WORKING PAPER 2019:27

Measuring job openings:
evidence from Swedish plant level data

Niels-Jakob Harbo Hansen

IFAU
INSTITUTE FOR
EVALUATION OF
LABOUR MARKET AND
EDUCATION POLICY

Measuring job openings: evidence from Swedish plant level data[a]

Niels-Jakob Harbo Hansen[b]

This version: October 28, 2019

Abstract

In modern macroeconomic models job openings are a key component. Thus, when taking these models to the data we need an empirical counterpart to the theoretical concept of job openings. To achieve this, the literature relies on job vacancies measured either in survey or register data. Insofar as this concept captures the concept of job openings well we should see a tight relationship between vacancies and subsequent hires on the micro level. To investigate this, I analyze a new data set of Swedish hires and job vacancies on the plant level covering the period 2001-2012. I find that vacancies contain little power in predicting hires above (i) whether the number of vacancies is positive and (ii) plant size. Building on this, I propose an alternative measure of job openings in the economy. This measure has the features of (i) better predicting hiring at the plant level and (ii) providing a better fitting aggregate matching function *vis-à-vis* the traditional vacancy measure.

[a]I am very grateful for helpful comments from Orley Ashenfelter, Tobias Broer, Saman Darougheh, Karl Harmenberg, John Hassler, Bertil Holmlund, Georg Marthin, Mounir Karadja, Per Krusell, Alexandre Kohlhas, Hannes Malmberg, Kurt Mitman, Erik Öberg, Torsten Persson, Robert Shimer, Jósef Sigurdsson, Hans Henrik Sievertsen, Karolina Stadin, David Strömberg, Olof Åslund as well as seminar participants at the Bern University, IIES, IFAU and Warwick University. IFAU and Handelsbanken's Research Foundations are gratefully acknowledged for generous financial support. All remaining errors are my own.

[b]IIES, nielsjakobharbo.hansen@iies.su.se

Contents

1 Introduction

One of the puzzles in macroeconomics after the Great Recession has been why unemployment in a number of advanced countries has been high, while job openings at the same time also have been high in a historical context. This observation is captured by the notion that the Beveridge curve apparently has shifted outwards in a number of OECD countries – including Sweden.[1] In this paper, I investigate whether problems in measuring job openings can be part of the explanation. My starting point for this study is a plant level hiring equation, which derives from the standard search and matching model. I estimate this equation using Swedish plant level data for vacancies and hires. Doing so, I find that the usual vacancy measure is only weakly related to hiring on the plant level, and that the fit of the plant level hiring equation can be improved on by allowing job openings to depend not only on posted vacancies but also on plant size. Based on these findings, I construct an alternative measure of job openings, which builds on the extensive margin of vacancies and plant size. This measure also improves the fit of the aggregate matching function. Also, when using this measure to analyze the Swedish labor market experience after the Great Recession, job openings appear less plentiful after the recession and the outward shift in the Beveridge curve is less pronounced.

Job openings are a key concept in modern macroeconomic models. Within the search-matching framework we need to know the number of job openings to infer the tightness of the aggregate labor market. On the micro level, a hire is made when a job opening and an unemployed worker are matched via the aggregate matching function.

When taking these models to the data we thus need to construct a mapping from the theoretical concept of a job opening to an empirical counterpart. To achieve this mapping the literature relies on data for job vacancies. These are either measured via surveys, where employers are asked about the number of jobs they are trying to fill, or via register data on job vacancies posted in newspapers or employment centers. Economists use these measures to guide discussions about the aggregate state of the labor market and to evaluate model predictions.[2] Yet so far, we know little about how these vacancy measures relate to actual hiring on the micro level. Insofar as job vacancies capture the notion of job openings well, we should, however, expect to see a tight relationship between job vacancies and subsequent hires on the micro level.

Specifically, according to the textbook search and matching model, aggregate hires can be written as $H = AV^{1-\alpha}U^{\alpha}$, where A and α are parameters, V is job openings and

[1] "Apparently" is used as the Beveridge curve plots job openings against unemployment. However, as I argue below job openings are not observed, but instead proxied using empirical measures.

[2] A particular discussion relates to the existence of constant returns to scale in the aggregate matching function (H=M(U,V)). To evaluate this prediction is its necessarily to have reliable data on aggregate hires, unemployment, as well as job openings.

U is unemployment.[3] Assuming homogeneity across plants, this implies a hiring equation on the plant level that reads $H_j = A\left(\frac{U}{V}\right)^{\alpha} V_j$. While a large literature has estimated matching functions on the aggregate level there is only little evidence on the plant level relationship – perhaps because it requires data for both hires and vacancies on the micro level.[4]

This paper is among the first to investigate this micro level relationship. Specifically, I study a new Swedish data set with hires and job vacancies on the plant level. Using this data, I find that the relationship between job vacancies and subsequent hiring is weak and concave, in contrast to a linear relationship as predicted by the standard search and matching model. That is, variations in vacancies explains very little of the variation in hiring on the plant level and additional vacancies predict less and less additional hiring. I also show that it is possible to improve the fit of the plant level regression by 10-100% (measured by the adjusted R^2) when allowing the measure of job openings to depend not only on listed vacancies, but also on plant size.[5]

Building on these plant level findings, I propose an alternative measure for the aggregate number of job openings in the economy. Motivated by the concave relationship between vacancies and hires on the plant level, and the predictive power of plant size, I use the *number of plants with a positive number of vacancies weighted by size* as an alternative measure of the total job openings. This measure improves the fit of the aggregate matching function by 50-70%.

These findings provide a new perspective on the ongoing policy discussion about why unemployment following the Great Recession has been high in a number of OECD countries (including Sweden) in spite of the stock of vacancies also being high. Some economists and policymakers have argued that declining match efficiency is behind this outward shift in the Beveridge curve (Hall and Schulhofer-Wohl, 2015; Sveriges Riksbank, 2012). However, using the alternative measure of job openings developed in this paper, the Swedish labor market appears less tight after the Great Recession. The reason is that vacancies have rebounded less in plants where hires per vacancies, the *vacancy yield*, is high. This suggests that the traditional vacancy measure may have overstated the number of job openings in the economy and made the labor market appear too tight. Thus, my finding provides one potential explanation behind a lower job finding probability after the Great Recession than what is predicted by a matching function estimated on historical data. Specifically, the actual job finding rate during 2010-12 was on average 2 percentage points lower than what is predicted by a standard matching function estimated on

[3] $A > 0$ and $0 < \alpha < 1$.

[4] See Petrongolo and Pissarides (2001) and Pissarides (2000) for an overview.

[5] This is not a trivial function of larger plants having more job openings. If job openings were fully captured by the measured job vacancies there should be no additional information in the inclusion of plant size in the regression.

pre-crisis data. However, it is only 1.2 percentage points lower than what is predicted by a matching function estimated on pre-crisis data using the alternative measure of job openings.

1.1 Related literature

My study relates to four strands of literature. First, the most closely related paper is that by Davis et al. (2013). They analyze the relationship between hires and a survey-based measure of vacancies (JOLTS) on the plant level in the United States. They document how hires per vacancy, the *vacancy yield*, behaves in the cross-section of plants and over time. Moreover, they develop a generalized matching function with a role for *recruitment effort*. They show that variation in recruitment effort can partly explain the recent break-down in the matching function for the U.S. My paper takes a somewhat different approach. Instead of introducing a time-varying measure of recruitment intensity, I construct an alternative measure of job openings which builds both on vacancies and plant characteristics.

Second, there is a vast literature which estimates matching functions using the aggregate number of vacancies, unemployment and job finding probabilities. Examples include Blanchard and Diamond (1990), Berman (1997), Yashiv (2000), Albaeck and Hansen (2004), Sunde (2007), Gross (1997), and Feve and Langot (1996).[6] My paper adds to this literature by discussing the micro-level properties of the vacancy data that goes into the estimation.

Third, another strand of literature discusses the duration of vacancies on the firm level, and how this duration is determined (Ours and Ridder, 1991; Burdett and Cunningham, 1998; Barron et al., 1997; Holzer, 1990). Here vacancies are studied on the micro level, but in isolation. My paper adds to this literature by investigating the *link* between vacancies and hires on the micro level.

Fourth, my paper relates to the debate on Beveridge curve movements after the Great Recession. As documented by Hobijn and Sahin (2012) the Beveridge curve has shifted outwards in a number of OECD countries in the aftermath of the Great Recession. Some, non-mutually exclusive, hypotheses have been put forward to explain this apparent puzzle. Hall and Schulhofer-Wohl (2015) have argued that declining matching efficiency in the pre-crisis period is behind the outward shift in the Beveridge curve in the United States. Sveriges Riksbank (2012) has argued that a similar mechanism has been operating in Sweden. Another hypothesis has been put forward by Kroft et al. (2016). They argue that duration dependence in workers' transition rates between employment, non-employment and non-participation can account for much of the outward shift in the Beveridge curve in the United States. Finally, Davis et al. (2013) have argued that variation in firms'

[6] A review of this literature is available in Pissarides (2000) and Petrongolo and Pissarides (2001).

recruitment intensity can explain parts of the outward shift. I add to this literature by arguing that mis-measurement of job openings can be part of the story in the case of Sweden.

1.2 Organization

The paper proceeds as follows. In Section 2, I describe my data sources and how the database is constructed. In Section 3, I document the relationship between vacancies and hires on the plant level. In Section 4, I build on the findings from the previous sections and propose an alternative measure of job openings in the economy. Section 5 concludes.

2 Data

2.1 Job vacancies

Job vacancies are the empirical counterpart to job openings in the search matching model. To this end the aim of job vacancy data is to measure the number of available jobs in the economy. Overall, two different approaches have been taken to do so over time and geography.[7] One approach is to rely on register data, where the actual number of vacancies posted is measured. Examples of such databases includes the Help-Wanted index compiled by the Conference Board in the US, or European databases compiled by Public Employment Services. Another, and newer, approach is to rely on survey data compiled by statistical agencies. The Job Openings and Labor Turnover Survey (JOLTS) from the U.S. is a prominent example of such data. Concerns about representativity, and shift in usage of recruitment channels, in the register data is one reason to prefer the survey over the register data. However, long time series for vacancies measured via survey data are scarce. In Europe vacancy surveys were only compiled in a few countries: Sweden, the Netherlands, and the United Kingdom (Elsby et al., 2015).

In this study, I draw on the micro data for job vacancies, as measured in the *Swedish Job Vacancy Survey*. This survey is administered by Statistics Sweden and has been collected on a quarterly basis since 2001. Two vacancy concepts are available from this survey: (1) The number of available positions in each plant, which has been made “available for external job-seekers via the newspapers, internet or another mean of dissemination”, and (2) the number of these positions that the employer wishes to fill immediately.[8] This way, the former concept is a superset of the latter. As the theoretical concept we seek to measure is job-openings in general, there is no theoretical reason to confine the analysis

[7] See Elsby et al. (2015) for a review

[8] In Swedish (1) is called *Vakanser* and (2) is called *Lediga jobb*.

to vacancies where work can start immediately. For this reason, I rely on the former definition in my study below.[9]

The *Swedish Job Vacancy Survey* is collected at the plant level, and all respondents are asked to report the number of vacancies in the middle of the reference month.[10] For the private sector the sampling is carried out on the plant level with approximately 16 700 workplaces sampled each period. For the public sector the sampling was also undertaken on the plant level until 2006Q2. In 2006Q2 the sampling was changed to the organizational level and on this level 650 organizations are sampled each period. Units larger than 100 employees are asked to report each month of the relevant quarter, whereas units with less than 100 employees only are asked to report in the reference month. Reporting occurs either via letter or online. Non-respondents are reminded via email, letter or phone. Until 2004, reporting was voluntary and the share of non-reporting units was 40% in the public sector and 20% in the private sector. In 2004, reporting became mandatory and currently the share of non-reporting, units is 11% in the private sector and 2% in the public sector.

The plant level distribution of vacancies is reported in Figure 1. On the plant level (Figure 1) the mean number of vacancies is 2.2, the median is 0, and the 90th percentile is 4. 73.4% of all plants do not report any vacancies in a given month. Only 14% of plants with zero vacancies in a given month report vacancies in the following month, and 30% of the plants reporting vacancy in a given month also report vacancies in the next.[11] Notice the small spikes at 10, 15, and 20 vacancies, which could indicate that plants have a tendency to report certain numbers.

2.2 Hires

For hires I have access to two data sources: (i) a survey-based measure from Statistics Sweden, and (ii) a register-based measure from the Swedish tax registry.

The survey-based measure of hires stems from the *Short-Term Employment Statistics* which is compiled by Statistics Sweden. This data is collected in combination with the *Job Vacancy Survey* described above and thus contains the same sample of plants. From this survey, I construct the total number of hires in a given month by adding up all reported new hires on temporary and permanent contracts. In addition to the number of hires in each month the survey also contains the number of workers employed at each plant.

[9] Moreover, one of the results below is that plants hire more workers than the vacancies they report. This result would likely only be amplified if using the narrower vacancy definition.

[10] Specifically, the respondents are asked to report the number of job openings on the Wednesday closest to the 15th of the reference month.

[11] To produce this calculation, I have restricted attention to the subset of plants for which there are observations in two consecutive months.

The second measure for hires is register-based and stems from the Swedish tax authorities. Specifically, the Institute for Evaluation of Labour Market and Education Policy (IFAU) maintains a database containing the start and end month of all employment spells as reported to the Swedish tax authorities. Along with the spell length the database contains an identifier for person, firm, and plant. From this data, I compute the number of monthly hires as the number of spells that start in a plant in a given month. To discard repeated, or interrupted, spells I remove all spells where the individual has been employed in the same plant or firm during the last 12 months.

The distribution of hires across plants is shown in Figure 2 and 3. For the survey-based measure of hires the mean is 1.8, the median 0, and the 95% percentile 6. As was the case with vacancies, most plants (64.55%) do not hire in a given month according to the survey-based measure. For the tax-based measure the mean is 1.5, the median is 0, the 95% percentile is 9 and 71.31% of all plants do not hire in a given month.

2.3 Background variables

I have access to background information on the plant and firm level from Statistics Sweden's *Short-Term Employment Statistics* and the register data in the *Swedish Firm Register*. This background information contains information on the number of employees and industry of each plant, while turnover and value added is available on the firm level. I report a summary of these variables in Table 1.

2.4 Data selection

In my analysis below I relate the number of vacancies in a given plant to the number of subsequent hires made at the same plant. For this purpose I need to decide on which measure of hires to use. Specifically, I need to choose between the survey- and tax-based measures. The tax-based measure has the advantage of being available for the universe of plants during all months, whereas the survey-based measure only is available for a plant if the plant was sampled in the given month. As I wish to relate vacancies to *subsequent* hires, this presents a problem as only larger plants are surveyed for consecutive months, as explained above. This point is illustrated in Table 1, where I compare the characteristics of the observations from the data set on survey vacancies, where I also have access to tax- and survey-based hires in the subsequent month, respectively. The table shows that the data set with survey hires contains larger plants in terms of employees, turnover (firm level), and value added (firm level). The tax-based measure further has the advantage of providing more observations, as shown in Table 2. However, this point is less important once we restrict attention to observations (i) where all background variables are available and (ii) where hires and vacancies are non-zero. The tax-based measure however has the problem of an upwardly biased number of hires in January, and downwardly biased number the rest of the year, as well as the downwards trend over time which is not observed in the survey-based data. Due to these pros- and cons of each measure of hires, I below relate vacancies to subsequent hires using *both* the survey- and tax-based measure of hires.

3 Plant level relationship

In this section, I investigate the plant level relationship between vacancies and hires.[12]

3.1 Descriptive statistics

Table 3 and Table 4 present the hiring rate, the vacancy rate and the vacancy yield in the cross-section of plants. The two tables present the rates and yield computed using the tax and survey data, respectively. The hiring and vacancy rate is expressed as the number of hires and vacancies per employee, while the vacancy yield is defined as the number of hires per vacancy. All numbers are computed on the plant level and averaged across the relevant dimension of the data. Across industries there is substantial discrepancy between the tax and survey data, which is likely caused by the differences in sampling described in Section 2.4. Across size and turnover the picture is however similar between the two data sources. Across plant size, as measured by number of employees, larger firms hire more workers per vacancies. Indeed, while the plants in the decile with fewest employees only hire $0.1 - 0.3$ workers per vacancy, the plants in the decile with most employees hire $2.3 - 2.6$ workers per vacancy.

A number of factors can potentially explain the observed heterogeneity in vacancy yields. First, plants may rely on other recruitment channels than vacancies, such as uninvited applications or informal social networks. In case the reliance on such alternative recruitment varies across plant characteristics this may give rise to the pattern observed in Table 3-4. For example Cahuc and Fontaine (2009) construct a model, where an employer's probability of filling a job is increasing in the size of the social network. To the extent that larger plants have larger social networks this can potentially go some way in explaining why the vacancy yield is increasing in plant size. Second, plants may rely on one vacancy to hire more than one worker. If a plant is attempting to hire workers with a

[12] Arguably it would be better to investigate the relationship on the firm-level, as this would circumvent the potential problem of having an employee formally hired in a different plant than where the relevant vacancy was posted. But the structure of the data precludes me from taking this approach. This problem is likely to be limited as it will only occur if a worker is hired at another plant than where the vacancy was posted.

homogenous skill set, it may only report one vacancy in spite on an intention to hire more than one worker. Such a behaviour would predict a higher vacancy yield in industries, where the required skill set of workers is more homogeneous. Third, larger plants may need to hire more workers simply because more workers are leaving each period. If this enhanced hiring need does not fully translate into more posted vacancies, *e.g.* because larger plants can choose to hire more workers per vacancy, this could also be part of the explanation.

Next, I investigate how the number of hires varies with vacancies in the cross section of plants. Figure 5-6 depicts the raw relationship between vacancies and hires in the following month on the plant level. Here each dot on the y-axis represents the average number of hires for the number of vacancies represented on the x-axis. This relationship appears concave, rather than linear, which suggests that one additional vacancy predicts less and less hiring. In particular, the relationship between hires and vacancies seen in Figure 5 appears to weaken after the first few vacancies. In this context, it is relevant to recall from section 2 that only 10% of all observations in the plant data have more than 4 vacancies.

In addition many hires happen in plants where no vacancies were reported. Figure 7 shows the share of all hires that are made in plants that did not report any vacancies in the preceding month. This share varies in the interval $40-50\%$ when using the tax based measure for hires, and $40-60\%$ when using the survey based measure. It falls to $30-40\%$ ($30-50\%$) if counting hires made without any vacancies during the last two preceding months. Some of these hires can be accounted by hiring out of other channels than vacancies, but some of the hires might also be explained by time aggregation issues. Indeed, since I only observe the stock of vacancies at a given point in time hiring may happen out of newly created vacancies that do not enter into the data set. I will address this issue along with other robustness issues in the Appendix A.

Finally, I investigate the distribution of vacancies on subsequent hiring in Table 5. Roughly 50% of all vacancies occur in plants, where there is hiring in the same month, the month after, or two month after. Approximately 40% of all vacancies happen in plants where there is no hiring within the next two month.

These initial descriptive statistics hint at (1) the distribution of vacancies plays a role and (2) our vacancy measure may not capture all job openings in the economy. Usually, we look at the sum of all vacancies to gauge the number of job openings in the economy. However, the descriptive statistics reported above suggests that this is potentially misleading. Indeed, if the observed variations the vacancy yield is caused by variation in the underlying number of actual job openings, then we need to account for the distribution when using vacancies as a measure of total job openings in the economy.

Moreover, the large share of hiring in plants without preceding vacancies also suggests that vacancies are incomplete as measure of job openings.

3.2 Estimating a hiring equation on the plant level

I now turn to the estimation of the relationship between vacancies and hires on the plant level. In the textbook search and matching model aggregate hiring is determined by the matching of unemployed workers (U) and job openings (V). This matching is done via an aggregate matching function with constant returns to scale $M(U, V)$.[13] Assuming plant homogeneity, and allowing the matching process to last one period, the number of hires in plant j at time t can then be written as

$$H(t, j) = \frac{M(U(t-1), V(t-1))}{V(t-1)} V(t-1, j) \tag{1}$$

Here the number of hires in plant j at time t is a function of (1) the tightness on the aggregate labor market[14], and (2) number of job openings posted by the plant.

Two predictions follow from equation (1). First, the number of hires made by plant j at time t is linear in the number of job openings posted by the plant. The coefficient on job openings is inversely related to labor market tightness, such that a tighter labor market predicts fewer hires per job opening. Second, we should only see hiring in plants where the number of job openings is positive. As explained above these predictions appear to be at odds with the data. In the estimations below, I will allow for a non-linear relationship between vacancies and hires, and in Section **??** I will investigate how much of the hiring without vacancies that can be accounted for by time aggregation.

When estimating (1) one has to take a stance on the appropriate interval between vacancy and relevant hire. To guide this choice, I rely on information on the duration of vacancies posted at the Public Employment Service (Figure 8). The average duration of vacancies posted here is 18 days, and 85% of all durations are less than a month. Informed by these findings, I set the interval between vacancy and hire to month. However, the results below are robust to increasing this interval (see Appendix).

To identify (1) in a flexible manner, I will estimate the following equation using the plant level data.

$$H(t, j) = \alpha(t-1) V(t-1, j)^{\gamma} \tag{2}$$

[13] As presented *e.g.* in Pissarides (2000)

[14] The definition of labor market tightness is often cause of confusion. Here I follow conventions and define labor market tightness as *number of job openings per unemployed worker*.

Here $\alpha(t-1)$ is a time fixed effect, which captures the aggregate conditions in equation (1). γ is an exponent on plant level vacancies, which allows for the possibility of a non-linear relationship between hires and vacancies. Insofar that the relationship is linear we should estimate a γ of unity.

Identifying (2) involves a choice of estimation strategy. One option is to estimate (2) in logs using ordinary least squares. This, however, comes at the cost of losing all observations with zero hires and/or vacancies. Another option is to estimate (2) in levels using non-linear least squares. This allows for the inclusion of all observations in the regression. Below I report the results from both estimation methods.

The estimation results are reported in the first column of Table 6 and 7. In Table 6 the estimation is done using ordinary least squares, while non-linear least squares is applied in Table 7. In panel A of the two tables hires are measured using the data from the Swedish tax authorities (see Section 2), while hires in panel B are measured using the survey data. The number of observations is determined by the existence of data on vacancies in a given month and data on hires in the following month. Variable definitions are as described in Section 2.

In the estimations in column one of Table 6 and 7 the exponent on vacancies is below unity. This speaks against a linear relationship between vacancies and hires. It is also relevant to note that most of the explanatory power in both estimations stems from the time-fixed effect. Indeed, without time-fixed effects the adjusted R^2 is only 0.03 suggesting that variation in vacancies explains little of the variation in the hiring on the plant level.

3.3 Can the measure of job openings be improved?

The findings in Table 6 and 7 above show that the relationship between vacancies and hires on the plant level is weak and non-linear. Moreover, the descriptive statistics in Table 3-4 pointed to the distribution being important for the job-content of the sum of observed vacancies. Specifically, the number of hires per vacancy was increasing in the plant size. A natural next question is thus, whether it is possible to construct an alternative measure of job openings, which is able to better predict hiring on the plant level.

To investigate this, I take point of departure in the plant level hiring equation from above (1). However, instead of just allowing job openings to be a function of vacancies, I will also allow it to be a function of plant size and other plant and firm level characteristics. Specifically, I will estimate the following relationship.

$$H(j,t) = \frac{M\left[U(t-1), V(t-1)\right]}{V(t-1)} F\left[V(j,t-1), \mathbf{x}(t-1)\right] \tag{3}$$

$$F\left[V(j,t-1), \mathbf{x}(t-1)\right] = V(j,t-1)^{\gamma_1} \times S(j,t-1)^{\gamma_2} \times T(j,t-1)^{\gamma_3} \times Va(j,t-1)^{\gamma_4}$$

This relationship between hires and job openings in (3) is an augmented version of that in equation (1). Whereas job openings in equation (1) were measured as posted vacancies only, job openings in (3) are measured by the function $F[V(j,t-1),\mathbf{x}(t-1)]$, in which job openings is allowed to be a function of posted vacancies $V(j,t-1)$, plant size $S_{j,t-1}$, firm turnover $T_{j,t-1}$ and firm value-added $Va_{j,t-1}$. Aggregate labor market conditions are again captured in the term $\frac{M[U(t-1),V(t-1)]}{V(t-1)}$ and will be modelled as a time-fixed effect in the regressions.

Equation (3) is estimated using ordinary least squares as well as using non-linear least squares in column 2-5 of Table 6 and 7. From column 2 to 5, I gradually allow job openings to be a function of more plant and firm level characteristics in addition to vacancies. Two results stand out from this exercise. First, the ability to predict hiring on the plant level is substantially improved when allowing job openings to depend also on plant and firm characteristics. This is witnessed by the increase in the adjusted R^2. Second, including these additional plant and firm variables decreases the exponent on vacancies towards zero. These two results are especially driven by plant size. Indeed, most of the increase in the fit, and decrease in the exponent on vacancies, comes from the inclusion of plant size in the regression. Relatively little additional fit is achieved from including the other firm and plant level variables.[15]

The results in this section suggest that we can improve our measure of job openings by taking plant characteristics as well as vacancies into account. Indeed, allowing job openings to be a function of vacancies and plant size substantially improves our ability to predict hiring on the plant level.[16] Specifically, the regressions showed that a measure of job openings, which combines vacancies and plant size in the following form

$$F(V(j,t),size(j,t)) = V(j,t-1)^a size(j,t-1)^b \tag{4}$$

outperformed the traditional vacancy in its ability to predict hiring on the plant level. In equation (4) a is effectively zero and b is estimated to be in the interval $0.4-0.5$. That a is effectively zero means that V_{jt}^a effectively takes the form of a 0/1 variable, which is 0 when the plant reports 0 vacancies and 1 as soon as the plant reports any positive number of vacancies. This binary variable is then multiplied with $size_{jt}^b$, which is a concave function of plant size. This does not just reflect that larger plants on average hire more workers in absolute terms. It reflects, that larger plants hire more workers for a given number of vacancies.

[15] Industry dummies are included for the eight categories reported in Table 4 and 3. Including industry dummies on two digit level from the SNI classification change the results very little.

[16] I am discussing why plant size could be important in predicting hirings in Section 3.1.

Thus, the takeaway from the regressions in this section is that we should be concerned about three questions when wanting to predict hiring in a given plant: (1) what are the aggregate conditions on the labor market[17], (2) whether or not the plant has any vacancies, and (3) the size of the plant.

4 Aggregate implications

In the sections above, I found that the relationship between vacancies and hires on the plant level is weak. Further I found that the predictive power of the plant level hiring equation was strengthened, when allowing job openings not just to be a function of vacancies but also of plant size. One interpretation of this finding, is that the traditional vacancy measure performs poorly in measuring actual job openings, and that we consequently should consider alternative ways of measuring these.

In this section, I discuss the implications of such an interpretation for aggregate labor market analysis. Specifically, I use the plant level findings from above to guide the construction of a simple alternative measure of aggregate job openings. Using this alternative measure I estimate aggregate matching functions and reassess the recent aggregate developments on the Swedish labor market.

4.1 An alternative measure for job openings

One interpretation of the results above is that the traditional vacancy measure of job openings can be improved. Indeed, the plant level findings suggest that an indicator variable for whether or not a plant has any vacancies multiplied by a concave function of plant size is a better measure of job openings *vis-à-vis* the number of vacancies posted at the relevant plant. Taken to the aggregate level, this interpretation would imply that the number of plants with a positive number of vacancies weighted by a function of their respective sizes provides a better measure of job openings in the economy than the sum of all vacancies.

Based on the estimated equation 4, I thus construct the following alternative measure for job openings in the aggregate:

$$V_{alt} = J \sum_{j} \left[\frac{I\left(V_j > 0\right) E_j}{\sum_j E_j} \right]. \tag{5}$$

Here, $I()$ is an indicator function, V_j is the number of vacancies in plant j, E_j is the employment at plant j, and J is the number of plants in the economy. Thus, V_{alt} is the

[17] As captured in the term $M(U(t-1), V(t-1))/V(t-1)$, which in the regressions is modelled as a time fixed effect.

sum of all plants with non-zero vacancies weighted by their share of total employment. I construct this measure using the micro data in the *Swedish Job Vacancy Survey* applying the sample weights provided by Statistics Sweden.[18]

Figure 12 depicts job openings in the economy using the traditional and alternative measures. The two time series develop broadly similarly, with the notable exception of the latest post-recession period. Here the traditional measure bounces back to a level above that in the pre-recession period, while the alternative measure stays below the pre-recession peak.

A quite similar picture is seen when looking at the development in labor market tightness (Figure 13). Using the traditional measure for job openings, the tightness on the labor market in 2012 was approximately 15% below its peak level in 2008. Using the alternative measure labor market tightness was approximately 30% below its peak level.

There are two reasons why the two measures develop differently in the post-recession period. First, the number of plants with a positive number of vacancies did not grow as strongly after the recession as did the number of vacancies. This is seen in Figure 14, where it is observed that the number of plants with a positive number of vacancies, as measured in per cent of the labor force, in the post-recession period stayed below its pre-recession peak level. This is in contrast to the number of vacancies, which bounced back to a level above its previous peak. Second, the average number of vacancies bounced back relatively less in larger plants, as illustrated in Figure 15. Taken together this suggests that the apparent surge in vacancies after the Great Recessions may partly have been deceptive: vacancies soared, but more so in plants where the vacancy yield was low.

4.2 Aggregate matching function

To assess how well the alternative measure for job openings explains the aggregate labor market development *vis-à-vis* the traditional measure, I rely on aggregate matching functions. Specifically, I assume that the aggregate matching function takes the following form:

$$M(U(t), V(t)) = AU(t)^{\alpha}V(t)^{1-\alpha}. \tag{6}$$

Consequently, the job finding probability can be written as

$$\frac{M(U(t), V(t))}{U(t)} = AU(t)^{\alpha-1}V(t)^{1-\alpha}. \tag{7}$$

[18] I have verified that computing the aggregate number of vacancies using the micro data for vacancies and the provided sample weights yields a time series for vacancies identical to the one published by Statistics Sweden.

which in log terms yields

$$\log\left(\frac{M(U(t),V(t))}{U(t)}\right) = \log(A) + (1-\alpha)\log\left(\frac{V(t)}{U(t)}\right). \tag{8}$$

In Table 9 and 10, I report the estimated matching function (8) using both the standard vacancy measure and the alternative measure for job openings. Data for the quarter-to-quarter job finding probability (at monthly frequency) is collected from the Swedish labor force survey. Table 9 shows the estimation results using seasonally adjusted data, while Table 10 uses non-seasonally adjusted data. In column (1)-(2), I carry out the estimation using OLS and contemporaneous variables. This approach faces an endogeneity concern as a high job finding rate will deplete the contemporaneous stock of vacancies and unemployed, respectively (Petrongolo and Pissarides, 2001). Thus, I follow the literature and do the same estimation by (i) instrumenting the right-hand variable with its lag (column 3-4) and (ii) using the lagged stocks as a right hand side variable (column 5-6).

Across all estimations in Table 9 and 10 the alternative measure of job openings yields the better fitting matching function. Specifically, comparing the adjusted R^2 values in the instrumented regression in column 3-4, we see that the fit is 55-70% higher in the latter column.

In spite of the differences in fit, the estimated coefficients in the matching function are not very different quantitatively. To see this compare column (1), (3), (5) with and (2), (4) and (6), respectively, in Table 9 and 10. In spite of this similarity, the two measures do however tell a somewhat different story about the recent development on the Swedish labor market. I adress this next.

4.3 Re-assessing the post-recession developments

In this section I reassess the apparent "break-down" in the Swedish matching function after the latest recession. It has been noted that the historical relationship between the job finding probability of unemployed workers, and tightness in the labor market appears to have changed in recent years (see e.g., Sveriges Riksbank (2012) and Haakanson (2014)). This is witnessed by (i) a lower job finding probability than what the historic relationship between the job finding probability and labor market tightness would imply (Figure 16) and (ii) an outward shift in the Beveridge curve (Figure 17). One interpretation consistent with this finding is that matching efficiency has declined.

If one instead observes the Swedish labor market through the lens of the alternative measure for job openings, the picture is somewhat different. In Figure 16, I show the actual and predicted job finding probability in Sweden, where the latter is estimated on the time series for job finding probabilities and labor market tightness up to 2008. The labor market tightness is computed using both the standard measure for job openings, the sum of all vacancies, and the alternative measure. The figure shows that the actual job finding rate during the recovery, 2010-2012, on average was 2 percentage points lower than what the historical relationship between job finding probabilities and labor market tightness (computed using the traditional measure for job openings) would suggest. However, when using the alternative measure for job openings the actual job finding probability is only 1.2 percentage points lower than predicted. Thus, using the alternative vacancy measure can account for approximately 40% of the post-recession breakdown in the relationship between hires and labor market tightness.

A similar picture is seen for the Beveridge curve. Figure 17-19 shows the Beveridge curve using both the traditional and alternative measure for job opening, respectively. For both measures there is an outward shift following 2008. However, when depicted using the alternative measure, the Beveridge curve after 2008 operates at a level closer to its 2006-07 level. From Figure 17-19 is it can also be seen that the level of vacancies is relatively lower in a historical context when using using the alternative measure. Indeed, unlike when using the traditional measure for job openings, the vacancy rate was higher during 2007-08 than during the recovery. Again the reason behind the less strong bounce back in the alternative measure for job openings is found in Figure 14 and 15: The number of vacancies rose during the recovery, but the number of plants with positive vacancies stayed below its previous peak and the average number of vacancies rose less in larger plants.

5 Conclusion

In modern macroeconomic models job openings are a key concept, and to measure these in data the literature relies on vacancy data. Such data is either obtained through surveys or register data. However, so far we know little about how job vacancies relate to actual hiring on the micro level. Insofar as job vacancies capture the concept of job openings well, we should expect to see a tight relationship between vacancies and subsequent hires.

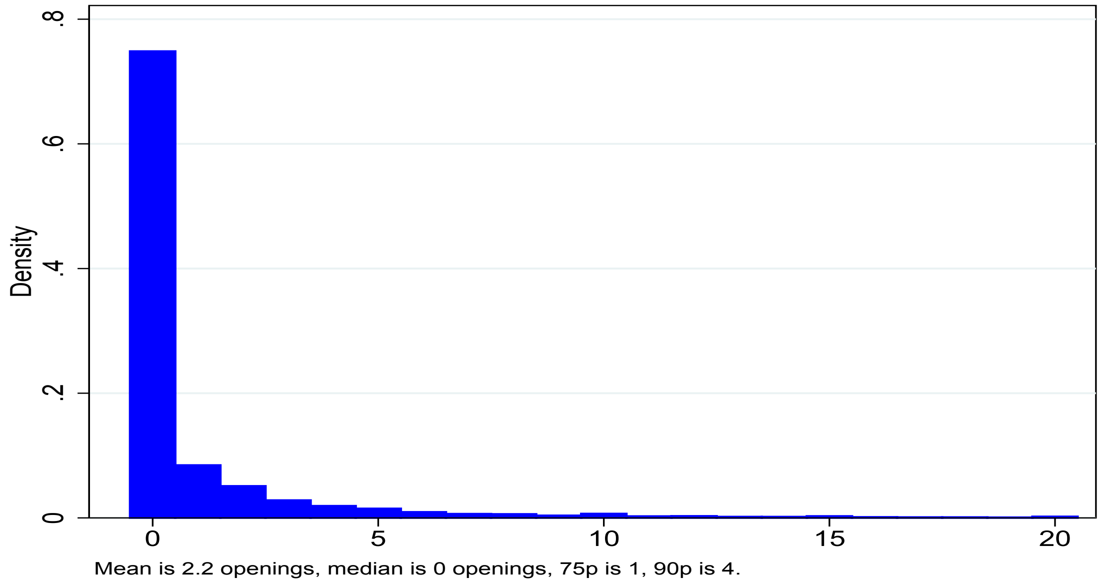
This paper is among the first to study this relationship on the plant level. Using a new Swedish data set, I show that the relationship between job vacancies and subsequent hires is weak and concave. That is, each additional vacancy on the plant level predicts less and less hiring. I also show that the number of hires per vacancy (the *vacancy yield*) varies in the cross-section of plants. In particular, I find it to be increasing in plant size.

One interpretation of these findings is that the traditional vacancy measure is a poor measure of actual job openings. Building on this interpretation, I construct an alternative measure for job openings. I use the *number of plants with a positive number of vacancies* *weighted by their size.* This measure is motivated by the concave relationship between vacancies and hires and the predictive power of plant size. I show that this measure both performs better in predicting hires on the micro level and yields a better fitting matching function on the aggregate level. This interpretation can partly explain why the job finding probabilities after the Great Recession were lower than what a matching function estimated on historical data predicts. Specifically, the predicted job finding probability during 2010-2012 is on average 0.8 percentage points lower than when using the traditional vacancy measure. This constitutes approximately 40% of the post Great Recession breakdown in the relationship between the job finding rate and labor market tightness.

More work is needed on how to best measure job openings in the economy. A substantial amount of hiring happens without preceding vacancies. This points to a reliability problem in our vacancy data. Understanding why hiring occurs without being registered in our vacancy measure would be a first step towards designing better measures of job openings.

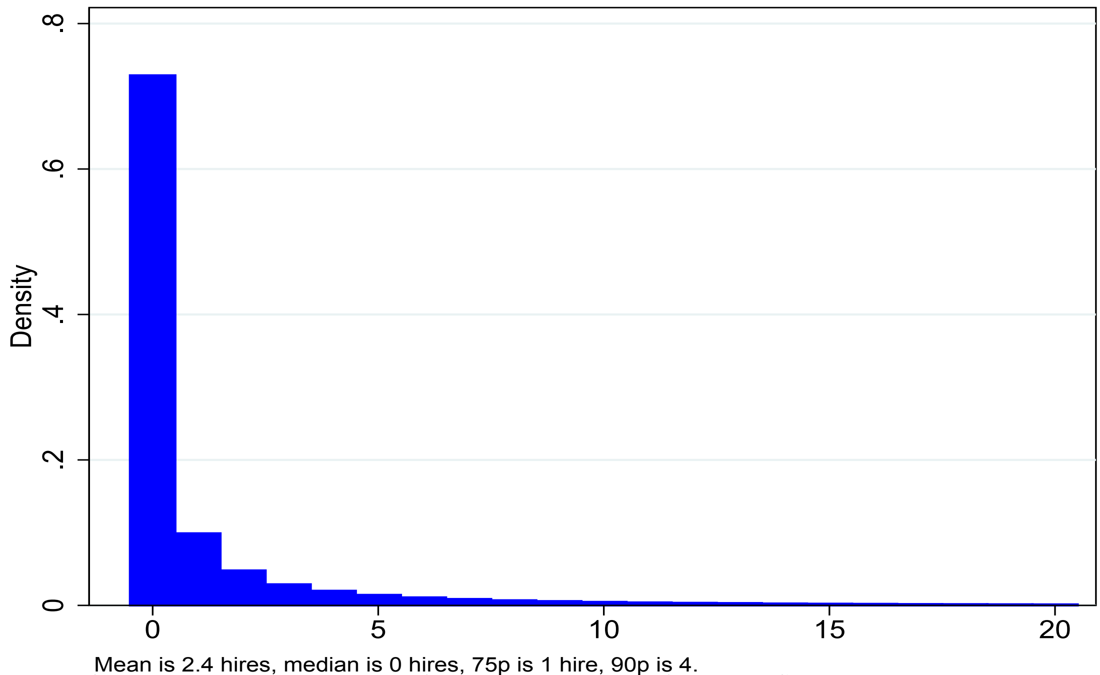
6 Figures

Figure 1: Distribution of vacancies at the plant level



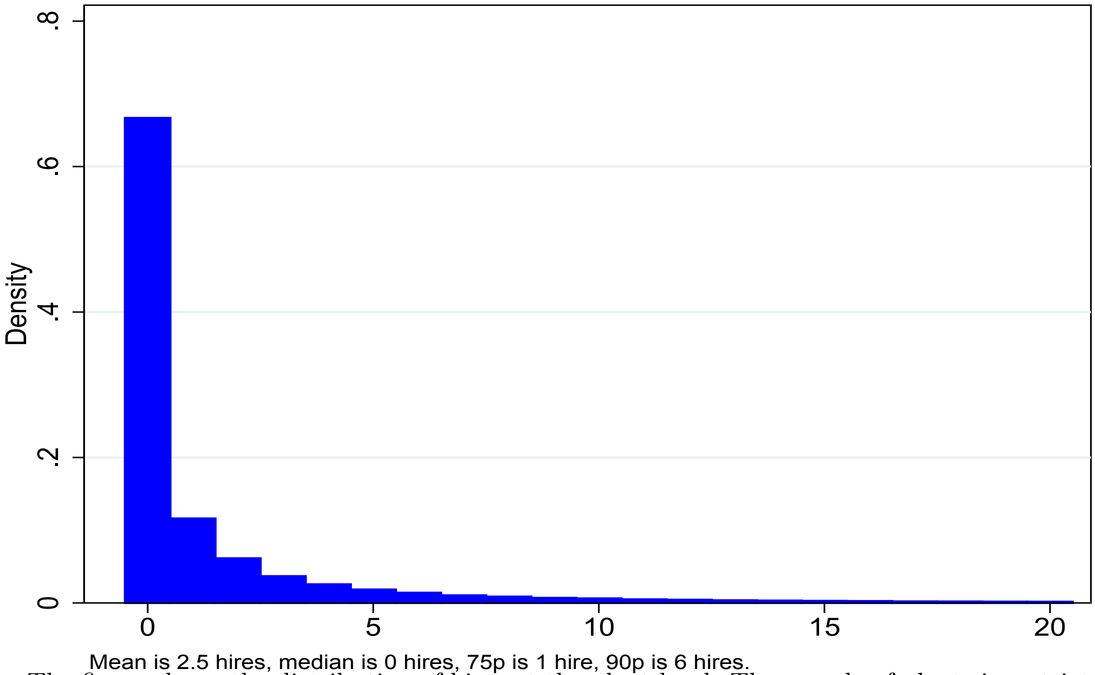
Notes: The figure shows the distribution of job openings in the *Job Vacancy Survey*.
Sources: Statistics Sweden.

Figure 2: Distribution of survey hires at the plant level



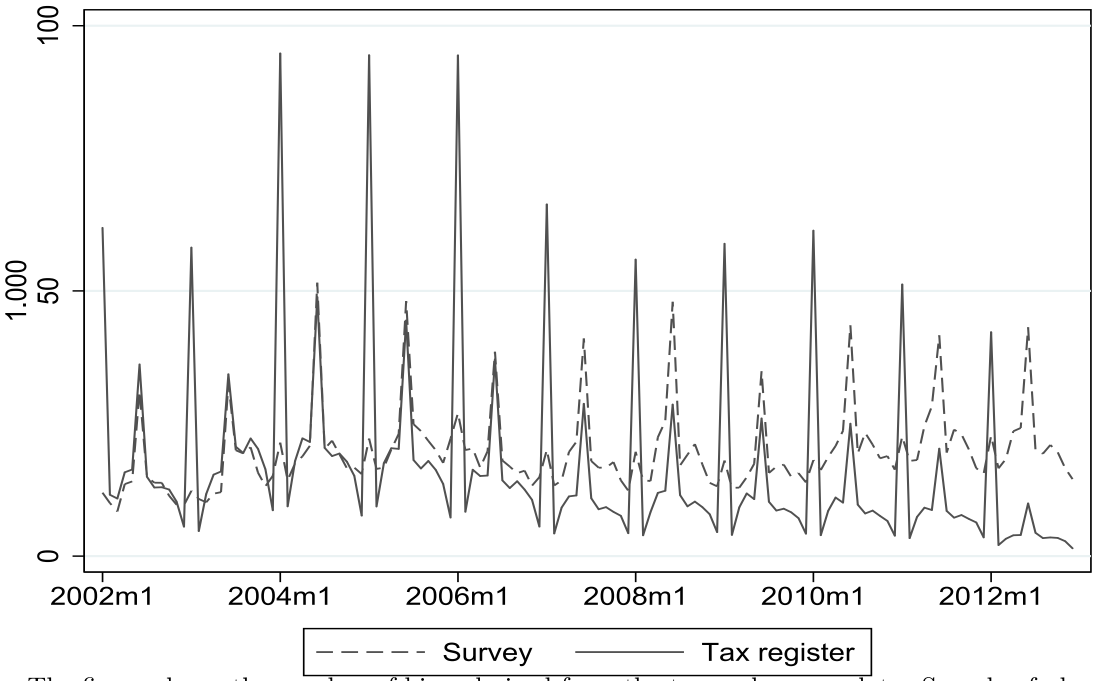
Notes: The figure shows the histogram of hires at plant level from the *Short-Term Employment Statistics*.
Sources: Statistics Sweden.

Figure 3: Distribution of hires at the plant level



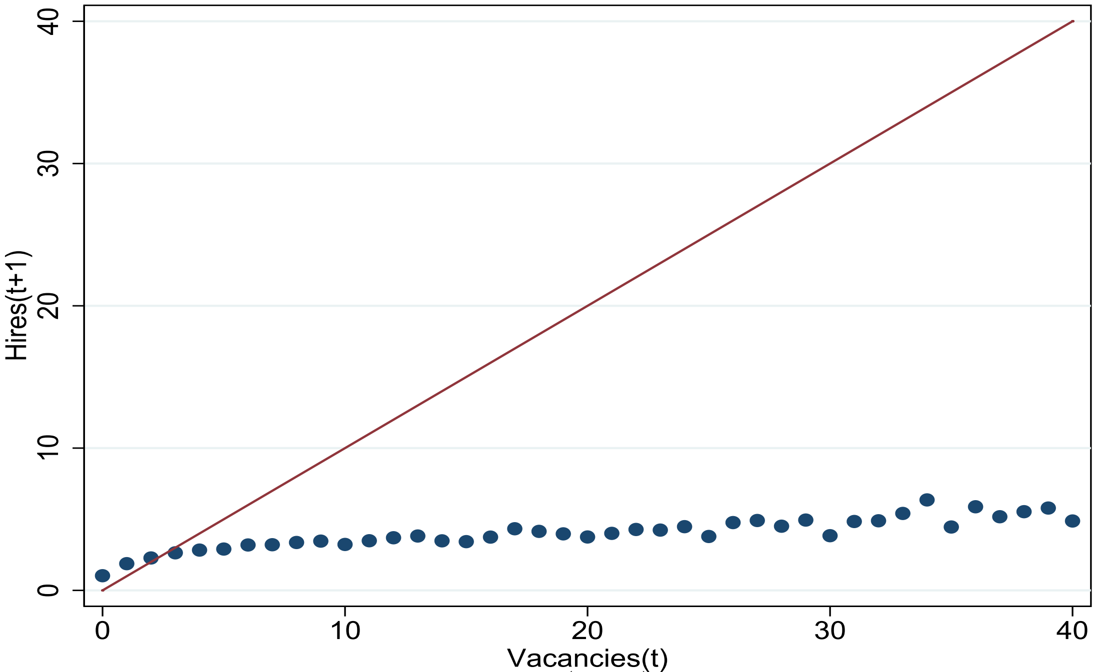
Notes: The figure shows the distribution of hires at the plant level. The sample of plants is restricted to those sampled in the *Short-Term Employment Statistics*.
Sources: Institute for Evaluation of Labour Market and Education Policy and Statistics Sweden.

Figure 4: Monthly hires in Sweden, tax and survey hires, 2002-2012



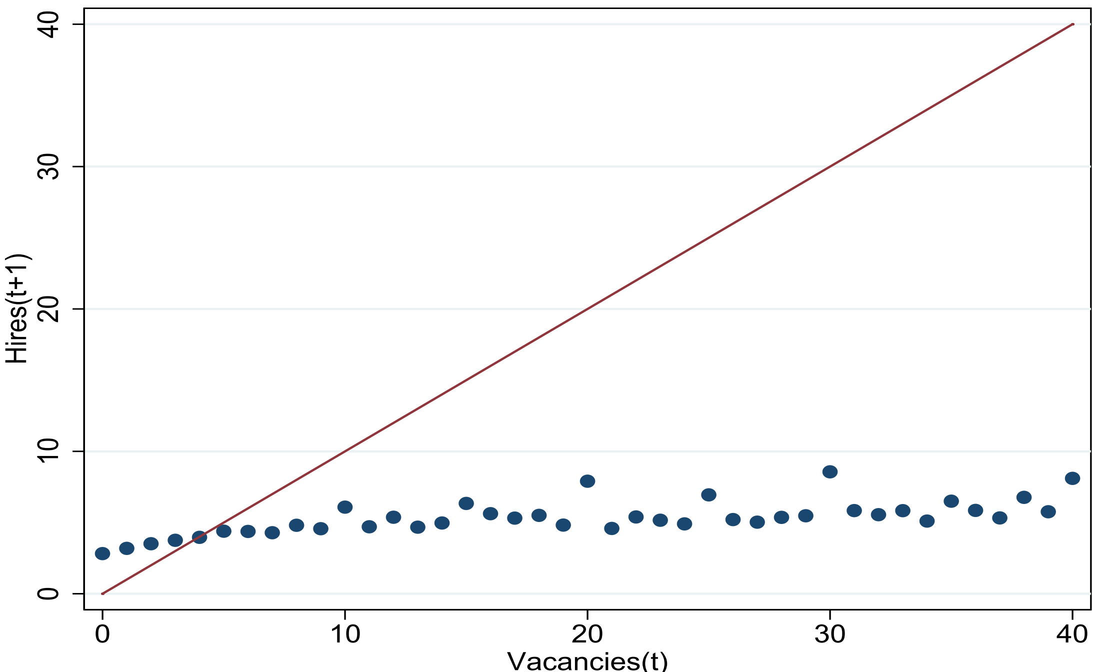
Notes: The figure shows the number of hires derived from the tax and survey data. Sample of plants is as in the *Short-Term Employment Statistics*.
Sources: Institute for Evaluation of Labour Market and Education Policy and Statistics Sweden.

Figure 5: Plant level relationship between vacancies and tax hires



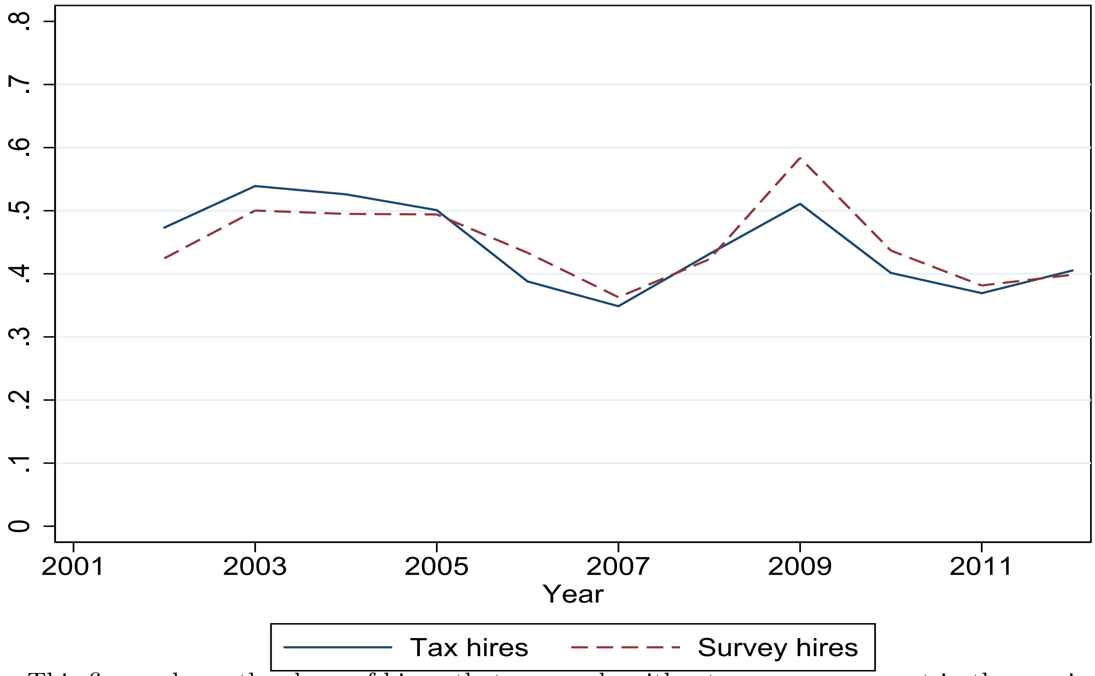
Notes: The figure shows the average number of hires (y-axis) for each number of vacancies in the previous month (x-axis). Period is 2001-2012. Hires are measured via tax data. The solid line denotes the 45-degree line.
Source: Own calculation on data from Statistics Sweden and IFAU.

Figure 6: Plant level relationship between vacancies and survey hires



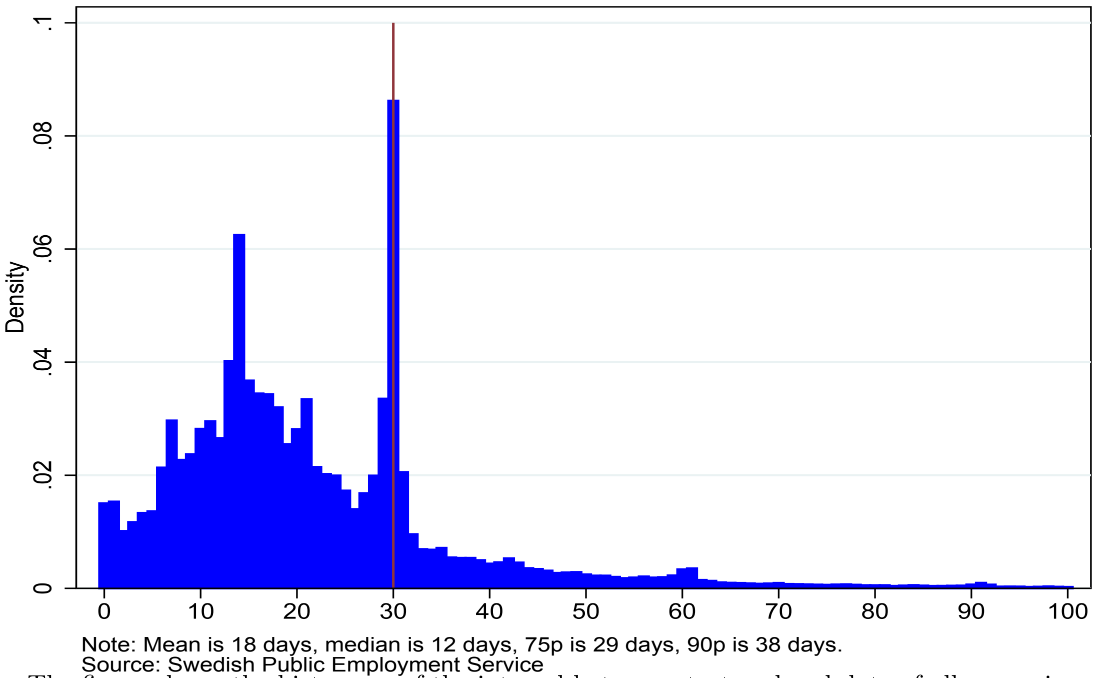
Notes: The figure shows the average number of hires (y-axis) for each number of vacancies in the previous month (x-axis). Period is 2001-2012. Hires are measured via survey data. The solid line denotes the 45-degree line.
Source: Own calculation on data from Statistics Sweden.

Figure 7: Share of hires without vacancies in the preceding month, 2002-2012



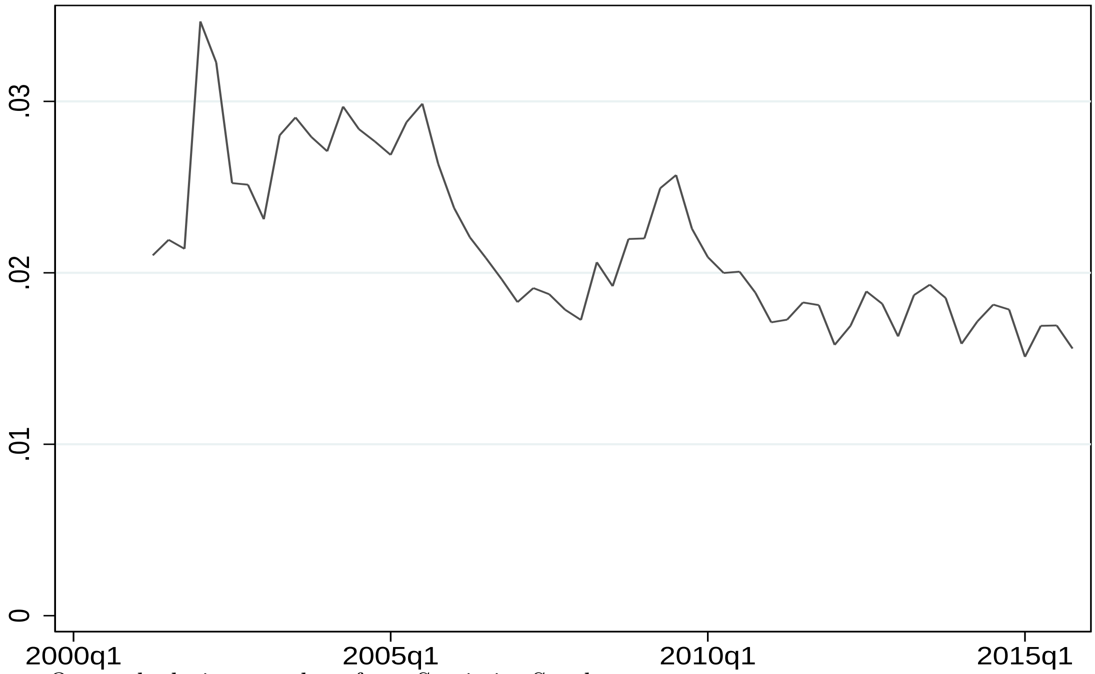
Notes: This figure shows the share of hires, that are made without a vacancy present in the previous month in the given plant. An average is computed for each year. The figure is done using both hires from tax and survey data.
Source: Own calculations on data from Statistics Sweden and IFAU.

Figure 8: Duration of vacancies at the Public Employment Service, 2001-2012



Notes: The figure shows the histogram of the interval between start and end date of all vacancies registered at the Public Employment Service during the period 2001-2013.
Source: The Swedish Public Employment Service.

Figure 9: Daily job-filling rates, 2001-2016

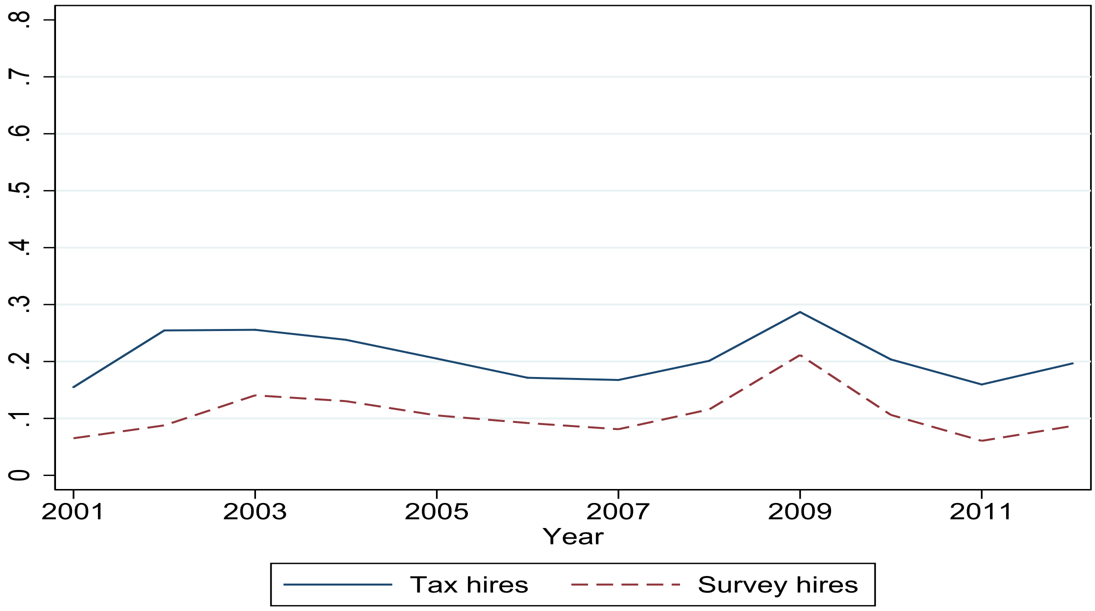


Sources: Own calculations on data from Statistics Sweden.

Figure 10: Monthly flow rates of new vacancies, 2001-2016

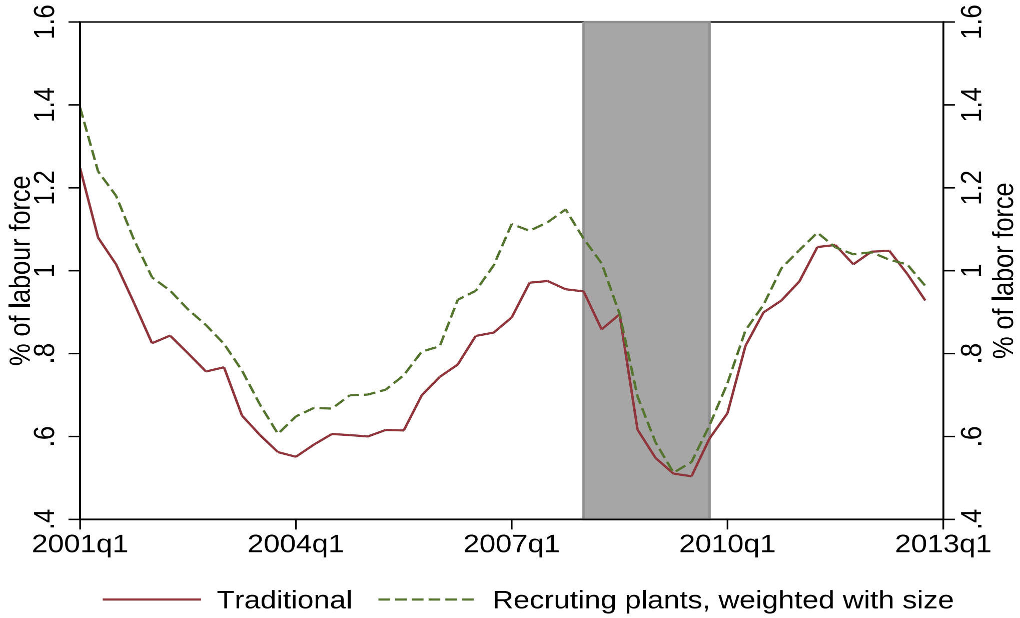
Sources: Own calculations on data from Statistics Sweden.

Figure 11: Share of hires without vacancies in the preceding month, 2001-2012, corrected for time aggregation



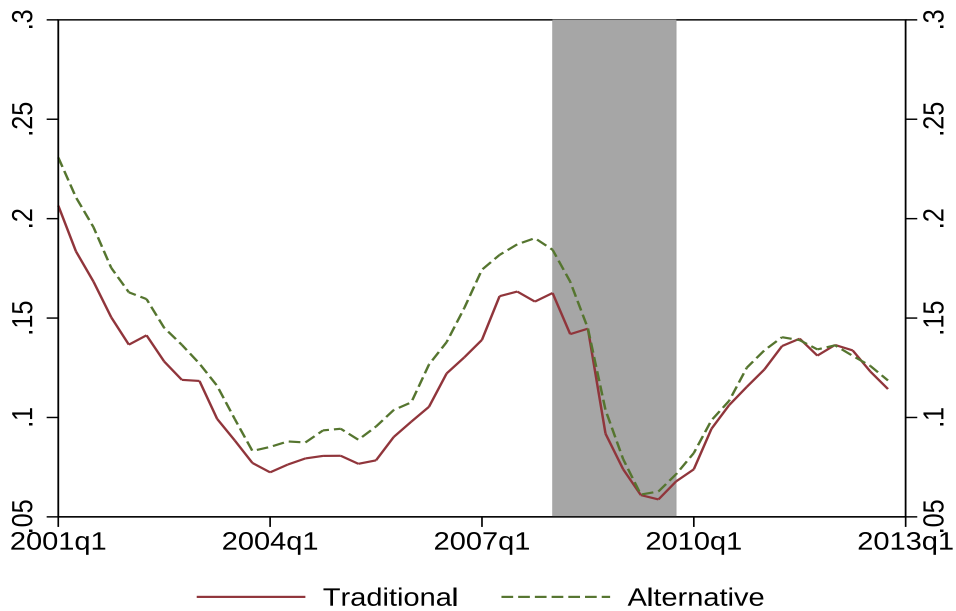
Notes: Figure depicts share of $h_{t,corrected}$ with $v_{t-1,ultimo}$ being above one, where $v_{t-1,ultimo}$ has been rounded to nearest integer.
Source: Own calculation on data from Statistics Sweden.

Figure 12: Job openings, traditional and alternative measure



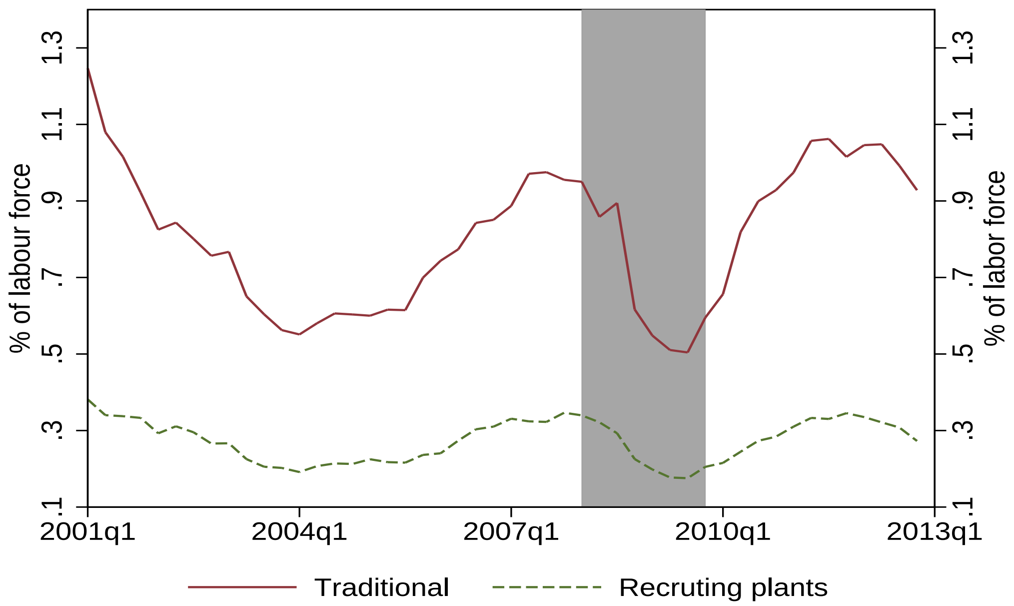
Notes: The figure shows job openings on the labor market measured via the traditional and alternative measure, respectively. The traditional measure uses vacancy as measure of job openings. The alternative uses the sum of plants with any vacancies weighted by number of employees. Data is seasonally adjusted. Shaded areas are the years with declining economic activity (2008-09)
Source: Own calculation on data from Statistics Sweden.

Figure 13: Labor market tightness, traditional and alternative job opening measure



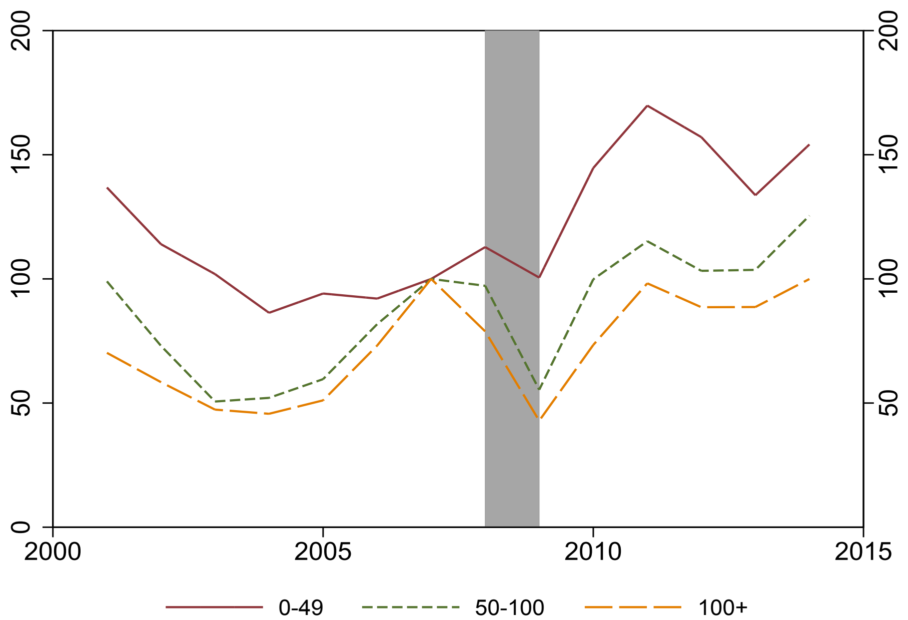
Notes: The figure shows labor market tightness defined as the stock of job openings divided by the stock of unemployed. The traditional measure uses vacancy as measure of job openings. Tthe alternative measure is the number of plants with a positive number of vacancies. In the lower panel it is the number of plants with a positive number of vacancies, weighted by employment shares. Shaded areas are the years with declining economic activity (2008-09).
Source: Own calculation on data from Statistics Sweden.

Figure 14: Job vacancies and number of plants with a positive number of vacancies



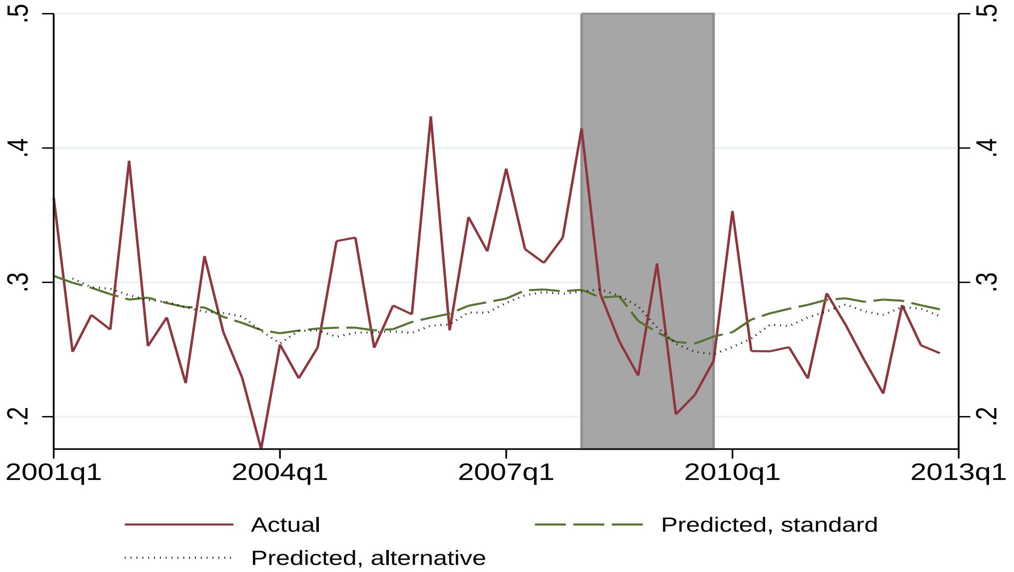
Notes: The figure shows the number of job vacancies as measured in the survey as well as the number of plants with a positive number of vacancies. Shaded areas are the years with declining economic activity (2008-09).
Source: Own calculation on data from Statistics Sweden.

Figure 15: Average number of vacancies across plant sizes, 2007=100



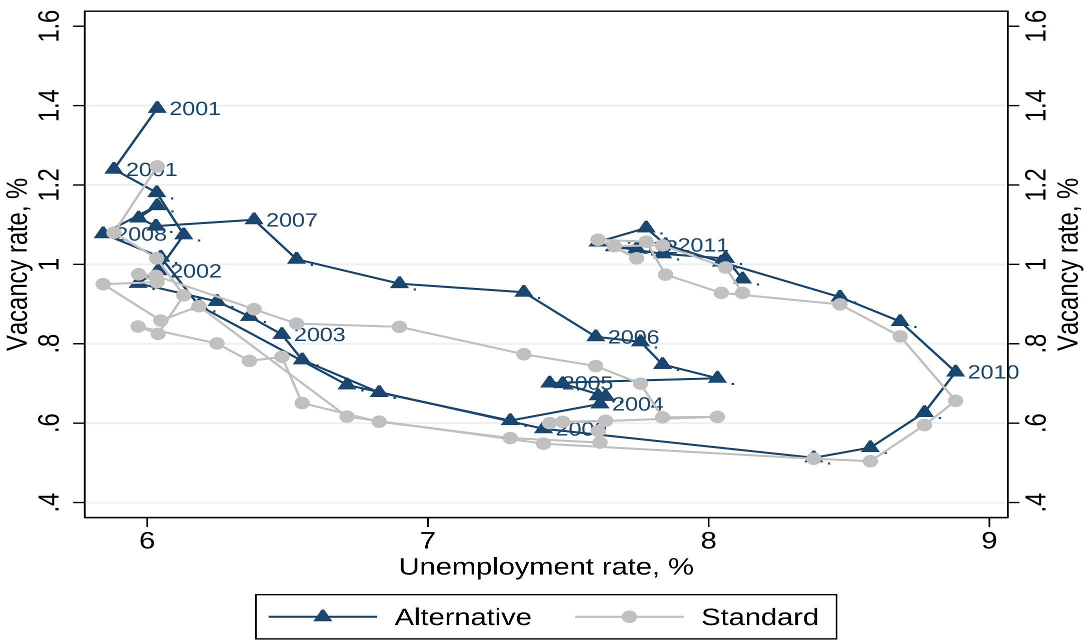
Notes: The figure shows the development in the average number of job openings, as measured in the survey, across the plant size. Shaded areas are the years with declining economic activity (2008-09).
Source: Own calculation on data from Statistics Sweden.

Figure 16: Actual and predicted job finding rate, estimated using traditional and alternative measure for job opening



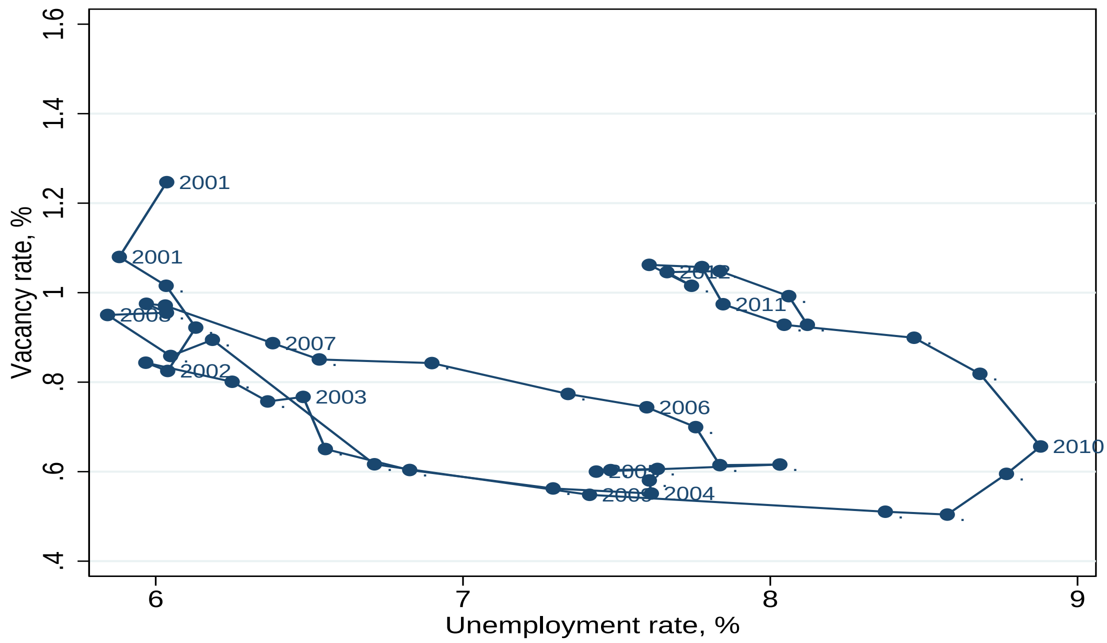
Notes: Figure shows the actual and predicted monthly job finding rate estimated via the traditional and alternative measure for job openings as input into the estimated matching function (Table 9, column 2-3). The matching function is estimated using on data up to the beginning of 2008. Shaded areas are the years with declining economic activity (2008-09).
Source: Own calculation on data from Statistics Sweden.

Figure 17: Beveridge curves



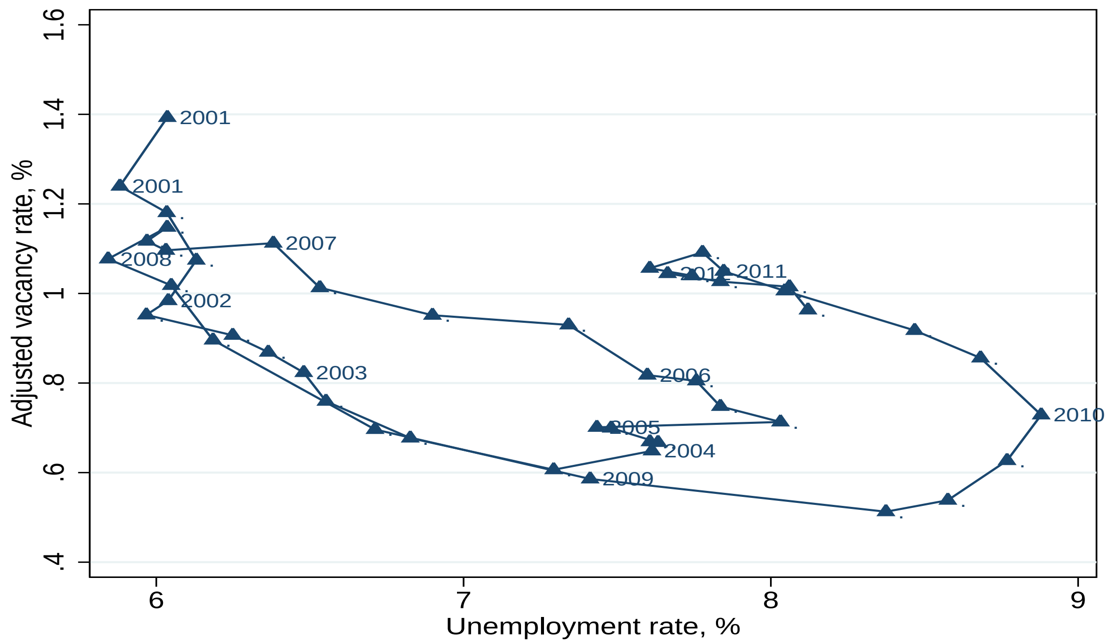
Notes: "Standard" shows the Beveridge curve drawn using the standard vacancy measure for job openings. "Alternative" shows the Beveridge curve drawn when using the number of plants with a positive number of vacancies weighted by their share of employment.
Source: Own calculation on data from Statistics Sweden.

Figure 18: Beveridge curve, traditional measure for job openings



Notes: Figure shows the Beveridge curve drawn using the standard vacancy measure for job openings.
Source: Own calculation on data from Statistics Sweden.

Figure 19: Beveridge curve, alternative measure for job openings



Notes: Figure shows the Beveridge curve drawn when using the number of plants with a positive number of vacancies weighted by their share of employment.
Source: Own calculation on data from Statistics Sweden.

7 Tables

Table 1: Background variables

Variable	Mean	Standard deviation	Min	Max	N
		Hires from survey data			
Employees	464.5	1,663	0	56,849	505,509
Turnover	3,467,440.5	9,700,977.7	-85,520	107,805,024	367,647
Valueadded	974,752.9	2,659,080	-12,151,558	39,204,988	367,647
		Hires from tax data			
Employees	5.4	2.9	1	10	1,014,332
Turnover	1,975,353.8	7,151,197	-85,520	107,805,024	846,167
Valueadded	539,580	1,933,399.6	-12,151,558	39,204,988	846,167

Notes: The sample is plants with hires availiable in period $t+1$, where period t is a period where a measure of survey vacancies is available for the given plant.
Source: Statistics Sweden and IFAU.

Table 2: Data selection

	Tax hires	Survey hires
All	1,006,525	428,016
- Non zero observations	121,836	119,331
With all background variables	770,481	334,926
- Non zero observations	86,009	100,806

Notes: The table shows the number of observations for each data selection using tax- and survey-hires, respectively. Vacancies are matched with hires in next month. Non zero observations counts the number of observations in the given data selection where both hires and vacancies are non-zero. *Source:* Statistics Sweden and IFAU.

Table 3: Average hiring rates, vacancy rates and vacancy yields, 2001-2013

Tax hires			
	Hiring rate (%)	**Vacancy rate** (%)	**Vacancy yield** (#)
By industry			
Farming, fishery, and mining	3.90	2.01	1.03
Manufacturing	1.86	0.97	1.80
Energy	1.44	1.35	0.73
Construction	1.72	1.49	0.65
Trade, hotel, and restaurants	3.42	1.45	1.57
Transportation and communication	1.89	1.52	1.11
Finance and business service	2.85	1.92	1.11
Public and personal services	3.41	1.84	1.52
Total	2.70	1.55	1.44
By number of employees (deciles)			
1	4.50	2.37	0.09
2	3.28	2.03	0.12
3	3.24	1.75	0.18
4	2.96	1.79	0.27
5	2.81	1.75	0.47
6	2.72	1.40	0.77
7	2.29	1.14	1.09
8	1.85	1.11	1.35
9	1.71	1.11	1.82
10	1.37	0.94	2.34
Total	2.70	1.55	1.44
By turnover (deciles)			
1	1.79	1.45	1.23
2	2.24	1.55	0.31
3	3.11	1.80	0.12
4	3.27	2.14	0.15
5	3.81	1.93	0.31
6	3.95	1.88	0.31
7	3.94	1.82	0.43
8	3.20	1.50	0.64
9	3.13	2.15	1.34
10	2.01	1.20	1.62
Total	2.59	1.51	1.43

Notes: The hiring rate is the fraction of hires to the plant size. The vacancy rate is the average fraction of vacancies to plant size. The vacancy yield is the average number of hires per vacancy. All rates and yields are computed on the plant level. Public sector has been dropped in tabulation by turnover.
Source: Own calculations from Statistics Sweden

Table 4: Average hiring rates, vacancy rates and vacancy yields, 2001-2013

Survey hires			
	Hiring rate (%)	**Vacancy rate** (%)	**Vacancy yield** (#)
By industry			
Farming, fisher, and mining	4.26	2.01	3.65
Manufacturing	1.68	0.97	2.19
Energy	1.68	1.35	1.38
Construction	1.78	1.49	3.53
Trade, hotel, and restaurants	2.94	1.45	2.50
Transportation and communication	2.44	1.52	1.92
Finance and business service	5.75	1.92	2.58
Public and personal services	1.95	1.84	1.45
Total	2.68	1.55	2.08
By number of employees (deciles)			
1	20.14	2.37	0.24
2	11.73	2.03	1.30
3	5.89	1.75	0.32
4	3.49	1.79	0.38
5	3.76	1.75	0.71
6	2.62	1.40	1.01
7	2.34	1.14	1.33
8	2.24	1.11	1.72
9	2.22	1.11	2.38
10	1.44	0.94	2.56
Total	2.68	1.55	2.08
By turnover (deciles)			
1	2.22	1.45	2.02
2	2.91	1.55	2.38
3	2.62	1.80	0.65
4	2.75	2.14	0.36
5	3.21	1.93	0.85
6	5.00	1.88	0.88
7	4.92	1.82	1.85
8	17.72	1.50	2.43
9	8.74	2.15	2.79
10	2.23	1.20	2.55
Total	3.04	1.51	2.54

Notes: The hiring rate is the fraction of hires to the plant size. The vacancy rate is the average fraction of vacancies to plant size. The vacancy yield is the average number of hires per vacancy. All rates and yields are computed on the plant level. Public sector has been dropped in tabulation by turnover.
Source: Own calculations from Statistics Sweden

Table 5: Distribution of vacancies across subsequent hiring, percent

	Survey hires	Tax hires
Hiring in month t+0	50.5	53.0
Hiring in month t+1	51.1	53.3
Hiring in month t+2	50.5	51.5
No hiring in month $[t, t+2]$	43.9	37.1

Notes: The table shows the distribution of vacancies across hiring in subsequent months. *E.g.* for 50.5% of all vacancies there is at least one (survey) hire made in the same period as the vacancy is present.
Source: Own calculations on data from Statistics Sweden.

Table 6: Plant level hiring regression, ordinary least squares, 2001-2012

	(1) Log(Hires)	(2) Log(Hires)	(3) Log(Hires)	(4) Log(Hires)	(5) Log(Hires)
			A. Tax hires		
Log(Vacancies)	0.32***	0.09***	0.08***	0.03***	0.03**
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Log(Plant size)		0.40***	0.40***	0.50***	0.52***
		(0.01)	(0.01)	(0.02)	(0.02)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	Yes	Yes	Yes
Value-added dummies	No	No	No	Yes	Yes
Turnover dummies	No	No	No	No	Yes
Observations	121836	121836	121836	86009	86009
Adjusted R^2	0.24	0.36	0.37	0.39	0.40
			B. Survey hires		
Log(Vacancies)	0.34***	0.17***	0.15***	0.15***	0.15***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Log(Plant size)		0.56***	0.58***	0.62***	0.63***
		(0.02)	(0.02)	(0.02)	(0.02)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	Yes	Yes	Yes
Value-added dummies	No	No	No	Yes	Yes
Turnover dummies	No	No	No	No	Yes
Observations	119331	119331	119331	100806	100806
Adjusted R^2	0.14	0.28	0.30	0.32	0.33

Notes: Standard errors clustered on firm level. * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Log(hires) are leaded one period vis-à-vis log(Vacancies).
Source: Own calculations on data from Statistics Sweden.

Table 7: Plant level hiring regression, non-linear least squares, 2001-2012

	(1) Log(Hires)	(2) Log(Hires)	(3) Log(Hires)
A. Tax hires			
Vacancies	0.21***	0.04***	0.04***
	(0.00)	(0.00)	(0.00)
Plant size		0.25***	0.25***
		(0.00)	(0.00)
Time fixed effects	Yes	Yes	Yes
Industry dummies	No	No	Yes
Observations	307009	307009	307009
Adjusted R^2	0.28	0.30	0.30
B. Survey hires			
Vacancies	0.22***	0.08***	0.07***
	(0.00)	(0.00)	(0.00)
Plant size		0.32***	0.34***
		(0.00)	(0.00)
Time fixed effects	Yes	Yes	Yes
Industry dummies	No	No	Yes
Observations	242940	242940	242940
Adjusted R^2	0.34	0.37	0.37

Notes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Log(hires) are leaded one period vis-à-vis log(Vacancies)
Source: Own calculations from Statistics Sweden

Table 8: Average job filling and vacancy creation rates, across industries, 2001-2012

	Daily job-filling rate (%)	Monthly vacancy flow rate (% of employment)
Farming, fishery, and mining	6.35	1.96
Manufacturing	2.05	3.94
Energy	3.18	3.01
Construction	2.23	1.02
Trade, hotels, and restaurants	1.93	0.45
Transportation, mail, and telecom	0.79	0.75
Finance and business service	0.97	0.79
Public and personal services	0.85	0.42
Total	2.13	0.81

Notes: Calculated using unweighted micro data on hires and vacancies. Total is computed using published data on hires and vacancies.

Source: Own calculations on data from Statistics Sweden

Table 9: Estimated matching function, non-seasonally adjusted data

	(1) Log(jfr)	(2) Log(jfr)	(3) Log(jfr)	(4) Log(jfr)	(5) Log(jfr)	(6) Log(jfr)
$\log(v/u)$	0.23**		0.11			
	(0.08)		(0.09)			
$\log(v^a/u)$		0.25**		0.18**		
		(0.08)		(0.09)		
$\log(v/u)(t-1)$					0.09	
					(0.08)	
$\log(v^a/u)(t-1)$						0.15*
						(0.08)
Observations	48	48	47	47	47	47
Adjusted R^2	0.134	0.170	0.076	0.129	0.004	0.052
Seasonal adjusted	Yes	Yes	Yes	Yes	Yes	Yes
Estimation method	OLS	OLS	IV	IV	OLS	OLS

Notes: v^a is the number of plants with a positive number of vacancies, weighted by employment share. Robust standard errors reported in parenthesis. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Quarterly data for 2001Q1 to 2012Q2. In column 3-4 the RHS variable is instrumented with its own lag.
Source: Own calculations from Statistics Sweden

Table 10: Estimated matching function, seasonally adjusted data

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(jfr)	Log(jfr)	Log(jfr)	Log(jfr)	Log(jfr)	Log(jfr)
$\log(v/u)$	0.18***		0.14***			
	(0.05)		(0.05)			
$\log(v^a/u)$		0.21***		0.18***		
		(0.05)		(0.05)		
$\log(v/u)(t-1)$					0.13**	
					(0.05)	
$\log(v^a/u)(t-1)$						0.16***
						(0.05)
Observations	48	48	47	47	47	47
Adjusted R^2	0.170	0.257	0.164	0.257	0.070	0.136
Seasonal adjusted	Yes	Yes	Yes	Yes	Yes	Yes
Instrumented stocks	No	No	Yes	Yes	No	No

Notes: v^a is the number of plants with a positive number of vacancies, weighted by employment share. Robust standard errors reported in parenthesis. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Quarterly data for 2001Q1 to 2012Q2. In column 3-4 the RHS variable is instrumented with its own lag.
Source: Own calculations from Statistics Sweden

Bibliography

Albaeck, K. and H. Hansen (2004). The Rise in Danish Unemployment: Reallocation or Mismatch? *Oxford Bulletin of Economics and Statistics 4*.

Barron, J. M., M. C. Berger, and D. A. Black (1997). Employer Search, Training, and Vacancy Duration. *Economic Inquiry 35*(1), 167–192.

Berman, E. (1997). Help Wanted, Job Needed: Estimates of a Matching Function from Employment Service Data. *Journal of Labor Economics 15*(1).

Blanchard, O. and P. Diamond (1990). The Cyclical Behavior of the Gross Flows of U.S. Workers. *Brookings Papers on Economic Activity 2*.

Burdett, K. and E. J. Cunningham (1998). Toward a Theory of Vacancies. *Journal of Labor Economics 16*(3), 445–478.

Cahuc, P. and O. I. S. Fontaine (2009). On the Efficiency of Job Search with Social Networks. *Journal of Public Economic Theory 11*(3), 411–439.

Davis, S., R. J. Faberman, and J. Haltiwanger (2013). The Establishment-Level Behavior of Vacancies and Hiring. *The Quarterly Journal of Economics 90*, 581–622.

Elsby, M. W. L., R. Michaels, and D. Ratner (2015). The Beveridge Curve: A Survey. *Journal of Economic Literature 53*(3), 571–630.

Feve, P. and F. Langot (1996, sep). Unemployment and the Business Cycle in a Small Open Economy: G.M.M. Estimation and Testing with French Data. *Journal of Economic Dynamics and Control 20*(9-10), 1609–1639.

Gross, D. M. (1997). Aggregate Job Matching and Returns to Scale in Germany. *56*(April 1996), 243–248.

Haakanson, C. (2014). A Divided Labour Market – on Matching on the Swedish Labour Market after the Economic Crisis. *Sveriges Riksbank Economic Review* (2), 52–70.

Hall, R. E. and S. Schulhofer-Wohl (2015). Measuring Job-Finding Rates and Matching Efficiency with Heterogeneous Jobseekers. *National Bureau of Economic Research Working Paper Series 20939*.

Hobijn, B. and A. Sahin (2012). Beveridge Curve Shifts across Countries since the Great Recession. *Federal Reserve Bank of San Francisco Working Paper 2012-24*.

Holzer, H. (1990). Job Vacancy Rates in the Firm: An Empirical Analysis. *NBER Working Paper 3524*.

Kroft, K., F. Lange, and L. F. Katz (2016). Long-Term Unemployment and the Great Recession: The Role of Composition, Duration Dependence, and Non-Participation. *Journal of Labor Economics*.

Ours, J. V. and G. Ridder (1991). Cyclical Variation in Vacancy Durations and Vacancy Flows: An Empirical Analysis. *European Economic Review 35*, 1143–1155.

Petrongolo, B. and C. A. Pissarides (2001). Looking into the Black Box : A Survey of the Matching Function. *Journal of Economic Literature XXXIX* (June), 390–431.

Pissarides, C. (2000). *Equilibrium Unemployment Theory*. Cambridge, MA: MIT Press.

Sunde, U. (2007). Empirical Matching Functions: Searchers, Vacancies and (Un-)biased Elasticities. *Economica 74* (295), 537–560.

Sveriges Riksbank (2012). *Monetary Policy Report October 2012*. Number October.

Yashiv, E. (2000). The Determinants of Equilibrium Unemployment. *The American Economic Review 90*, 1297–1321.