Did the Housing Price Bubble Clobber Local Labor Market Job and Worker Flows When It Burst?

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We integrate local labor market data on worker flows (accession and separation rates), job flows (creation and destruction rates), employment levels, and earnings with MSA-level data on housing prices and local area unemployment, in order to study the local labor market dynamics associated with the U.S. housing price bubble of the late 2000s. We proceed to study the magnitude and timing of the relation between the changes in local housing prices and local worker and job flows, local labor market earnings. In addition to the unique contribution of using both local labor and housing market data, the paper also considers the contributions of the local labor markets to the aggregate movements in the worker and job flows.

I. Data sources

The U.S. Census Bureau has published its local labor market indicators, known as the Quarterly Workforce Indicators (QWI), since 2003. Over the course of the 2000s, these data became national, and now cover 92 percent of the private non-agricultural workforce (Abowd and Vilhuber, 2011). The complete set of detailed flows – job creations, job destructions, accessions, separations, churning, earnings, and earnings changes – are available for 566 micropolitan areas and 357 Metropolitan Statistical Area (MSA)s). For most of these areas, the data are available from the mid-1990s onwards. There are very few data suppressions, and these affect only certain items – earnings data are never suppressed (see Abowd et al. (2009) for a detailed description). The data include statistics by age, sex, race, ethnicity and education. We focus our attention on full-quarter jobs, and the associated earnings. Full-quarter jobs are those with observed earnings in at least three consecutive quarters, and from such an earnings pattern, continuous employment throughout (at least) the middle quarter is inferred (see Abowd et al. (2009) for the precise definition of this and the other QWI-related concepts used in this article). This definition therefore excludes very short jobs - those lasting only portions of one or two quarters. The average full-quarter earnings zw_3 associated with full-quarter jobs f are a good approximation of a wage rate. We also use average earnings $zwfs$ associated with separations from full-quarter jobs fs, and equivalently, average earnings $zwfa$ associated with accessions to full-quarter jobs fa. Finally, the associated job creation and destruction rates $fjcr$ and $fjdr$ are also part of the QWI.

The Federal Housing Finance Agency (FHFA) publishes house price indices (HPI) for single-family detached properties using data on repeat sales and refinancings obtained from the Federal Home Loan Mortgage Corporation (Freddie Mac) and the Federal National Mortgage Association (Fannie Mae), based on a modified version of the weighted-repeat sales (WRS) methodology proposed by Case and Shiller (1987), as described by Calhoun (1996). The HPI data are published at the level of MSAs. Coverage excludes mortgage transactions on attached and multi-unit properties, properties financed by government insured loans, and properties financed by mortgages exceeding the conforming loan limits determining eligibility for purchase by Freddie Mac or Fannie Mae. Data are available for 366 MSAs.

We also use additional information on na-

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tional and local labor market unemployment rates as estimated by the Bureau of Labor Statistics (BLS).

The merged dataset has information on 354 MSAs, which are home to about 81 percent of the (2009) US population, and in which 84 percent of the US workforce could be found at the end of 2006. These data are ideal for studying the local labor market dynamics associated with the U.S. housing price bubble that burst nationally between April and December 2006 (authors' private calculations from Case-Shiller and national HPI data).

II. Model

The basic national equation relating housing price changes to labor market flows can be expressed as

$$y_{\circ t} = x_{\circ t}\bar{\beta} + \epsilon_{\circ t}.$$

for any variable $y_{\circ t}$ under study and any vector $x_{\circ t}$ of housing price and aggregate labor market conditions (including an intercept and lags, in our case for 5 quarters without restriction). The local labor market variable can be modeled as a composite of national and local effects which we represent as

$$y_{jt} = x_{\circ t}\bar{\beta} + (x_{jt} - x_{\circ t})\,\beta_j + \epsilon_{\circ t} + \epsilon_{jt}.$$

Then, the purely local equation can be written as

$$(1) \qquad y_{jt} - y_{\circ t} = (x_{jt} - x_{\circ t})\,\beta_j + \epsilon_{jt}$$

where the MSA-specific effect β_j is modeled as a mixed effect. We relax the specification by eliminating the implicit assumption that the relevant MSA-level equation is a strict deviation from the national equation, which gives

$$(2) \quad y_{jt} = \beta_{1j}y_{\circ t} + \beta_{2j}x_{\circ t} + \beta_{3j}x_{jt} + \epsilon_{jt},$$

where $\beta_{1j} = 1$ with no MSA-level variation, and $-\beta_{2j} = \beta_{3j}$ if the correct model is equation 1.

Restating equation 2 as a mixed-effects linear model, gives

$$(3) \quad \begin{aligned} y_{jt} \;=\; & \bar{\beta}_1 y_{\circ t} + \bar{\beta}_2 x_{\circ t} + \bar{\beta}_3 x_{jt} \\ & + \tilde{v}_{1j} y_{\circ t} + \tilde{v}_{2j} x_{\circ t} + \tilde{v}_{3j} x_{jt} \\ & + \epsilon_{jt} \end{aligned}$$

where $\bar{\beta}_1$, $\bar{\beta}_2$, and $\bar{\beta}_3$ are the fixed national average coefficients, and $\tilde{v}_{1j}$, $\tilde{v}_{2j}$, and $\tilde{v}_{3j}$ are the random deviations of MSA-specific coefficients from the national average. The fitted marginal predictor captures the effects of the overall market conditions and MSA variation in the housing market and local labor market conditions

$$(4) \qquad \widehat{\bar{y}}_{jt} = \widehat{\bar{\beta}}_1 y_{\circ t} + \widehat{\bar{\beta}}_2 x_{\circ t} + \widehat{\bar{\beta}}_3 x_{jt}$$

The linear predictor inclusive of the estimated random effects captures the incremental contribution of the MSA-specific variation in the coefficients

$$(5) \quad \widehat{\widehat{\bar{y}}}_{jt} = \widehat{\bar{y}}_{jt} + \widehat{\tilde{v}}_{1j} y_{\circ t} + \widehat{\tilde{v}}_{2j} x_{\circ t} + \widehat{\tilde{v}}_{3j} x_{jt}.$$

The model is fit for full-quarter employment, worker flows, job flows, log full-quarter monthly earnings, log full-quarter monthly earnings of accessions (hires plus recalls) and log full-quarter earnings of separations (voluntary plus involuntary) by restricted maximum likelihood assuming that the residuals and the random effects have independent normal distributions with zero means and constant variances.

III. Results

Figure 1 shows all of the housing price indices normalized to take the same value in 1995:1. The national index is shown as the solid dark line, which peaks in 2006:4. In that quarter, we identify the top decile of MSAs with a cross-hatch, then display the history of their local housing price indices in the other quarters. All other MSAs are displayed as dots. It turns out that the 35 MSAs at the top of this chart are the most important ones for understanding local variability in the response to the housing price bubble. Collectively, these 35 MSAs all spent at least 4 years above the national average.

These MSAs are also the local areas that experienced the most rapid housing price deflation, as illustrated in Figure 2. In the decade leading up to the housing price peak, shown as the solid vertical line on the graph, the MSAs in the top decile consistently experienced the fastest price increases. But the bubble started to deflate before the peak for this group, as shown by the cross-hatches signifying the same MSAs as in Figure 1. Well before the official onset of the recession, 2007:4, these MSAs were experiencing price decreases substantially greater (in absolute value) than the national average (solid line), and in the depths of the recession, these MSAs displayed the largest price reductions of all, accounting for the lower tail of distribution even after housing prices started to recover.

To begin the description of how the differential incidence of the housing price bubble is working its way through the labor market, consider Figure 3, which shows the level of full-quarter employment nationally from 1993:1 to 2010:2 with the two recessions that have occurred in that period shaded gray. Full-quarter employment fell during both recessions. In the most recent recession, it did not level off until after the recession had been over for several quarters, and it is still not clear that it has begun to grow again. Overall, the economy lost 4.8 million private full-quarter jobs from 2007:4 to 2009:4. This loss of stable jobs represents 76% of the 6.3 million full-quarter jobs that were gained from 2002:4 to 2007:4 (trough to peak following the 2001 recession. Exploiting the flow identities, we can see that the loss of full-quarter jobs during the most recent recession was accomplished by a precipitous decline in accessions to full-quarter employment accompanied by a very mild decline in full-quarter separations, which generated substantial negative net full-quarter employment growth. Using the job creation destruction identity, we see that the same period saw a mild decline in gross full-quarter job creations and a substantial increase in full-quarter gross job destructions. Nationally, then, the 4.8 million net full-quarter jobs loss was accomplished by slashing the hiring rate and allowing jobs to be destroyed through separations.

Turn now to Figure 4, which shows the level of full-quarter employment and the associated worker and job flow rates for the top decile housing price gain MSAs. These 35 MSAs, which accounted for 17% or 16.6 million of the 97.8 million full-quarter jobs at the peak of the housing price boom (2006:4), lost 1.1 million full-quarter jobs from 2007:4 to 2009:4.[1] The massive loss of full-quarter jobs in the MSAs that had the most extreme housing price bubbles was accomplished through worker flows in which full-quarter accessions fell off the cliff, only beginning to recover in 2010:2, while full-quarter separations fell only very gently over the same period. From the gross job flow side of the identities, full-quarter job creations fell strongly, while full-quarter job destructions increased mildly. The local labor markets with the strongest housing price bubbles experienced a more extreme form of the adjustment process that occurred nationally–destroying stable jobs by massively reducing hiring while separations only fell slightly.

To attempt to capture the differentially strong effect of the housing price bubble on the top MSAs, we report the results of the MSA-level estimates of the responsiveness of gross worker and job flows to the local housing price index. By controlling for the national level of the labor market flow variable, national housing price movements, local and national labor market conditions, we can isolate the marginal contribution of the local HPI on the predicted flows. By allowing the effect to be heterogeneous across MSAs, we allow for the possibility that high-HPI MSAs had differential responses to all of the control variables. These results are partially summarized in Table 1. For all four MSA-specific gross flow rates, the coefficient on the equivalent national gross flow is essentially unity on average, but with a substantial standard de-

[1] There is a break in the comparability of the MSA data between 2005:1 and 2005:2 which accounts for the apparent large increase in the stock of full-quarter workers in the top HPI decile in the mid-2000s. From 2005:2 through 2010:2, there are no composition changes in the MSA data.

viation for the MSA-specific random component. In the case of gross worker flows, the random component has a standard deviation of about 14 percentage points while for gross job flows the standard deviation of the random component is about 25 percentage points. Both of these estimates imply very substantial MSA-specific deviation in the gross flows. Appendix figures A1, A2, A3, and A4 (available online) show that for all four gross flows, the estimated variation in the MSA-specific deviation from the national average is greatest for the top HPI group. That is, the most volatile local labor markets were those in which the housing price bubble was greatest.

Table 1 also shows the responsiveness of the flows to the local HPI, holding constant the national HPI, local and national labor market conditions. These effects are all positive on average (the estimated long-run effect is zero in all cases, not shown). Except for the full-quarter job creation rate, the standard deviation of the effect is about half the effect magnitude, indicating that heterogeneity in the response to the housing price changes also contributed to differential local labor market outcomes.

A full explanation for why the local labor markets in the top HPI MSAs were more volatile and experienced a more severe recession than the national average awaits further modeling. There are some clues, however, in the wage rate movements. Local labor market spatial equilibrium models predict that local housing prices and local wage rates move in the same direction Moretti (2011). Figure 5 shows what happened to log real full-quarter monthly earnings over the course of the recession. For the middle deciles of the HPI distribution the real earnings fell very gently. For the top decile, those earnings fell more strongly; however, the predicted fall in the log real monthly earnings of full-quarter workers, according to equation 4, shown as the "average marginal prediction (top decile)" in the figure, is much greater. This result means that if wages had responded in these 35 MSAs in a manner consistent with the national average response, those wages would have fallen much more strongly. Hence, the movement towards a new spatial equilibrium in these local markets has been much slower than predicted. Appendix figures A5 and A6 (available online) show that the same phenomenon occurred for the log real monthly earnings of full-quarter accessions, which exacerbated the adjustments, and full-quarter separations, which mitigated the effects of the full-quarter accession wage rate stability.

IV. Discussion

The housing price bubble was most extreme in 35 Metropolitan Statistical Areas identified as occupying the top decile of the housing price index in the quarter of its peak in real terms (2006:4). These 35 MSAs experienced a precipitous drop in full-quarter (stable) employment that was much steeper than the drop in the overall economy. The decline in the levels resulted from gross worker flows in which the full-quarter accession rate fell off a cliff while the full-quarter separation rate declined very slowly. In terms of gross job flows, the full-quarter job creation rate fell sharply while the full-quarter job destruction rate rose only modestly. In the economy as a whole, MSA-specific log real full-quarter monthly earnings fell over the course of the recession, which helped to restore the spatial equilibrium. However, in the 35 MSAs in the top decile of the housing price bubble, this did not happen, which probably exacerbated the local labor market adjustments as evidenced by sustained above-prediction earnings for full-quarter accessions. The log real earnings of full-quarter separations in these labor markets also fell more slowly than predicted, which may have offset the exacerbating effect of the accession earnings.[2]

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[2]Further discussion of the results can be found in our presentation on January 07, 2012, 2:30 pm, Hyatt Regency, Grand Ballroom A.

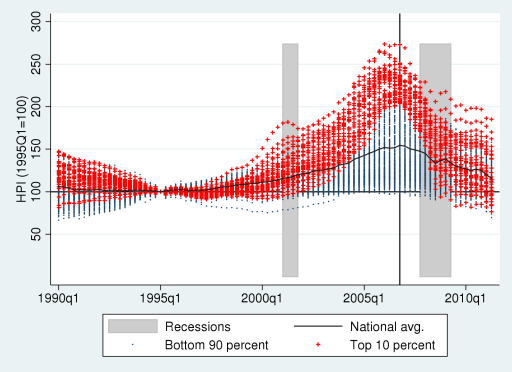

FIGURE 1. HPI, TOP 10 PERCENT AS OF 2006Q4

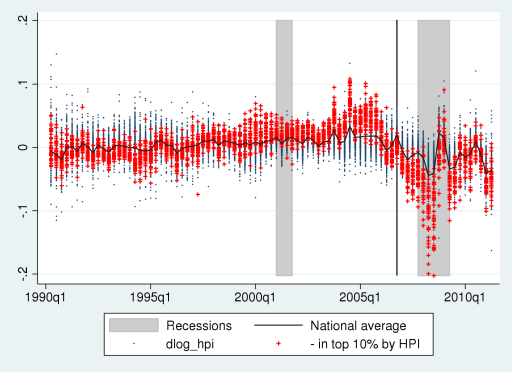

FIGURE 2. LOG CHANGE IN HPI

TABLE 1—SELECTED RESULTS FROM MIXED EFFECT ESTIMATION OF FULL-QUARTER FLOW RATES

Dependent Variable	National Variable Coefficient	Random Effect Standard Deviation	Log Local Housing Price Index Coefficient	HPI Random Effect Standard Deviation
FQ accession rate	0.9649	0.1364	0.0267	0.0110
	(0.0307)		(0.0072)	
FQ separation rate	1.0318	0.1519	0.0222	0.0146
	(0.0407)		(0.0084)	
FQ job creation rate	0.9748	0.2485	0.0133	-
	(0.0399)		(0.0069)	
FQ job destruction rate	1.0236	0.2693	0.0101	0.0128
	(0.0491)		(0.0079)	
Standard errors are in parentheses.				

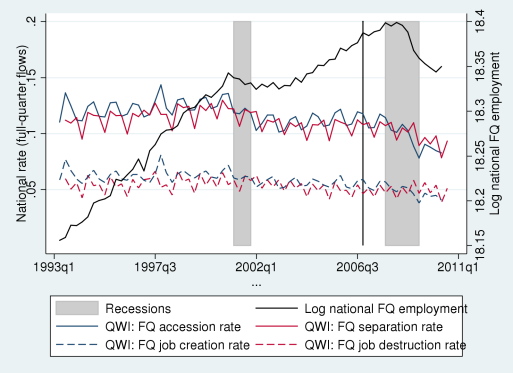

FIGURE 3. NATIONAL FULL-QUARTER EMPLOYMENT AND FLOWS

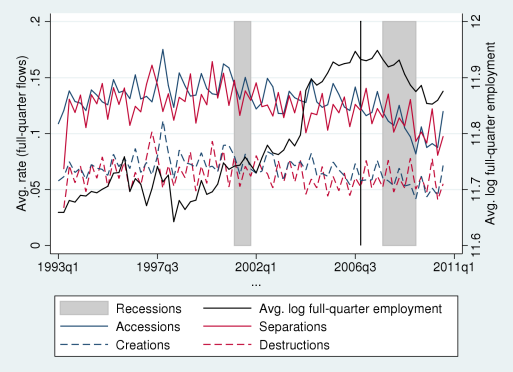

FIGURE 4. FULL-QUARTER EMPLOYMENT AND FLOWS FOR TOP DECILE MSAS BY HPI

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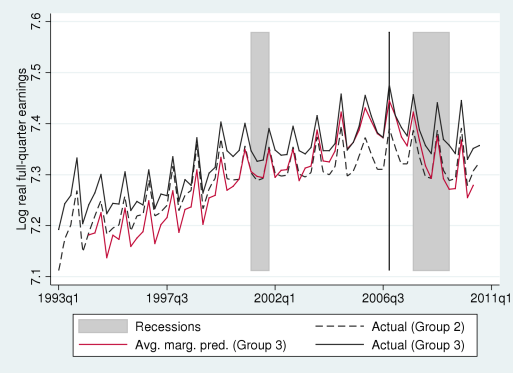

FIGURE 5. LOG FULL-QUARTER MONTHLY EARNINGS ACTUAL AND PREDICTED, TOP AND MIDDLE GROUPS BY HPI

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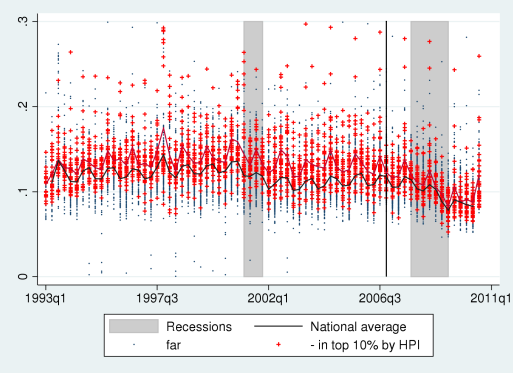

FIGURE A1. FULL-QUARTER ACCESSION RATES

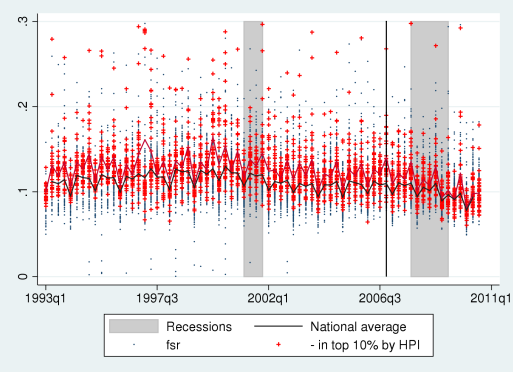

FIGURE A2. FULL-QUARTER SEPARATION RATES

Online Appendix

APPENDIX FIGURES

Not all of these graphs will be present in the final publication.

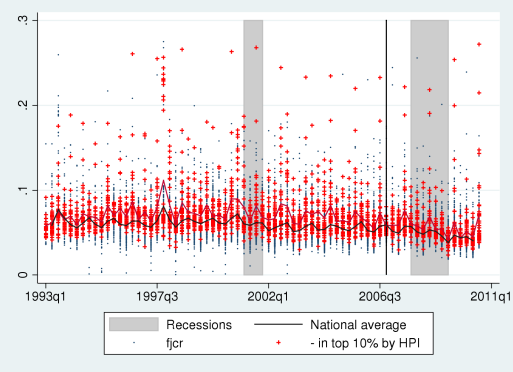

FIGURE A3. FULL-QUARTER JOB CREATION RATES

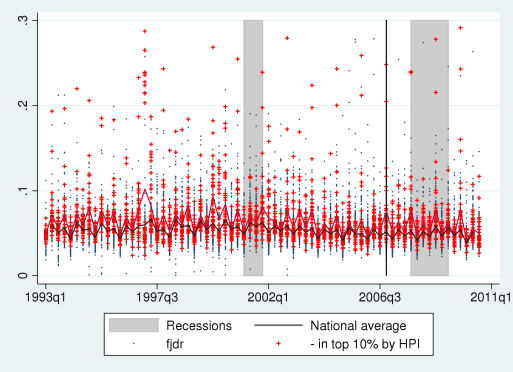

FIGURE A4. FULL-QUARTER JOB DESTRUCTION RATES

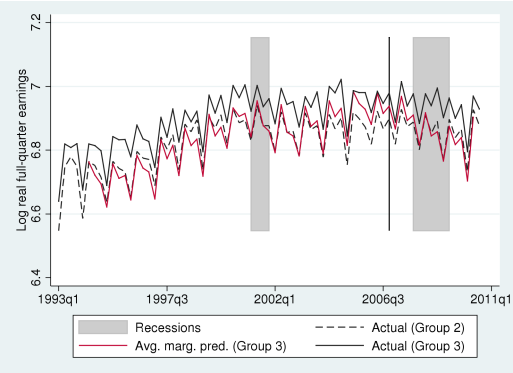

FIGURE A5. LOG FULL-QUARTER MONTHLY EARNINGS FOR ACCESSIONS, ACTUAL AND PREDICTED, TOP AND MIDDLE GROUPS BY HPI

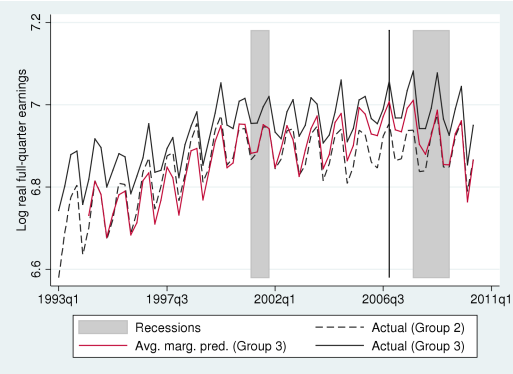

Figure A6. Log Full-quarter Monthly Earnings for Separations, Actual and Predicted, Top and Middle Groups by HPI

Data Appendix

This data appendix will not be available in the final publication; it and the data described herein will be made available online.

B1. QWI data

QWI are provided by the U.S. Census Bureau, and can be downloaded from the VirtualRDC at http://www.vrdc.cornell.edu/qwipu.

The QWI are released at the county, Workforce Investment Board (WIB), and Core-Based Statistical Area (CBSA) level. The geographic definitions stem from TIGER 2006 Second Edition. For the CBSA files, a total of 566 micropolitan areas and 357 MSAs are defined in the QWI.

For this paper, data on the 365 MSAs were extracted from the R2011Q3 release of the QWI, covering data through 2010Q4. Historical data availability varies by state, with some states only providing data from 2004Q1 (AZ) onwards, and other providing data from as early as 1990Q1 (MD). Data for NH and MA were not available. Eight MSA definitions used in the QWI no longer exist in the 2009 MSA definitions, which the HPI use, and are excluded from the analysis:

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17180
23020
42260
47860
48260
48340
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For MSAs spanning state borders, the QWI report each state's section separately. These have been aggregated up to the full MSA level, however, in years when data for only some, but not all of the states in the multi-state MSAs are available, this aggregation may not be complete.

We also use the prototype National QWI first developed in Abowd and Vilhuber (2011), updated to cover data through 2010Q3. In contrast to the data described in Abowd and Vilhuber (2011), this is the first documented use of the full-quarter variables. The National QWI will be downloadable from http://www.vrdc.cornell.edu/news/data/qwi-national-data/.

B2. HPI data

House Price Indexes (HPI) data used in this paper were downloaded from the Federal Housing Finance Agency (FHFA) (http://www.fhfa.gov/Default.aspx?Page=87. We use the data files through 2011Q2, accessed on Sept 15, 2011. HPI are available for 355 MSAs and 29 Metropolitan Statistical Division (MSD)s. We aggregate the MSD components up to their corresponding MSA, yielding 366 MSAs. We also use national HPI numbers for the same time period. All indices were rebaselined to 1995Q1 = 100.

B3. Unemployment data

National unemployment data are provided by BLS. Data (series LNU04000000Q) were downloaded from ftp://ftp.bls.gov/pub/time.series/ln/ on Dec 20, 2011. Local Area Unemployment Statistics (LAUS) are provided by the BLS (see Bureau of Labor Statistics (1997) and Brown (2005)). Data were downloaded from ftp://ftp.bls.gov/pub/time.series/la/ on Nov 24, 2011. Data on New England City and Town Area (NECTA)s were excluded, data on MSDs were aggregated to their corresponding MSA, and then further aggregated to quarterly values by taking the simple 3-month average for each calendar quarter.

QWI Concepts and Definitions

This section provides a summary of the concepts and definitions underlying the QWI. For a more comprehensive discussion of this, the reader is referred to Abowd et al. (2009).

C1. Employment for a full quarter

The concept of full-quarter employment estimates individuals who are likely to have been continuously employed throughout the quarter at a given employer. An individual is defined as full-quarter-employed if that individual has valid UI-wage records in the current quarter, the preceding quarter, and the subsequent quarter at the same employer (SEIN). That is, in terms of the point-in-time definitions, if the individual is employed at the same employer at both the beginning and end of the quarter, then the individual is considered full-quarter employed in the QWI system.

C2. Accession and separation from full-quarter employment

Full-quarter employment is not a point-in-time concept. Full-quarter accession refers to the quarter in which an individual first attains full-quarter employment status at a given employer. Full-quarter separation occurs in the last full-quarter that an individual worked for a given employer.

As noted above, full-quarter employment refers to an estimate of the number of employees who were employed at a given employer during the entire quarter. An accession to full-quarter employment, then, involves two additional conditions that are not relevant for ordinary accessions. First, the individual (PIK) must still be employed at the end of the quarter at the same employer (SEIN) for which the ordinary accession is defined. At this point (the end of the quarter where the accession occurred and the beginning of the next quarter) the individual has acceded to continuing-quarter status. An accession to continuing-quarter status means that the individual acceded in the current quarter and is end-of-quarter employed. Next the QWI system must check for the possibility that the individual becomes a full-quarter employee in the subsequent quarter. An accession to full-quarter status occurs if the individual acceded in the previous quarter, and is employed at both the beginning and end of the current quarter.

Full-quarter separation works much the same way. One must be careful about the timing, however. If an individual separates in the current quarter, then the QWI system looks at the preceding quarter to determine if the individual was employed at the beginning of the current quarter. An individual who separates in a quarter in which that person was employed at the beginning of the quarter is a separation from continuing-quarter status in the current quarter. Finally, the QWI system checks to see if the individual was a full-quarter employee in the preceding quarter. An individual who was a full quarter employee in the previous quarter is treated as a full-quarter separation in the quarter in which that person actually separates. Note, therefore, that the definition of full-quarter separation preserves the timing of the actual separation (current quarter) but restricts the estimate to those individuals who were full-quarter status in the preceding quarter.

C3. Full-quarter job creations, job destructions and net job flows

The QWI system applies the same job flow concepts to full-quarter employment to generate estimates of full-quarter job creations, full-quarter job destructions, and full-quarter net job flows. Full-quarter employment in the current quarter is compared to full-quarter employment in the preceding quarter. If full-quarter employment has increased between the preceding quarter and the current quarter, then full-quarter job creations are equal to full-quarter employment in the current quarter less full-quarter employment in the preceding

quarter. In this case full-quarter job destructions are zero. If full-quarter employment has decreased between the previous and current quarters, then full-quarter job destructions are equal to full-quarter employment in the preceding quarter minus full-quarter employment in the current quarter. In this case, full-quarter job destructions are zero. Full-quarter net job flows equal full-quarter job creations minus full-quarter job destructions.

C4. Average earnings of full-quarter employees

Measuring earnings using UI wage records in the QWI system presents some interesting challenges. The earnings of end-of-quarter employees who are not present at the beginning of the quarter are the earnings of accessions during the quarter. The QWI system does not provide any information about how much of the quarter such individuals worked. The range of possibilities goes from 1 day to every day of the quarter. Hence, estimates of the average earnings of such individuals may not be comparable from quarter to quarter unless one assumes that the average accession works the same number of quarters regardless of other conditions in the economy. Similarly, the earnings of beginning-of-quarter workers who are not present at the end of the quarter represent the earnings of separations. These present the same comparison problems as the average earnings of accessions; namely, it is difficult to model the number of weeks worked during the quarter. If we consider only those individuals employed at the employer in a given quarter who were neither accessions nor separations during that quarter, we are left, exactly, with the full-quarter employees, as discussed above.

The QWI system measures the average earnings of full-quarter employees by summing the earnings on the UI wage records of all individuals at a given employer who have full-quarter status in a given quarter then dividing by the number of full-quarter employees. For example, suppose that in 2000:2 employer A has 10 full-quarter employees and that their total earnings are $\$300,000$. Then, the average earnings of the full-quarter employees at A in 2000:2 is $\$30,000$. Suppose, further that 6 of these employees are men and that their total earnings are $\$150,000$. So, the average earnings of full-quarter male employees is $\$25,000$ in 2000:2 and the average earnings of female full-quarter employees is $\$37,500$ $(= \$150,000/4)$.

C5. Average earnings of full-quarter accessions

As discussed above, a full-quarter accession is an individual who acceded in the preceding quarter and achieved full-quarter status in the current quarter. The QWI system measures the average earnings of full-quarter accessions in a given quarter by summing the UI wage record earnings of all full-quarter accessions during the quarter and dividing by the number of full-quarter accessions in that quarter.

C6. Average earnings of full-quarter separations

Full-quarter separations are individuals who separate during the current quarter who were full-quarter employees in the previous quarter. The QWI system measures the average earnings of full-quarter separations by summing the earnings for all individuals who are full-quarter status in the current quarter and who separate in the subsequent quarter. This total is then divided by full-quarter separations in the subsequent quarter. The average earnings of full-quarter separations is, thus, the average earnings of full-quarter employees in the current quarter who separated in the next quarter. Note the dating of this variable.

C7. Overview and basic data processing conventions

C8. Individual concepts

Flow employment

(m): for $qfirst \leq t \leq qlast$, individual i employed (matched to a job) at some time during period t at establishment j

$$m_{ijt} = \begin{cases} 1, \text{ if } i \text{ has positive earnings at establishment } j \text{ during quarter } t \\ 0, \text{ otherwise.} \end{cases} \tag{C1}$$

Flow employment corresponds to the presence of a UI wage record in the system.

Beginning of quarter employment

(b): for $qfirst < t$, individual i employed at the beginning of t (and the end of $t-1$),

$$b_{ijt} = \begin{cases} 1, \text{ if } m_{ijt-1} = m_{ijt} = 1 \\ 0, \text{ otherwise.} \end{cases} \tag{C2}$$

End of quarter employment

(e): for $t < qlast$, individual i employed at j at the end of t (and the beginning of $t+1$),

$$e_{ijt} = \begin{cases} 1, \text{ if } m_{ijt} = m_{ijt+1} = 1 \\ 0, \text{ otherwise.} \end{cases} \tag{C3}$$

Full quarter employment

(f): for $qfirst < t < qlast$, individual i was employed at j at the beginning and end of quarter t (full-quarter job)

$$f_{ijt} = \begin{cases} 1, \text{ if } m_{ijt-1} = 1 \ \& \ m_{ijt} = 1 \ \& \ m_{ijt+1} = 1 \\ 0, \text{ otherwise.} \end{cases} \tag{C4}$$

Accessions to consecutive quarter status

(a_2): for $qfirst < t < qlast$, individual i transited from accession to consecutive-quarter status at j at the end of t and the beginning of $t+1$ (accession in t and still employed at the end of the quarter)

$$a_{2ijt} = \begin{cases} 1, \text{ if } a_{1ijt} = 1 \ \& \ m_{ijt+1} = 1 \\ 0, \text{ otherwise.} \end{cases} \tag{C5}$$

Accessions to full quarter status

(a_3): for $qfirst + 1 < t < qlast$, individual i transited from consecutive-quarter to full-quarter status at j during period t (accession in $t-1$ and employed for the full quarter in t)

$$a_{3ijt} = \begin{cases} 1, \text{ if } a_{2ijt-1} = 1 \ \& \ m_{ijt+1} = 1 \\ 0, \text{ otherwise.} \end{cases} \tag{C6}$$

Separations from full-quarter status

(s_3): for $qfirst + 1 < t < qlast$, individual i separated from j during t with full-quarter status during $t-1$

$$s_{3ijt} = \begin{cases} 1, \text{ if } s_{2ijt} = 1 \ \ \& \ \ m_{ijt-2} = 1 \\ 0, \text{otherwise.} \end{cases} \tag{C7}$$

Total earnings during the quarter

(w_1): for $qfirst \leq t \leq qlast$, earnings of individual i at establishment j during period t

$$w_{1ijt} = \sum \text{all } UI\text{-covered earnings by } i \text{ at } j \text{ during } t \tag{C8}$$

Earnings of full-quarter individual

(w_3): for $qfirst < t < qlast$, earnings of individual i at establishment j during period t

$$w_{3ijt} = \begin{cases} w_{1ijt}, \text{ if } f_{ijt} = 1 \\ \text{undefined, otherwise} \end{cases} \tag{C9}$$

Earnings of full-quarter accessions

(wa_3): for $qfirst + 1 < t < qlast$, earnings of individual i at employer j during period t

$$wa_{3ijt} = \begin{cases} w_{1ijt}, \text{ if } a_{3ijt} = 1 \\ \text{undefined, otherwise} \end{cases} \tag{C10}$$

Earnings of full-quarter separations

(ws_3): for $qfirst + 1 < t < qlast$, individual i separated from j during $t+1$ with full-quarter status during t

$$ws_{3ijt} = \begin{cases} w_{1ijt}, \text{ if } s_{3ijt+1} = 1 \\ \text{undefined, otherwise} \end{cases} \tag{C11}$$

C9. Establishment concepts

For statistic x_{cijt} denote the sum over i during period t as $x_{c\cdot jt}$. For example, beginning of period employment for firm j is written as:

$$B_{jt} = b_{\cdot jt} = \sum_i b_{ijt} \tag{C12}$$

All individual statistics generate establishment totals according to the formula above. For reference, only a few are listed here.

Beginning-of-period employment

(number of jobs)

$$B_{jt} = b_{\cdot jt} \tag{C13}$$

End-of-period employment

(number of jobs)

$$E_{jt} = e_{\cdot jt} \tag{C14}$$

Full-quarter employment

$$F_{jt} = f_{\cdot jt} \tag{C15}$$

Average employment

for establishment j between periods $t-1$ and t

$$\bar{E}_{jt} = \frac{(B_{jt} + E_{jt})}{2} \tag{C16}$$

Average full-quarter employment

for establishment j during period t

$$\bar{F}_{jt} = \frac{F_{jt-1} + F_{jt}}{2} \tag{C17}$$

Flow into full-quarter employment

for establishment j during t

$$FA_{jt} = a_{3\cdot jt} \tag{C18}$$

Average rate of flow into full-quarter employment

for establishment j during t

$$FAR_{jt} = FA_{jt} \,/\, \bar{F}_{jt} \tag{C19}$$

with equivalent definitions for the flow out of full-quarter employment (FS_{jt}, FSR_{jt}). Job flow concepts are only defined for the establishment, and are described here.

Net job flows

(change in employment) for establishment j during period t

$$JF_{jt} = E_{jt} - B_{jt} \tag{C20}$$

Net change in full-quarter employment

for establishment j during period t

$$FJF_{jt} = F_{jt} - F_{jt-1} \tag{C21}$$

Average full-quarter employment growth rate

for establishment j between $t-1$ and t

$$FG_{jt} = \frac{FJF_{jt}}{\bar{F}_{jt}} \tag{C22}$$

Full-quarter job creations

for establishment j between $t-1$ and t

$$FJC_{jt} = \bar{F}_{jt} \max\left(0, FG_{jt}\right) \tag{C23}$$

Average full-quarter job creation rate

for establishment j between $t-1$ and t

$$FJCR_{jt} = FJC_{jt} \,/\, \bar{F}_{jt} \tag{C24}$$

Full-quarter job destruction

for establishment j between $t-1$ and t

$$FJD_{jt} = \bar{F}_{jt} \operatorname{abs}\left(\min\left(0, FG_{jt}\right)\right) \tag{C25}$$

Average full-quarter job destruction rate

for establishment j between $t-1$ and t

$$FJDR_{jt} = FJD_{jt} \,/\, \bar{F}_{jt} \tag{C26}$$

Average earnings of full-quarter employees

$$ZW_{3jt} = W_{3jt} \,/\, F_{jt} \tag{C27}$$

Average earnings of transits to full-quarter status

$$ZWFA_{jt} = WFA_{jt} \,/\, FA_{jt} \tag{C28}$$

Average earnings of separations from full-quarter status (most recent full quarter)

$$ZWFS_{jt-1} = WFS_{jt-1} \,/\, FS_{jt} \tag{C29}$$

C10. Identities

The identities stated below hold at the establishment level for every subcategory. These identities may not hold in the published data exactly, due to the application of disclosure avoidance protocols.

DEFINITION 1: *Employment at beginning of period t equals end of period $t-1$*

$$B_{jt} = E_{jt-1}$$

DEFINITION 2: *Evolution of end of period employment*

$$E_{jt} = B_{jt} + A_{jt} - S_{jt}$$

DEFINITION 3: *Evolution of average employment*

$$\bar{E}_{jt} = B_{jt} + (A_{jt} - S_{jt})/2$$

DEFINITION 4: *Evolution of full-quarter employment*

$$F_{jt} = F_{jt-1} + FA_{\ jt} - FS_{jt}$$

DEFINITION 5: *Full-quarter creation-destruction identity*

$$F_{jt} = F_{jt-1} + FJC_{jt} - FJD_{jt}$$

DEFINITION 6: *Full-quarter job flow identity*

$$FJF_{jt} = FJC_{jt} - FJD_{jt}$$

DEFINITION 7: *Full-quarter creation-destruction/accession-separation identity*

$$FA_{jt} - FS_{jt} = FJC_{jt} - FJD_{jt}$$

DEFINITION 8: *Full quarter employment growth rate identity*

$$FG_{jt} = FJCR_{jt} - FJDR_{jt}$$

DEFINITION 9: *Full quarter creation-destruction/accession-separation rate identity*

$$FJCR_{jt} - FJDR_{jt} = FAR_{jt} - FSR_{jt}$$

DEFINITION 10: *Full-quarter payroll identity*

$$W_{3jt} = W_{2jt} - WCA_{jt}$$

C11. Aggregation of job flows

The aggregation of job flows is performed using growth rates to facilitate confidentiality protection. The rate of growth JF for establishment j during period t is estimated by:

$$G_{jt} = \frac{JF_{jt}}{\bar{E}_{jt}} \tag{C30}$$

For an arbitrary aggregate $k = (\ ownership\times\ state\times\ substate\text{-}geography\times\ industry\times\ demographic)$ cell, we have:

$$G_{kt} = \frac{\sum_{j\in\{K(j)=k\}} \bar{E}_{jt} \times G_{jt}}{\bar{E}_{kt}} \tag{C31}$$

where the function $K(j)$ indicates the classification associated with firm j. We calculate the aggregate net job flow as

$$JF_{kt} = \sum_{j \in \{K(j)=k\}} JF_{jt}. \tag{C32}$$

Substitution yields

$$JF_{kt} = \sum_{j} (\bar{E}_{jt} \times G_{jt}) = G_{kt} \times \bar{E}_{kt}, \tag{C33}$$

so the aggregate job flow, as computed, is equivalent to the aggregate growth rate times aggregate employment. Gross job creation/destruction aggregates are formed from the job creation and destruction rates by analogous formulas substituting JC or JD, as appropriate, for JF (Davis, Haltiwanger and Schuh, 1996, p. 189 for details). Aggregates for the gross worker flows (AR and SR)follow the definitions in Abowd, Corbel and Kramarz (1999).

Abbreviations

This list of abbreviations will not be available in the final publication.

BLS Bureau of Labor Statistics

CBSA Core-Based Statistical Area

FHFA Federal Housing Finance Agency

HPI House Price Indexes

LAUS Local Area Unemployment Statistics

MSA Metropolitan Statistical Area

MSD Metropolitan Statistical Division

NECTA New England City and Town Area

QWI Quarterly Workforce Indicators

WIB Workforce Investment Board

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