What Explains the 2007-2009 Drop in Employment?

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Abstract

We show that deterioration in household balance sheets, what we refer to as the *housing net worth* channel, played a significant role in the sharp decline in U.S. employment between 2007 and 2009. Using geographical variation across U.S. counties, we show that counties with a larger decline in housing net worth experience a larger decline in non-tradable employment. This result is not driven by industry-specific supply-side shocks, exposure to the construction sector, policy-induced business uncertainty, or contemporaneous credit supply tightening. We find little evidence of labor market adjustment in response to the housing net worth shock. There is no expansion in the tradable sector in affected counties, and the correlation between the housing net worth decline and job losses in the tradable sector is zero. There is no evidence of wage adjustment, or of net labor emigration out of affected counties either.

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The 2007 to 2009 recession led to the largest decline in employment in the United States since the Great Depression. The employment to population ratio dropped from 63% in 2007 to 58% in 2009, a loss of 8.6 million jobs. Understanding large drops in employment is one of the central questions in macroeconomics. Why did the employment level drop so drastically between 2007 and 2009? We approach this question with a particular focus on the *housing net worth channel*.

The *housing net worth channel* refers to a decline in employment because of a sharp reduction in the housing net worth of consumers. A decline in housing net worth could reduce employment by suppressing consumer demand either through a direct wealth effect or through tighter borrowing constraints driven by the fall in collateral value. Mian, Rao and Sufi (2013) show that households experiencing a decline in housing net worth cut back significantly on spending, with spending cuts per dollar of lost net worth being larger for households in poorer zip codes and zip codes with higher leverage – in line with the predictions of a concave consumption function.

The 2007 to 2009 housing bust led to a large decline in housing net worth, and the magnitude of the decline varied greatly across the United States. The cross-sectional variation in the net worth decline depended on (a) the extent of the house price decline in an area, and (b) the amount of leverage on household balance sheets. We use this cross-sectional variation to test if the broader decline in employment is related to the fall in housing net worth.

We begin with the observation that the impact of the decline in spending in a county due to a fall in housing net worth should show up foremost in non-tradable sector employment of that county. The non-tradable sector in a county depends primarily on local demand in that county, while the tradable sector is more diversified in its geographic origins of demand. We therefore

separately track tradable and non-tradable employment using detailed 4-digit industry employment data by county.

We classify 4-digit industries into tradable and non-tradable sectors using two independent methods. The first method defines retail- and restaurant-related industries as non-tradable, and industries which show up in global trade data as tradable. We also introduce a second method based on the idea that industries reliant on national demand will tend to be geographically concentrated, while industries relying on local demand will be more uniformly distributed. Industries are thus defined as non-tradable if they have a low geographical concentration herfindahl and tradable otherwise.

We find strong support for the housing net worth channel. Job losses in the non-tradable sector between 2007 are 2009 are significantly higher in counties with a large decline in housing net worth. A one standard deviation change in housing net worth decline is associated with a 3.1 percentage point decline in non-tradable employment, or 51% of the standard deviation of change in non-tradable employment. Survey evidence from U.S. businesses also shows a rapid increase in concern about "poor sales" starting in 2007, with the increase in this response concentrated in states with largest decline in housing net worth.

We show that the strong correlation between housing net worth decline and the decline in non-tradable employment is not driven by alternative explanations, such as industry-specific supply-side shocks. Using Saiz (2011) housing supply elasticity as an instrument for housing net worth decline, we show that the impact of housing net worth shock on non-tradable employment is not driven by exposure to construction-related sectors. Housing supply elasticity strongly predicts the change in housing net worth, but is completely *orthogonal* to construction activity in a county due to two countervailing forces: while high housing supply elasticity puts downward

pressure on prices thus reducing the incentive to build, it also reduces the marginal cost of constructing an extra housing unit by definition.

We also include as controls the share of employment in a county devoted to each of the 23 two-digit industries at the start of the Great Recession. If counties experiencing a large decline in housing net worth were spuriously exposed to any of these 23 industries, the controls would correct for such supply-side shocks. However, the impact of change in housing net worth on non-tradable employment remains unchanged despite a significant increase in R-sq.

We further test if a spurious correlation between housing net worth shock and a rise in policy-driven business uncertainty might explain our findings. The survey of business owners shows that while there was an increase in concern among business owners regarding "regulation and taxes", the timing of the increase *follows* both the decline in employment and business owners' concern about "poor sales." Moreover, the cross-sectional increase in concern regarding regulation and taxes is not correlated with the housing net worth decline, making the uncertainty hypothesis an unlikely explanation for our results.

We also consider the possibility that our results might be driven by tighter credit constraints faced by establishments in areas with large decline in housing net worth, but find no support for this hypothesis. First, business owners' concern about "financing" remains extremely low throughout our sample period. Second, we split our sample by the size of establishments and show that the correlation between change in non-tradable employment and housing net worth shock is *stronger* among large establishments that are less likely to suffer from credit constraints. Third, the cross-sectional correlation between employment loss and housing net worth decline *only* holds true for non-tradable sector, and not for the tradable sector. If credit constraints were

behind the correlation, the correlation should have held for both tradable and non-tradable industries.

While non-tradable employment suffers significantly due to the housing net worth shocks, the economy-wide impact of these shocks depends on the extent of rigidity – both nominal and real - in the labor market. The initial shock to non-tradable employment can lead to reduced wages, labor out-migration and – most importantly - expansion in the tradable sector. A simple model shows that flexibility in wages and labor mobility across sectors can neutralize the non-tradable employment loss through gains in the tradable sector. However, rigidities in wage setting and real search frictions may limit any adjustment on the tradable sector margin.

An important contribution of our paper is that we directly estimate the extent of adjustment through the tradable sector. If the loss in non-tradable employment in counties with large decline in housing net worth is compensated by a gain in tradable employment then we should see such a gain in data. However, remarkably we find *zero* correlation between the housing net worth shock and the change in tradable employment. There is no evidence that workers who lose jobs in the non-tradable sector tend to gain jobs in the tradable sector.

It is also possible that workers who lose jobs in the adversely affected counties migrate to less-affected counties and gain employment there. However, we find no evidence of labor mobility from counties with a large decline in housing net worth to less-affected counties. We also show that local wages are sticky in the sense that they are largely non-responsive to severe housing net worth shocks.

The presence of wage and search frictions in the labor market implies that not only are the employment losses in the non-tradable sector more durable, but the total impact of the housing net worth shock is larger once one takes into account the rest of the sectors as well. In

particular, when households cut spending due to lower net worth, the employment consequences will impact all sectors of the economy through the trade channel.

Our cross-sectional analysis does not capture this "level shift" in the rest of the sectors through the trade channel. However, we can compute the potential magnitude of the housing net worth channel on total employment under some plausible assumptions. For example, if households have the same elasticity of spending with respect to housing net worth for non-tradable sector and other sectors, and the elasticity of labor demand for non-tradable and other sectors is similar, then the results for non-tradable sector can be extrapolated to the entire economy. We provide more details relating to such calculations in section 5.

Our paper is related to a string of recent theoretical work that shows how demand shocks driven by a weakness in household balance sheet translate into a decline in real activity due to the presence of nominal or labor market rigidities (see e.g. Eggertsson and Krugman (2012), Guerrieri and Lorenzoni (2011), Hall (2011), Midrigan and Philippon (2011), and Farhi and Werning (2013)). This paper is one of the first empirical studies that exploit detailed cross-sectional variation to explicitly test the employment consequences of housing net worth shocks.[1] We discuss some other related work in sections 5 and 6.

The rest of the paper is structured as follows. Section 1 describes the data, section 2 provides the main empirical results regarding the effect of net housing shock on non-tradable employment. Section 3 outlines a simple model that discusses potential adjustment mechanisms in the labor market in reaction to the impact on the non-tradable sector. Section 4 tests for the presence of these labor market adjustments and section 5 provides baseline calculation of the overall impact of housing net worth shock. Section 6 concludes.

[1] Bils, Klenow, and Malin (2012) use a strategy based on variation in demand shocks for non-durable and durable goods to estimate the effect of demand shocks on employment.

Section 1: Data, Industry Classification, And Summary Statistics

A. Data

We build a county-level data set that includes employment data by 4-digit industry in a county, household balance sheet information including total debt and housing value, wages and other demographic and income information.

County by industry employment and payroll data are from the County Business Patterns (CBP) data set published by the U.S. Census Bureau. CBP data are recorded in March each year. We use CBP data at the 4-digit industry level, so we know the breakdown of number of employees and total payroll bill within a county for every 4-digit industry.[2] We place each of the 4-digit industries into one of four categories: non-tradable, tradable, construction, and other. We discuss the classification scheme in the next subsection. We supplement the CBP data with hourly wage data from the annual American Community Survey (ACS). ACS is based on a survey of 3 million U.S. residents conducted annually.

One of our key right hand side variables is the change in household net worth between the end of 2006 and 2009. We define net worth for households living in county *i* at time *t* as, $NW_t^i = S_t^i + B_t^i + H_t^i - D_t^i$, where the four terms on the right hand side represent market values of stocks, bonds, housing, and debt owed, respectively. We compute the market value of stock and bond holdings (including deposits) in a given county using IRS Statistics of Income (SOI) data. We estimate the value of housing stock owned by households in a county using the 2000 Decennial Census data as the product of the number of home owners and the median home value. We then project the housing value into later years using the Core Logic zip code level house price index and an estimate of the change in homeownership and population growth.

[2] County data at the 4 digit industry level is at times suppressed for confidentiality reasons. However, in these situations the Census Bureau provides a "flag" that tells us of the range within which the employment number lies. We take the mean of this range as a proxy for the missing employment number in such scenarios.

Finally, we measure debt using data from Equifax Predictive Services that tells us the total borrowing by households in each county in a given year.

Mian, Rao and Sufi (2013) provide a more detailed discussion of the construction of the net worth variable. The change in total net worth between 2006 and 2009 due to the housing shock can be written as $\Delta logp_{06-09}^{H,i} * H_{2006}^{i}$, or $\Delta HNW = \frac{\Delta logp_{06-09}^{H,i} * H_{2006}^{i}}{NW_{2006}^{i}}$ in percentage terms. The latter term, ΔHNW, is what we call the *housing net worth shock* . The housing net worth shock calculation ignores the possibility of debt write-off due to default. However, our Equifax data on household debt has very accurate information on defaults and write downs, and accounting for debt write-downs does not change any of our core results.

B. Classifying industries into tradable and non-tradable categories

Splitting employment into jobs producing tradable versus non-tradable goods is a crucial part of our empirical strategy. The difficulty is that many industries produce goods that fit into both non-tradable and tradable categories. For example, some banking services cater to local demand--a consumer may need a physical branch to deposit funds. Other banking services cater to national or international demand--for example, investment banking for large corporations. Given that many industries could be possibly categorized as producing both tradable and non-tradable goods, subjectivity is a real problem in this setting.

Our solution to this problem has three components. First, we are fully transparent in our classification of industries, providing a detailed listing of which category each of the 4-digit industries falls into. Second, we provide two independent methods of industry classification which serve as a cross-check on each other. Moreover, one of these methods is based on an objective criterion of an industry's geographical concentration. Third, we are deliberately conservative in classifying industries as either tradable or non-tradable. Or in other words, we try

to minimize the Type I error of wrongly classifying an industry as non-tradable (or tradable) when it actually is not.

We describe our two different methods of classifying industries below:

1. Retail and world trade based classification

For the first classification scheme, we define a 4-digit NAICS industry as *tradable* if it has imports plus exports equal to at least $10,000 per worker, or if total exports plus imports for the NAICS 4-digit industry exceeds $500M.[3] *Non-tradable* industries are defined as the retail sector and restaurants. We have also used a more restricted version of non-tradable industries that includes only grocery retail stores and restaurants as robustness. A third category is *construction*, which we define as industries related to construction, real estate, or land development. A large number of industries do not fit neatly into one of these three categories. We treat these other industries as a separate category we label as *other*. Table 1 presents the top ten NAICS coded industries in each of our four categories based on the fraction of total employment as of 2007, and Appendix Table 1 lists all 294 4-digit industries and their classification. The shares of total employment as of 2007 for the four categories are: tradable (11%), non-tradable (20%), construction (11%), and other (59%).[4]

2. Geographical concentration based classification

An alternative classification of industries is based on an industry's geographical concentration. The idea is that the production of tradable goods requires specialization and scale, so industries producing tradable goods should be more concentrated geographically. Similarly,

[3] The industry level trade data for the U.S. is taken from Robert Feenstra's website http://cid.econ.ucdavis.edu. The trade data is based on 2006 numbers.

[4] Tradable goods are mostly manufacturing, while the largest industries in the "other" category are service oriented industries such as health care and education. However, our second method of classification –described below - is based on geographical concentration of industries and allows all such sectors to be classified as tradable or non-tradable.

there are goods and services (such as vacation beaches and amusement parks) that may not be tradable themselves, but rely on national demand rather than local demand. For our empirical approach, these industries that are likely to be concentrated geographically should be classified as tradable. In contrast, industries producing non-tradable goods should be dispersed given that all counties need such goods and services.[5]

We construct a geographical Herfindahl index for each industry based on the share of an industry's employment that falls in each county. Consistent with the intuition that geographic concentration captures tradable and non-tradable goods production, we find a Herfindahl index of 0.018 for industries that we classify as tradable in our first classification scheme, and a Herfindahl index of 0.004 for industries we classify as non-tradable. This is a large difference in Herfindahl given that the mean and standard deviation of Herfindahl index across industries is 0.016 and 0.023, respectively.

Table 2 lists the top 30 most concentrated industries and whether they are classified as tradable according to our previous categorization. A number of new industries, such as securities exchanges, sightseeing activities, amusement parks, and internet service providers, show up as tradable under the new scheme. This is sensible given that these activities cater to broader national level demand. Similarly, the bottom 30 industries according to the concentration index reveal a number of new industries classified as non-tradable, including lawn and garden stores, death care services, child care services, religious organizations, and nursing care services. These are all industries that cater mostly to local demand but were missed in our previous classification.

We categorize the top and bottom quartile of industries by geographical concentration as tradable and non-tradable, respectively. We can also use the underlying index as a continuous

[5] As an example, the tradable automobile manufacturing employment shown in Figure 3 is present in 1,528 counties only, while the non-tradable automobile retail employment is present in almost every county (3,009).

measure of "tradability" in some of our robustness checks below. Appendix Table 1 lists all 294 4-digit industries and their Herfindahl index.

C. Summary statistics

Table 3 presents summary statistics for our sample. The average housing net worth shock in a county between 2006 and 2009 is 6.5% (9.5% when population weighted) with a large standard deviation of 8.5% (10.0% weighted). Overall employment drops from 2007 to 2009 by 5.3%, while the drop is 16.1% for construction, 11.6% for tradable goods, 4.0% for non-tradable goods and 2.6% for other sectors. Nominal wage growth computed from the CBP data is positive. However, this wage is computed as total payroll divided by the number of employees and as such the change in wage includes possible changes in the number of hours worked. We therefore also construct hourly wage data from the American Community Survey (ACS). The average hourly reported wage is $21.1 in 2007 and grows at the rate of 4.0% from 2007 to 2009.

Section 2: Housing Net Worth and the Decline in Non-Tradable Employment

Shocks to housing net worth can have important consequences for spending and employment. Households, especially in the presence of debt, respond to a decline in housing net worth by reducing spending, which can have an adverse impact on employment in the presence of nominal rigidities. This housing net worth hypothesis has been put forward by economists such as Irving Fisher and James Tobin, and formalized more recently by work such as Eggertsson and Krugman (2012) and Farhi and Werning (2013).

Mian, Rao and Sufi (2013) provide evidence that counties with large decline in housing net worth cut back more in spending. Moreover the marginal propensity to cut spending for a dollar decline in net worth is significantly stronger in neighborhoods where households are more levered. We take the overall effect of housing net worth on spending – which is driven by both a

decline in house prices and their interaction with leverage – as given. Our goal in this section is to evaluate the employment consequences of the housing net worth shock.

A. The housing net worth hypothesis

The key parameter of interest is the elasticity of employment with respect to housing net worth shock. How much does employment decline for each percentage decline in housing net worth? Estimating this parameter is complicated by the fact that reduction in spending as a result of net worth decline in an area impacts employment *everywhere* through the trade channel, making it difficult to trace the employment effect of local net worth shocks.

Our solution to this problem lies in isolating the impact of change in net worth on employment in the non-tradable sector. The non-tradable sector relies primarily on spending in its geographical proximity by definition. Therefore by restricting attention to employment in the non-tradable sector, we can test if housing net worth shocks translate into employment loss. The equation to estimate is the following:

$$\Delta log E_i^{NT} = \alpha + \eta * \Delta NHW_i + \epsilon_i \qquad (1)$$

where $\Delta log E_i^{NT}$ is the log change in non-tradable employment (excluding construction) in county *i* between 2007 and 2009, ΔNHW_i is the housing net worth shock defined as $\frac{\Delta log p_{06-09}^{H,i} * H_{2006}^i}{NW_{2006}^i}$, and η is the elasticity of interest. [6]

Figure 1 plots $\Delta log E_i^{NT}$ against ΔNHW_i for the two definitions of non-tradable employment mentioned in section 1. The left panel is based on restaurants and retail stores as the non-tradable sector definition. There is a strong positive correlation between the two variables. Counties with bigger decline in housing net worth experience a larger decline in non-tradable employment. The thin black line in the left-panel plots the non-parametric relationship between

[6] Note that the change in housing net worth is larger when the change in house price is larger *and* when household leverage is higher.

change in employment in the non-tradable sector and change in housing net worth, and shows that there is some convexity in the relationship between the two variables.

The right-panel of Figure 1 repeats the exercise using the second definition of non-tradable based on geographical concentration of each 4-digit industry. While the set of industries defined as non-tradable under the second definition is quite distinct from those defined as non-tradable under the first definition, the results are remarkably similar.[7] Columns 1 and 2 of Table 4 regress the change in non-tradable employment using the two definitions of non-tradable employment on change in housing net worth. The correlation documented in Figure 1 is strong and significant at the 1% level.

All standard errors in this paper are clustered at the state level to allow for spatial correlation across counties within a state, and to allow for correlation within a state due to state-specific foreclosure, bankruptcy or other labor market laws. In the appendix we also show robustness to computing standard errors that allow for spatial correlation among counties that are close to each other but in different states[8].

While the correlation between $\Delta log E_i^{NT}$ and ΔNHW_i in columns 1 and 2 is strong, we need to be confident that the causality in this relationship runs from the change in housing net worth to the change in non-tradable employment. In particular, we want to make sure that ΔNHW_i is not acting as a proxy for non-housing net worth shocks such as supply side industry-specific shocks that impact both employment and housing net worth, credit supply tightening, or policy-induced business uncertainty.

[7] For visual clarity, we exclude some outlier counties with large decline in housing net worth (below -0.3). However, all these counties are included in the regression analysis and hence are not excluded from our formal analysis.
[8] In particular, we use the latitude and longitude of the center of each county to compute the distance between all county pairs. We then allow for county-pairs to have correlation that varies inversely with the distance between them. See Appendix Table 2.

We address each of these concerns in this section, starting with using the housing supply elasticity introduced by Saiz (2010) as an instrument for the change in housing net worth. Earlier work has shown that the Saiz measure is a powerful predictor of the house price boom-and-bust cycle. Mian, Rao and Sufi (2013) discuss in detail the mechanisms through which the housing supply instrument influences change in housing net worth.

They show that housing supply elasticity generates variation in house price growth that is largely orthogonal to a number of important variables that one might otherwise view as endogenous to the determination of house price dynamics. In particular, cities with inelastic housing supply did not experience any differential permanent income shock – as proxied by the change in wage growth – between 2002 and 2006. Similarly, cities with lower housing supply elasticity did not have significantly different exposure to the construction sector, nor did they experience different growth in the construction sector. The zero correlation between housing supply elasticity and the construction sector is important in ruling out that the housing net worth effect is driven by the construction sector. Finally, despite having higher house price growth, more inelastic cities had slightly slower population growth.

Columns 3 and 4 in Table 4 present the instrumental variables estimate using housing supply elasticity as an instrument for housing net worth shock. The estimated coefficient increases in the IV estimate, especially in column 3 that uses restaurants and retail sector as non-tradable sector definition. The number of observations declines because the housing supply elasticity variable is not available for all counties. In unreported regressions, we find that the increase in coefficient relative to the OLS version is not driven by the smaller sample size.

The estimated coefficients in Table 4 are large. For example, the IV estimate in column 3 implies that a one standard deviation decline in the change in housing net worth is associated

with a 3.1 percentage point drop in employment in the non-tradable sector, or one-half the standard deviation of non-tradable employment.[9] The elasticity of spending with respect to housing net worth is estimated to be 0.77 in Mian, Rao and Sufi (2013), which implies an elasticity of non-tradable employment with respect to spending of 0.4.[10]

The IV estimates suggest that variation in housing net worth decline generated by differences in land topology – as opposed to economic fundamentals – lead to changes in employment in the non-tradable sector. We next perform a number of additional checks to test if this result might be driven by alternative explanations.

B. Supply-side sector-specific shocks

One alternative explanation for the results in columns 1 through 4 of table 4 is that certain county-specific supply-side shocks affect local demand, local house prices, and local non-tradable employment all at the same time. For example, sectors such as construction and real estate were hit particularly hard during the Great Recession. If counties that were more exposed to construction-related activity also experienced more severe housing net worth shocks, then the decline in spending and non-tradable employment in these counties may be a result of such industry-specific supply-side shocks.

However, we show that our result is not driven by such supply-side concerns. Columns 5 and 6 control for cross-county differences in industry exposure by including the share of a county's employment in 2006 that is in *each of the 23 two-digit industries*. There are thus 23 additional control variables that allow for separate industry effects for industries such as

[9] We use weighted mean and standard deviation in all our calculations.
[10] Elasticity of spending from Table III, column 4 of Mian, Rao and Sufi (2013), 0.4=0.31/0.77.

agriculture, mining, utilities, construction, wholesale trade, retail trade, finance, real estate, construction and health care.[11]

The results show that the coefficient on the housing net worth shock does not change in any statistically significant sense, despite the fact that the R-square increases significantly. Oster (2014) suggests a test for omitted variable bias that uses the information contained in the change in coefficient and the change in R-square when moving from uncontrolled to controlled regression. Her methodology based on Altonji, Elder and Taber (2005) shows that if selection on the observed controls is proportional to the selection on the unobserved controls, then we can compute an identified set. Oster (2014) suggests testing whether the identified set for the treatment effect includes zero.

We perform this test using information in columns 1, 2, 5 and 6 by computing her recommended identified set $[\tilde{\beta}, \beta^{*'}(2.2\tilde{R}, 1)]$, where $\beta^{*'}(2.2\tilde{R}, 1) = \tilde{\beta} - \frac{(\dot{\beta}-\tilde{\beta})(2.2\tilde{R}-\tilde{R})}{(\tilde{R}-\dot{R})}$ [12]. The recommended sets [0.131, 0.174] and [0.0492, 0.166] safely exclude zero, thus rejecting that the effect of housing net worth shock on non-tradable employment is driven by omitted variables.

It should be noted that the slight decline in coefficient estimates in columns 5 and 6 could also be the result of measurement error becoming more important as we saturate the right hand side with more covariates. This is consistent with the increase in IV estimate in columns 7 and 8. The IV coefficient of interest remains as strong despite the inclusion of industry-specific controls.

The Oster (2014) procedure ignores measurement error and hence would extrapolate further any decline in coefficient due to measurement error in the controlled regression.

[11] Table 4 lists all of the 23 two-digit industries.
[12] See Oster (2014) for definitions.

However, despite this possible bias of the Oster methodology working against us, our results are robust to her prescribed robustness check.

Columns 5 through 8 have taken a flexible and agnostic approach toward the possible source of industry-specific supply side shocks. Such shocks may originate in any of the 23 2-digit industries. Since the construction and real estate sectors are of special concern during the 2007-09 Great Recession, we conduct some additional checks in Table 5 to test if our result might be driven by a spurious exposure of counties with large housing net worth decline to the construction sector. We limit the sample to 540 counties with data on housing supply elasticity for consistency across columns. However, none of the results are materially different if we expand to the full sample of 944 counties whenever possible.

Columns 1 and 2 show that the un-instrumented change in housing net worth is indeed correlated with both the share of employment in construction in 2007 and the growth in construction sector employment between 2000 and 2007. However, columns 3 and 4 show that including these variables as controls do not affect our coefficient of interest and the coefficients on the controls are insignificant. This should not come as a surprise given our earlier result from Table 4 that included separate controls for each of the 23 two-digit industries.

The economic rationale for why construction and real estate related activity is orthogonal to the impact of housing net worth shock on non-tradable employment is provided in columns 5 and 6. The results show that when change in housing net worth is instrumented using the housing supply elasticity variable, it is no longer significantly correlated with either the share of construction sector in 2007 or the pre-recession growth in construction sector.[13] In other words,

[13] It should be kept in mind that we explicitly removed any construction, real estate, or mortgage-related employment from the definition of non-tradable sector.

the variation in the change in net housing wealth that comes from housing supply elasticity is completely uncorrelated with the construction sector.

Why is the instrumented change in housing net worth uncorrelated with the construction share and the growth in construction sector? The answer lies in the dual role played by the housing supply elasticity instrument. On one hand, less elastic counties see sharper increases in house prices during the boom. This makes more credit available due to higher collateral value and facilitates more construction activity--for example, home remodeling. On the other hand, less elastic counties have – by definition – a higher marginal cost to expand the housing stock. The combination of these two opposing forces makes housing elasticity uncorrelated with construction activity, but strongly correlated with house price volatility and the accumulation of leverage.

Columns 7 and 8 explicitly *control* for job losses in construction between 2007 and 2009. It is an extreme test because putting the change in construction employment on the right hand side is likely to "over control": the spending response to housing net worth decline will impact housing and construction sector as well.[14] Nonetheless column 7 shows that the coefficient on change in housing net worth remains negative and statistically significant at the 1% confidence level.

More importantly, when we instrument the change in housing net worth with housing supply elasticity in column 8, the coefficient is the same as without the contemporaneous construction employment decline control variable. Table 5 thus provides strong evidence that our estimate is not polluted by issues related to construction.

[14] Consistent with this argument, the right panel of Appendix Figure 3 shows that the change in housing net worth does an excellent job predicting job losses in the construction sector. In unreported results, we find that the change in housing net worth is a stronger predictor of construction job losses than either the share of construction employment as of 2007 or the growth in construction from 2002 to 2007.

C. The business uncertainty hypothesis

We next consider if the effect of net housing wealth shock on non-tradable employment can be explained by the business uncertainty hypothesis. A number of commentators and academics have put forth policy, regulatory, or other government-induced business uncertainty as an explanation for the decline in macroeconomic aggregates (e.g. Baker, Bloom, and Davis (2011), Bloom (2009), Bloom, Foetotto, and Jaimovich (2010), Fernandez-Villaverde, Guerron-Quintana, Kuester, and Rubio-Ramirez (2011), and Gilchrist, Sim, and Zakrajsek (2010)). The canonical argument, as illustrated by Bloom (2009), is that uncertainty causes firms to temporarily pause their investment and hiring.[15]

In its most basic form, an increase in business uncertainty at the *aggregate* level does not explain the stark *cross-sectional* patterns in non-tradable employment losses that we have documented above. Thus for the business uncertainty hypothesis to qualify as an explanation for our results, it has to be the case that the increase in business uncertainty is somehow larger in counties that experienced large decline in housing net worth.

Of course, if businesses face more uncertainty because of a large decline in local demand in these areas, then this is simply another manifestation of the housing net worth hypothesis. Therefore, the alternative explanation must involve greater uncertainty in areas with large housing net worth decline for reasons other than the decline in local demand itself. For example, perhaps there is more uncertainty regarding state government policies in states with severe housing problems.

[15] An alternative hypothesis relates to uncertainty about future income in the household sector that can induce precautionary savings (as in Carroll and Kimball (2008)). Such household-based uncertainty could be heightened in high leverage areas experiencing sharp house price declines. If household-based uncertainty due to balance sheet shocks induces a reduction in household spending, we view this as part of the demand shock we emphasize.

We test this hypothesis using quarterly state-level survey response data from the *National Federation of Independent Businesses* between 2002 and 2012. The NFIB conducts monthly surveys of small businesses in which they ask a series of questions (Dunkelberg and Wade (2012)). One of the survey questions specifically asks business owners, "What is the single most important problem facing your business today?" There are ten potential answers: 1. Taxes, 2. Inflation, 3. Poor sales, 4. Financing and interest rates, 5. Cost of labor, 6. Government requirements and red tape, 7. Competition from large businesses, 8. Quality of labor, 9. Costs/Availability of insurance, and 10. Other.

Figure 2 plots the percentage response to some of the ten potential answers over time. The percentage of respondents citing "poor sales" as their single most important problem increases from around 10% in 2006 to 33% towards the end of 2009. Moreover the increase in respondents citing poor sales starts in the second half of 2007, coinciding with the start of the economic recession. The rise in concern for poor sales is consistent with the hypothesis that weakness in household balance sheets reduced overall demand.

What about concerns regarding business uncertainty? We group business owners citing "taxes" and "government requirements and red tape" together to proxy for concerns regarding government policy uncertainty. Figure 2 shows that the percentage of respondents citing taxes or government red tape as top concern also rises during the recession. However, the increase happens significantly later, in the fourth quarter of 2008, than the increase in concerns regarding poor sales.

The top panel in Figure 3 displays the state-level correlation between the increase in businesses citing "poor sales" as their major concern between 2006 and 2009 and the change in housing net worth during the same period. The bottom panel repeats this exercise for the increase

in businesses citing regulation and taxes as their single most important problem. There is a stark difference in the correlation patterns.

Consistent with our result in Table 4, the fraction of businesses citing poor sales as their most important problem increased more in states experiencing a larger decline in housing net worth. The slope of the OLS predictive relationship in the top panel of figure 3 is -0.55 with a t-stat of 3.6 and R-sq of 25%. Further, a regression of job losses in the non-tradable sector in a given state from 2007 to 2009 on the contemporaneous increase in the fraction of businesses citing poor sales as their top concern reveals a negative and statistically significant relation. In other words, states in which businesses were citing poor sales were the states in which household spending was sharply down and jobs were disproportionately lost.

However, the lower panel of Figure 3 shows that there is no negative relationship between the increase in concerns regarding government taxation/red-tape and the change in housing net worth. In fact the sign of the relationship goes in the wrong direction, although it is not statistically significant. The slope of the OLS predictive relationship is 0.21 with a t-stat of 1. In short, not only does the state-level measure of business uncertainty increase much later in time, it is also not correlated in the cross-section with the change in housing net worth.

These results suggest that the uncertainty hypothesis is unlikely to be driving our main result. There is additional evidence that further corroborates this view. As we will see later in this paper, there is no correlation between the change in housing net worth and change in tradable employment in a county. If supply-side driven business uncertainty were responsible for high non-tradable job losses in counties with large housing net worth decline, then we would have expected the same result for tradable sector job loss as well.

In the appendix, we also address one additional form of uncertainty suggested by the work of Mericle, Shoag, and Veuger (2012). Governments in states with housing problems may need to cut expenditures dramatically, thus raising business uncertainty.[16] However, as we show in the appendix, such state government cuts were concentrated in 2009, much later than when job losses started. Further, we can control directly for mid-year state budget cuts and the results are robust.

D. The credit supply hypothesis

Another alternative explanation for the relationship between change in non-tradable employment and housing net worth shocks is based on the possibility that firms in counties with larger decline in housing net worth faced larger decline in credit supply, forcing them to lay off more workers. For example, firms using real estate as collateral for funding might experience a more severe reduction in credit supply in counties harder hit by the decline in house prices.

While credit supply shocks can be important drivers of firm investment, survey evidence from business owners presented in Figure 2 suggests that financing was not the most important concern faced by businesses during the Great Recession. Only 3% of respondents report financing as their main problem in 2007, and more importantly there is no appreciable increase in the response rate as the recession unfolds. This result is in sharp contrast to the fact that businesses start complaining about poor sales and government regulation at a significantly higher rate.

A second result that goes against the credit supply hypothesis is presented in the next section where we show that change in tradable sector employment is not correlated with the

[16] We are grateful to Daniel Shoag for raising this issue and for providing data from Mericle, Shoag, and Veuger (2012).

change in housing net worth. If reduction in credit supply were making firms fire workers, we would expect the reduction to take place in both tradable and non-tradable sectors.

Finally, although unlikely, one may argue that business credit supply shocks only affect non-tradable industries. We test whether the relationship between change in non-tradable employment and housing net worth shocks is driven by credit supply tightening in Table 6. County business pattern data breaks down county-level employment in each 4-digit industry further by the size of the underlying reporting establishment. If our main result were driven by credit supply tightening, then we would expect the result to be stronger among smaller establishments.

Panel A splits the change in non-tradable employment by establishment size and regresses it on the change in housing net worth. Panel B repeats this exercise using IV specification. If differential credit supply shocks in counties with large decline in housing net worth were driving our results, we would expect our effect to be stronger for smaller establishments. Instead we find completely the opposite, suggesting that firms respond to lower demand by laying off workers.

Panel C performs a different test of the credit supply hypothesis. It splits our sample into counties that are primarily served by national banks, and counties that are largely served by local banks. Using the summary of deposits data from the FDIC, for every bank, we calculate the share of deposits of that bank in every county. Then, for every county, we average this statistic over the banks located in the county.[17] A county that has banks that have a very low fraction of their deposits in that county is considered a national banking county. They therefore should not be as sensitive to local credit supply conditions. However, we find that the same pattern between

[17] We weight this average by the amount of deposits the bank has in the county.

non-tradable employment growth and housing net worth change holds within both national and local banking counties.

Section 3: Understanding The Adjustment Mechanisms: Theory

The decline in county-level non-tradable employment in response to the decline in housing net worth potentially represents a partial equilibrium response of the local labor market. The overall impact of these shocks depends on the extent to which general equilibrium adjustments in the labor market compensate for the loss in local non-tradable employment.

For example, if wages are flexible and search frictions (real rigidity) not very strong, a negative shock to non-tradable employment might be compensated by a fall in local wages and increased employment in the tradable sector. If such adjustment mechanisms are strong enough, the negative impact documented earlier might not be important for the aggregate employment picture. On the other hand, the presence of real and nominal rigidities can make the effect of housing net worth shock more durable.

The question of rigidities and their implication for macroeconomic effects one of the oldest and most central questions in macroeconomics. An important contribution of our paper is that we illustrate how geographical dispersion of shocks can be combined with a separate analysis of tradable and non-tradable sectors to evaluate the extent and possible presence of labor market rigidities – both nominal and real. The methodology outlined below can be utilized more generally in other contexts as well.

A. Baseline Model

Consider an economy made up of S equally sized counties or "islands" indexed by c. Each county produces two types of goods, tradable (T) and non-tradable (N). Counties can freely trade the tradable good among themselves, but must consume the non-tradable good produced in

their own county. We impose the restriction that labor cannot move across islands but can move freely between the tradable and non-tradable sectors within an island.

Each island has D_c units of total (nominal) consumer demand. Consumers have Cobb Douglas preferences over the two consumption goods, and spend consumption shares $P_c^N C_c^N = \alpha D_c$ and $P^T C_c^T = (1-\alpha) D_c$ on the non-tradable and tradable good, respectively.

All islands face the same tradable good price, while the non-tradable good price may be county-specific since each county must consume its own production of the non-tradable good. Production is governed by a constant returns technology for tradable and non-tradable goods with labor (*e*) as the only factor input and produces output according to $y_c^T = be_c^T$, and $y_c^N = ae_c^N$, respectively.

Total employment on each island is normalized to one with $e_c^T + e_c^N = 1$. Wages in the non-tradable and tradable sectors are given by $w_c^N = aP_c^N$ and $w_c^T = bP^T$ respectively. Free mobility of labor across sectors equates the two wages, making the non-tradable good price independent of its county, i.e., $P_c^N = \frac{b}{a} P^T$. Goods market equilibrium in non-tradable and tradable sectors implies that $y_c^N = C_c^N$ on each island and $\sum_{c=1}^{S} y_c^S = \sum_{c=1}^{S} C_c^T$.

We first solve the model under the symmetry assumption that in the initial steady state all islands have the same nominal demand $D_c = D_0$. Solving for output, employment and prices, and denoting the initial steady state by superscript (*), we obtain:

$$e_c^{*N} = \alpha, e_c^{*T} = (1-\alpha),\ P_c^{*N} = \frac{D_0}{a}, P_c^{*T} = \frac{D_0}{b}, w_c^{*N} = w_c^{*T} = D_0$$

The model is "money neutral" with nominal shocks translating one for one into prices and wages. Real allocation across islands remains unchanged in response to the shock, with employment in non-tradable and tradable sectors given by α and $(1-\alpha)$, respectively.

We next consider what happens if counties are hit with differing household expenditure shocks driven by the shocks to housing net worth discussed earlier. In particular, we normalize initial nominal demand $D_0 = 1$ and introduce the possibility of negative demand shocks (δ_c) that differ across counties such that $D_c = 1 - \delta_c$.[18] Without loss of generality we index counties such that $\delta_{c+1} > \delta_c$ and the average of the demand shocks is $\bar{\delta}$.

With the introduction of county-specific demand shocks, there are two different scenarios to consider: one without any nominal or real rigidities and another with rigidities.

B. No nominal or real rigidity

Suppose prices and wages are perfectly flexible (no nominal rigidity), and there are no search or other friction for labor to switch sectors (no real rigidity). Then there is deflation in response to negative demand shocks and an expansion in the tradable sector in certain counties. The change in prices and wages in the flexible price equilibrium is given by (see appendix for details): $\Delta P_c^T = -\frac{\bar{\delta}}{b}$, $\Delta P_c^N = -\frac{\bar{\delta}}{a}$, $\Delta w_c^N = \Delta w_c^T = -\bar{\delta}$.

The downward adjustment in prices and wages allows the economy to remain at full employment after the shock, with the change in non-tradable and tradable employment in each county given by: $\Delta e_c^N = -\alpha\left(\frac{\delta_c - \bar{\delta}}{1-\bar{\delta}}\right)$, and $\Delta e_c^T = \alpha\left(\frac{\delta_c - \bar{\delta}}{1-\bar{\delta}}\right)$. As a result, counties with stronger demand shocks see a larger decline in non-tradable employment, which is completely compensated by an equivalent increase in tradable employment in these counties.[19]

C. Full nominal or real rigidity

[18] Both Eggertsson and Krugman (2012) and Guerrieri and Lorenzoni (2011) model the demand shock as a tightening of the borrowing constraint on levered households who respond by reducing consumption.

[19] This solution holds under the assumption that there are no corner solutions in any island, i.e. $\alpha\frac{(1-\delta_c)}{(1-\bar{\delta})} = e_c^N \leq 1$, which translates into $\delta_1 \geq \frac{\bar{\delta}-(1-\alpha)}{\alpha}$. See appendix for full details.

Suppose instead that prices and wages are fully rigid, fixed at their initial steady state level of $P_c^{*N},\ P_c^{*T},\ w_c^{*N}$ and w_c^{*T}. With fixed prices, the goods and labor markets do not clear. In this case, we follow traditional "Keynesian" models where output and employment become "demand constrained" when prices are rigid (e.g., Hall (2011) in particular Figure 3 and Bils, Klenow and Malin (2012)).

Output and employment in the non-tradable sector is then governed by the new local demand for non-tradable goods at old steady state prices, giving us $e_c^N = \alpha(1-\delta_c)$. Output and employment in the tradable sector however depends on the average demand for tradable goods across all islands, giving us $e_c^T = (1-\alpha)(1-\bar{\delta})$. Let $Y_c^N = -\Delta e_c^N$ and $Y_c^T = -\Delta e_c^T$ denote total employment loss in county *c* in the non-tradable and tradable sectors respectively. Then total employment loss, $Y_c = Y_c^N + Y_c^T$, can be written as:

$$Y_c = \alpha\delta_c + (1-\alpha)\bar{\delta} \qquad (2)$$

As equation (2) shows, with nominal rigidity, job losses in a county have a non-tradable component that depends only on the county-specific household expenditure shock, and a tradable component that depends on the overall expenditure shock hitting the entire economy.

A comparison of the flexible and rigid price scenarios shows that the key difference between the two is the correlation of tradable sector employment growth with the household expenditure shock δ_c. Under flexible prices, tradable employment increases in high δ_c counties, thereby compensating for jobs lost in the non-tradable sector in these counties. However, under price rigidity, there is no such adjustment in the tradable sector, generating zero correlation between tradable employment growth and δ_c.

The example here uses nominal rigidity as the friction that translates a decline in household spending into a decline in aggregate employment. A similar result would be obtained

if we instead added real rigidity – i.e. that employees cannot easily switch from non-tradable to tradable sector jobs. In that scenario as well, the loss in the non-tradable jobs in affected counties would be permanent with no compensating increase in tradable sector jobs.

Our model assumed that there is no mobility across islands. Allowing for labor mobility will tend to reduce the dispersion across islands in labor market outcomes. In the empirical section, we will test if labor systematically migrates from highly impacted counties to less impacted counties.

Section 4: Understanding The Adjustment Mechanisms: Empirics

A. Housing net worth shock and tradable sector employment

With no nominal or real rigidity, the negative impact of housing net worth shock on non-tradable employment is reversed by employment gain in the tradable sector. This is a precise prediction that we can take to data.

Figure 4 plots the change in tradable employment in a county between 2007 and 2009 against the change in housing net worth from 2006 to 2009. The left panel uses the first definition of tradable employment based on industries that are traded internationally, while the right panel uses the second definition of tradable employment based on geographical concentration of industries. Despite the fact that the two definitions have a number of non-overlapping industries, they paint the same picture. There is *no evidence* of a gain in tradable employment in counties experiencing larger decline in housing net worth.

Columns 1 and 2 of Table 7 regress the two definitions of the change in log of tradable employment on the change in housing net worth. The estimated coefficients are close to zero and precisely estimated. The difference between the coefficients for tradable job losses in columns 1 and 2 of Table 7 and that for non-tradable job losses in columns 1 and 2 of Table 4 are also

statistically significant at the 1% level. Columns 3 and 4 add the share of employment in each of 23 two-digit industries separately to control for differences in industry exposure across counties. The coefficient on housing net worth change is materially unchanged.

The estimated constants in columns 1 and 2 of Table 7 are negative, large in magnitude, and statistically significant. Thus the tradable sector suffers uniformly everywhere regardless of the magnitude of the local housing net worth shock. This is exactly the prediction of our model with rigidities, implying that the effect of housing net worth shocks at the county level are propagated through the tradable sector on the entire economy.

Column 5 uses the entire distribution of industries based on industry concentration instead of grouping firms into non-tradable and tradable categories. The regression is thus run at the county-industry level, with each county-industry observation weighed by the total employment in that cell in 2007. The estimated coefficient on the change in housing net worth is positive and significant, which implies that job losses in the least concentrated (most non-tradable) industries are much more severe in counties with large housing net worth decline. The negative and significant coefficient on the interaction term shows that an increase in concentration (i.e. tradability) reduces the cross-sectional effect of housing net worth shock on job losses. This result confirms that our findings are not an artifact of our discontinuous grouping of industries into non-tradable and tradable categories.

Column 6 adds 4-digit industry fixed effects (294 industries) and column 7 further adds county fixed effects (944 counties). The industry fixed effects force comparison to be made within the same 4-digit industry across counties. Such fixed effects thus control for aggregate shifts at the industry level during the 2007-2009 period. Similarly, county fixed effects non-parametrically take out any county-specific changes over 2007-2009. Despite the inclusion of

these fixed effects, our key result remains unchanged: the effect of change in housing net worth is much stronger for non-tradable industries that are geographically least concentrated across the United States.

B. Housing net worth shock, wage flexibility and labor mobility

Our results on the tradable sector suggest that the presence of nominal and real rigidities in the labor market that we can also estimate directly. Columns 1 and 2 of Table 8 and the top two panels of Figure 5 use county level data on wages to show that counties with large decline in housing net worth experience a slight relative decline in wages from 2007 to 2009. However, the coefficient is not statistically significant[20]. The lack of response on the wage dimension in Table 8 stands in stark contrast to the result in Table 5 that shows a strong response of non-tradable employment to the same shocks.

In the spirit of Blanchard and Katz (1992), we also evaluate mobility. The bottom-left panel of Figure 5 and column 3 of Table 5 correlate county level population growth from 2007 to 2009 with the change in housing net worth. There is no evidence that counties with less severe housing net worth decline experience stronger expansion in population. If anything, the opposite is true, although the coefficient estimate in column 3 is not significant.

The lower-right panel of Figure 5 and column 4 repeat this analysis using labor force data from the Bureau of Labor Statistics. As before, there is no obvious relation. The results in Figure 5 and Table 8 show that the migration of workers from counties with large decline in housing net worth to counties with smaller declines is unlikely to explain the drop in non-tradable employment in counties with a large decline in housing net worth.

Section 5: Understanding the Potential Magnitude

[20] There are a number of other papers independently arguing for the presence of price and wage rigidities in the Great Recession. In particular, Daly, Hobijn, and Lucking (2012); Daly, Hobijn, and Wiles (2011); Fallick, Lettau, and Wascher (2011); and Hall (2011).

A. The impact on non-tradable sector jobs

A natural implication of labor market rigidities is that the estimated impact of housing net worth shocks on non-tradable employment is likely to be durable. Our preferred IV estimate from table 4 column 3 implies that going from the 10^{th} to the 90^{th} percentile of change in housing net worth distribution in the cross-section lead to a loss in non-tradable employment of 6.5%. Non-tradable employment declines by 12% when we move from the 10^{th} to the 90^{th} percentile.[21] Thus our estimate can potentially account for 54.2% of the cross-sectional variation in non-tradable employment loss.

A natural limitation of cross-sectional analysis is that it cannot directly identify the fraction of the aggregate change that can be attributed to the treatment of interest. This is the price one must pay for gaining better identification. For example, a study that is very similar to ours in terms of empirical methodology is Autor, Dorn and Hansen (2013). The authors use cross-sectional variation in exposure of U.S. producers to imports from China to estimate the effect of import competition on job losses in the U.S.

The main concern raised by the inability to identify the "level effect" directly is that the effect identified in cross-sectional analysis may not last in aggregate due to general equilibrium adjustment mechanisms. This is precisely why we conducted an exhaustive analysis of possible labor market adjustment in reaction to the effect of housing net worth shock on non-tradable employment. There was no evidence of such adjustment: The tradable sector in impacted counties fails to expand, wages tend to be sticky, and there is no systematic mobility of labor from more-affected to less-affected counties. The theory outlined in Section 3 suggests that in the presence of such labor market rigidity, the cross-sectional effect on non-tradable employment will have an aggregate impact as well.

[21] The calculation is based on the same 540 counties that are used in the IV regression.

There is also the possibility that in reaction to the negative shock in the United States, there is adjustment in the external margin with dollar depreciating and U.S. exports rising. However, we know that job gains in the export sector were modest, and as the summary statistics show, between 2007 and 2009, job losses in the tradable sector were 12% and higher than losses in any other sector. The export-adjustment margin is unlikely to be a meaningful contributor for job creation during the 2007 to 2009 period.

B. Extrapolating to other sectors

We have argued that the cross-sectional estimate of the impact of housing net worth shock on non-tradable employment is likely to be durable. Almost 20% of employment in 2007 belonged to the non-tradable sector. What about the impact of housing net worth shock on employment in the remaining sectors?

Since the impact of housing net worth shock on sectors beyond the non-tradable industry spills over across local geographical boundaries, our cross-sectional analysis cannot be used directly for estimating its impact. However, we can gain an understanding of its potential magnitude using some plausible assumptions.

Let i denote the non-tradable sector, $\bar{\imath}$ sectors other than the non-tradable sector, and η_i the elasticity of non-tradable employment with respect to housing net worth estimated using equation (1). How does $\eta_{\bar{\imath}}$ compare with η_i? Stumpner (2014) extends our methodology to estimate $\eta_{\bar{\imath}}$ for the tradable sector, which is defined as industries covered by the Commodity Flow Survey (CFS). He uses intra-U.S. trade data to construct tradable sector demand shocks driven by a county's exposure to other counties through trade, and the household balance sheet shock experienced by trading counties.

Stumpner (2014) shows that the trade channel acts as a powerful mechanism to transmit the impact of housing net worth shocks throughout the United States. Moreover, he can use the trade-weighted household balance sheet shocks to estimate $\eta_{\bar{\imath}}$ directly. His results indicate that the elasticity of tradable sector employment with respect to household balance sheet shocks is *larger* than the elasticity of non-tradable sector employment.[22]

The result in Stumpner (2014) is limited to the tradable sector. More generally, η_i can be written as the product of the spending elasticity for the non-tradable sector with respect to housing net worth, $\eta_{s,i}$, and the elasticity of labor demand for the non-tradable sector with respect to spending in the non-tradable sector, $\eta_{l,i}$.

The value of $\eta_{\bar{\imath}}$ depends on its corresponding components $\eta_{s,\bar{\imath}}$ and $\eta_{l,\bar{\imath}}$. Mian, Rao and Sufi (2013) estimate the elasticity of spending with respect to housing net worth to be 0.8 for a broad basket of spending. One sub-category of spending is restaurants, a non-tradable portion of spending. The elasticity of spending on restaurants is 0.4, about half that of the overall spending elasticity, and the difference between the two is significant at the 1% level. This evidence suggests that $\eta_{s,\bar{\imath}} > \eta_{s,i}$.

We are not aware of estimates of elasticity of labor demand for non-tradable and other sectors. However, there is no particular reason to believe that this elasticity should be significantly larger for the non-tradable sector. In fact the total loss in non-tradable employment between 2007 and 2009 is 4.0% versus 5.7% for all other sectors, suggesting that labor demand for other sectors is more elastic to macroeconomic shocks compared to non-tradable sector.

[22] The earlier version of our paper used debt to income ratio as of 2006 as the right hand side variable. Stumpner (2014) extends our methodology using this particular variable. Our results are essentially identical using this earlier variable as well.

One can therefore reasonably conjecture that the elasticity of non-tradable employment with respect of housing net worth, η_i, is *lower* than $\eta_{\bar{\imath}}$. Extrapolating the non-tradable elasticity estimate of 0.31 for the overall economy implies that a 9.5% reduction in housing net worth (which is what the economy experienced between 2007 and 2009) leads to a reduction in overall employment of 2.9%, or 55% of the actual decline in total employment of 5.3%.

Section 6: Conclusion

The Great Recession resulted in a remarkable loss of jobs between 2007 and 2009. The recession was also accompanied by a large decline in housing net worth with strong cross-sectional variation. This paper estimates the effect of the housing net worth shock on employment and suggests a significant role played by the housing net worth channel in generating job losses.

Our empirical analysis focused on the non-tradable sector since this sector relies primarily on local demand conditions for employment. We find that weakness in demand-side conditions generated by housing net worth losses leads to significant non-tradable sector job losses in the cross-section. This result is not driven by cross-sectional variation in supply-side differences such as industry structure, exposure to construction sector, policy-induced business uncertainty or credit supply conditions.

We also do not find much evidence of labor market adjustment in response to the loss of jobs in the non-tradable sector. In particular, there is no relative expansion in the tradable sector in counties harder hit by the housing net worth shock and the resulting loss in non-tradable sector jobs. In fact, despite the strong cross-sectional relationship between housing net worth shock and job losses in the non-tradable sector, there is *zero* correlation between housing net worth shock and tradable sector job losses.

Wages do not respond in a significant manner to the housing net worth shock either, consistent with the notion of rigid wages. There is also no evidence of labor mobility from counties harder hit by the housing net worth shock to less affected counties. Taken together the evidence on labor market rigidity implies that not only is the effect of housing net worth shocks on non-tradable sector jobs durable, but they also affect broader sectors of the economy. We discussed the potential magnitude of these effects in Section 5.

Our overall results are robust to two very different definitions of non-tradable and tradable sectors. Our second definition of non-tradable and tradable sectors, based on the geographical concentration of each 4-digit industry, is new to the literature and can be used more generally in empirical papers exploiting regional or international shocks.

In terms of future research, an important question concerns the effect of the *housing boom* on employment. Our study uses as its starting point the demand shock due to high household debt levels and the housing collapse that began in 2007. The relevant counter-factual is therefore the state of the economy if the balance sheet shock had never taken place. This is a natural counter-factual to understand the short-term employment consequences of the sharp drop in consumer demand due to the housing collapse.

However, the housing boom may have affected employment patterns before the recession, and the job losses that we document may represent the return to more normal housing conditions (see for example the importance of home equity withdrawal during the housing boom in Mian and Sufi (2011) or the recent working paper by Charles, Hurst, and Notowidigo (2012)). It is important to emphasize that the employment losses we find in this study are not related to construction; however, aggressive household spending out of home equity during the housing boom may have had important employment effects in non-construction related industries.

This is related to a broader question regarding the *persistence* of high levels of unemployment beyond 2009. This question is beyond the scope of our paper. A recent paper by Hagedorn et al (2013) argues that unemployment benefit extensions explain a large part of the persistently high level of unemployment post-2009. Jaimovich and Siu (2013) argue that the automation of routine tasks over time leads to job polarization in the face of a sudden downturn, generating a "jobless recovery" where the recovery in employment is concentrated in the non-routine sectors.

More broadly these papers suggest that once an economy experiences a sharp downturn and loss in jobs as seen during the 2007 to 2009 period, a host of factors can contribute to "hysteresis" where employment level remains low despite the initial shock receding to some extent. Understanding such hysteresis effects remains a question of great interest.

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Figure 1
Housing Net Worth Shock and Non-tradable Employment

This figure presents scatter-plots of county level non-tradable employment growth from 2007Q1 to 2009Q1 against the change in housing net worth from 2006 to 2009. The left panel defines industries in restaurant and retail sector as non-tradable, and the right panel defines industries as non-tradable if they are geographically dispersed throughout the United States. The sample includes counties with more than 50,000 households. The thin black line in the left panel is the non-parametric plot of non-tradable employment growth against change in housing net worth.

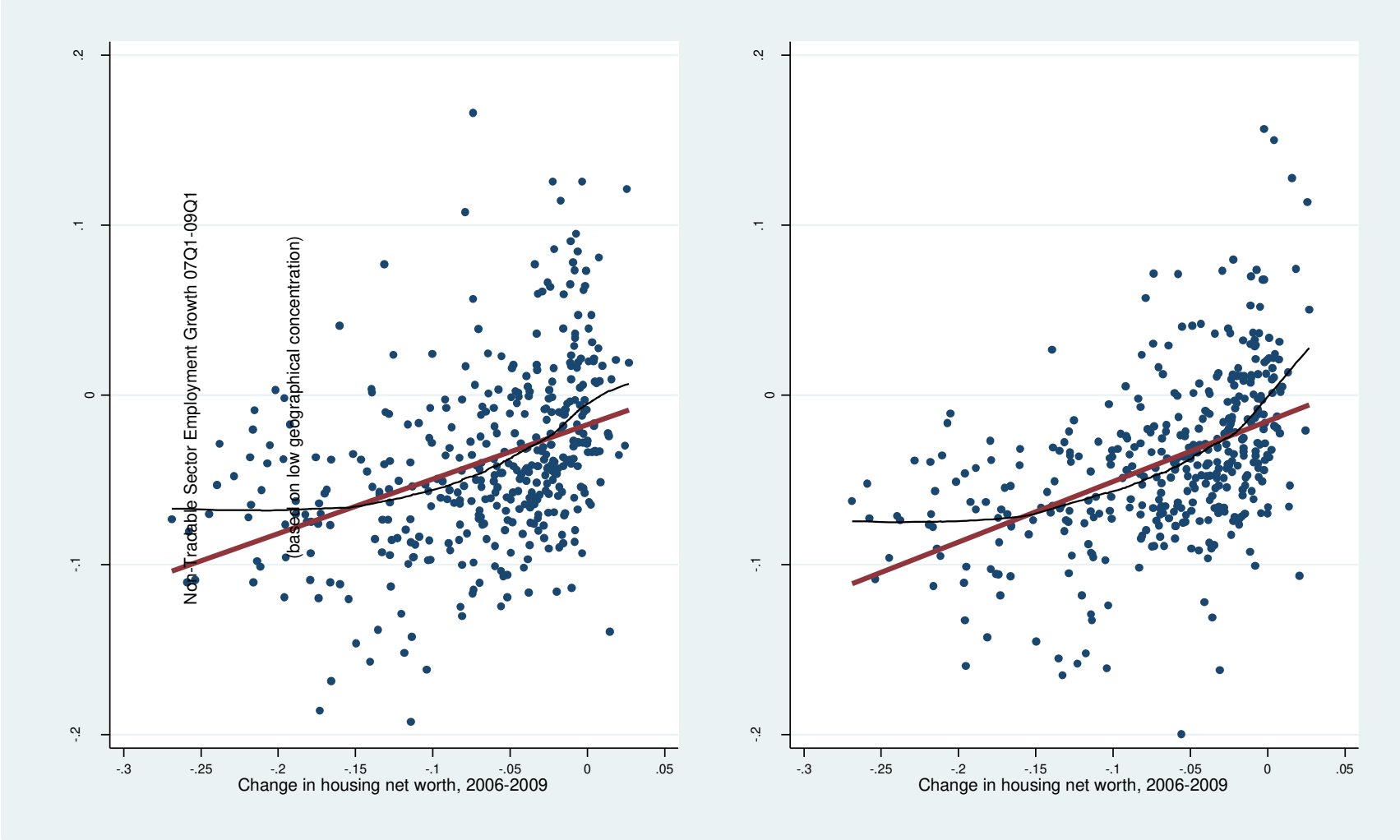

Figure 2
Top Business Concerns Over Time

The figure plots responses to the National Federation of Independent Businesses survey between 2002 and 2012. The survey asks small business owners to respond to the following question: "What is the single most important problem facing your business today?" The figure shows responses to five of the ten possible answers, with "regulation" and "taxes" combined into one category.

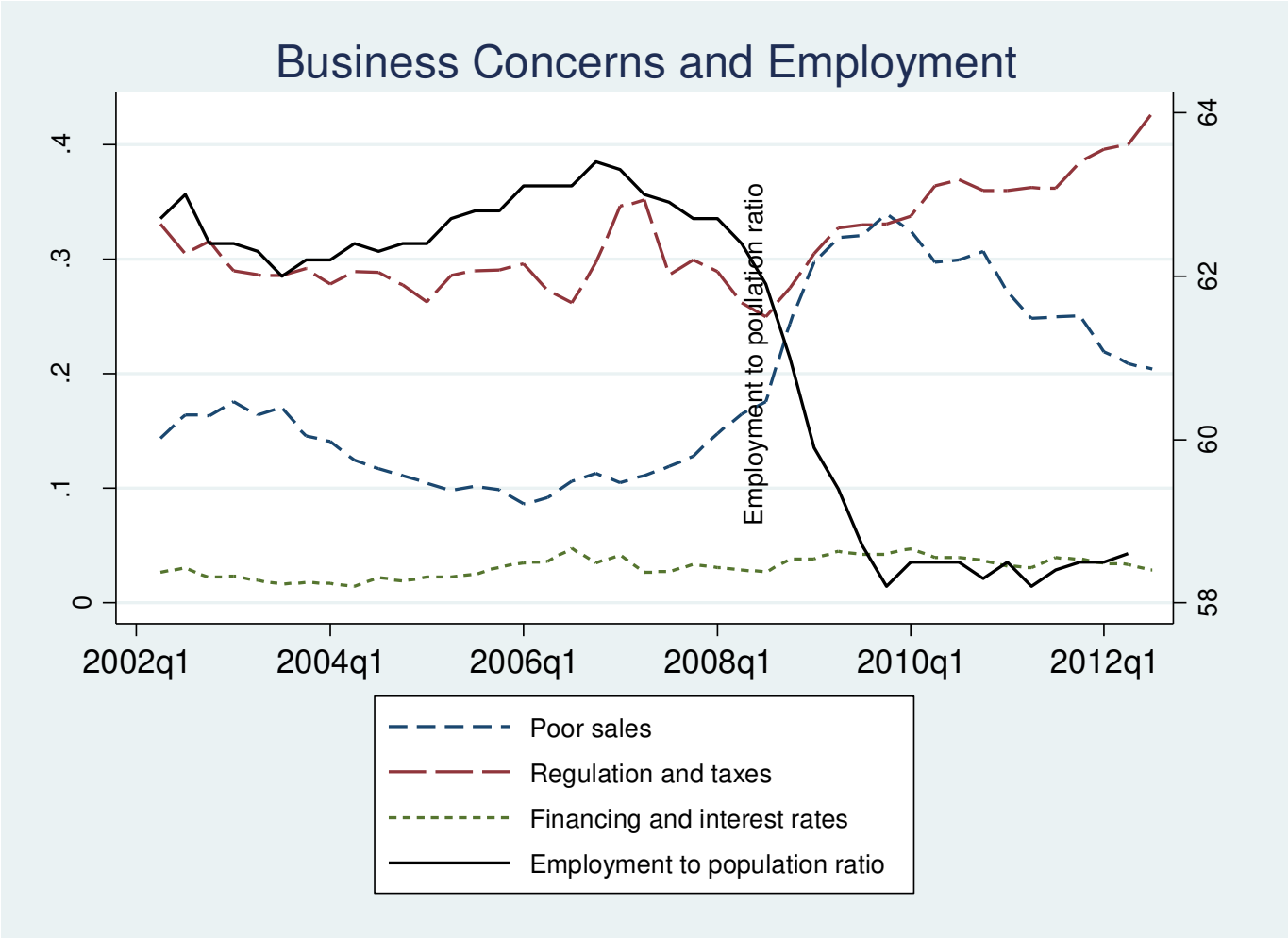

Figure 3
Change in Business Concerns And Housing Net Worth Shock

The top panel shows the state-level correlation between the increase in fraction of businesses complaining about "poor sales" as their single most important problem from 2006 to 2009 and change in housing net worth over the same period. The bottom panel repeats this exercise for fraction of businesses complaining about "regulation and taxes" as their single most important problem.

Figure 4
Change in Tradable Employment And Housing Net Worth Shock

This figure presents scatter-plots of county level tradable employment growth from 2007Q1 to 2009Q1 against the change in housing net worth from 2006 to 2009. The left panel defines industries as tradable if they appear in U.S. global trade, and the right panel defines industries as tradable if they are geographically concentrated in the United States. The sample includes counties with more than 50,000 households.

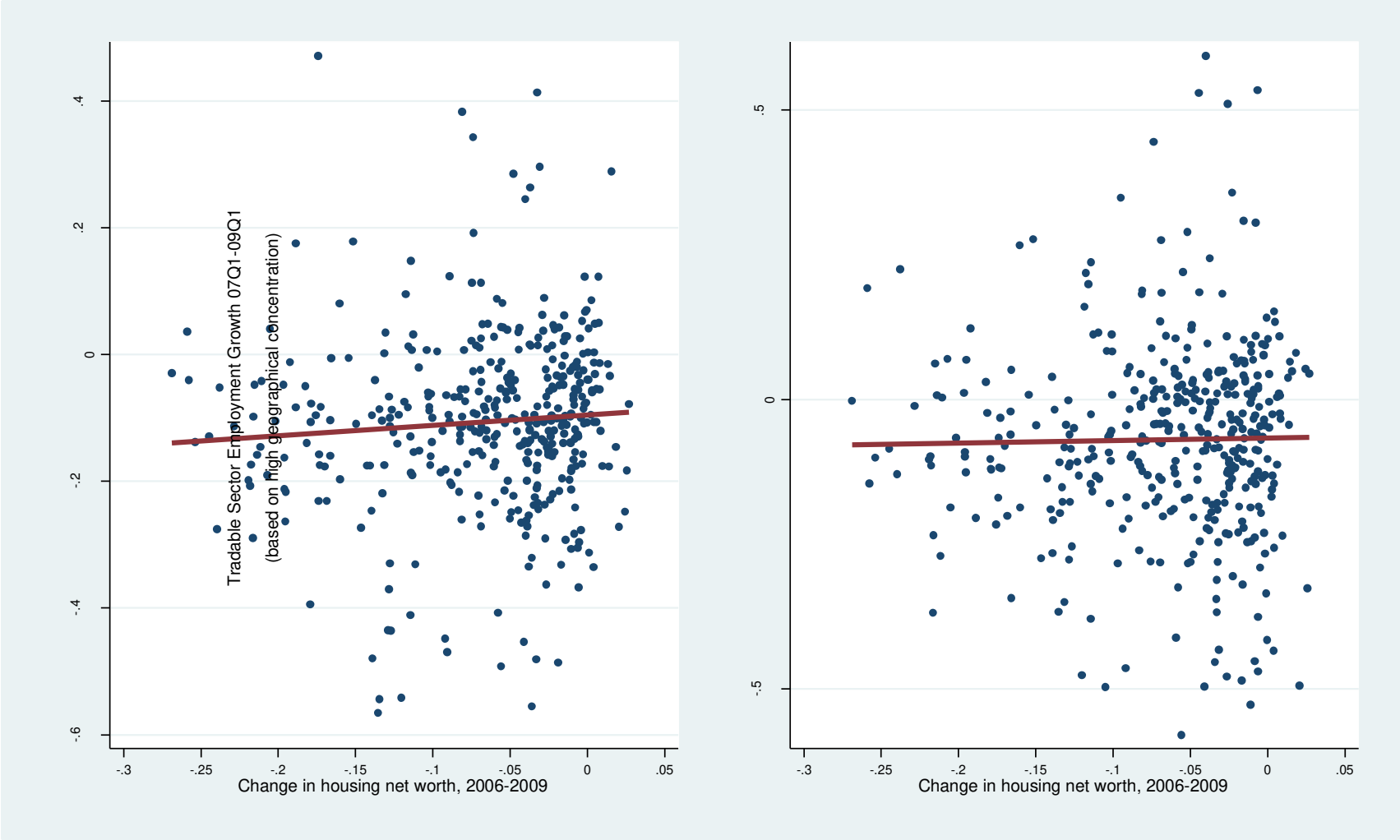

Figure 5

Change in Wages, Labor Mobility And Housing Net Worth Shock

The top two panels plot wage growth (using payroll data) and hourly wage growth (using ACS data) against the change in housing net worth at the county level. The bottom panel plots population growth and labor force growth against the change in housing net worth.

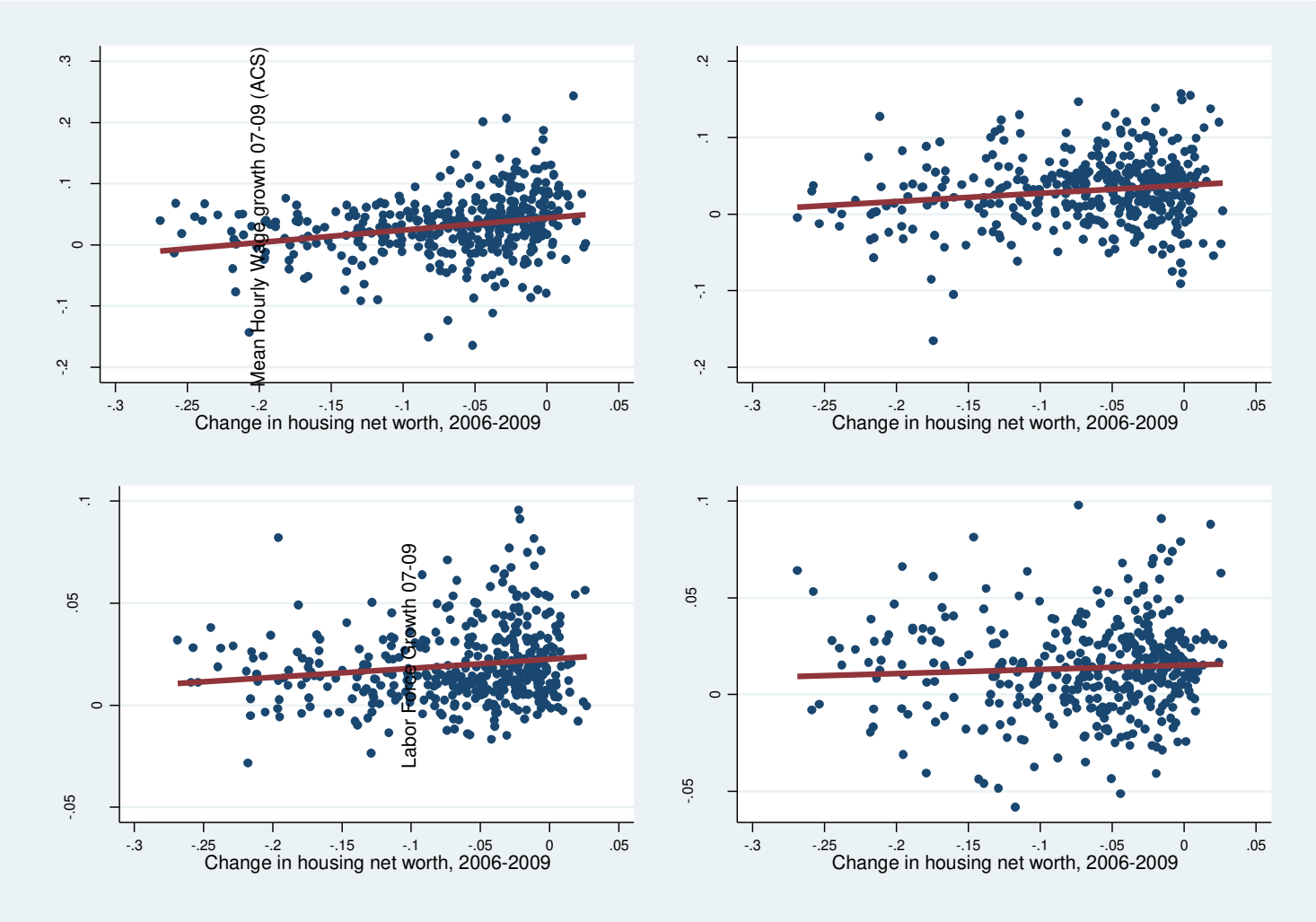

Table 1
Industry Categorization

This table presents the largest 10 industries in each category of goods produced. The % column gives the percentage of the entire 2007 labor force represented by the industry in question. Please see the text for the methodology used to categorize each industry. See Appendix Table 1 for a complete list of industries and their categorization.

Non-tradable Industries
(19.6% of total employment)

NAICS	Industry name	%
7221	Full-service restaurants	3.76
7222	Limited-service eating places	3.40
4451	Grocery stores	2.13
4521	Department stores	1.36
4529	Other general merchandise stores	1.12
4481	Clothing stores	1.06
4461	Health and personal care stores	0.89
4471	Gasoline stations	0.73
7223	Special food services	0.49
4511	Sporting goods hobby and music stores	0.38

Tradable Industries
(10.7% of total employment)

NAICS	Industry name	%
3261	Plastics product manufacturing	0.60
3231	Printing and related support activities	0.53
3363	Motor vehicle parts manufacturing	0.52
3116	Animal slaughtering and processing	0.44
3364	Aerospace product and parts manufacturing	0.35
3327	Machine shops; screw nut and bolt manufacturing	0.33
3345	Navigational and control instruments manufacturing	0.33
3344	Semiconductor and other electronic manufacturing	0.32
3399	Other miscellaneous manufacturing	0.31
5112	Software publishers	0.29

Construction Industries
(11.2% of total employment)

NAICS	Industry name	%
2382	Building equipment contractors	1.62
5413	Architectural engineering and related services	1.19
4441	Building material and supplies dealers	1.00
2381	Foundation structure and building contractors	0.91
2383	Building finishing contractors	0.78
2361	Residential building construction	0.75
2362	Nonresidential building construction	0.64
5313	Activities related to real estate	0.54
2389	Other specialty trade contractors	0.48
5311	Lessors of real estate	0.45

Other Industries
(58.5% of total employment)

NAICS	Industry name	%
6221	General medical and surgical hospitals	4.31
5511	Management of companies and enterprises	2.60
5613	Employment services	2.56
6211	Offices of physicians	1.79
5221	Depository credit intermediation	1.77
7211	Traveler accommodation	1.54
5617	Services to buildings and dwellings	1.42
8131	Religious organizations	1.39
6231	Nursing care facilities	1.37
6113	Colleges universities and professional schools	1.35

Table 2
Industry Categorization Based On Geographical Concentration

This table lists the top and bottom 30 industries by geographical concentration. For each industry we compute Herfindahl index based on the shares of employment for that industry across counties. The most concentrated (top 30) are likely to be "tradable" in that they depend on national or international demand. If an industry needs to be physically present in an area to provide its goods or services, then it is likely to be non-tradable and least concentrated (bottom 30). The indicator variable for traded and non-traded reports the classification according to our other methodology reported in Table 1. Appendix Table 1 lists the geographical Herfindahl index for each of the 294 4-digit industries.

Herfindahl Top-30		**Herfindahl Bottom-30**	
Industry name	Traded?	Industry name	Non-Traded?
Securities and commodity exchanges	0	Lawn and garden equipment stores	0
Pipeline transportation of crude oil	0	Farm product raw material wholesalers	0
Cut and sew apparel manufacturing	1	Gasoline stations	1
Motion picture and video industries	0	Nonmetallic mineral mining and quarrying	0
Agents and managers for artists athletes	0	Other general merchandise stores	1
Deep sea coastal and lakes transportation	0	RV parks and recreational camps	0
Cable and other subscription programming	0	Sawmills and wood preservation	0
Sound recording industries	0	Florists	1
Tobacco manufacturing	1	Death care services	0
Independent artists writers and performers	0	General rental centers	0
Railroad rolling stock manufacturing	1	Direct selling establishments	0
Scenic and sightseeing transportation other	0	Building material and supplies dealers	0
Amusement parks and arcades	0	Other motor vehicle dealers	1
Scenic and sightseeing transportation water	0	Nursing care facilities	0
Securities and commodity brokerage	0	Automotive parts accessories and tire stores	1
Internet Service Providers and Web Search	0	Logging	0
Metal ore mining	1	Specialized freight trucking	0
Support activities for water transportation	0	Cement and concrete product manufacturing	0
Apparel goods wholesalers	0	Other wood product manufacturing	0
Other support activities for transportation	0	mental health and substance abuse facilities	0
Monetary authorities- central bank	0	Beer wine and liquor stores	1
Oil and gas extraction	1	Community care facilities for the elderly	0
Fishing	1	Child day care services	0
Apparel knitting mills	1	Vocational rehabilitation services	0
Internet Publishing and Broadcasting	0	Consumer goods rental	0
Pipeline transportation of natural gas	0	Electric power generation transmission	0
Footwear manufacturing	1	Plastics product manufacturing	0
Manufacturing magnetic and optical media	1	Religious organizations	0
Ship and boat building	1	Animal food manufacturing	0
Textile furnishings mills	1	Highway street and bridge construction	0

Table 3
Summary Statistics

This table presents summary statistics for the county-level data used in the analysis. Employment data are from the Census County Business Patterns, wage data are from the American Community Survey, debt data are from Equifax, and income data are from the IRS. The last two columns are weighted by the number of households in the county as of 2000, except industry level herfindahl, which is weighed by an industry's 2007 total employment. The data are restricted to the 944 counties for which the housing net worth shock variable can be constructed. These counties represent 80% of total U.S. population.

	N	Mean	SD	10^{th}	90^{th}	Weighted mean	Weighted SD
Housing net worth shock, 2006-2009	944	-0.065	0.085	-0.172	0.003	-0.095	0.100
Number of households, 2000	944	98,197	187,506	12,841	237,783	455,860	666,240
Labor force growth, 2007 to 2009	944	0.014	0.030	-0.018	0.050	0.014	0.025
Total employment, 2007	944	110,725	235,669	9,652	267,278	543,470	809,861
Employment growth, 2007 to 2009	944	-0.052	0.066	-0.123	0.021	-0.053	0.047
Average wage, 2007	944	7.338	2.414	5.234	9.985	9.727	3.790
Average wage growth, 2007 to 2009	944	0.028	0.071	-0.044	0.100	0.026	0.056
Housing supply elasticity (Saiz)	540	2.204	1.117	0.943	3.589	1.718	0.990
Non-tradable employment growth, 2007 to 2009	944	-0.029	0.086	-0.110	0.063	-0.040	0.061
Food industry employment growth, 2007 to 2009	944	-0.012	0.090	-0.093	0.089	-0.021	0.063
Tradable employment growth, 2007 to 2009	944	-0.115	0.192	-0.337	0.062	-0.116	0.136
Construction employment growth, 2007 to 2009	944	-0.163	0.164	-0.368	0.023	-0.161	0.136
Other employment growth, 2007 to 2009	944	-0.021	0.082	-0.103	0.070	-0.026	0.052
Industry geographical herfindahl, 2007	294	0.016	0.023	0.0034	0.0338	0.0083	0.011
Hourly wage, 2007	944	18.978	3.447	15.484	23.354	21.086	3.692
Hourly wage, 10th percentile, 2007	944	5.801	0.830	4.834	7.000	6.241	0.774
Hourly wage, 25th percentile, 2007	944	9.052	1.450	7.500	10.955	9.808	1.464
Hourly wage, median, 2007	944	22.975	4.697	18.269	29.101	25.683	5.109
Hourly wage, 75th percentile, 2007	944	34.714	7.487	27.404	44.535	39.478	8.658
Hourly wage, 90th percentile, 2007	944	14.494	2.710	11.731	18.229	15.984	2.880
Wage growth, 2007 to 2009	943	0.012	0.089	-0.099	0.124	0.011	0.066
Wage growth, 10th percentile, 2007-09	943	0.053	0.064	-0.022	0.137	0.048	0.049
Wage growth, 25th percentile, 2007 to 2009	943	0.058	0.055	-0.006	0.134	0.051	0.041
Wage growth, median, 2007 to 2009	943	0.050	0.068	-0.030	0.136	0.040	0.048
Wage growth, 75th percentile, 2007 to 2009	943	0.066	0.057	-0.001	0.137	0.056	0.042
Wage growth, 90th percentile, 2007 to 2009	943	0.039	0.057	-0.031	0.107	0.032	0.039

Table 4
Non-Tradable Employment Growth And The Housing Net Worth Shock

This table presents coefficients from regressions relating non-tradable employment growth in a county from 2007 to 2009 to the change in housing net worth between 2006 and 2009. Non-tradable employment is defined at the 4-digit industry level and then aggregated up separately for each county. We use two different definitions of non-tradable industries, one based on restaurant and retail sector, and another based on an industry's geographical concentration. All regressions are weighted using the total number of households in a county as weights. The instrumental variables specifications use the housing supply elasticity as an instrument for the change in housing net worth in the first stage. Standard errors are adjusted for spatial correlation across counties, with the correlation proportional to the inverse of the distance between any two counties.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Employment growth, non-tradable industries, 2007-2009							
Non-tradable definition used:	Restaurant & Retail	Geographical Concentration	Restaurant & Retail	Geographical Concentration	Restaurant & Retail	Geographical Concentration	Restaurant & Retail	Geographical Concentration
Change in Housing Net Worth, 2006-2009	0.190**	0.199**	0.305**	0.227*	0.174**	0.166**	0.374**	0.208*
	(0.042)	(0.049)	(0.101)	(0.106)	(0.043)	(0.046)	(0.132)	(0.086)
Constant	-0.022**	-0.021**	-0.010	-0.017	0.176	0.070	0.445	1.233**
	(0.007)	(0.007)	(0.010)	(0.010)	(0.443)	(0.286)	(0.536)	(0.438)
Specification	OLS	OLS	IV	IV	OLS	OLS	IV	IV
2-digit 2006 employment share controls included?[#]					YES	YES	YES	YES
N	944	944	540	540	944	944	540	540
R^2	0.096	0.156	0.057	0.166	0.175	0.236	0.158	0.275

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively.

The 23 two-digit industries are: Agriculture, Mining, Utilities, Construction, Manufacturing (3 2-digit industries),Wholesale Trade, Retail trade (2 2-digit industries), Transportation (2 2-digit industries), Information, Finance, Real Estate, Professional Services, Management, Administrative Services, Education, Health Care, Entertainment, Accommodation and Food Services, Other Services.

Table 5
Is Non-Tradable Employment Growth Driven By Construction Sector Shock?

This table tests if the relationship between non-tradable employment growth in a county from 2007 to 2009 and the change in housing net worth between 2006 and 2009 is driven by exposure to construction sector employment. Non-tradable employment is defined as employment in restaurant and retail industries at the 4-digit industry level and then aggregated up separately for each county. All regressions are weighted using the total number of households in a county as weights. The instrumental variables specifications use the housing supply elasticity as an instrument for the change in housing net worth in the first stage. Standard errors are adjusted for spatial correlation across counties, with the correlation proportional to the inverse of the distance between any two counties.

Dependent variable	(1) Share of construction, 2007	(2) ΔConstruction Employment, 2000-07	(3) Non-tradable Employment Growth, 2007-2009	(4) Non-tradable Employment Growth, 2007-2009	(5) Share of construction, 2007	(6) ΔConstruction Employment, 2000-07	(7) Non-tradable Employment Growth, 2007-2009	(8) Non-tradable Employment Growth, 2007-2009
Change in Housing Net Worth, 2006-2009	-0.103**	-0.743*	0.192**	0.191**	-0.025	-0.028	0.111**	0.286*
	(0.026)	(0.278)	(0.049)	(0.050)	(0.039)	(0.374)	(0.038)	(0.125)
Share of construction, 2007			0.10					
			(0.132)					
ΔConstruction Employment, 2000-07				0.013				
				(0.018)				
ΔConstruction Employment, 2007-09							0.103**	0.027
							(0.032)	(0.063)
Constant	0.101**	0.886**	-0.032*	-0.033*	0.109**	0.956**	-0.013	-0.008
	(0.005)	(0.034)	(0.015)	(0.016)	(0.005)	(0.043)	(0.008)	(0.008)
Specification					IV	IV		IV
N	540	539	540	539	540	539	540	540
R^2	0.095	0.063	0.11	0.110	0.040	0.005	0.143	0.075

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 6
Is Non-Tradable Employment Growth Driven By Credit Supply Tightening?

This table presents coefficients from regressions relating non-tradable employment growth in a county from 2007 to 2009 to the change in housing net worth between 2006 and 2009. Panels A and B reports the OLS and IV coefficient estimates respectively for establishments of varying sizes. Panel C reports the coefficients separately for national and local banking markets. Non-tradable employment is defined as employment in restaurant and retail industries at the 4-digit industry level and then aggregated up separately for each county. All regressions are weighted using the total number of households in a county as weights. The instrumental variables specifications use the housing supply elasticity as an instrument for the change in housing net worth in the first stage. Standard errors are adjusted for spatial correlation across counties, with the correlation proportional to the inverse of the distance between any two counties.

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A (OLS): Effect of Change in Housing Net Worth on Non-tradable Employment Growth By Establishment Size (N=944 counties)					
	Establishment Size In Terms Of Number of Employees:					
	1 to 4	5 to 9	10 to 19	20 to 49	50 to 99	100+
Change in Housing Net Worth, 2006-2009	0.070**	0.032	0.022	0.134**	0.152	0.434**
	(0.025)	(0.036)	(0.044)	(0.032)	(0.097)	(0.061)
	Panel B (IV): Effect of Change in Housing Net Worth on Non-tradable Employment Growth By Establishment Size (N=540 counties)					
	Establishment Size In Terms Of Number of Employees:					
	1 to 4	1 to 4	1 to 4	1 to 4	1 to 4	1 to 4
Change in Housing Net Worth, 2006-2009	-0.134	0	-0.022	0.193*	0.335	0.770**
	(0.147)	(0.125)	(0.109)	(0.086)	(0.191)	(0.208)
	Panel C: Effect of Change in Housing Net Worth on Non-tradable Employment Growth By Banking Type					
	Banking Type:					
	National (OLS, N=472)	Local (OLS, N=304)	National (IV, N=472)	Local (IV, N=236)		
Change in Housing Net Worth, 2006-2009	0.186**	0.306	0.233**	0.308**		
	(0.041)	(0.178)	(0.068)	(0.107)		

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 7
Tradable Employment Growth And The Housing Net Worth Shock

This table presents coefficients from regressions relating tradable employment growth in a county from 2007 to 2009 to the change in housing net worth between 2006 and 2009. Tradable employment is defined at the 4-digit industry level and then aggregated up separately for each county. We use two different definitions of tradable industries, one based on US import/export, and another based on an industry's geographical concentration. There are 23 2-digit industry employment share variables as controls in columns 3 and 4. There are 294 4-digit industry fixed effects in columns 6 and 7, and 944 county fixed effects in column 7. All regressions are weighted using the total number of households in a county as weights. The instrumental variables specifications use the housing supply elasticity as an instrument for the change in housing net worth in the first stage. Standard errors are adjusted for spatial correlation across counties, with the correlation proportional to the inverse of the distance between any two counties.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment growth, tradable industries, 2007-2009				Employment growth, 2007-2009 (county-4digitIndustry level)		
Tradable definition used:	Global Trade	Geographical Concentration	Global Trade	Geographical Concentration			
Change in Housing Net Worth, 2006-2009	0.018	-0.085	0.064	-0.063	0.221**	0.157***	-
	(0.099)	(0.063)	(0.098)	(0.074)	(0.062)	(0.065)	
Industry Geographical Herfindahl Index					-3.864**	-	-
					(0.600)		
ΔHNW * (Geographical Herfindahl)					-13.592**	-11.22**	-11.24**
					(3.089)	(2.22)	(2.19)
Constant	-0.114**	-0.091**	-0.286	0.542	-0.067**	-	-
	(0.012)	(0.012)	(0.950)	(1.144)	(0.011)		
2-digit 2006 employment share controls?			Yes	Yes			
4-digit Industry Fixed Effects						Yes	Yes
County Fixed Effects							Yes
N	944	944	944	944	180,756	180,756	180,756
R^2	0.000	0.002	0.079	0.064	0.006	0.134	0.17

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 8
Wages and Mobility

Columns 1 and 2 present coefficients from regressions relating wage growth in a county from 2007 to 2009 to the change in housing net worth between 2006 and 2009. The specifications in column 1 uses total wages from the Census County Business Patterns data. The specification in column 2 uses hourly wage growth data from the American Community Survey. Columns 3 and 4 present coefficients from regressions relating mobility and labor force participation in a county from 2007 to 2009 to the change in housing net worth. The specification in column 3 uses census data on population growth. The specification in column 4 uses labor force data from the Bureau of Labor Statistics. All regressions are weighted using the total number of households in a county as weights. Standard errors are adjusted for spatial correlation across counties, with the correlation proportional to the inverse of the distance between any two counties.

	(1) Total wage growth, 2007 to 2009, CBP	(2) Average Hourly wage growth, 2007 to 2009, ACS	(3) Population growth, 2007-2009	(4) Labor force growth, 2007-2009
Change in Housing Net Worth, 2006-2009	0.061	0.054	0.019	-0.0094
	(0.041)	(0.039)	(0.021)	(0.020)
Constant	0.031**	0.037**	0.021**	0.0136
	(0.007)	(0.003)	(0.004)	(0.004)
Specification				
Sample				
N	944	943	939	944
R^2	0.012	0.018	0.009	0.001

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively