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Cities and Innovation

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ABSTRACT: By raising commuting costs, an increase in gasoline prices should reduce the demand for housing in areas far from employment centers relative to locations closer to jobs. Using annual panel data on a large number of ZIP codes and municipalities from 1981 to 2008, we find that a 10 percent increase in gas prices leads to a 10 percent decrease in construction in locations with a long average commute relative to other locations, but to no significant change in house prices. Thus, the supply response may prevent the change in housing demand from capitalizing in house prices.

JEL Codes: Q31, R21, R23

Keywords: Gasoline price, household location, housing, commuting

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1. Introduction

The price of gasoline rose steeply from 2003 to 2008, reaching a level higher in real terms than its previous peak of the early 1980s (see Figure 1). Although the price has come down since 2008, it remains high by historical standards. The run-up in gasoline prices has stimulated much discussion in the popular press and academic research concerning the long-run impact of higher gas prices. While attention has focused on issues concerning changes in motor vehicle fuel economy and modes of transportation, another effect worth considering is the impact on residential location and the geographic distribution of housing units.[1] Rising gas prices increase the cost of driving to work, which should make some individuals choose to live closer to their place of work than they would have otherwise. As housing demand grows in locations closer to employment centers, we would expect the quantity and/or price of housing in those areas to increase relative to more distant locations, depending on the elasticity of housing supply. Because housing is so durable, the influence of gasoline prices on construction has a lasting effect on the urban landscape.

Although households take transportation costs into consideration when choosing where to live, changes in commuting costs are usually too small to cause people to move.[2] According to the Consumer Expenditure Survey, households spend between 3 and 4 percent of total expenditures on gasoline in the typical year, and these expenditures include non-commuting travel. Despite the increase in gas prices since 2003, gasoline expenditures were still only 5 percent of total spending in 2008. By contrast, moving costs are much larger. Li, Liu, and Yao

[1] For example, Li, Timmins, and von Haefen (2009) find that the increase in gas prices in the 2000s caused a shift towards more fuel-efficient cars. In their review of the literature on the demand for gasoline, Parry and Small (2004) report that an increase in gasoline prices reduces both the demand for gasoline and total vehicle travel.
[2] According to the March Current Population Survey (CPS), less than 1 percent of the population each year reports commuting concerns as their primary reason for moving in the previous year. Nevertheless, this fraction rose markedly from 2006 to 2007 (from 0.50 percent of the population to 0.63 percent) and remained high through 2009.

(2009) find that the costs of housing adjustment amount to roughly 15 percent of house value, which would be about $30,000 at the median house value in 2008. This cost is more than 10 times larger than average gasoline expenditures in 2008, which were $2,715. Therefore, we do not expect changes in gas prices to cause households to move if they have no reason to move otherwise. Nevertheless, changes in gas prices are likely to influence the location decisions of those who have already decided to move for other reasons such as an employment change or life-cycle event. With more than 10 percent of households moving every year, the location choice of migrants can be large enough to make a noticeable impact on local housing markets.

Prior research on the effect of gas prices on residential location is relatively thin and was mostly done following the oil price shocks of the 1970s and early 1980s. Coulson and Engle (1987) find that increases in gas prices between 1974 and 1979 boosted the differential between central city and suburban house prices in a sample of 6 cities. Using the 1970 Census data from Chicago, Anas and Chu (1984) report that the probability of living in a neighborhood is decreasing in its average travel time and travel cost. To the best of our knowledge, the only paper that has examined this question more recently is Cortright (2008), who shows that from 2006:Q4 to 2007:Q4, house prices in 5 metropolitan areas fell more in ZIP codes with longer average commuting distances.

Our study contributes to the existing literature on several fronts. First, in contrast to the more limited geographic scope of previous research, we use data covering a large fraction of the metropolitan areas in the United States. This more expansive dataset allows us to examine the types of locations where gas prices have the largest impact. Second, our longer sample period includes episodes of unusually large increases and decreases in gas prices, providing more variation to identify any potential effect. The longer sample period also allows us to control for other macroeconomic factors that might be correlated with both gas prices and the location decision. Third, we examine the gas price effects on the quantity of housing units as well as on house prices. These supply effects are important because changes in housing demand will not be capitalized in house prices in locations where the supply is elastic. Lastly, in contrast to the existing literature, our regression model controls for unobserved heterogeneity across geographic areas and allows for the effect of gas prices on housing markets to take several years.

Our empirical strategy is to estimate the differential impact of changes in gas prices on the price and quantity of housing in locations with different average commute times to work. Our sample period extends from 1981 to 2008, and we use house price data for 4,250 ZIP codes in 202 metropolitan areas and construction data for 5,325 permit-issuing places in 357 metropolitan areas. We find that a 10 percent increase in gas prices reduces construction by 10 percent after 4 years in locations with a long average commute time compared with other locations. Although this effect is not large, it reveals that migrants do consider commuting costs when deciding where to locate. In most locations, this supply response is large enough that house prices are unchanged. However, we find suggestive evidence that house prices do respond to gas prices in locations where the supply of housing is constrained.

The remainder of the paper proceeds as follows. The next section describes the data and our regression model. In the third section, we present some baseline results, show that these results are robust to a variety of specifications, and explore the heterogeneity of the gas price effect across locations. The last section concludes.

2. Data and Methodology

In one of the most basic and widely used models in urban economics, households choose their distance from the city center depending on land prices and transportation costs (Alonso (1964), Mills (1967), Muth (1969), and Wheaton (1974)).[3] The cost of transportation depends on time costs, gasoline costs, and other monetary costs. When the price of gas increases, transportation costs rise accordingly, especially for households with a long commute. Since migration is costly, households should consider the expected future price of gas when deciding how far to live from work. Empirically, however, the current level of gas prices appears to be a good proxy for the expected future price. Using data from 1959 to 2009, a standard Dickey-Fuller test cannot reject a unit root in the level of the real gas price. Moreover, a number of studies have found that the spot price of oil is at least as good as the futures price in predicting oil prices (Alquist and Kilian 2010, Bopp and Lady 1991, Chinn and Coibion 2010).[4] Thus, all else equal, an increase in gas prices today should reduce housing demand in outlying areas relative to the urban center. We can observe this change in demand through changes in the price and quantity of housing in these two types of locations.

Our empirical strategy is a simple difference-in-difference framework that compares the effect of gas prices on the price and quantity of housing in locations with long average commute times to other locations within the same metropolitan area. We focus on differences within metropolitan areas for two reasons. First, cross-MSA moves are predominately driven by life-cycle and employment reasons. In the 2003 Current Population Survey (a year when gas prices were about their average over the previous 20 years), 61 percent of inter-state migrants moved

[3] Many researchers have investigated the cross-sectional correlation between house prices or land values and distance from the city center (examples include Atack and Margo 1998, Bryan and Sarte 2009, Coulson 1991, and McMillen 1996). Tse and Chan (2003) draw the connection between distance and transportation cost, showing that residential property prices in Hong Kong are lower in locations with larger commuting costs.

[4] In addition, we find that oil price futures are highly correlated with the current spot price, suggesting that market participants expect the current price to remain unchanged. Specifically, a regression of monthly changes in the West Texas Intermediate spot price on its 2-year ahead futures contract yields a coefficient of 0.73 (using data from 1996 to 2008). The market for gasoline futures is not thick enough to make a similar comparison.

for family-related or employment reasons, whereas only 2 percent moved for commuting reasons. Thus, concerns about commuting are unlikely to cause the marginal migrant to move to a different MSA. Indeed, 87 percent of migrants in the CPS who reported moving for commuting reasons remained in the same state. The second reason for focusing on within-MSA differences is that we are able to net out any MSA-specific economic shocks that might be correlated with gas prices and housing market activity. This approach ensures that observations in the "control" group (i.e. locations where the average commute time is not long) are more similar to those in the "treatment" group.

In order to have data with meaningful variation in commute times and housing markets across locations within the same metropolitan area, we would like to measure housing market outcomes at the smallest possible geographic unit of analysis. This desire leads us to create a different dataset for each of our outcomes of interest. To measure the change in house prices, we use repeat-sales house price indexes (HPI) for ZIP codes. To measure the change in the stock of housing, we use annual data on building permits and decadal data on housing stocks for permit-issuing places, which are usually small municipalities. Although we would prefer to use the same geographic unit of analysis for both prices and quantities, doing so would require using county-level data and counties are too large to provide enough variation within MSAs.

As shown in Table 1, ZIP codes tend to be larger than permit-issuing places; they have greater land area and more housing units.[5] Nevertheless, in both samples more than 60 percent of MSAs have 5 or more locations, suggesting that both geographic units are small enough to provide meaningful differences in commuting time and housing market fluctuations within a metropolitan area. Our final place-level sample covers about 40 percent of construction in the

[5] In general, ZIP codes tend to be smaller than permit-issuing places. However, the smaller ZIP codes do not have enough home sales to estimate a repeat-sales price index. Our results are unchanged if we limit the construction and house price samples to places and ZIP codes of similar sizes.

typical metropolitan area and our final ZIP code-level sample covers about 75 percent of housing units in the typical metropolitan area. Thus, our sample covers a large fraction of housing market activity in the US.

For each outcome of interest, we estimate the following regression model:

$$Outcome_{i,t} = \alpha + \sum_{s=1}^{4} \beta_s \ln\left(\frac{g_{t-s}}{g_{t-s-1}}\right) * LC_i + \sum_{s=1}^{4} \gamma_s \ln\left(\frac{g_{t-s}}{g_{t-s-1}}\right) * \ln(Density_i)$$
$$+ \sum_{s=1}^{4} \delta_s \ln\left(\frac{GDP_{t-s}}{GDP_{t-s-1}}\right) * LC_i + \sum_{s=1}^{4} \lambda_s \ln\left(\frac{FRM_{t-s}}{FRM_{t-s-1}}\right) * LC_i + MSA_i * \theta_t + \eta_i + \varepsilon_{i,t} \qquad (1)$$

The equation is estimated using annual data from 1981 to 2008. The dependent variable, $Outcome_{i,t}$, is either the change in ln(house price) in ZIP code i in year t, or the growth in the housing stock in place i during year t. We use price and quantity data for single-family housing units because multifamily units tend to be in dense locations where alternate commuting methods are easily available. Since data on housing stocks are not available at an annual frequency, we proxy for growth in the stock as the number of building permits issued in year t divided by an estimate of the housing stock in year $t-1$. The data on annual permit issuance are published by the Census Bureau for about 18,000 permit-issuing places. For the denominator, we use place-level data on the number of housing units from the 1980, 1990 and 2000 Censuses and the accumulation equation:

$$Stock_{i,t} = Stock_{i,t-1} + Permits_{i,t-1} - Depreciation_{i,t} \qquad (2)$$

where $Depreciation_{i,t}$ is a place- and decade-specific factor that we back out from the change in the single-family housing stock and cumulative permit issuance over each ten-year period.[6]

The data on house prices were purchased from LoanPerformance, a subsidiary of First American CoreLogic, and we use the 4th quarter values so that the change in the index reflects

[6] For the years after 2000, we assume that depreciation is 1.5 percent per year.

the cumulative change in prices over the year, just as annual permit issuance reflects the cumulative change in the housing stock.[7] We drop ZIP codes and places that experienced large changes in land area between 1990 and 2000 in order to exclude locations that changed boundaries.[8] In addition, we limit our samples to ZIP codes and places that lie within metropolitan areas because the joint commuting-location decision is only relevant in large areas with significant differences in commuting time across locations. After making these sample restrictions, we are left with 5,325 places in 357 metropolitan areas and 4,250 ZIP codes in 202 metropolitan areas.[9]

Our main independent variable of interest is the real gas price, g_t, interacted with LC_i, a dummy variable for whether the average commute time in location i in 1980 was over 24 minutes (approximately the 70th percentile in the commute time distribution for both types of locations). We calculate real gas prices by dividing the price index for consumer expenditures on gasoline and other motor fuel by the price index for all other consumer expenditures.[10] Figure 2 shows the annual changes in real gas prices over our sample period. Prices rose substantially in 1980, 2000, from 2003 to 2005, and in 2008. Prices also dropped considerably in 1986, 1998, and 2009. Such large movements in gas prices, which include both positive and negative changes, generate useful variation for us to identify the effect of gas prices on housing markets. Notably, there is no trend in changes in gas prices during our sample period that would cause our results to be driven by an unobserved secular trend such as gentrification. Additionally, changes

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[7] Results are similar if we use the annual average of house prices instead of the 4th quarter values.
[8] Only 3 percent of ZIP codes and1 percent of places experienced a change in land area of this magnitude, and the average commute time of these locations is not different from other locations. We use 1990 land area instead of 1980 land area because land area is not available for ZIP codes and small cities in the 1980 Census. When we look at the sample of places for which we have 1980 land area (which tend to be larger), very few experienced large changes in land area. Excluding these locations does not affect our results.
[9] The results are unchanged if we limit both samples to the same set of metropolitan areas.
[10] Both of these price indexes are published by the Bureau of Economic Analysis.

in gas prices vary a good bit over the entire sample period; they are not concentrated in a single episode of rising or falling prices.

Although the price of gas paid at the pump varies across locations, we do not use local data on gas prices for three reasons. First, most of the variation in local gas prices is time-series variation that is due to changes in oil prices. Second, the cross-sectional variation in local gas prices is partly influenced by the demand for gas in different locations, making it endogenous to the location decisions of households. Third, we only observe local gas prices at the level of metropolitan areas and these data are only available for years after 1990.[11]

To measure commute time in each location, we use the average number of minutes needed for a one-way trip to work among workers 16 years and over from the 1980 Census.[12] We fix commute time in 1980 because changes in commute times might be correlated with other aspects of local housing markets that in turn affect households' location choices. Our hypothesis is that in areas where the commute time is relatively long, increases in gas prices will depress house prices and building activity by more than in areas with a shorter commute time. Therefore, we expect $\beta_s < 0$. We have allowed for gas prices as well as the other control variables to affect house prices and construction with a lag because we do not expect changes in gas prices to cause people to move if they do not plan to move otherwise. Since households typically move every 5 to 6 years, they would not be able to factor gas prices into their location choice decision until other exogenous forces cause them to move. Thus, a change in gas prices will affect housing markets for at least several years after the initial shock. Our regression model

[11] The MSA-level gas prices are collected by American Chamber of Commerce Research Association.
[12] The 1980 Census does not report commuting time separately for workers using cars and workers using public transportation. Given that most people drive to work in most locations, we do not think that using the commute time of all workers is a severe source of measurement error.

allows for a lag of up to 4 years. In robustness checks not shown in this paper, we include lags of up to 8 years, and the effect of gas prices always dies out after 4 years.

Local house prices and housing stocks evolve over time for many reasons beyond gas price changes, and the remaining variables in the regression model control for factors that might be correlated with commute times, gas prices, and housing market fluctuations. We include a full set of ZIP code or place fixed effects (η_i) in our model to control for location-specific trends in the price and quantity of housing. We also include metropolitan area interacted with year fixed effects so that the coefficients are identified by comparing the housing market of one location to other locations in the same metropolitan area in the same year. The MSA*year fixed effects also control flexibly for market-specific and macro-economic shocks.

Because locations with long average commute times tend to be less-densely inhabited and far from the city's urban center, commute time might be correlated with the local elasticity of housing supply. To account for the possibility that commute times reflect local supply conditions rather than commuting costs, we control for interactions between gas price changes and local housing density. We measure density as the ratio of 1980 housing units to 1990 land area because no land area measures are available in the 1980 Census. Another concern is that the types of workers who live in outlying areas have a different sensitivity to the business cycle and mortgage market conditions than workers who live in the urban center. We allow for these possibilities by interacting changes in real GDP and changes in the interest rate on 30-year fixed rate mortgages with the long-commute indicator.

In all results reported below, we cluster the standard errors by MSA because locations in the same MSA are in the same housing and labor market and therefore experience many similar shocks. Technically, it would be preferable to use the two-way clustering method described in

Cameron, Gelbach, and Miller (2007) to cluster the standard errors at the level of both MSA and year, because one of our main variables of interest—gas prices—is the same for all locations in the same year. However, we find slightly smaller standard errors when we do the two-way clustering. For simplicity and to be conservative, we choose to cluster the standard errors by MSA, but the results are robust to alternative methods of computing the standard errors. In addition, all regressions are weighted by the number of single-family housing units in each location in 1980.

3. Results

3.1 Baseline results

Table 2 reports estimates from our main specification. An increase in gas prices significantly reduces construction in locations with a long average commute time compared to locations that are closer to jobs. The effect is strongest in the first three years following the shock to gas prices, and then it dies down.[13] After four years, a 10 percent increase in real gas prices results in a cumulative change in the housing stock that is 0.3 percentage points smaller in long-commute locations compared to short-commute locations. Although statistically significant, this effect is only about one tenth of the median rate of construction of 2.9 percent over four years in this sample. With a median number of single-family housing units of 1500 in 2008, this effect is equivalent to 5 units per place being built in places with short commute times instead of farther-away locations. For comparison, the median place in 2008 had built 42 housing units in the previous 4 years.

Turning to the house price regressions, the effect of gas prices is similar in locations with long and short commutes; the coefficients on the interaction of gas prices and commute time are

[13] Additional lags are also small and insignificantly different from zero.

small and insignificantly different from zero. Thus, we find that an increase in gas prices results in a change in the quantity of housing, but does not alter house prices. These results suggest that in the typical location, the change in demand brought about by a change in gas prices is met relatively quickly by a change in supply, resulting in an adjustment in the spatial distribution of the housing stock and little change to house prices.[14]

Turning to the control variables, we find that increases in gas prices also affect construction differently in dense and spread-out locations. In addition, changes in mortgage rates affect construction differentially in locations with longer commutes. In the house price regressions, the correlation of changes in GDP with house prices varies by commute time. Even though these control variables are significantly correlated with our outcome variables, omitting them does not qualitatively change the results.

3.2 Robustness

Tables 3 and 4 show that our baseline results, shown in column 1, are robust to including a variety of other control variables. First, we address the concern that our baseline specification does not adequately control for other economic conditions that might be correlated with gas prices and distance from the urban center. In columns 2 and 3, we control for other measures of aggregate economic activity—namely changes in real disposable income per capita and aggregate employment—interacted with commute time.[15] In column 4, we include changes in metropolitan area employment and income interacted with commute time.[16] In each of these

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[14] Glaeser and Gyourko (2003) find that house prices were close to construction costs in most cities in 1989 and 1999, which they interpret as evidence that the housing supply is elastic in most locations.

[15] We include each variable in place of GDP rather than including them all in the same regressions because there are only 28 years of data so including four lags of each aggregate variable would use up too many degrees of freedom.

[16] These data are from the Bureau of Economic Analysis's Regional Economic Information System. Specifically, we use the total number of employees and income per capita deflated by the aggregate PCE chain price index.

specifications, the estimated effect of gas prices is unchanged. Next, we assess whether gas prices are acting as a proxy for more general conditions in commodity markets. As shown in column 5, the estimated effect of gas prices is the same if we include changes in other commodity prices interacted with commute time.[17] Finally, one might be concerned that gas prices are correlated with heating and cooling costs, and outlying homes tend to be larger and therefore require more energy to heat and cool. In column 6 we include changes in heating and cooling costs interacted with the average number of rooms per housing unit in each location in 1980.[18] The estimated coefficients on gas prices are almost identical to the baseline results.

Our results are also not sensitive to the functional form that we use to specify commute time. In particular, we find similar results when we measure commute time as the logarithm of average commute time or the fraction of residents with a commute time greater than 45 minutes instead of using a dummy variable for a long average commute.[19] We also estimate similar effects for different sample periods, indicating that our baseline results are not driven by a single episode of energy price shocks and/or housing market cycle.

Next, we explore relaxing the constraint that the relationship between changes in gas prices and housing market fluctuations is linear. Table 5 shows three different ways in which the effect of gas prices might be nonlinear. First, we allow changes in gas prices to have a different effect when they are unusually large, which we define as a change in the logarithm of the real gas price that is greater than 0.15 or less than -0.15. We observe changes of this magnitude in one eighth of our sample period, and they are spread relatively evenly over time.[20] As shown in

[17] We measure other commodity prices as the Producer Price Index for commodities excluding energy.
[18] Heating and cooling costs are measured using the PCE price index for electricity and gas relative to the PCE price index for all other goods and services.
[19] In most locations, between 3 and 20 percent of residents had a commute longer than 45 minutes.
[20] Specifically, the real change in gas prices was larger than 0.15 in 1979, 1980, 2000 and 2005, and it was smaller than -0.15 in 1986 and 1998.

the first row of panel A, the interaction between gas prices and commute time does not have a different effect on house prices or construction when gas price changes are large.[21] Moreover, when we add the coefficients together (rows 4 and 5), the effect of a large change in gas prices is about the same as the effect of a small change.

Next, we allow the effect of gas prices to be asymmetric by creating variable for whether real gas prices are falling and interacting it with the interaction between gas price changes and the long-commute indicator. As shown in panel B, positive and negative changes have very similar effects on construction. Although house prices appear to respond in opposite directions to positive and negative changes in gas prices, the standard errors of these coefficient estimates are very large.[22]

Third, we create an indicator for periods when the real level of gas prices is unusually high, because the high price level might make gas prices more salient to household decision-making. We define a high price level as over $2 per gallon in 2005 dollars, which includes the years 1980 to 1984 and 2005 to 2008. We find that changes in gas prices do not have a different effect when the level of gas prices is unusually high (panel C). Overall, the estimates shown in Table 5 suggest that changes in gas prices have a fairly linear effect on housing market fluctuations.

If households are risk averse, then the variance of gasoline prices also might influence the household location decision because large fluctuation in gas prices would make households want to reduce their exposure to fluctuating commuting costs. We test this hypothesis by including the variance of gas prices (measured as the variance of the real price level in the previous 8 or 20

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[21] The regression also includes the two-way interaction between the long-commute dummy and the indicator for large changes in gas prices, as well as all of the other variables in our baseline specification.

[22] Taking these coefficient estimates at face value, they suggest that house price appreciation is a bit larger in outlying locations when gas prices fall. However, they also suggest that house prices rise even more in these locations when gas prices rise, which we find difficult to interpret.

quarters) interacted with the long-commute indicator. Similar to the baseline specification, we include 4 lags of this variance. We try specifications that also include the change in real gas prices as well as specifications that exclude the change in real gas prices. No matter the specification or measure of variance used, the coefficients on the variance terms are small and frequently the wrong sign (positive). These results suggest that households do not choose their location in order to hedge against gas price volatility.

3.3 Geographic variation in the effects

Finally, we explore the heterogeneity of the gas price effects across locations. This exercise is useful because it can reveal the types of locations where gas prices matter most. The effects might be economically important in these locations, even if they are small in the typical location. Moreover, it would be reassuring to find that the gas price effects are larger in the types of locations that we would expect.

To begin, we examine distance from the urban center in greater detail by dividing the commute time indicator into finer categories. Table 6 shows the results from interacting changes in gas prices with indicators for average commute time between 17 and 20 minutes, 20 and 24 minutes, 24 and 28 minutes, and greater than 28 minutes (the 25th, 50th, 75th and 90th percentiles of commute time, respectively).[23] The negative effect on construction increases with commute time, showing that gas prices reduce construction the most in locations farthest from jobs. However, the effects are still relatively moderate even in the furthest locations. A 10 percent increase in gas prices would lead to 17 percent less construction in locations with an average commute longer than 28 minutes compared to locations with an average commute less than 17

[23] These statistics are for the construction sample. Commute times for ZIP codes are about 2 minutes longer.

minutes.[24] The effect of gas prices on house prices also appears to be somewhat larger in locations with very long commute times, although the estimated coefficients are not significantly different from zero.

To further explore the types of locations where the effects of gas prices are most relevant, we estimate equation (1) in various subsamples of the data. Table 7 reports two sets of results that illustrate how the effect of gas prices on housing demand differs across locations. The top panel divides the sample by the fraction of the population in each location that used a car to commute in 1980. We would expect the effects to be larger in locations where more people depend on cars to get to work. As predicted, the effect on construction is much stronger in locations where more than 90 percent of residents (the median of car use) commuted by car. The coefficients in the house price regression are also larger (more negative) in this group of locations, although the estimated effects are not significantly different from zero.

The bottom panel of Table 7 compares results for locations in metropolitan areas with large differences in commute time to locations in metropolitan areas with relatively homogeneous commute times. We expect the effects to be larger in metropolitan areas with more heterogeneous commute times, since gas prices should not affect residential location if commuting takes about the same time in all locations. We measure commute-time heterogeneity as the difference between the maximum and minimum commute times of the locations within each metropolitan area. We split the sample at the 75th percentile of this difference, which is 14 minutes for both the construction sample and the house price sample.[25] The estimated effect of gas prices on construction is more pronounced in metropolitan areas where there is a large

[24] Given the median 4-year construction rate of 2.9 percent, 0.1*0.050/0.029 = 0.17.

[25] We choose this cutoff because metropolitan areas with large differentials in commute time tend to be larger and comprise more locations, so there are relatively few locations in metropolitan areas with a commute time differential less than the median. Nevertheless, results are similar when we use different cutoffs.

difference in commute times across locations. The estimated coefficients on house prices are also larger in magnitude in these metropolitan areas, although they are not statistically significant. Overall, Table 7 shows that gas prices affect both construction and house prices more in locations where more residents drive to work and where commute times differ significantly within the MSA. Because the effects on construction and house prices are larger in similar locations, these results are consistent with larger shifts in the housing demand curve in these types of locations.

Even for the same change in housing demand, the resulting change in housing market activity should depend on the local elasticity of housing supply. To assess this possibility, we measure supply constraints in two ways. First, we use the number of housing units per square kilometer because dense locations have a limited supply of land on which to build new homes. Second, we use an index of regulatory constraint constructed by Gyourko, Saiz and Summers (2008) from a 2005 survey of municipal planning directors.[26] The survey included questions on the characteristics of the regulatory process, the rules of local residential land use regulation, and the cost of development (in terms of both money and time). The index is increasing in the degree of regulation and has a mean of zero.[27]

As shown in Table 8, the effect of gas prices on construction is larger in less dense and less regulated locations. A 10 percent increase in gas prices leads to 18 percent less construction

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[26] The index is constructed for municipalities, which is frequently the same level of aggregation as permit-issuing places. We associate the degree of regulation in each ZIP code with the municipality in which it is located. It would be preferable to use regulations that were in place prior to our sample period because regulations might be stricter in locations with strong housing demand. However, no comprehensive measure of the regulatory environment for individual municipalities exists prior to the 2005 survey. Nevertheless, since the severity of housing supply regulation tends to be persistent, we think that the regulations in place in 2005 are a decent proxy for regulation throughout our sample period.

[27] In contrast to data on metropolitan areas, housing unit density and regulation are not highly correlated at the place level. The correlation coefficient of regulation and ln(density in 1980) across places in our sample is -0.08, and the correlation of regulation with ln(density in 2000) is -0.01.

in less dense locations and 24 percent less construction in less regulated locations[28]. Turning to house prices, the effects are larger in denser and more-regulated locations. The highly-regulated subsample is noteworthy because the estimated coefficients are larger than in other samples and they are significantly different from zero. In this sample, a 10 percent increase in gas prices leads to 0.6 percentage point lower house price appreciation after four years, which is 13 percent of the median 4-year real house price appreciation rate in this sample. Thus, while the supply response seems to be large enough to prevent a notable change in prices in most locations, there are some locations where the restricted construction response results in a larger price effect.

In summary, the results displayed in Tables 7 and 8 show that changes in gas prices do not affect housing markets uniformly across locations. Consistent with what theory would predict, we find that both construction and house prices respond more to gas prices changes in locations where we would expect them to have a larger impact on housing demand. We also find that the construction effect is larger in locations where housing supply is more elastic, and the price effect is larger in locations where housing supply is less elastic. These findings reassure us that our estimates are unlikely to be driven by omitted variables that are correlated with gas price changes, commute time, and housing market dynamics.

4. Conclusion

Using ZIP code-level house price data and place-level building permit data in a large number of metropolitan areas, we study the effect of gasoline price changes on local housing markets over nearly three decades. We estimate a flexible regression model that controls for MSA-year specific shocks and allows gas price changes to affect housing markets with a lag.

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[28] These calculations are based on median 4-year construction rates of 4.9 percent in less dense places and 3.5 percent in less regulated places. The regulation sample is much smaller than our baseline sample because the regulation index was only computed for 1/4 of the places in our baseline sample.

Our central estimates suggest that a 10 percent increase in gas prices induces a 10 percent decline in construction after 4 years in locations far away from the employment center relative to locations closer to jobs. In contrast, we do not find that house prices in outlying locations to respond to gas price changes differently than house prices in more urban locations. These results are robust to a variety of specifications.

Taken together, our findings show that housing supply in most areas is elastic enough for gas prices to affect the quantity of housing but not the price. These results stand in sharp contrast to the existing literature, which has found that increases in gas prices significantly depress house prices in outlying areas relative to centrally-located areas. This discrepancy is primarily driven by the fact that previous studies did not have a long enough sample to sufficiently control for factors that were correlated with both gas prices and house prices. For example, we find a significant house price effect if we regress the log difference in house prices on the log difference in gas prices with no controls other than MSA fixed effects, which is similar to the specification used in Coulson and Engle (1987). However, the price effect disappears once we control for more variables such as year fixed effects, the interaction between gas price changes and local housing density, the interaction between mortgage interest rate and long-commute indicator, and the MSA-year fixed effects.[29] This exercise highlights the importance of controlling for potential confounding factors when comparing the housing markets of urban locations to farther-out locations.

Reducing commuting distance by living closer to work is only one of the variety of ways in which households can adjust to a change in gas prices. The existence of other options, such as driving a more fuel-efficient car, carpooling, or taking public transportation, should reduce the

[29] We find these results in both our full sample and the 1981 to 1985 period, which is closer to the Coulson and Engle sample period. These results also hold for both our full set of metropolitan areas and the 6 MSAs used in their paper.

effect of gas prices on households' location choice. Fuel efficiency has increased significantly over the past 30 years (Ramey and Vine 2010), and the wider availability of more fuel efficient cars should lead us to estimate smaller effects on house prices and construction later in our sample period. On the other hand, the fraction of workers carpooling or taking public transportation has fallen from 1980 to 2008, which lead to a larger effect of gas prices.[30] Empirically, our estimates are not qualitatively different in the first and second halves of our sample, suggesting that these effects have either been small or offsetting.

Our estimated effect of gas price changes on construction is statistically significant but economically moderate. However, the aggregated effect may be economically significant when gas prices rise substantially. For example, the national average gas price rose from about $3 per gallon to over $4 per gallon within 4 months between February and June of 2008. An increase of this magnitude is consistent with nearly 1/3 less construction in outlying areas relative to closer-in locations. In addition, the durable nature of housing means that changes in location choices made by households will have a long-lasting effect on urban landscape. To the extent that high gas prices reduce the desirability of living far from the urban center, many of the houses that were built in ex-urban areas when gas prices were low may remain vacant for some time.

[30] Based on our tabulations of the 1980 Census, the 2000 Census and the 2008 American Community Survey, the fraction of workers who carpool fell from 20 percent to 11 percent and the fraction of workers who use public transportation fell from 6 percent to 5 percent.

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Figure 1: Quarterly Real Gasoline Prices

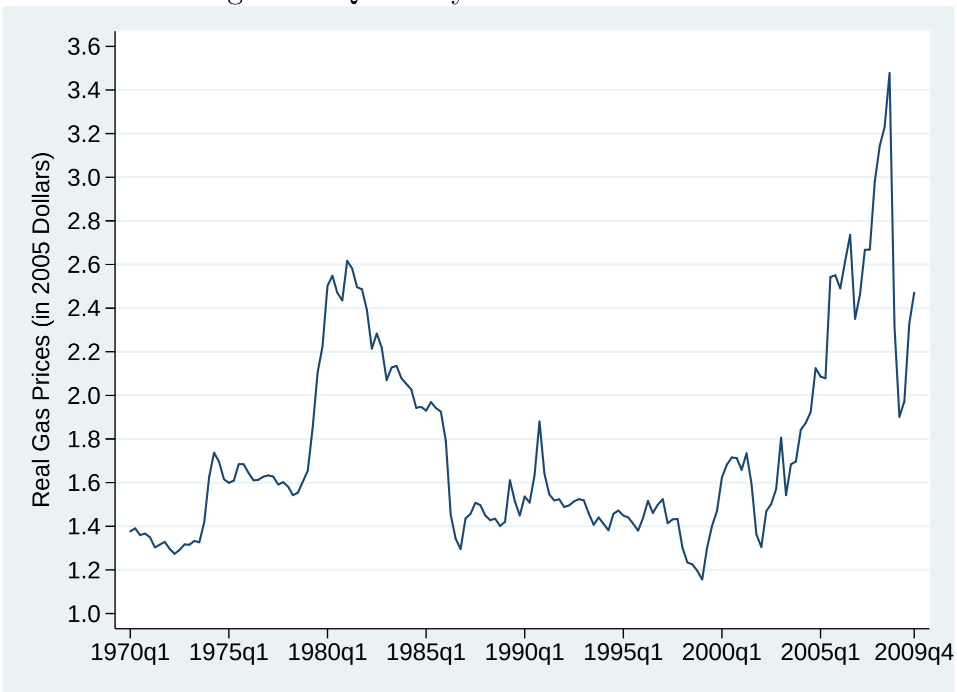

Figure 2: Annual Log Difference in Real Gasoline Prices

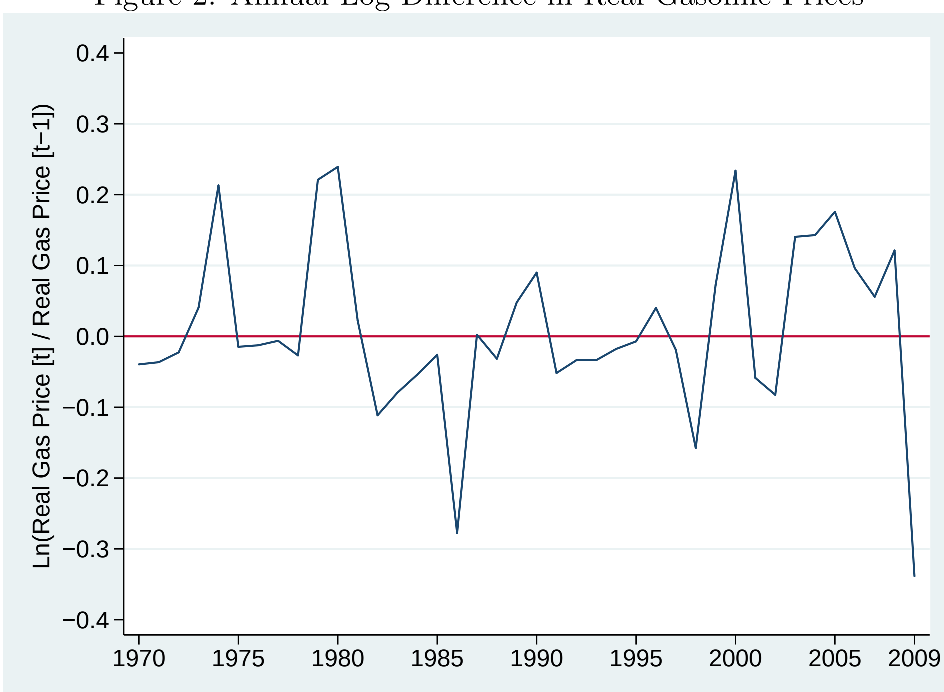

Table 1: Summary Statistics

	#observations	#locations	#MSAs
House Price Sample	119,000	4,250	202
Construction Sample	145,444	5,325	357
	Mean	Median	S.D.
Number of ZIP Codes in a MSA	21	8	39
Number of Places in a MSA	15	7	39
ZIP Code Land Area in 1990 (in square km)	81	31	155
Place Land Area in 1990 (in square km)	24	7	71
Number of Housing Units in a ZIP Code in 1980	9,565	8,515	6,341
Number of Housing Units in a Place in 1980	7,036	1,467	19,708
Change in Real House Price (%)	0.9	0.8	8.5
Change in Housing Stock (%)	1.6	0.6	3.8
Change in Real Gas Price (%)	0.7	-1.2	10.7
Commuting Time by ZIP Code (in minutes)	23.0	22.0	5.6
Commuting Time by Place (in minutes)	20.8	20.1	5.3

Table 2: Main Results

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$ (1)	Δln(House Price) (2)
$\Delta ln(\text{Gas Price}_{t-1}) * (\text{Commute Time} > 24\text{min})$	-0.009*	0.005
	(0.004)	(0.006)
$\Delta ln(\text{Gas Price}_{t-2}) * (\text{Commute Time} > 24\text{min})$	-0.008*	-0.004
	(0.003)	(0.007)
$\Delta ln(\text{Gas Price}_{t-3}) * (\text{Commute Time} > 24\text{min})$	-0.008**	-0.004
	(0.003)	(0.005)
$\Delta ln(\text{Gas Price}_{t-4}) * (\text{Commute Time} > 24\text{min})$	-0.004	-0.006
	(0.002)	(0.006)
Sum of Coefficients on 4 Lags of:		
$\Delta ln(\text{Gas Price}) * (\text{Commute Time} > 24\text{min})$	-0.030*	-0.009
	(0.012)	(0.016)
$\Delta ln(\text{Gas Price}) * ln(\text{Density})$	0.027**	0.005
	(0.005)	(0.003)
$\Delta ln(\text{GDP}) * (\text{Commute Time} > 24\text{min})$	-0.058	-0.186*
	(0.036)	(0.083)
$\Delta ln(\text{Mortgage Rate}) * (\text{Commute Time} > 24\text{min})$	0.024*	0.005
	(0.012)	(0.021)
N	145,444	119,000

Note: The construction regression is estimated at the place level and the house price regression is estimated at the ZIP code level. All regressions are estimated from 1980 to 2008 and include MSA-year fixed effects and location (i.e., ZIP code or place) fixed effects. Regressions are weighted by the number of single-family housing units in 1980 in each location. Standard errors in parentheses are clustered at the MSA level. * and ** indicate significance at the 5% and 1% levels respectively.

Table 3: Robustness Checks on the Housing Stock Effect

	(1)	(2)	(3)	(4)	(5)	(6)
Δln(Gas Price$_{t-1}$) $*$ (Commute Time $>$ 24min)	-0.009*	-0.009*	-0.009*	-0.009*	-0.007*	-0.009*
	(0.004)	(0.005)	(0.004)	(0.004)	(0.003)	(0.004)
Δln(Gas Price$_{t-2}$) $*$ (Commute Time $>$ 24min)	-0.008*	-0.008*	-0.008*	-0.009*	-0.006*	-0.008*
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
Δln(Gas Price$_{t-3}$) $*$ (Commute Time $>$ 24min)	-0.008**	-0.007*	-0.008*	-0.009*	-0.007**	-0.008*
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Δln(Gas Price$_{t-4}$) $*$ (Commute Time $>$ 24min)	-0.004	-0.004	-0.003	-0.006*	0.002	-0.005
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)
Sum of Coefficients on 4 Lags of:						
Δln(Gas Price) $*$ (Commute Time $>$ 24min)	-0.030*	-0.029*	-0.028*	-0.033**	-0.018*	-0.030*
	(0.012)	(0.011)	(0.012)	(0.013)	(0.008)	(0.012)
Other Controls Included:						
Δln(Gas Price) $*$ ln(Density)	Y	Y	Y	Y	Y	Y
Δln(Mortgage Rate) $*$ (Commute Time $>$ 24min)	Y	Y	Y	Y	Y	Y
Δln(GDP) $*$ (Commute Time $>$ 24min)	Y			Y		Y
Δln(Income) $*$ (Commute Time $>$ 24min)		Y				
Δln(Employment) $*$ (Commute Time $>$ 24min)			Y			
Δln(MSA Income) $*$ (Commute Time $>$ 24min)				Y		
Δln(MSA Employment) $*$ (Commute Time $>$ 24min)				Y		
Δln(Commodity Price) $*$ (Commute Time $>$ 24min)					Y	
Δln(Heating/Cooling Cost) $*$ (Average # of Rooms)						Y
N	145,444	145,444	145,444	145,444	145,444	145,444

Note: The construction regressions are estimated at the place level. All regressions are estimated from 1980 to 2008 and include MSA-year fixed effects and place fixed effects. Regressions are weighted by the number of single-family housing units in 1980 in each location. Standard errors in parentheses are clustered at the MSA level. * and ** indicate significance at the 5% and 1% levels respectively.

Table 4: Robustness Checks on the Housing Price Effect

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta ln(\text{Gas Price}_{t-1}) * (\text{Commute Time} > 24\text{min})$	0.005	0.012	-0.002	0.007	0.005	0.006
	(0.006)	(0.007)	(0.005)	(0.006)	(0.007)	(0.006)
$\Delta ln(\text{Gas Price}_{t-2}) * (\text{Commute Time} > 24\text{min})$	-0.004	-0.004	-0.012	-0.004	-0.002	-0.004
	(0.007)	(0.006)	(0.007)	(0.007)	(0.008)	(0.007)
$\Delta ln(\text{Gas Price}_{t-3}) * (\text{Commute Time} > 24\text{min})$	-0.004	-0.001	-0.010	-0.003	0.005	-0.004
	(0.005)	(0.005)	(0.006)	(0.006)	(0.008)	(0.006)
$\Delta ln(\text{Gas Price}_{t-4}) * (\text{Commute Time} > 24\text{min})$	-0.006	-0.004	-0.011	-0.004	0.010	-0.007
	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)
Sum of Coefficients on 4 Lags of:						
$\Delta ln(\text{Gas Price}) * (\text{Commute Time} > 24\text{min})$	-0.009	0.002	-0.036*	-0.005	0.018	-0.010
	(0.016)	(0.016)	(0.017)	(0.018)	(0.019)	(0.016)
Other Controls Included:						
$\Delta ln(\text{Gas Price}) * ln(\text{Density})$	Y	Y	Y	Y	Y	Y
$\Delta ln(\text{Mortgage Rate}) * (\text{Commute Time} > 24\text{min})$	Y	Y	Y	Y	Y	Y
$\Delta ln(\text{GDP}) * (\text{Commute Time} > 24\text{min})$	Y			Y		Y
$\Delta ln(\text{Income}) * (\text{Commute Time} > 24\text{min})$		Y				
$\Delta ln(\text{Employment}) * (\text{Commute Time} > 24\text{min})$			Y			
$\Delta ln(\text{MSA Income}) * (\text{Commute Time} > 24\text{min})$				Y		
$\Delta ln(\text{MSA Employment}) * (\text{Commute Time} > 24\text{min})$				Y		
$\Delta ln(\text{Commodity Price}) * (\text{Commute Time} > 24\text{min})$					Y	
$\Delta ln(\text{Heating/Cooling Cost}) * (\text{Average \# of Rooms})$						Y
N	119,000	119,000	119,000	119,000	119,000	119,000

Note: The house price regressions are estimated at the ZIP code level. All regressions are estimated from 1980 to 2008 and include MSA-year fixed effects and ZIP code fixed effects. Regressions are weighted by the number of single-family housing units in 1980 in each location. Standard errors in parentheses are clustered at the MSA level. * and ** indicate significance at the 5% and 1% levels respectively.

Table 5: Nonlinearity in Gas Price Changes

A. Large Change vs Small Change

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$	Δln(House Price)
Sum of Coefficients on 4 Lags of:		
Δln(Gas Price) $*$ (CT $>$ 24min) $*$ (Large Change)	0.011	0.001
	(0.010)	(0.023)
Δln(Gas Price) $*$ (CT $>$ 24min)	-0.036*	-0.006
	(0.015)	(0.024)
(CT $>$ 24min) $*$ (Large Change)	-0.002	0.010*
	(0.002)	(0.004)
Interpretations:		
Overall Effect of Large Gas Price Changes	-0.027	0.005
	(0.014)	(0.033)
Overall Effect of Small Gas Price Changes	-0.036*	-0.006
	(0.015)	(0.024)

B. Negative Change vs Positive Change

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$	Δln(House Price)
Sum of Coefficients on 4 Lags of:		
Δln(Gas Price) $*$ (CT $>$ 24min) $*$ (Negative Change)	-0.003	-0.078*
	(0.021)	(0.039)
Δln(Gas Price) $*$ (CT $>$ 24min)	-0.028*	0.052
	(0.014)	(0.047)
(CT $>$ 24min) $*$ (Negative Change)	0.001	0.006
	(0.001)	(0.004)
Interpretations:		
Overall Effect of Negative Gas Price Changes	-0.030	-0.020
	(0.025)	(0.033)
Overall Effect of Positive Gas Price Changes	-0.028*	0.052
	(0.014)	(0.047)

C. When Gas Price is High vs When Gas Price is Low

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$	Δln(House Price)
Sum of Coefficients on 4 Lags of:		
Δln(Gas Price) $*$ (CT $>$ 24min) $*$ (Gas Price Above \$2)	0.005	-0.004
	(0.025)	(0.156)
Δln(Gas Price) $*$ (CT $>$ 24min)	-0.026	0.080
	(0.014)	(0.055)
(CT $>$ 24min) $*$ (Gas Price Above \$2)	0.001	0.003
	(0.001)	(0.004)
Interpretations:		
Overall Effect of When Gas Price is High	-0.021	0.078
	(0.033)	(0.180)
Overall Effect of When Gas Price is Low	-0.026	0.080
	(0.014)	(0.055)

Note: The construction regression is estimated at the place level and the house price regression is estimated at the ZIP code level. All regressions are estimated from 1980 to 2008 and include MSA-year fixed effects and location (i.e., ZIP code or place) fixed effects. Regressions are weighted by the number of single-family housing units in 1980 in each location. Standard errors in parentheses are clustered at the MSA level. * and ** indicate significance at the 5% and 1% levels respectively.

Table 6: Nonlinearity in Commute Times

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$ (1)	Δln(House Price) (2)
Sum of Coefficients on 4 Lags of:		
Δln(Gas Price) $*$ (17 $<$ Commute Time $<$ 20min)	0.009	-0.009
	(0.012)	(0.013)
Δln(Gas Price) $*$ (20 $<$ Commute Time $<$ 24min)	-0.026	-0.006
	(0.015)	(0.014)
Δln(Gas Price) $*$ (24 $<$ Commute Time $<$ 28min)	-0.043*	-0.014
	(0.018)	(0.019)
Δln(Gas Price) $*$ (Commute Time $>$ 28min)	-0.050*	-0.019
	(0.022)	(0.025)
N	145,444	119,000

Note: The construction regression is estimated at the place level and the house price regression is estimated at the ZIP code level. All regressions are estimated from 1980 to 2008 and include MSA-year fixed effects and location (i.e., ZIP code or place) fixed effects. Regressions are weighted by the number of single-family housing units in 1980 in each location. Standard errors in parentheses are clustered at the MSA level. * and ** indicate significance at the 5% and 1% levels respectively.

Table 7: Effect of Gas Price by Commute Time Dispersion and Car Use

A. By Car Use in Locations (Low is <90% and High is >90%)

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$		Δln(House Price)	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
$\Delta ln(\text{Gas Price}_{t-1}) * (\text{Commute Time} > 24\text{min})$	-0.003	-0.016*	0.010	-0.002
	(0.004)	(0.007)	(0.014)	(0.006)
$\Delta ln(\text{Gas Price}_{t-2}) * (\text{Commute Time} > 24\text{min})$	-0.003	-0.017**	-0.003	-0.006
	(0.003)	(0.006)	(0.012)	(0.006)
$\Delta ln(\text{Gas Price}_{t-3}) * (\text{Commute Time} > 24\text{min})$	-0.002	-0.014**	-0.002	-0.005
	(0.003)	(0.005)	(0.009)	(0.006)
$\Delta ln(\text{Gas Price}_{t-4}) * (\text{Commute Time} > 24\text{min})$	0.000	-0.013**	-0.003	-0.006
	(0.002)	(0.004)	(0.019)	(0.07)
Sum of Coefficients on 4 Lags of:				
$\Delta ln(\text{Gas Price}) * (\text{Commute Time} > 24\text{min})$	-0.007	-0.060**	0.002	-0.019
	(0.011)	(0.019)	(0.022)	(0.015)
N	79,763	65,681	43,820	75,180

B. By Commute Time Dispersion in MSA (Low is <p75 and High is >p75)

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$		Δln(House Price)	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
$\Delta ln(\text{Gas Price}_{t-1}) * (\text{Commute Time} > 24\text{min})$	0.003	-0.011*	0.001	0.006
	(0.007)	(0.004)	(0.010)	(0.007)
$\Delta ln(\text{Gas Price}_{t-2}) * (\text{Commute Time} > 24\text{min})$	-0.001	-0.009*	0.009	-0.007
	(0.009)	(0.004)	(0.012)	(0.007)
$\Delta ln(\text{Gas Price}_{t-3}) * (\text{Commute Time} > 24\text{min})$	-0.004	-0.008*	0.002	-0.006
	(0.007)	(0.003)	(0.014)	(0.006)
$\Delta ln(\text{Gas Price}_{t-4}) * (\text{Commute Time} > 24\text{min})$	-0.006	-0.004	0.004	-0.008
	(0.004)	(0.002)	(0.010)	(0.007)
Sum of Coefficients on 4 Lags of:				
$\Delta ln(\text{Gas Price}) * (\text{Commute Time} > 24\text{min})$	-0.008	-0.032*	0.017	-0.015
	(0.024)	(0.013)	(0.041)	(0.016)
N	46,409	99,035	42,336	76,664

Note: The construction regression is estimated at the place level and the house price regression is estimated at the ZIP code level. All regressions are estimated from 1980 to 2008 and include MSA-year fixed effects, location (i.e., ZIP code or place) fixed effects, gas price interacted with density, GDP interacted with commute time, and mortgage rate interacted with commute time. Regressions are weighted by the number of single-family housing units in 1980 in each location. Standard errors in parentheses are clustered at the MSA level. * and ** indicate significance at the 5% and 1% levels respectively.

Table 8: Effect of Gas Price by Density and Regulation Index

A. By Housing Density in Locations (Low is <p50 and High is >p50)

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$		Δln(House Price)	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
$\Delta ln(\text{Gas Price}_{t-1}) * (\text{Commute Time} > 24\text{min})$	-0.028*	-0.005	-0.003	0.005
	(0.013)	(0.004)	(0.005)	(0.007)
$\Delta ln(\text{Gas Price}_{t-2}) * (\text{Commute Time} > 24\text{min})$	-0.022	-0.004	0.003	-0.008
	(0.014)	(0.003)	(0.006)	(0.009)
$\Delta ln(\text{Gas Price}_{t-3}) * (\text{Commute Time} > 24\text{min})$	-0.023*	-0.004	-0.005	-0.001
	(0.012)	(0.003)	(0.007)	(0.006)
$\Delta ln(\text{Gas Price}_{t-4}) * (\text{Commute Time} > 24\text{min})$	-0.015	-0.000	0.003	-0.007
	(0.008)	(0.002)	(0.006)	(0.010)
Sum of Coefficients on 4 Lags of:				
$\Delta ln(\text{Gas Price}) * (\text{Commute Time} > 24\text{min})$	-0.089*	-0.014	-0.003	-0.011
	(0.044)	(0.010)	(0.013)	(0.019)
N	72,110	73,334	59,500	59,500

B. By Wharton Regulation Index in MSA (Low is <0 and High is >0)

	$\frac{\text{Construction}_t}{\text{Housing Stock}_{t-1}}$		Δln(House Price)	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
$\Delta ln(\text{Gas Price}_{t-1}) * (\text{Commute Time} > 24\text{min})$	-0.024	-0.007	0.001	-0.001
	(0.014)	(0.007)	(0.013)	(0.009)
$\Delta ln(\text{Gas Price}_{t-2}) * (\text{Commute Time} > 24\text{min})$	-0.019	-0.010	-0.007	-0.016
	(0.014)	(0.007)	(0.016)	(0.009)
$\Delta ln(\text{Gas Price}_{t-3}) * (\text{Commute Time} > 24\text{min})$	-0.027	-0.003	-0.003	-0.014*
	(0.016)	(0.006)	(0.011)	(0.007)
$\Delta ln(\text{Gas Price}_{t-4}) * (\text{Commute Time} > 24\text{min})$	-0.013	-0.002	-0.004	-0.023*
	(0.011)	(0.005)	(0.014)	(0.010)
Sum of Coefficients on 4 Lags of:				
$\Delta ln(\text{Gas Price}) * (\text{Commute Time} > 24\text{min})$	-0.084	-0.021	-0.013	-0.055**
	(0.051)	(0.033)	(0.041)	(0.015)
N	19,935	16,516	20,972	33,180

Note: The construction regression is estimated at the place level and the house price regression is estimated at the ZIP code level. All regressions are estimated from 1980 to 2008 and include MSA-year fixed effects, location (i.e., ZIP code or place) fixed effects, gas price interacted with density, GDP interacted with commute time, and mortgage rate interacted with commute time. Regressions are weighted by the number of single-family housing units in 1980 in each location. Standard errors in parentheses are clustered at the MSA level. * and ** indicate significance at the 5% and 1% levels respectively.

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