led to so-called spatial mismatch, where poor minority workers are concentrated in city neighborhoods, while appropriate service jobs are mostly located in the growing, mostly white suburbs (Kain 1992). Unemployment among poor minorities is at least partially due to spatial mismatch.

The spatial mismatch literature has expanded beyond a focus on minorities to other specific population groups, as well as a recognition that spatial mismatch is embedded in social structures and labor market processes (Fan 2011). For example, there is a "modal mismatch" if employment is inaccessible to residents without cars because of auto-oriented land-use patterns, and there is a "skill mismatch" when employment is inaccessible to geographically proximate residents because they do not possess the required skills/education (Chapple 2001; Ong and Miller 2005; Grengs 2010; Fan 2011). Clearly the jobs-housing literature overlaps with the spatial mismatch literature. Which is likely why Cervero (1989) states: "in sum, many of the nation's most pressing and persistent metropolitan concerns- congestion, energy depletion, air pollution, sprawl, and class segregation-would be relieved by balancing job and housing growth."

Alternate Views of Job-Worker Balance

The benefits of a job-worker balance are not universally accepted. Jonathan Levine (1998) concludes that while the potential for job-worker balance to alter residential locations exits, even under the best circumstances achieving a job-worker balance is unlikely to reduce congestion. Where congestion is relieved by the availability of affordable housing stock in the vicinity of employment centers, other locators may still increase congestion in the region. Levine (1998) also notes that households that have a range of locational choices tend to seek lower residential densities at increasing distances from work.

Altshuler and Gomez-Ibanez (1993) argue that other factors have more influence on residential location than accessibility to jobs. Perhaps the availability of services and shopping or local school quality is more important. Job mobility, race, two-worker households may exert greater influence on residential location than accessibility to jobs. For these reasons, "residents in

communities planned for greater job-worker balance appear to commute about as far as residents of unplanned communities" (Altshuler and Gomez-Ibanez 1993, 74).

Economists think market forces will balance jobs and workers without intervention from local governments (Bookout 1990). A job-worker balance might be a "self-correcting" phenomenon (Altshuler and Gomez-Ibanez 1993; Peng 1997). More jobs will gradually move into areas with a housing surplus and more housing will gradually move into areas with a job surplus (Downs 1992).

Evidence certainly exists to support these counterclaims. In a study of Toronto by Miller and Ibrahim (1998), the researchers found the ratio of jobs to residents and the number of jobs within 5 km of residences had little influence on vehicle kilometers traveled to work (Cervero & Duncan 2007). Similarly, jobs-housing balance has not been found to influence travel substantially in Portland and Southern California (Wachs et al. 1993; Guiliano and Small 1993; Peng 1997).

Achieving a job-worker balance may just be one of many steps needed to reduce congestion, and policy makers should exercise caution when touting the benefits of job-worker balance (Levine 1998; Cervero & Duncan 2007).

Measuring Job-Worker Balance

There are several ways to measure job-worker balance. The simplest way is to compare the number of jobs to the number of resident workers. If there are 100 jobs in a census tract, and 100 resident workers in that census tract, then the tract is numerically balanced.

Several authors have suggested a ratio of jobs to housing that constitutes a balanced community (Table 2). Balance depends, of course, on the number of workers in the average household. Margolis (1973) suggested the rule of thumb that areas are balanced when the ratio of jobs to housing units lies within the range of 0.75 to 1.25. These values suggest that there is roughly one worker per household living in an area, plus or minus. That means that there will be one job for every worker. Cervero (1989) suggested a more reasonable balance is around 1.5 jobs per household. This value is based on the assumption that the average household has 1.5 workers. A jobs/housing ratio above this value "suggests that there is an insufficient supply of available housing to meet the needs of the local work force, resulting in a predominant pattern of in-commuting of workers in the morning and out-commuting in the evening" (Cervero 1989).

While a ratio of 1.5 jobs per household may be a good rule of thumb (Weitz 2003), this number can vary from community to community and is changing with time. Changing demographics, such as the anticipated increase in unmarried single wage earners would change what constitutes a balanced community, bringing the point of balance closer to one job per household. Where possible, the standard for a jobs-housing balance should be based on an analysis of local data on workers per household (Weitz 2003).

Table 2. Common Jobs-Housing Measurements and Standards (adapted Weitz 2003)

Jobs-Housing Balance	Recommended Target Standard (Implies Balance)	Recommended Target Range (Implies Balance	Reference
Jobs to housing units ration	1.5:1	1.3:1 to 1.7:1, or 1.4:1 to 1.25:1	Ewing 1996; Cervero 1991
Jobs to employed residents ratio	1:1	0.8:1 to 1.25:1	Cervero 1996
Jobs-household ratio	1:1	0.8:1.2	Frank 1994

These measures indicate a numerical balance of jobs and workers, but jobs and workers may not be qualitatively equivalent. We can improve upon this basic calculation by measuring the fit between local workers and local jobs as measured by earned income.

The Scale of Jobs-Housing Balance

One of the most persistent and challenging issues in measuring job-worker balance is identifying an appropriate geographic scale of analysis. For example, if the study area is an entire metropolitan region, which is definition an economically self-contained units, most likely there is a balance of jobs and workers. Alternately, if a researcher examines a census block, it is unlikely that even if there is a rough job-worker balance people will not live and work in the same block because it is too small. As Levine (1998) aptly notes, "there is no non-arbitrary geographic scale within which to assess the match or mismatch…[and] any desired outcome could be generated by simply adjusting catchment area boundaries". Nonetheless, researchers have measured jobs-housing balance at several scales.

The census tract has frequently been the geographic unit to assess jobs-housing balance (Frank 1994; Kitamura et al. 1994). Census tracts size varies tremendously because of population density. Census tracts on average are 4,000 people where 1,000 people are the minimum and 8,000 people are the maximum. Therefore census tracts in urban areas and metropolitan areas are geographically smaller than rural census tracts. In rural Southern California, some census tracts are 13,000+ sq. miles, while in downtown Los Angeles census tracts are sometimes only several square blocks (Figure 2).

Figure 2. Census Tract Size in Southern California

Peng (1997) says the census tract as the unit of analysis is too limited to apply in policy-oriented research, where: "it is inappropriate and even misleading to consider jobs and housing balanced only when the residents live and work in the same census tract or neighborhood. This definition of the jobs-housing balance deems residents working in neighboring census tracts as mismatched, even though they may travel only a short distance to their jobs."

Instead of the census- tract , Peng (1997) suggests that the actual average or median commute distances reflects the outcome of the market forces that shape residential and job locations, which implies a variable standard that differs from place to place. He uses the median home to work travel distance in his study site (Portland) to justify an appropriate travel range. The median home-to-work and 6.12 miles, and the standard deviation is 0.7, so he measures jobs-housing balance with a 5-7 mile radius. Oddly, this means that anyone living in this buffer has up to 14 mile commute within the 153.94 square mile buffer.

Other researchers have had different ideas about what represents a reasonable commute distance to assess jobs-housing balance: Levingston (1989) suggest 6-8 miles, Deakin (1989) recommends 3-10 miles as an appropriate distance; Cervero (1989) suggests 3 mile radius as the appropriate shed for each suburban employment center, and Pisarsky (1987) provides a national estimate for the average suburb-to-suburb commute of 9 miles. For our study, we elect to use 3 mile buffers around the centroid of a census tract.

Data and Measures

We use the Census Transportation Planning Package (CTPP) 2000. The CTPP database is the product of a cooperative effort between the American Association of State Highway and

Transportation Officials (AASHTO), State Departments of Transportation, U.S. Census Bureau, Federal Highway Administration (FHWA), Bureau of Transportation Statistics (BTS), Federal Transit Administration (FTA), and Transportation Research Board (TRB). The CTPP data is a tabulation of responses from households completing the decennial census long form. It contains tabulations by place of residence (Part I), place of work (Part II), and journey to work (Part III). The CTPP database has been used by other researchers to study job-worker balance (Cervero 1996; Sultana 2002; Cervero and Duncan 2007; Laymen and Horner 2010). We used the journey to work data (Part III).

The journey to work data provides detailed information about respondents commute trip from home to work, and is calculated at the following summary levels: State, County, County Subdivision, County Subdivision Place, and Census-Tract. We obtained data at the census tract level.

The data includes census tract FIPS code for respondent's place of residence as well as their place of work. For example, the data might indicate that 200 workers live in census tract X, but work in census tract Y, while 50 people live and work in census tract X. Thus the data indicates how many people live and work in the same census tract as well as journey to work data.

The data also provides the number of residents and workers for each census tract according to their income level. There were four income categories; less than $30,000, $30,000-$49,999, $50,000-$74,999, and $75,000 or more. We used the mid-points of these categories to calculate the average income of residents and workers for each income. This information provided a data to measure income balance within each census tract.

Rather than using census tracts as our geographic scale to asses job-worker and income balance, we use geographic information systems (GIS) to create a 3 mile buffer around the centroid of the census tract, and all census tracts whose centroid is contained within the buffer is included in the selection. Data from all census tracts within the buffer are aggregated. Thus, we have used a 28.27 square mile commuter shed to assess job-worker and income balance and we refer to these groups of census tracts as clusters.

In order to minimize overlap between clusters, and increase errors introduced by spatial auto correlation, we use a sample of census tracts. We randomly selected 25% of census tracts fully contained within metropolitan areas giving us a sample size of 4,614 clusters. Our sample size is sufficiently large to ensure accurate parameter estimation, ensure the direction of an effect, and estimate that effect accurately (Jiroutek et al. 2003; Maxwell et al. 2008).

Measuring Job-Worker Balance

The primary independent variables for this present study are job-worker balance, and income balance. We measured job-worker balance as:

$$Jobs\ Worker\ Balance = 1 - \frac{ABS(Residents\ - Workers)}{Residents + Workers}$$

This calculation yields a result between zero and one. A value of zero represents a perfect imbalance between jobs and housing, and a value of one indicates a perfect balance between jobs and housing. This measure of job-worker balance has been applied to developing predictive travel models for mixed use developments (Ewing et al. 2011) and LEED ND development projects (Ewing, in Press).

We calculated income balance using a similar formula:

$$Income\ Balance = 1 - \frac{ABS(Avg\ Income\ of\ Residents\ - Avg\ Income\ of\ Workers)}{AvgIncome\ of\ Residents + Avg\ Income\ of\ Workers}$$

This calculation also yields a result between zero and one. A value of zero represents a perfect imbalance between the average income of residents and the average income of workers in a census tract. Alternately, a value of one indicates a perfect balance between the average income of workers and the average income of residents.

Internal capture is the dependent variable for this present study. Internal capture refers to the number of people who live and work in the same area. We aggregated the number of residents for each census tract, and calculated how many people lived and worked in the same census tract. Internal capture is measured on a scale of 0 to 1, where a value of 1 is perfect internal capture and zero represents no internal capture.

We calculated the internal capture rate for each census tract using the formula:

$$Internal\ Capture = \frac{2 \times Number\ of\ workers\ living\ and\ working\ in\ census\ tract}{Number\ of\ workers\ living\ in\ census\ tract + number\ working\ in\ the\ census\ tract}$$

Data Analysis

We performed an ordinary least squares (OLS) regression to evaluate the relationship between jobs–worker balance and income balance on internal capture. This analysis provides a model to predict internal capture based on job-worker and income balance.

Initially, we used all census tracts for model development. However, we modified our methodology to select only census tracts located in metropolitan counties in order to exclude rural census tracts. The logic was that census tracts are determined by population size and rural census tract sizes would be much larger than census tracts in metropolitan areas. Geographically large census tracts likely have higher internal capture. Furthermore, jobs-worker balance has not been an issue for planners in rural areas.

Other variables Used in Models

In order to assess the relative contribution of job-worker balance and income balance on internal capture, several variables were used in the models to control for differences across the census tracts. We assumed that internal capture increases with a greater total of jobs and workers in a cluster since the more activity; the easier it should be to get a match of jobs to workers. We therefore include *jobs plus workers* as a variable in our model. We also assume that internal capture is higher in low income areas, because the low-income workers look for jobs near home. As such, we include the *average income of residents* in each cluster.

Analysis

The results of the OLS regression are presented in Table 3. All variables in the model are significant, which is to be expected with a large sample size. The model indicates that as job-worker balance and income balance increases, so does internal capture. The effect of income balance is greater than job-worker balance on internal capture.

Overall, the model explains 31% of the variance in the data, and is better than the explanatory power of similar research on job-worker balance's effect on travel (Levine 1998; Cervero & Duncan 2007).

Table 4. Job-worker balance and income balance model for census tracts in the U.S

	Coefficient	**Std. Error**	***p***
Constant	-.593	0.051	<0.001
Ln (Job-Worker Balance)	0.577	0.005	<0.001
Ln (Income Balance)	2.135	0.221	<0.001
Average Income of Residents	-1.338E-5	0.000	<0.001
Residents + Workers	7.954E-7	0.000	<0.001
R-Squared		0.310	
Number of Clusters		4,614	

Note:

1) Dependent Variables: Natural Logarithm of Internal Capture for a Cluster of Census Tracts

Results and Discussion

The results support the hypothesis that job-worker balance and income balance increase internal capture in census tracts across the U.S. Income balance has a greater influence on internal capture than job-worker balance. The linear regression model fits the data adequately and is comparable to other studies on the effect of job-worker balance on travel behavior (Levine 1998; Cervero & Duncan 2007).

Our results support previous findings by Frank and Pivo (1995), Cervero (1996), Ewing (1998), and Sultana (2002), where job-worker balance (as opposed to imbalance) leads to more people living and working in the same area. Where Frank and Pivo (1995) found that the average distance of work trips was 29% shorter than less balanced tracts, our research indicates that more people will live in and work in the same census tract the greater the job-worker balance (Table 5). Our data prohibits conclusions about driving distances, but we can assume that the greater the job-worker balance, the more people live and work in the same census tract, the less distance they drive to work.

Similarly to Cervero (1996), Levine (1998) and Cervero & Duncan (2007), or model predicts that income balance has a greater influence on whether people are able to live and work in the same area than job-worker balance. Cervero (1996) found that mismatches between worker earnings and housing prices are more of a barrier to balanced growth than a numerical parity between jobs and housing. Cervero and Duncan (2007) found that for every 10% increase in in the number of jobs in the same occupational category is associated with a 3.29% decrease in daily work trip VMT. Levine (1998) suggested that a greater impact on regional housing preferences would be experienced by providing affordable housing near jobs center. Our findings add to the evidence that a balance between incomes of residents and workers is a greater influence on whether people live and work in the same census tract than is job-worker balance. Our findings improve upon previous knowledge by expanding analysis of job-worker and income balance to the national scale. Where other studies used a just a few cities, our research examines a sample of metropolitan census tracts from across the country.

Since the coefficients of our predictive models are elasticities, we can compare the effects on internal capture to jobs housing balance and income balance. For every 1% increase in income balance, we expect internal capture to increase 2.64% (Table 4) and for every 1% increase in job-worker balance, we expect internal capture to increase 0.3%.

The models generated by this study should be generalizable across the country because they are derived from a national database. The necessary inputs for the models are readily available and free to planners. We've used a simple measure of job-worker balance (number of residents in a census tract and the number of workers in the census tract), as well as a simple measure of income balance (average income of both residents and workers) and this simplicity make it a readily accessible tool for planners across the country.

These models should prove useful in scenario planning, where the outcomes of multiple development futures can be compared. The outputs of the models will allow planners to anticipate the effects of improving the job-worker and income balance for a region.

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