What Explains High Unemployment?
The Aggregate Demand Channel

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Abstract

A drop in aggregate demand driven by shocks to household balance sheets is responsible for a large fraction of the decline in U.S. employment from 2007 to 2009. The aggregate demand hypothesis for employment losses makes the joint prediction that job losses in the *non-tradable* sector will be higher in high leverage U.S. counties that were most severely impacted by the balance sheet shock, while losses in the *tradable* sector will be distributed uniformly across all counties. We find exactly this pattern from 2007 to 2009. Alternative hypotheses for job losses based on business uncertainty or structural unemployment related to construction do not explain our results. Using the relation between non-tradable sector job losses and demand shocks and assuming Cobb-Douglas preferences over tradable and non-tradable goods, we quantify the effect of aggregate demand channel on total employment. Our estimates suggest that the decline in aggregate demand driven by household balance sheet shocks accounts for almost 4 million of the lost jobs from 2007 to 2009, or 65% of the lost jobs in our data.

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The 2007 to 2009 recession witnessed one of the largest declines in employment in U.S. history. The employment to population ratio dropped from 63% in 2007 to 58% in 2009. Why did the employment level drop so drastically? Despite the importance of this question, there is a lack of consensus on the reasons for the drop in employment. The main hypotheses put forth include a decline in aggregate demand, business uncertainty, and housing sector-related structural adjustment of the labor force.

We quantify the impact of aggregate demand shocks on employment loss between 2007 and 2009 by utilizing the cross-sectional relationship between local demand shocks and job losses in the non-tradable and tradable sectors. Mian, Rao and Sufi (2012) show that counties with high household leverage as measured with the 2006 household debt to income ratio experienced a much sharper decline in household expenditure between 2007 and 2009.

The aggregate demand hypothesis for employment losses predicts that these local expenditure shocks translate into local job losses in the non-tradable sector but nation-wide job losses in the tradable sector. For example, if Californians cut back on consumption significantly more than Texans because of the relative household balance shock in California, the non-tradable sector in California loses more jobs than the non-tradable sector in Texas. However, because Californians buy tradable goods produced throughout the country, job losses in the tradable sector will be distributed evenly between California and Texas.

We find strong support for the aggregate demand hypothesis for employment losses. Using *industry-by-county* data on employment, we classify industries as non-tradable if they are focused in the retail or restaurant business. In order to remove any direct effect of the residential housing boom and bust, we explicitly remove construction or any other real-estate related sector from the non-tradable definition. Similarly, we classify industries as tradable if goods in that industry are commonly traded across national borders.

We find that job losses in the non-tradable sector between 2007 are 2009 are significantly higher in high leverage counties that experienced sharp demand declines. In particular, a one standard deviation increase in the 2006 debt to income ratio of a county is associated with a 3 percentage point drop in non-tradable employment during this time period. At the same time, the large decline in employment in the tradable sector is completely *uncorrelated* with 2006 debt to income – exactly as predicted by the aggregate demand hypothesis.

Any alternative explanation for these cross-sectional results must simultaneously explain the strong correlation of household leverage with non-tradable employment declines across counties, but no correlation of household leverage with tradable employment declines. We argue that theories of employment losses based on heightened economic and policy uncertainty facing businesses cannot explain these patterns.

Another explanation for job losses is based on structural adjustment problems relating to the displacement of labor from overly-inflated housing, construction, and financial industries. One may argue that such structural adjustment issues are more prevalent in more levered counties. However, our definition of non-tradable job losses explicitly removes job losses associated with construction and other related industries. Moreover, the construction share of employment as of 2007 or the growth in the construction sector from 2000 to 2007 are uncorrelated with non-tradable sector job losses across counties.

We also show that both the construction share as of 2007 and the growth in the construction sector during the housing boom are uncorrelated with county-level household leverage when instrumented with housing supply elasticity. The reason for this perhaps surprising result is that low housing supply elasticity areas had higher price appreciation during the boom and hence more leverage, but it was also more costly to expand the housing stock in these areas.

We also examine other margins of adjustment in the labor market. Given the disproportionate job losses in the U.S. economy, one would expect a decline in wages. However, research demonstrates that nominal wages have displayed substantial downward rigidity during the Great Recession (Daly, Hobijn, and Lucking (2012); Daly, Hobijn, and Wiles (2011); Fallick, Lettau, and Wascher (2011)). Our finding that tradable employment in high leverage counties does not increase when non-tradable employment collapses is consistent with the importance of nominal wage rigidity. In the cross-section of counties, we find marginally statistically significant negative effects of demand shocks on nominal wages, but the wage declines are very small relative to the large decline in employment. One might also expect that workers would move out of high household leverage counties in response to deterioration in local labor markets. However, we find no evidence of such mobility.

Our theoretical framework provides a methodology for calculating total jobs lost due to the negative demand shocks. The idea is based on extrapolating the observed job losses in the non-tradable sector to job losses in remaining sectors by using a Cobb-Douglas assumption on preferences (see Section 2). We estimate that the aggregate demand channel can account for 4 million of the 6.2 million jobs lost between March 2007 and March 2009. The implied elasticity of job losses in the non-tradable sector with respect to the demand shock is 0.36.

Recent theoretical papers have argued that demand shocks related to household balance sheets can lead to significant job losses under frictions such as nominal rigidity (e.g. Eggertsson and Krugman (2012), Guerrieri and Lorenzoni (2011), Hall (2011), Midrigan and Philippon

(2011)). Our study is among the first that exploits detailed cross-sectional variation across U.S. counties to empirically verify the employment consequences of household demand shocks.[1]

The rest of the study proceeds as follows. Section 1 provides background information, and Section 2 builds our methodology. Section 3 presents the data and our classification scheme for tradable and non-tradable goods. Section 4 presents the results of our analysis. Section 5 conducts our final aggregate calculation, and Section 6 concludes.

Section 1: Motivation and Background

A. Household leverage and the shock to household spending

The starting point of our analysis is the large relative to decline in household spending during the recession in high household leverage counties as shown in Mian, Rao and Sufi (MRS 2012). Figure 1 replicates their main finding. To construct the figure, they split U.S. counties into deciles based on the household debt to income ratio as of 2006. In Figure 1, high (low) household leverage counties are counties in the top (bottom) decile of the 2006 household debt to income distribution.[2]

The top left panel shows that high household leverage counties experienced dramatic house price declines during the recession. House prices declined by almost 40% in these areas. The combination of high debt levels and the sharp decline in house prices represented a severe balance sheet shock to households. As the other three panels of Figure 1 show, households in high leverage counties responded to this shock by sharply cutting consumption. The drop in durable consumption was very large, but the drop in grocery spending was also pronounced.

House prices declined by much less in low leverage counties, and consumption levels did not decline nearly as much. MRS 2012 find that the magnitude of the relative drop in

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[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.

[2] Please see MRS 2012 for details on the data used in these figures.

consumption in high debt counties was very large, and they find that high leverage counties were the driving force behind the decline in aggregate household spending from 2007 to 2009.

What is the precise economic mechanism through which household spending decreased so dramatically in counties with a high debt to income ratio as of 2006? This is the central focus of MRS 2012. They provide evidence that it was the *combination* of historically high debt levels and the dramatic decline in house prices in these areas. The evidence is less consistent with the view that the decline in spending was due to a pure housing wealth effect or an expectations shock unrelated to household balance sheet problems. For example, they show that even within high leverage counties, the decline in household spending was much larger for high leverage households even controlling for the same decline in house prices. Further, problems directly related to high levels of debt--such as deleveraging and an inability to access lower interest rates--were highly operative in these areas.

MRS 2012 conclude that the decline in aggregate consumption during the 2007 to 2009 recession is most consistent with models in which household balance sheet weakness plays a crucial role (e.g., Eggertsson and Krugman (2012), Guerrieri and Lorenzoni (2011), Hall (2011), and Midrigan and Philippon (2011)).

As Figure 1 shows, there was an indisputable larger decline in consumption levels from 2007 to 2009 in counties with a high debt to income ratio as of 2006. In this study, we take this relative demand shock as given, and we limit the exploration of the reasons behind this demand shock given the extensive work already in MRS 2012.[3] Instead, our primary purpose here is to show that this relative demand shock was a primary driver of the decline in aggregate employment from 2007 to 2009.

[3] Of course, in this study, we will directly address alternative hypotheses for the large decline in employment in high leverage areas.

B. *Understanding variation in the 2006 debt to income ratio*

Since the main source of variation for the decline in household spending is the 2006 county-level debt to income ratio, it is important to understand the source of this variation. This issue is dealt with in detail in Mian and Sufi (2009) and Mian and Sufi (2011). Mian and Sufi (2009) show that an expansion in the *supply* of mortgage credit to the U.S. from 2002 to 2006 had a differential effect on house price growth across U.S. counties. In particular, areas that were more constrained in their capacity to supply housing due to more difficult-to-build terrain as identified by Saiz (2011)), experienced larger house price gains as credit supply expanded.

Mian and Sufi (2011) use individual level panel data on consumer borrowing to show that U.S. households borrowed 25 to 30 cents for every dollar increase in the value of their housing. As a result, house price growth fueled by the expansion in mortgage credit supply led to much higher levels of debt in counties where the supply of housing was naturally restricted. This mechanism explains a substantial part of the cross-sectional variation in leverage as of 2006.[4]

A natural instrument for the 2006 leverage ratio is therefore the elasticity of housing supply in the county introduced by Saiz (2011). This measure is available for 877 counties.[5] Column 1 of Table 1 presents the first stage regression of debt to income on housing supply elasticity which indeed predicts leverage strongly. The Saiz elasticity instrument has another attractive characteristic in that, once instrumented, 2006 county level leverage ratios are *uncorrelated* with both the share of construction workers in 2007 and the growth in the construction industry during the housing boom. This – as we discuss in detail below - allows us to cleanly separate the aggregate demand channel from the construction-related structural adjustment hypothesis.

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[4] Cities in Arizona and Nevada are important outliers. See Mian and Sufi (2009, 2011) for more details.
[5] The Saiz (2011) measure is constructed at the CBSA level. For the 877 counties for which the Saiz (2011) data are available, there are 260 CBSAs. The average number of counties per CBSA is 3 and the median is 2.

Section 2: Empirical Framework

We now present a simple model that illustrates how household expenditure shocks translate into employment losses, and how the cross-sectional distribution of employment losses differs for the non-tradable versus tradable sector. The model outlines how total employment loss can be backed out from the cross-sectional distribution of non-tradable employment losses. In doing so, the model also highlights assumptions regarding labor market and price adjustments that are sufficient to deliver the results.

A. Basic framework and initial steady state

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. Labor cannot move across islands but can move freely across 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 $y_c^T = b e_c^T$, and $y_c^N = a e_c^N$, 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 $w_c^N = a P_c^N$ and $w_c^T = b P^T$ 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.

B. Heterogeneous demand shocks

We now consider what happens if counties are hit with differing household expenditure shocks as in Figure 1. We normalize initial nominal demand $D_0 = 1$ and introduce the possibility of negative demand shocks (δ_c) that differ across counties such that $D_c = 1 - \delta_c$.[6] 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 with flexible prices, and another with complete nominal rigidity.

<u>1. Fully flexible price adjustment:</u>

If prices and wages are perfectly flexible, there is price and wage deflation in response to negative demand shocks. The change in prices and wages in the flexible price equilibrium is given by (see appendix for details): $\Delta P_c^T = -\frac{\bar{\delta}}{b}, \Delta P_c^N = -\frac{\bar{\delta}}{a}, \Delta w_c^N = \Delta w_c^T = -\bar{\delta}$.

[6] 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.

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.[7]

2. Full nominal rigidity:

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 $Y_c = -(\Delta e_c^N + \Delta e_c^T)$ denote total employment loss in county c. We obtain,

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

As equation (1) 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.

[7] 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.

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.

In the model above, we use nominal rigidity as the friction that translates a decline in household spending into a decline in aggregate employment. This friction produces testable cross-sectional predictions based on non-tradable and tradable sector employment across counties with varying demand shocks. We justify this friction given substantial evidence on the importance of price and wage rigidities in the Great Recession (e.g., Daly, Hobijn, and Lucking (2012); Daly, Hobijn, and Wiles (2011); Fallick, Lettau, and Wascher (2011); and Hall (2011)). However, we are open to the idea that other frictions could potentially explain why demand shocks translate into employment losses. These frictions would need to explain why negative demand shock counties experience a sharp relative decline in non-tradable sector employment, but no compensating increase in tradable sector employment.

C. Other sources of employment loss

Equation (1) assumes that demand shocks are the only source of employment losses in the economy. However, there may be alternative reasons for employment declines that need to be considered when taking the aggregate demand hypothesis to data. We consider two other mechanisms highlighted in the literature. First, declines in output and employment may be due to economy-wide factors such as uncertainty shocks which lead to firms freezing hiring and investment (Bloom (2009); Baker, Bloom, and Davis (2011)). Second, certain counties may be more exposed to employment losses due to housing sector related structural adjustment. For example, if the economic decline is driven by a re-allocation of resources away from finance and construction toward other sectors, then counties with larger gains from finance and construction in the housing boom period will have more unemployed workers. Unemployment may remain high as these unemployed workers are retrained for new jobs.

Let η denote employment losses common to all counties due to economy wide factors such as business uncertainty shocks and let s_c denote employment losses in county *c* due to structural shocks. Then total employment losses Y_c in a county are given by:

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

D. Isolating the impact of the aggregate demand shock on aggregate employment

Equation (2) represents total employment losses in a given county inclusive of the three main hypotheses we have considered. Total employment losses from demand shocks δ_c are obtained by summing (2) across counties, giving us, $JOBSLOSTDEMAND = S\bar{\delta}$.[8]

Our task is to estimate $JOBSLOSTDEMAND$ using county-level data. Doing so requires the removal of structural unemployment s_c and economy wide shock η from (2). We also need a suitable measure of δ_c. Define the non-tradable sector as the sector that is non-tradable *and* not exposed to structural unemployment.[9] Then,

$$Y_c^N = \alpha\delta_c + \alpha\eta \tag{3}$$

where Y_c^N represents employment losses in the non-tradable sector, $Y_c = Y_c^N + Y_c^T$ and $Y_c^T = (1-\alpha)\bar{\delta} + (1-\alpha)\eta + s_c$. Equation (3) takes out the impact of structural employment by limiting itself to the non-tradable sector.

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[8] That is: $\sum_{c=1}^{S}\alpha\delta_c + \sum_{c=1}^{S}(1-\alpha)\bar{\delta}$

[9] In the empirical section, this translates into removing construction and real-estate related industries from the definition of non-tradable goods.

A problem with estimating (3) is that the county-level demand shock δ_c is not directly observed. However, suppose there is an observable county characteristic X_c such that X_c is monotonically related to δ_c (and hence $\alpha\delta_c$). In our context, X_c represents the debt to income ratio as of 2006 which is strongly correlated with the strength of the consumer demand decline across counties (MRS (2012)). We can use X_c to back out the marginal effect of the demand shock δ_c on non-tradable employment. To see this, rewrite (3) in differences such that,

$$\Delta Y_c^N = Y_c^N - Y_1^N = (\alpha\delta_c - \alpha\delta_1) \tag{4}$$

The differencing in equation (4) has stripped out the effect of economy wide shock η from the equation. More importantly, given the monotonic relationship between X_c and δ_c, an unbiased estimate of ΔY_c^N is given by:

$$[E(Y_c^N|X_c) - E(Y_1^N|X_1)] \tag{5}$$

The term in square brackets can be estimated non-parametrically, or if the relationship between Y_c^N and X_c is linear then via standard OLS. Let $\widehat{\Delta Y_c^N} = [E(Y_c^N|X_c) - E(Y_1^N|X_1)]$, be an unbiased estimate for ΔY_c^N then

$$\sum_{c=2}^{S} \widehat{\Delta Y_c^N} = \sum_{c=2}^{S} (\alpha\delta_c - \alpha\delta_1) = \alpha S\bar{\delta} - \alpha S\delta_1 \tag{6}$$

Equation (6) and the analysis above gives us the following proposition that summarizes our methodology for estimating $JOBSLOSTDEMAND$.

<u>*Proposition 1:*</u> As long as the employment effect of the demand shock is non-positive for the county that is least impacted (i.e. $\alpha\delta_1 \geq 0$), the estimate $\frac{1}{\alpha}\left[\sum_{c=2}^{S} \widehat{\Delta Y_c^N}\right]$ represents an underestimate of the total employment loss in the economy due to the aggregate demand shock.

The parameter α can be estimated as the share of non-tradables in the overall economy. In our empirical analysis that follows, we will explicitly test for the condition $\alpha\delta_1 \geq 0$ and implement the methodology summarized in Proposition 1.[10]

Section 3: Data, Motivating Example, and Industry Classification

A. Data

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. The most recent data available is for 2009. 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.[11] 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.

As mentioned above, a key variable in the analysis is the leverage ratio of a county, which is measured as the household debt to income ratio as of 2006. Total debt in a county is measured using consumer credit bureau data from Equifax and income is measured as total wages and salary in a county according to the IRS. It is adjusted for potential double-counting using credit bureau information from the Federal Reserve Bank of New York. For more information on the construction of the debt to income ratio, see Mian, Rao, and Sufi (2012).

[10] This condition, $\alpha\delta_1 \geq 0$, which is satisfied in the data, helps to mitigate concerns that general equilibrium effects are leading to an over-estimate of the employment losses using the cross-sectional approach. Whatever positive general equilibrium effects on employment are present in counties with low household leverage, they are not positive enough to avoid job losses in those counties. This is precisely why our methodology under-estimates the total job losses due to the aggregate demand channel.

[11] 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.

B. Motivating example

Figure 2 plots total employment change in a county between 2007 and 2009 against 2006 household debt to income ratio that generates the local demand shocks highlighted in Figure 1. There is a strong negative correlation between the two as counties with high household leverage experience much sharper declines in employment during the recession. Column 2 of Table 1 presents the weighted least squares version of the scatter-plot in Figure 1 and confirms the statistical significance of the relationship.[12]

While Figure 2 suggests a link between household demand shocks and employment losses, the aggregate demand hypothesis makes a more powerful prediction: job losses in the non-tradable sector will be correlated with household leverage while job losses in the tradable sector will be uncorrelated with household leverage. The automobile sector provides an interesting case study to test this hypothesis because within the *same* sector there is a manufacturing sub-sector that is tradable and a retail service sub-sector that is non-tradable. [13]

Figure 3 plots the change in employment in the auto retail (left panel) and auto manufacturing (right panel) against a county's debt to income ratio as of 2006. Since county population distribution is highly skewed we plot only the 450 counties with more than 50,000 households. The results are exactly in line with the aggregate demand channel predictions.

Column 3 in Table 1 and the left panel of Figure 3 show that the relationship between change in auto retail employment and household leverage is strongly negative as predicted. Moreover, column 4 and the right panel of Figure 3 show that there is no relationship between

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[12] Appendix Figure 1 shows a close correspondence with unemployment rates--employment losses in high debt to income counties translated directly into higher unemployment rates.

[13] Automobile manufacturing consists of the following four digit industry codes: motor vehicle manufacturing (3361), motor vehicle body and trailer manufacturing (3362), and motor vehicle parts manufacturing (3363). Automobile retail consists of: Automobile dealers (4411), other motor vehicle dealers (4412), Automotive parts accessories and tire stores (4413), and motor vehicle parts and supplies merchant stores (4231).

the change in auto manufacturing employment and household leverage as auto manufacturing employment declined uniformly across the entire country.[14]

Figure 3 illustrates our methodology through a simple transparent example. The negative shock to the demand for autos leads to a reduction in the automobile manufacturing employment everywhere. However, the drop in retail employment is more closely tied with economic geography: the drop in retail automobile sector employment is stronger in areas where the drop in demand for automobiles is higher. Given that low leverage counties experienced only a minor drop in demand for autos and minor job losses in the auto retail sector, we can confidently ascribe the job losses in the auto manufacturing sector *throughout the country* to the reduction in demand coming from high leverage counties. As we show below, this basic pattern extends to employment in all sectors, not just autos.

C. Classifying industries into tradable and non-tradable categories

Splitting employment into jobs producing tradable versus non-tradable goods is a crucial and non-trivial 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

[14] One concern is the large number of counties that show zero growth in auto manufacturing employment from 2007 to 2009. Many of these counties have very few jobs in manufacturing employment. We can limit the sample to counties above the 25th percentile in auto manufacturing employment which substantially reduces the number of zero growth counties. The results are similar.

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 can afford to be conservative and only minimize Type I error because our aggregate calculation in Section 2 only requires that the relation between non-tradable employment losses and household leverage be accurately estimated. Beyond that as long as the "α" used in our calculations corresponds to the chosen set of industries classified as non-tradable, our overall methodology remains accurate.

We describe our two different methods of classifying industries below:

1. Retail and world trade based classification

For our 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.[15] *Non-tradable* industries are defined as the retail sector and restaurants. We also use a more restricted version of non-tradable industries that includes only grocery retail stores and restaurants. 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 2 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

[15] 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.

2007 for the four categories are: tradable (11%), non-tradable (20%), construction (11%), and other (59%).[16]

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, 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.[17]

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 3 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

[16] 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.

[17] 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).

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 measure of "tradability" in some of our robustness checks below.

D. Summary statistics

Table 4 presents summary statistics for our sample. The average debt to income ratio of a county is 1.6 with a large standard deviation if 0.6. Overall employment drops from 2007 to 2009 by 5%, while the drop is 12% for construction and tradables, 2.5% for non-tradables and 1.3% for the food industry. 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 $17 in 2007 and grows at the rate of 2.9% from 2007 to 2009.

Section 4: Demand Shocks and Employment Losses

In this section, we implement the methodology of Section 2 to estimate the effect of the aggregate demand shock related to household balance sheet weakness on aggregate employment.

A. Demand shocks and employment losses in non-tradable and tradable industries

The left panel of Figure 4 presents the scatter-plot of employment losses in non-tradable industries (excluding construction) from 2007 to 2009 against the 2006 debt to income ratio of the county. There is a strong negative correlation and even at the lowest end of the demand shock, the predicted level of employment change is non-positive. As Proposition 1 explained, this is important for our aggregate calculation.[18] The thin black line in the left panel of Figure 4 plots the non-parametric relationship between job losses in the non-tradable sector and county leverage and shows that linearity is a reasonable assumption.

While job losses in the non-tradable sector are strongly negatively correlated with the 2006 debt to income ratio of the county, the right panel of Figure 4 shows no such relation between leverage and job losses in the tradable sector. Instead, the OLS prediction has a negative constant and is flat across the entire distribution. This is exactly the expected relationship under the aggregate demand hypothesis given that the labor demand shock for tradable goods production should be evenly distributed across the economy.

Table 5 presents the regression coefficients relating employment growth in non-tradable industries from 2007 to 2009 to the 2006 debt to income ratio of the county. The instrumental variables estimate in column 3 implies that a one standard deviation increase in ex ante county leverage is associated with a 3.0% drop in employment in the non-tradable sector. Alternatively, moving from the 10th percentile of the leverage distribution to the 90th percentile – which translates into a 17.2% further drop in consumption - is associated with a 6.2% larger drop in employment in industries producing non-tradable goods. This implies an elasticity of employment growth with respect to consumption growth of 0.36.

[18] In our actual aggregate calculation, we are conservative and use the debt to income ratio at the 10th percentile of the distribution as our control group.

One concern is that counties with high debt to income ratios are somehow spuriously correlated with the type of industries they specialize in. For example, if these industries received a stronger shock, our results could be spurious. Column 4 includes the share of employment devoted to each sector as of 2007 as controls and the coefficient of interest does not change. We have also included even finer industry controls at the county level – for example, the share of employment at the 2-digit industry level–the results are unaffected.

Column 5 uses the stricter definition of non-tradable which includes only industries related to retail grocery and restaurants. This alternative definition is a strict subset of our earlier definition. The coefficient on debt to income is negative and statistically significant, although it is slightly smaller than the column 2 estimate. The difference in magnitude reflects the fact that demand for groceries is less elastic than other goods bought in retail stores.[19]

Columns 6 and 7 report specifications relating job losses in the tradable sector to the 2006 debt to income ratio of a county. The coefficient is close to zero and precisely estimated. The difference between the coefficients for tradable job losses in column 6 and that for non-tradable job losses in column 1 is also statistically significant at the 1% level. The results in columns 6 and 7 also show a statistically significant negative coefficient on the constant. This reflects the fact that employment losses are evenly distributed across the entire country in industries producing tradable goods.

Figure 5 and Table 6 repeat the analysis using the geographical concentration based-definition of tradable and non-tradable industries. Despite being a completely different classification scheme, the results are remarkably similar. The left panel of Figure 5 and columns 1 through 4 of Table 6 show that the relationship between job losses in non-tradable industries –

[19] Mian, Rao, and Sufi (2012) show that that the relative reduction in consumption in high leverage counties from 2007 to 2009 is smallest for groceries, which is consistent with a lower income elasticity.

as defined by industries that are least concentrated geographically - and the debt to income ratio as of 2006 is strongly negative. The right panel of Figure 5 and the results in columns 5 and 6 of Table 6 show that the relationship between job losses in tradable industries – as defined by industries that are most concentrated geographically – and debt to income as of 2006 is completely uncorrelated.

In column 7 of Table 6, we use the entire distribution of industries based on industry concentration instead of grouping firms into non-tradable and tradable categories. The estimated coefficient on the 2006 debt to income ratio is negative and significant, which implies that job losses in the least concentrated (most non-tradable) industries are much more severe in high debt to income counties. The positive and significant coefficient on the interaction term shows that an increase in concentration (tradability) leads to a less negative effect of job losses in that industry for high debt to income counties. This result confirms that our findings are not an artifact of our discontinuous grouping of industries into non-tradable and tradable categories.

B. Testing alternative explanations

The decline in employment in industries producing non-tradable goods from 2007 to 2009 is concentrated in high leverage U.S. counties that simultaneously experience sharp relative declines in credit limits, house prices, debt levels, and consumption. The decline in employment in industries producing tradable goods is spread evenly across U.S. counties. These facts are consistent with the aggregate demand hypothesis of high unemployment levels that we outline in Section 2 above. Could our results also be explained by alternative hypotheses? We discuss this question below.

1. The business uncertainty hypothesis

A number of commentators and academics have put forth policy, regulatory, or 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.[20] As we show in Section 2, in its most basic form, an increase in business uncertainty at the *aggregate* level does not explain the stark *cross-sectional* patterns in employment losses that we observe in non-tradable and tradable industries across U.S. counties.

A more nuanced version of the business uncertainty hypothesis is that businesses in high leverage areas face relatively more uncertainty, and this can explain the employment losses in these areas. Of course, if businesses face more uncertainty because of a large decline in demand in these areas, then this is simply another manifestation of the aggregate demand channel. However, the argument may be that businesses face more uncertainty in high leverage areas for reasons other than just the decline in demand. For example, perhaps there is more uncertainty regarding state government policies in states with severe housing problems.

Even this more nuanced version is difficult to reconcile with the results for the following reason: the job losses in non-tradable industries are concentrated in high leverage counties whereas job losses in tradable industries are spread throughout the country. A business uncertainty explanation based on local factors must explain why only businesses in non-tradable industries react to this uncertainty.

[20] 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.

In the appendix, we address one particular form of uncertainty that may be important: governments in states with housing problems must cut expenditures more dramatically which introduces heightened business uncertainty.[21] As we show there, state government expenditure cuts were concentrated in 2009 after housing problems and job losses started. Further, we can control directly for mid-year state budget cuts and the results are similar.

2. The construction-related structural unemployment hypothesis

Another common explanation given for high unemployment is the displacement of workers from real estate related "bubble" industries such as construction and mortgages. Since job losses in these sectors are likely to be permanent once the bubble burst, it will take time for these workers to get re-trained and absorbed in alternative industries.

There are a number of reasons why the construction-related hypothesis is unlikely to explain our results. First, we explicitly remove any employment associated with the construction, real estate, or mortgages from our non-tradable definition. The strong correlation between leverage and the decline in non-tradable employment is not driven by construction related employment changes.

However, perhaps our debt to income measure as of 2006 is correlated with the construction sector shock, and a negative shock to construction indirectly affects other non-tradable sector employment. Table 7 tests this concern by first correlating the 2006 debt to income ratio across counties with the county-level share of employment in construction in 2007, and the growth in construction related employment from 2000 to 2007. Columns 1 and 3 of Table 7 show that both these measures of exposure to the construction sector in a county are

[21] We are grateful to Daniel Shoag for raising this issue and for providing data from Mericle, Shoag, and Veuger (2012) that allows us to test it.

positively correlated with the 2006 debt to income ratio. How can we be sure that we are capturing a demand effect and not a construction effect?

One answer is in results shown above. In Tables 5 and 6, we include the share of workers in construction as of 2007 as a control variable. The inclusion of this control does not affect the results. In fact, the construction share of employment as of 2007 is barely correlated with job losses in non-construction non-tradable industries when no other variables are included.[22]

A second answer lies in our instrumental variables specification. Columns 2 and 4 of Table 7 show that when we instrument the 2006 debt to income ratio using housing supply elasticity, the predicted values of the debt to income ratio are *not* correlated with either the construction share as of 2007 or the growth in the construction share from 2000 to 2007. In other words, when we isolate the variation in the 2006 debt to income ratio that comes from housing supply elasticity, the variation is uncorrelated with the construction sector.

Recall that column 4 in Table 1 shows that the debt to income ratio as of 2006 is strongly correlated with housing supply elasticity, with an R^2 of 0.18. Why is the instrumented debt to income ratio uncorrelated with the construction share and the growth in construction sector in Table 7? The answer lies in the dual role played by the elasticity instrument. On one hand, less elastic counties saw sharper increases in house prices during the boom. The increase in house prices made credit more easily available due to higher collateral value therefore facilitating more construction activity. 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

[22] See the middle panel of Appendix Figure 3. When we estimate the corresponding weighted least squares regression in column 1 of Table 5 using the construction share of employment as of 2007 instead of the debt to income ratio as of 2006, the coefficient is -0.047 with a p-value of 0.373. The standard deviation of the construction share weighted by total population is only 0.039. This implies both a very small and statistically weak effect of the construction share on subsequent employment losses in non-construction non-tradable industries.

housing elasticity uncorrelated with construction activity, but strongly correlated with the accumulation of leverage due to the home equity borrowing effect.

Columns 5 and 6 perform an extreme test by explicitly *controlling* 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 consumption shock in high leverage counties will force them to cut back on housing and construction sector as well.[23] Nonetheless column 5 shows that the coefficient of debt to income remains negative and statistically significant at the 1% confidence level. More importantly, when we instrument the 2006 debt to income ratio using housing supply elasticity in column 6, the coefficient is exactly the same as without the contemporaneous construction employment decline control variable. Taken together, the results in Table 7 show powerful evidence that our estimate is not polluted by issues related to construction.

3. The business credit supply hypothesis

Another possible explanation for high unemployment is based on counties experiencing differential credit supply shocks depending on the severity of the house price collapse. Because leverage as of 2006 is strongly correlated with subsequent house price declines and real estate may be used as collateral for business credit, collateral-induced tightness in business credit might reduce employment in high leverage counties.

One problem with this alternative explanation is that it does not explain why higher job losses in high leverage counties were only concentrated in non-tradable industries. An

[23] Consistent with this argument, the right panel of Appendix Figure 3 shows that the debt to income ratio as of 2006 does an excellent job predicting job losses in the construction sector. In unreported results, we find that the debt to income ratio as of 2006 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.

explanation based on business credit supply would imply more job losses within high leverage counties in *all* industries--we find no such effect in industries producing tradable goods.

Although unlikely, one may argue that business credit supply shocks only affect non-tradable industries. If that were case, one would expect the effect of credit supply shocks to bind harder for smaller sized firms that are more credit constrained. However, splitting non-tradable employment by firm size (see Appendix Table 3), we find that the negative correlation between employment growth in non-tradable industries from 2007 to 2009 and the ex ante county leverage ratio is in fact stronger in *larger* establishments.

As another test of the credit supply hypothesis, we isolate the sample to counties that have predominantly national banks. National banks have branches everywhere and therefore should not be sensitive to local credit supply conditions. However, we find that the same pattern between non-tradable employment growth and county household leverage holds within this subset of counties as well (see Appendix Table 4).

C. Other labor market margins of adjustment: Wages and labor mobility

Our theoretical framework assumed complete nominal wage rigidity. This assumption is supported by empirical evidence from Daly, Hobijn, and Lucking (2012); Daly, Hobijn, and Wiles (2011); and Fallick, Lettau, and Wascher (2011). It is also supported by one of our key results: tradable employment did not increase relatively more in counties with the largest negative demand shocks. Recall that in the frictionless model developed in Section 2, negative demand shocks should translate into a substantial decline in wages throughout the country, and a relative increase in employment in the tradable sector in high leverage counties. Neither effect is present in the data.

A remaining question is whether nominal wages adjust more in high leverage counties. Columns 1 and 2 of Table 8 and the top two panels of Figure 6 use county level data on wages to show that high leverage counties experienced a slight relative decline in wages from 2007 to 2009, but the coefficient is only statistically significant using the ACS data.

How much do wages move? Strictly speaking, neither the frictionless nor nominal price rigidity frameworks developed in Section 2 predict a *relative* decline in wages in high leverage counties. In the frictionless model, all of the adjustment takes place in *aggregate* wages. In the model with nominal rigidities, all of the adjustment takes place in employment with high leverage counties experiencing a larger relative employment decline due to non-tradables.

However, a useful benchmark is to compare the decline in wages in high leverage areas with the decline in employment in those areas. The elasticity of employment with respect to wages implied by the change from 2007 to 2009 can be easily calculated using the coefficient on the debt to income variable in column 2 of Table 1 divided by the coefficient in column 1 of Table 8. Such a calculation gives an elasticity of employment with respect to wages of 2.8 (-0.028/-0.010). While this number includes all equilibrium responses and should therefore not be interpreted as a labor supply elasticity, it is very large relative to traditional estimates of labor supply responses. This estimate demonstrates that employment in high leverage counties was much more responsive than nominal wages to the demand shock.

In the spirit of Blanchard and Katz (1992), we also evaluate mobility. The bottom-left panel of Figure 6 and column 3 of Table 8 use census county level data on population growth from 2007 to 2009 and show that there is no evidence of higher population growth for counties less impacted by the local demand shock. If anything, the opposite is true. The lower-right panel of Figure 6 and column 4 of Table 8 repeat this analysis using labor force data from the bureau of labor statistics. There is no obvious relation. The results in Figure 6 and Table 8 show that the migration of workers from high to low leverage counties is unlikely to explain the drop in employment in high leverage counties.

Section 5: The Aggregate Calculation

A. Baseline calculation

We can now apply the methodology outlined in section 1 and summarized by Proposition 1 to compute the aggregate loss in employment due to the aggregate demand shock related to weak household balance sheets. The employment loss due to these demand shocks is given by $\frac{1}{\alpha}\left[\sum_{c=2}^{S}\widehat{\Delta Y_c^{NT}}\right]$, where $\widehat{\Delta Y_c^{NT}} = [E(Y_c^{NT}|X_c) - E(Y_1^{NT}|X_1)]$.

The relationship between non-tradable employment loss and 2006 leverage is almost linear (see Figure 4). We can therefore use results from our main linear regression specification (column 1 of Table 5) to estimate $\widehat{\Delta Y_c^{NT}}$ for each county. This is done by using the predicted value for each county from column 1 of Table 5, and subtracting the predicted value of employment losses for the county with the lowest leverage in 2006.

In order to be conservative and also to avoid basing our estimate on potentially noisy outliers in our sample distribution, we pick the 10th percentile of leverage distribution as our base county. Therefore, $E(Y_1^{NT}|X_1)$ equals the predicted non-tradable employment losses for the county that corresponds to the 10th percentile of cross-county 2006 leverage distribution. $\widehat{\Delta Y_c^{NT}}$ is set to zero for all counties below the 10th percentile county.

While this is also visually apparent from Figure 4, the predicted log change in non-tradable employment for the 10th percentile county is negative and equals -0.006. As stated in Proposition 1, it is important for our calculation that our base county non-tradable employment change be negative.

We multiply the predicted percentage change in non-tradable employment for a given county by the level of non-tradable employment in 2007 in that county to compute the predicted change in number of non-tradable jobs. Summing this estimate across counties gives us an estimate of 769 thousand jobs lost in the *non-tradable* sector due to the demand shock.

In order to translate this number into total jobs lost across all sectors, we need to multiply it by the inverse of the share of non-tradable sector, $1/\alpha$. Given a share of 19.6% of non-tradable employment in total employment, we get an estimate of 3.92 million jobs lost across all sectors due to the aggregate demand shock. The total number of jobs lost in our data between 2007 and 2009 equals 6.05 million jobs. As a result, our estimated jobs lost due to the demand shock equals 64.7% of total jobs lost in the economy from 2007 to 2009.

B. Robustness to alternative assumptions

Our estimate for jobs lost due to demand shocks is likely to be an underestimate of the true effect for two reasons. First, as is highlighted in Proposition 1, we do not include in our estimate jobs lost due to demand shocks in the lowest end of county distribution. We have been cautious in using only the 10^{th} percentile as our base county. If we were to use the 5^{th} percentile county instead, which has predicted log change employment of -0.002, then our estimated job loss due to demand shocks would have been 4.45 million jobs or 73.4% of total jobs lost.

Second, our methodology in Section 1 assumes that the labor demand response to a percentage drop in consumer demand is proportional for tradable and non-tradable goods. However, there is evidence that the demand for industries not included in the non-tradable definition such as durable goods and construction is *more* sensitive to a negative demand shock related to weak household balance sheets. For example, Mian, Rao, and Sufi (2012) show that the relative decline in durable goods purchases for leverage counties is much larger than the relative decline for other goods. Incorporating a higher income elasticity of demand for industries not included in the non-tradable sector would increase our estimate of jobs lost. Based on these factors, we feel that our reported estimate - while already large and significant - is likely to be an underestimate of the true employment losses due to demand shock.

Our macro calculation could overestimate the true job losses in the economy if relative wage declines in high leverage counties had attracted more jobs in the tradable sector. However, we see no evidence of this as the relationship between employment declines in the tradable sector and county leverage is zero and precisely estimated.[24]

On a related note, when we extrapolate the effect on tradables using the non-tradable estimate, we implicitly assume that the aggregate demand effect is similar for exports. This may not be the case if one believes that the aggregate demand shock was limited to the United States.. Since the U.S. exports 8.4% of its GDP, assuming no demand effect on exporting sector would reduce our aggregate employment loss number to (1-0.084)*64.7= 59.3% of total jobs lost.

Section 6: Conclusion

This study examines the reasons for job losses during the heart of the Great Recession from 2007 to 2009. We develop a methodology that uses the relation between local demand shocks and employment losses in the non-tradable and tradable sectors to identify the net impact of demand shocks on job losses. We find that 4 million of the 6.2 million jobs lost between March 2007 and March 2009 were due to demand shocks.

Alternative hypotheses such as business uncertainty, credit supply to businesses, or structural adjustment of the construction labor force are less consistent with the facts. We find

[24] There remains a possible external adjustment mechanism via trade with the rest of the world. In particular, a serious devaluation of the dollar may induce job creation in the overall export sector all across the U.S. However, job gains in the export sector were modest, and as the summary statistics in Table 4 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 very meaningful for job creation during the 2007 to 2009 period.

some evidence of falling nominal wages in response to demand shocks, but the decline in nominal wages is very small relative to the large decline in employment. We find no evidence that mobility helps offset the employment effects coming from the demand channel.

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. Frictions - such as nominal rigidity - may help us understand the rapid rise in unemployment in the face of demand shocks, but are such rigidities powerful enough to keep employment low over a long period of time? Why is it so difficult for the typical adjustment mechanisms that theory postulates to bring the economy back to full employment in practice? These are important questions to address in the future.

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Figure 1
Household Balance Sheet Weakness and Aggregate Demand

This figure plots house prices, home equity limits, household borrowing, and auto sales for high and low household leverage counties in the U.S. from 2006 to 2009. High and low household leverage counties are defined to be the top and bottom decile counties based on the debt to income ratio as of 2006. Deciles are weighted by population of the county, so both the top and bottom decile contain the same number of households.

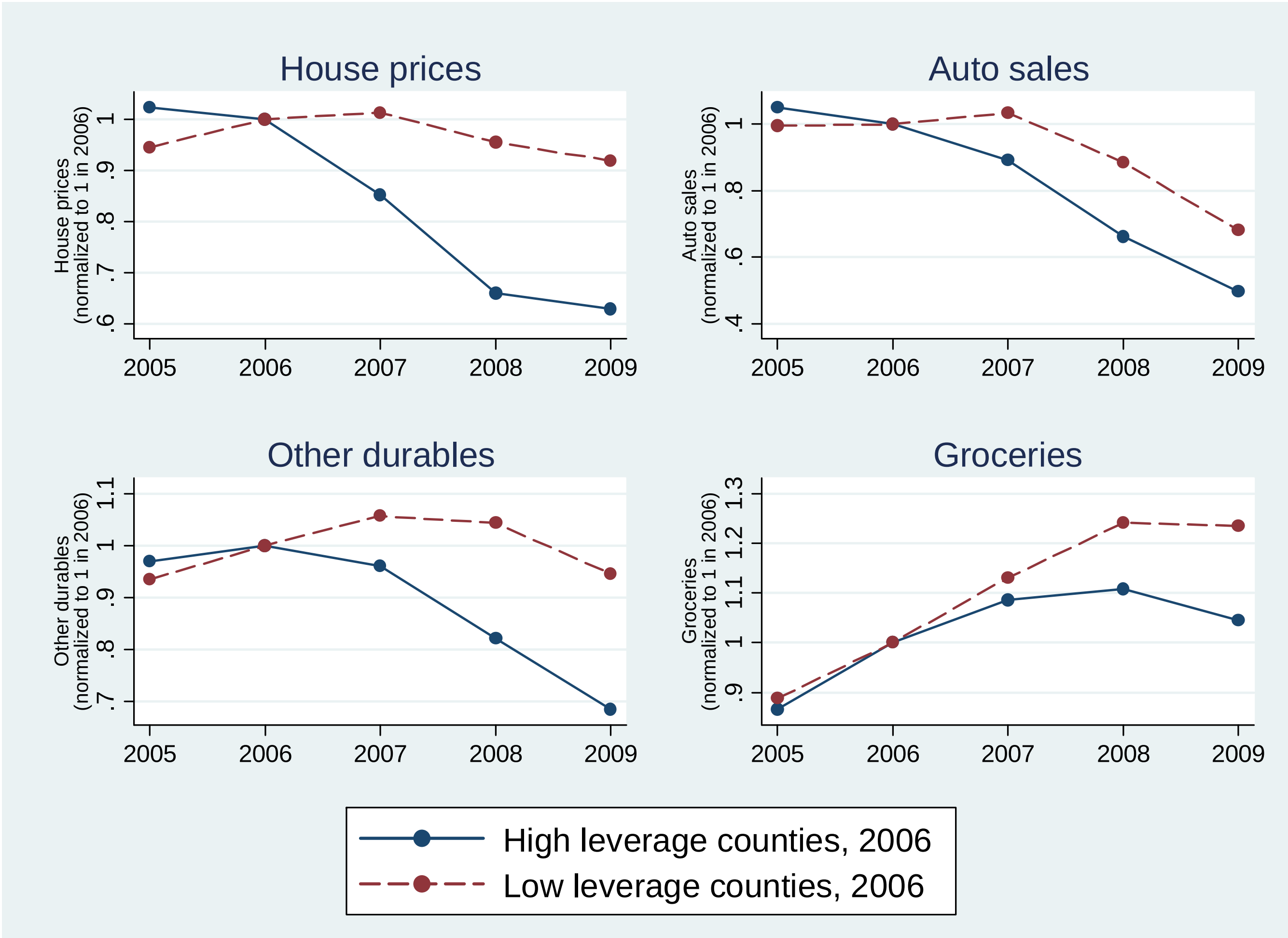

Figure 2

Aggregate Demand and Employment across Counties: All Industries

This figure presents a scatter-plot of county level employment growth from 2007Q1 to 2009Q1 against the debt to income ratio of the county as of 2006. All industries are included. The sample includes only counties with more than 50,000 households.

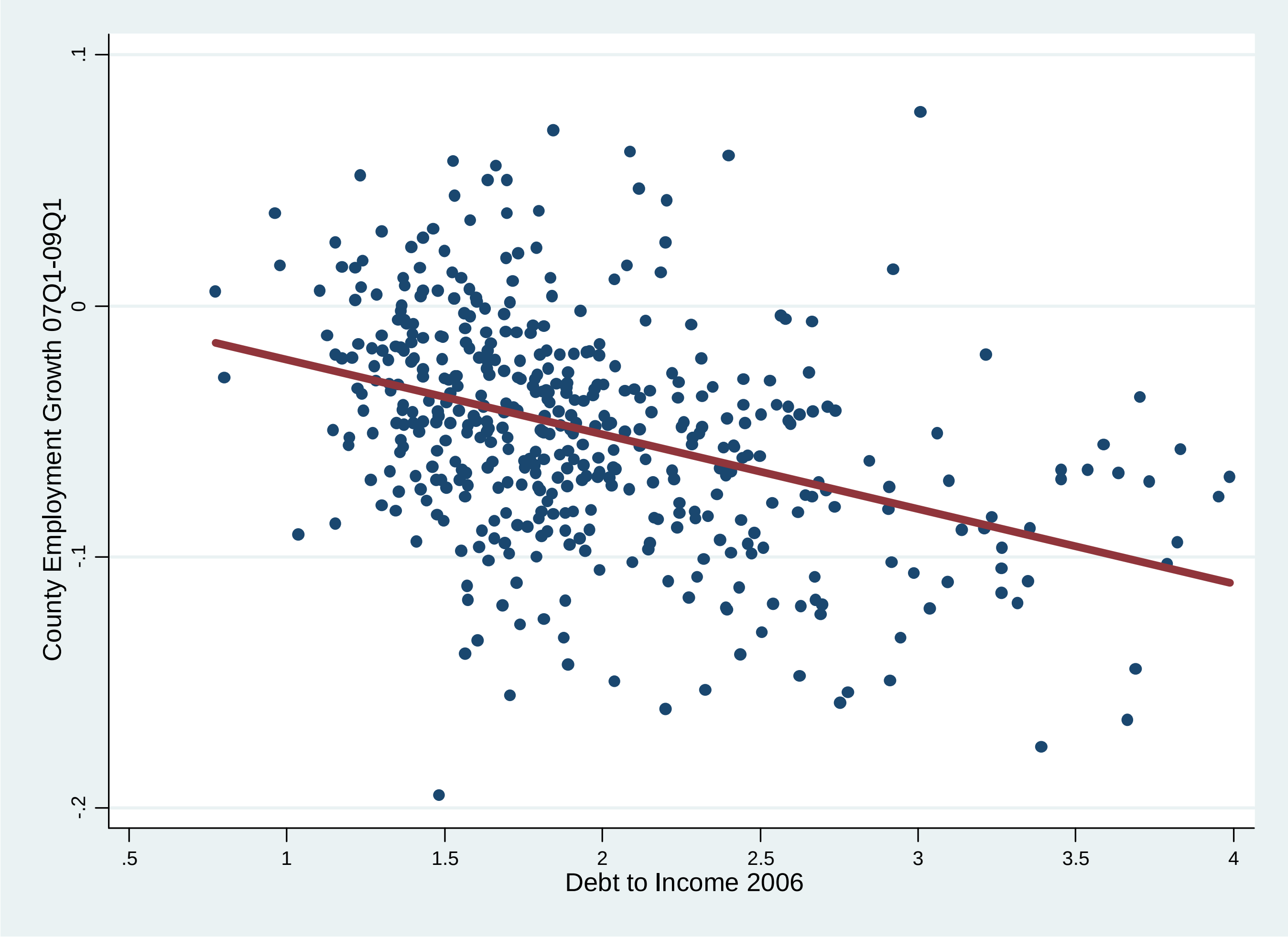

Figure 3
Aggregate Demand and Employment across Counties
Motivating Example: Auto Retail and Auto Manufacturing

This figure presents scatter-plots of county level employment growth from 2007Q1 to 2009Q1 against the debt to income ratio of the county as of 2006. The left panel examines employment in the automobile retail sector and the right panel focuses on automobile manufacturing sector. The sample includes counties with more than 50,000 households.

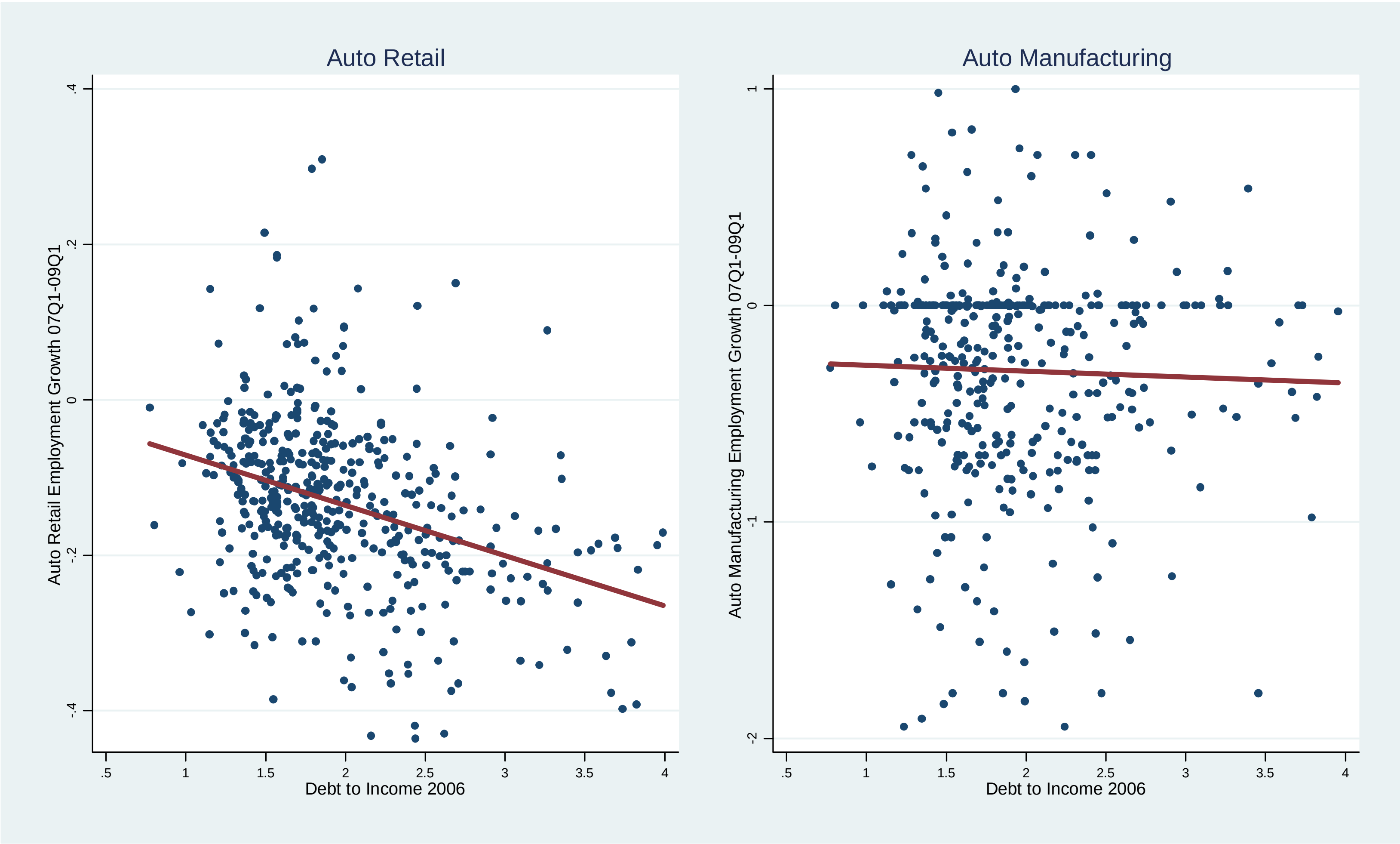

Figure 4

Aggregate Demand and Employment across Counties: Non-Tradable and Tradable Industries

This figure presents scatter-plots of county level employment growth from 2007Q1 to 2009Q1 against the debt to income ratio of the county as of 2006. The left panel examines employment in non-tradable industries excluding construction and the right panel focuses on tradable industries. The sample includes only 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 debt to income.

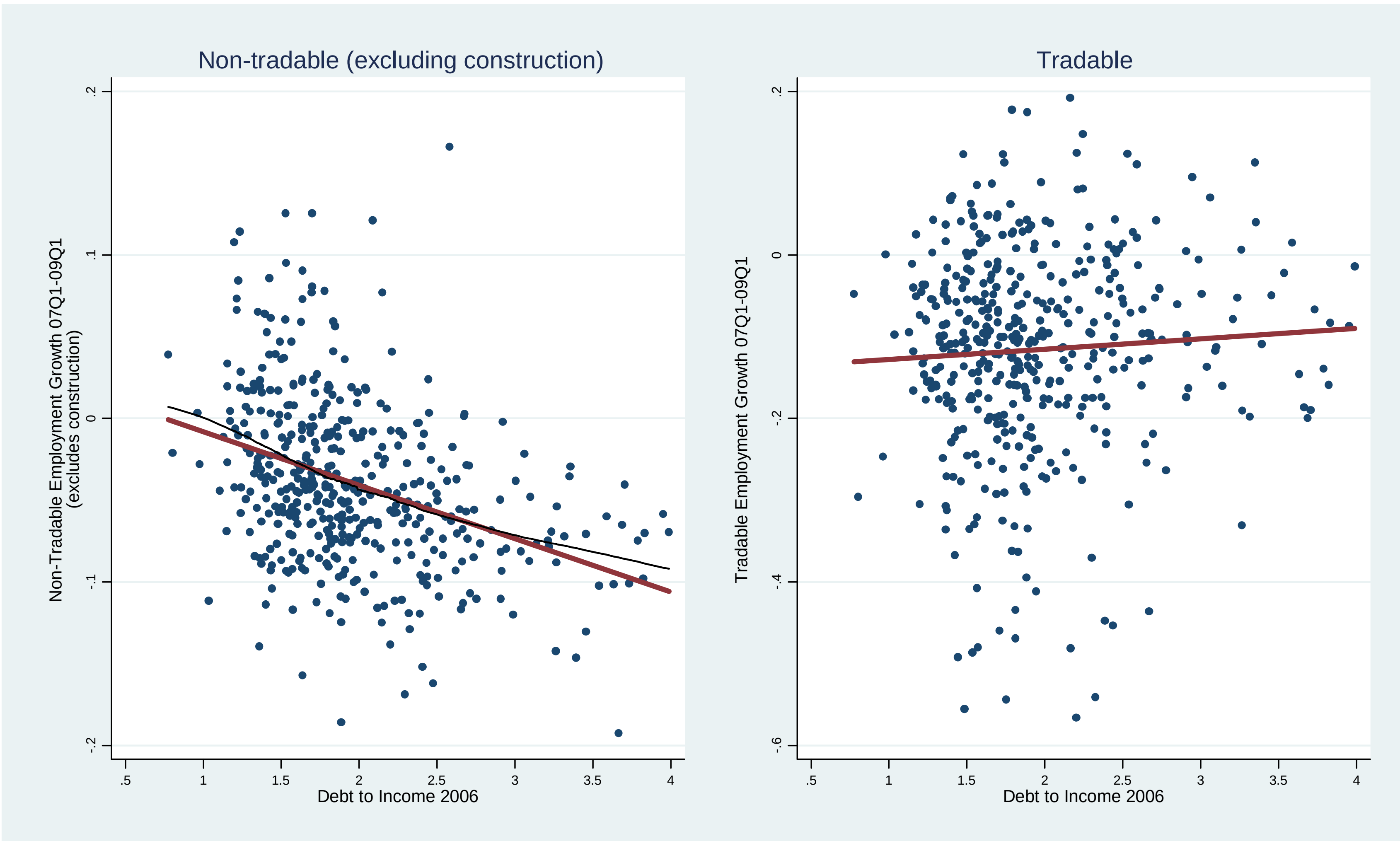

Figure 5

Aggregate Demand and Employment across Counties:

Geographical Herfindahl-Based Non-Tradable and Tradable Industries

This figure presents scatter-plots of county level employment growth from 2007Q1 to 2009Q1 against the debt to income ratio of the county as of 2006. The left panel examines employment in non-tradable industries based on geographical herfindahl index and the right panel focuses on tradable industries based on the same index. The sample includes only counties with more than 50,000 households.

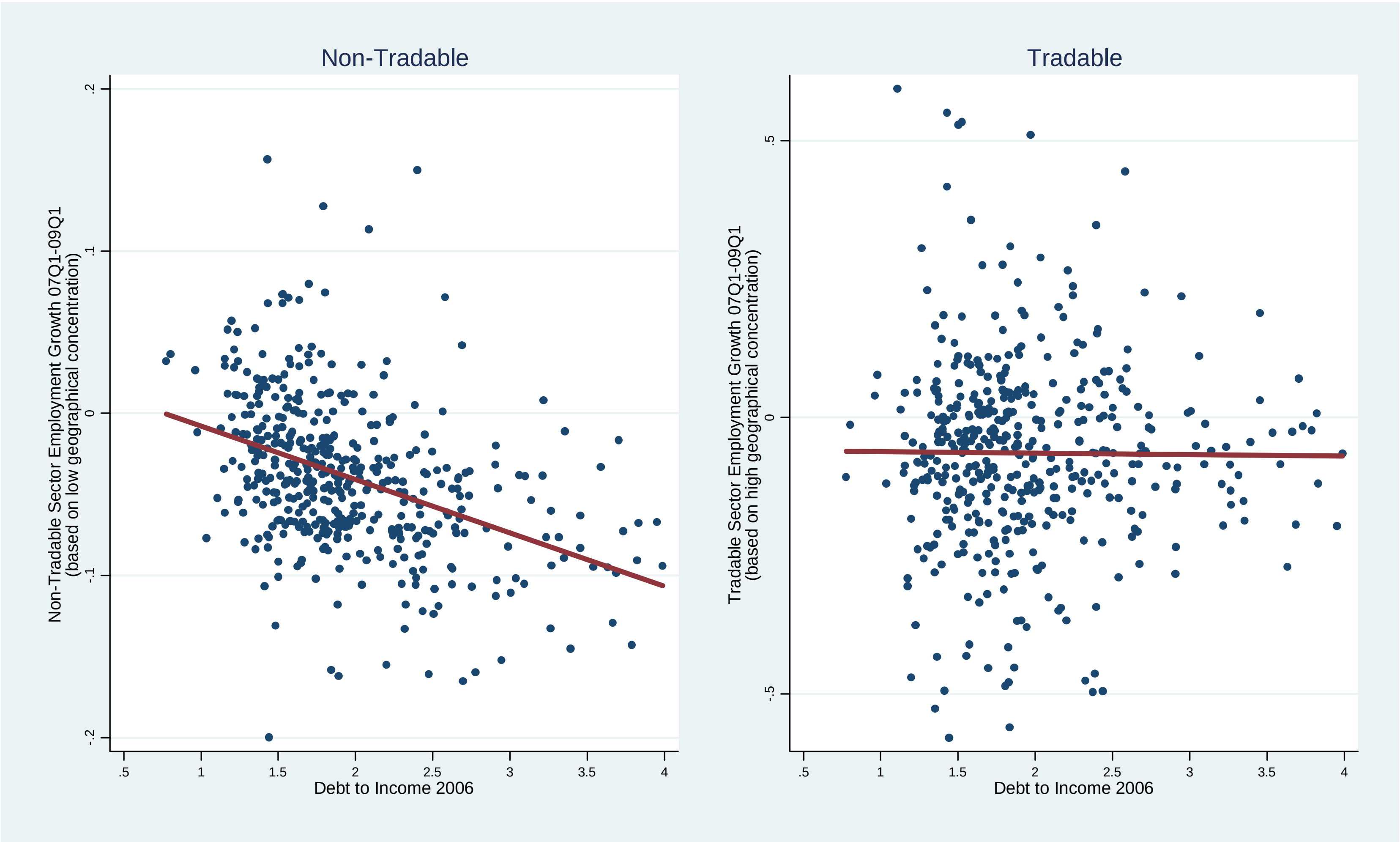

Figure 6

Aggregate Demand, Wage Growth, Mobility And Labor Supply Growth

This top panel presents scatter-plots of wage per employee growth and hourly wage growth from 2007Q1 to 2009Q1 against the debt to income ratio of the county as of 2006. The bottom panel presents scatter-plots of mobility from 2007 to 2009 against the debt to income ratio of the county/state as of 2006. The bottom-left panel utilizes county level data from the Census on total population growth. The bottom-right panel uses labor force data from the county business patterns. The sample includes only counties with more than 50,000 households.

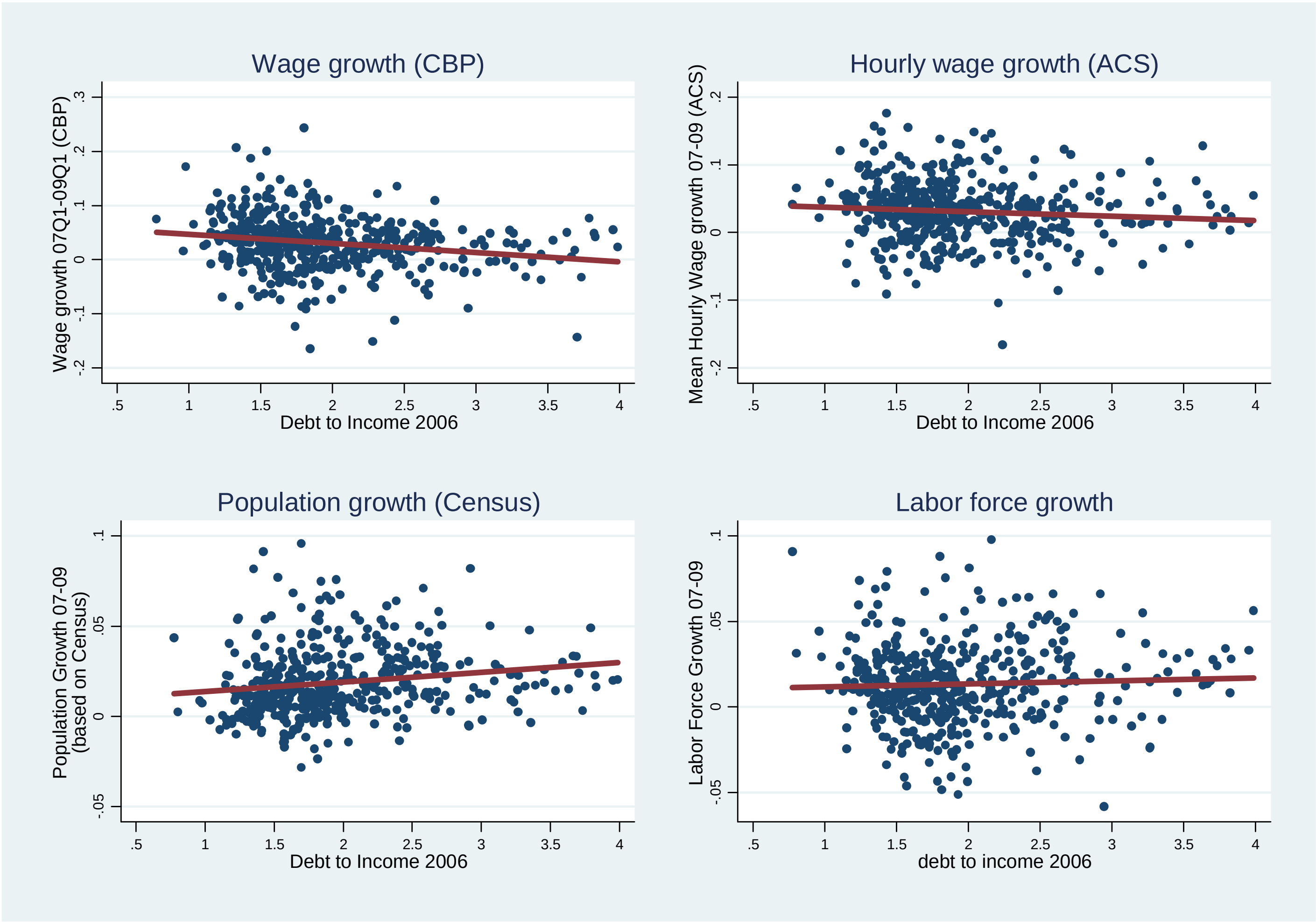

Table 1
Household Leverage, Housing Supply Elasticity, and Employment in the Auto Sector

Column 1 of this table presents the first stage estimate of the relation between household leverage in a county and housing supply elasticity (Saiz (2011)). Column 2 presents the correlation between employment growth from 2007 to 2009 in a county and the debt to income ratio of the county as of 2006. Columns 3 and 4 evaluate employment in the auto retail and manufacturing sectors. Standard errors are heterskedasticity robust, clustered by state. All specifications are weighted by the population of the county.

			Motivating Example	
	(1)	(2)	(3)	(4)
	Debt to income, 2006	Total Employment growth, 2007-2009	Auto Retail Employment growth, 2007-2009	Auto Manufacturing Employment growth, 2007-2009
Housing supply elasticity (Saiz)	-0.238**			
	(0.039)			
Debt to income, 2006		-0.028**	-0.056**	0.010
		(0.005)	(0.006)	(0.038)
Constant	2.383**	0.001		-0.319**
	(0.109)	(0.011)	-0.019	(0.080)
			(0.013)	
Specification	WLS	WLS	WLS	WLS
Sample	Elasticity available	Full	Full	Full
N	868	3,135	3,009	1,528
R^2	0.177	0.096	0.045	0.000

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

Table 2
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 category.

	Non-tradable Industries (19.6% of total employment)			**Tradable Industries** (10.7% of total employment)	
		%	NAICS	Industry name	%
7221	Full-service restaurants	3.76	3261	Plastics product manufacturing	0.60
7222	Limited-service eating places	3.40	3231	Printing and related support activities	0.53
4451	Grocery stores	2.13	3363	Motor vehicle parts manufacturing	0.52
4521	Department stores	1.36	3116	Animal slaughtering and processing	0.44
4529	Other general merchandise stores	1.12	3364	Aerospace product and parts manufacturing	0.35
4481	Clothing stores	1.06	3327	Machine shops; screw nut and bolt manufacturing	0.33
4461	Health and personal care stores	0.89	3345	Navigational and control instruments manufacturing	0.33
4471	Gasoline stations	0.73	3344	Semiconductor and other electronic manufacturing	0.32
7223	Special food services	0.49	3399	Other miscellaneous manufacturing	0.31
4511	Sporting goods hobby and music stores	0.38	5112	Software publishers	0.29

	Construction Industries (11.2% of total employment)			**Other Industries** (58.5% of total employment)	
NAICS	Industry name	%	NAICS	Industry name	%
2382	Building equipment contractors	1.62	6221	General medical and surgical hospitals	4.31
5413	Architectural engineering and related services	1.19	5511	Management of companies and enterprises	2.60
4441	Building material and supplies dealers	1.00	5613	Employment services	2.56
2381	Foundation structure and building contractors	0.91	6211	Offices of physicians	1.79
2383	Building finishing contractors	0.78	5221	Depository credit intermediation	1.77
2361	Residential building construction	0.75	7211	Traveler accommodation	1.54
2362	Nonresidential building construction	0.64	5617	Services to buildings and dwellings	1.42
5313	Activities related to real estate	0.54	8131	Religious organizations	1.39
2389	Other specialty trade contractors	0.48	6231	Nursing care facilities	1.37
5311	Lessors of real estate	0.45	6113	Colleges universities and professional schools	1.35

Table 3
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 2.

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 4
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.

	N	Mean	SD	10th	90th	Weighted mean	Weighted SD
Debt to income, 2006	3135	1.590	0.622	0.968	2.329	1.904	0.626
Number of households, 2000, thousands	3135	37	111	2	73	370	621
Labor force growth, 2007 to 2009	3135	0.012	0.041	-0.035	0.055	0.013	0.029
Total employment, 2007, thousands	3135	39	138	1	74	439	754
Employment growth, 2007 to 2009	3135	-0.048	0.103	-0.157	0.057	-0.052	0.056
Average wage, 2007	3091	5.731	2.146	3.719	8.127	8.905	3.822
Average wage growth, 2007 to 2009	3074	0.049	0.187	-0.090	0.196	0.028	0.074
Housing supply elasticity (Saiz)	877	2.509	1.349	1.059	4.003	1.801	1.079
Non-tradable employment growth, 2007 to 2009	3132	-0.025	0.153	-0.158	0.118	-0.037	0.073
Food industry employment growth, 2007 to 2009	3132	-0.013	0.162	-0.154	0.142	-0.020	0.077
Tradable employment growth, 2007 to 2009	3053	-0.121	0.380	-0.481	0.182	-0.116	0.187
Construction employment growth, 2007 to 2009	3126	-0.123	0.237	-0.401	0.139	-0.152	0.151
Other employment growth, 2007 to 2009	3134	-0.017	0.123	-0.146	0.111	-0.025	0.065
Industry geographical herfindahl, 2007	294	0.016	0.023	0.003	0.034	0.020	0.023
Hourly wage, 2007	3142	17.005	2.715	14.511	20.300	20.178	3.848
Hourly wage, 10th percentile, 2007	3142	5.345	0.734	4.525	6.250	6.050	0.835
Hourly wage, 25th percentile, 2007	3142	8.238	1.217	6.923	9.633	9.466	1.534
Hourly wage, median, 2007	3142	20.441	3.631	17.094	24.583	24.512	5.235
Hourly wage, 75th percentile, 2007	3142	30.717	5.660	25.641	36.813	37.517	8.827
Hourly wage, 90th percentile, 2007	3142	12.997	2.137	11.058	15.385	15.326	2.961
Wage growth, 2007 to 2009	3141	0.029	0.104	-0.108	0.154	0.014	0.076
Wage growth, 10th percentile, 2007 to 2009	3141	0.068	0.072	-0.022	0.155	0.051	0.054
Wage growth, 25th percentile, 2007 to 2009	3141	0.066	0.064	-0.009	0.153	0.054	0.047
Wage growth, median, 2007 to 2009	3141	0.056	0.080	-0.044	0.163	0.044	0.056
Wage growth, 75th percentile, 2007 to 2009	3141	0.079	0.061	0.011	0.158	0.060	0.047
Wage growth, 90th percentile, 2007 to 2009	3141	0.048	0.067	-0.033	0.139	0.035	0.046

Table 5

Aggregate Demand and Unemployment across Counties: Non-Tradable And Tradable Industries

This table presents coefficients from regressions relating employment growth in a county from 2007 to 2009 to the debt to income ratio of the county as of 2006. We split employment into non-tradable and tradable industries. The specification "WLS" is weighted least squares where the weights are total number of households in the county. The instrumental variables specification in column 3 uses the housing supply elasticity of the county (Saiz (2011)) as an instrument for the debt to income ratio in the first stage. Standard errors are heterskedasticity robust, clustered by state.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment growth, non-tradable industries, 2007-2009				Employment growth, food retail only, 2007-2009	Employment growth, tradable industries, 2007-2009	
Debt to income, 2006	-0.033**	-0.033**	-0.048**	-0.036**	-0.027**	0.011	-0.001
	(0.005)	(0.007)	(0.018)	(0.006)	(0.005)	(0.013)	(0.017)
Construction share, 2007				0.135*			0.030
				(0.057)			(0.146)
Non-tradable share, 2007				-0.070			0.147
				(0.070)			(0.169)
Tradable share, 2007				-0.035			-0.317**
				(0.028)			(0.106)
Constant	0.026*	0.026	0.055	0.034*	0.031*	-0.137**	-0.111
	(0.012)	(0.015)	(0.032)	(0.016)	(0.012)	(0.027)	(0.061)
Specification	WLS	WLS	IV	WLS	WLS	WLS	WLS
Sample	Full	elasticity available	elasticity available	Full	Full	Full	Full
N	3,132	868	868	3,132	3,132	3,053	3,053
R^2	0.078	0.109	0.086	0.085	0.047	0.001	0.018

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

Table 6
Aggregate Demand and Unemployment across Counties:
Using Concentration to Measure Tradability

This table presents coefficients from regressions relating employment growth in a county from 2007 to 2009 to the debt to income ratio of the county as of 2006. We use an alternative measure of non-tradable industries based on the concentration of employment across counties--low concentration industries are assumed to be more non-tradable. Columns 1 through 4 examine industries in the bottom quartile based on concentration, columns 5 and 6 examine industries in the top quartile based on concentration. Column 7 uses a continuous measure of concentration in which every industry is grouped into one of four quartiles (Concentration, 2006) and then interacted with debt to income as of 2006. Standard errors are heterskedasticity robust, clustered by state

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	Employment growth, 2007-2009						
Industries?	Lowest concentration quartile industries				Highest concentration quartile industries		All industries
Debt to income, 2006	-0.030**	-0.034**	-0.042*	-0.029**	0.016*	0.005	-0.040**
	(0.006)	(0.009)	(0.019)	(0.008)	(0.007)	(0.009)	(0.007)
Lowest Concentration Quartile Share, 2007				-0.000			
				(0.000)			
Highest Concentration Quartile Share, 2007						0.000	
						(0.001)	
Concentration, 2006							-3.333**
							(0.566)
Debt to income, 2006*Concentration, 2006							1.308**
							(0.229)
Construction share, 2007				-0.089**		-0.401**	
				(0.032)		(0.089)	
Non-tradable share, 2007				0.035		0.369*	
				(0.067)		(0.148)	
Tradable share, 2007				-0.168*		-0.332*	
				(0.063)		(0.155)	
Constant	0.018	0.028	0.044	0.040*	-0.113**	-0.086	0.031*
	(0.013)	(0.018)	(0.034)	(0.017)	(0.018)	(0.050)	(0.014)
Specification	WLS	WLS	IV	WLS	WLS	WLS	WLS
Sample	Full	elasticity available	Elasticity available	Full	Full	Full	Full
N	3,134	868	868	3,134	3,067	3,067	12,464
R^2	0.089	0.161	0.152	0.110	0.002	0.023	0.020

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

Table 7
Addressing Construction

Columns 1 through 4 report regressions relating measures of construction to the debt to income ratio of a county as of 2006. Columns 5 and 6 examine the effect of the debt to income ratio of a county as of 2006 on employment growth in non-tradable industries from 2007 to 2009 after controlling for employment growth in the construction sector from 2007 to 2009. The specification "WLS" is weighted least squares where the weights are total number of households in the county. The instrumental variables specifications use the housing supply elasticity of the county (Saiz (2011)) as an instrument for the debt to income ratio in the first stage. The sample in all specifications is limited to counties with housing supply elasticity data available. Standard errors are heterskedasticity robust, clustered by state.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Construction share, 2007		Construction employment growth, 2000-2007		Employment growth, non-tradable industries, 2007-2009	
Debt to income, 2006	0.023**	0.000	0.155*	0.025	-0.022**	-0.045*
	(0.008)	(0.007)	(0.066)	(0.063)	(0.005)	(0.022)
Construction employment growth, 2000-2007						
Construction employment growth, 2007-2009					0.085**	0.025
					(0.022)	(0.051)
Constant	0.067**	0.111**	0.653**	0.907**	0.018	0.053
	(0.015)	(0.012)	(0.123)	(0.121)	(0.012)	(0.034)
Specification	WLS	IV	WLS	IV	WLS	IV
N	868	868	866	866	868	868
R^2	0.145	0.005	0.087	0.025	0.133	0.098

**,* 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 debt to income ratio of the county as of 2006. 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 debt to income ratio of the county as of 2006. 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. "WLS" is weighted least squares where the weights are total number of households in the county. Standard errors are heterskedasticity robust, clustered by state.

	(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
Debt to income, 2006	-0.010	-0.010*	0.007*	0.002
	(0.007)	(0.005)	(0.003)	(0.004)
Constant	0.047**	0.054**	0.003	0.010
	(0.016)	(0.008)	(0.007)	(0.009)
Specification	WLS	WLS	WLS	WLS
Sample	Full	Full	Full	Full
N	3,074	3,134	3,124	3,135
R^2	0.007	0.017	0.040	0.002

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