Mis-Measuring Job Openings: Evidence from Swedish Plant Level Data*

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Abstract

In the textbook search and matching model job openings are a key component. Thus, when taking this model 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, that 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 construct a new dataset with hires and job vacancies on the plant level for Sweden covering the period 2001-2012. I show that vacancies contain little power in predicting hires above (i) whether the number of vacancies is positive and (ii) plant size. Building on these findings, I propose an alternative measure of job openings in the economy. This measure has the attractive feature of providing a better fitting matching function *vis-a-vis* the traditional vacancy measure. Using the new measure, it is less clear that the Beveridge curve has shifted outwards in the aftermath the Great Recession.

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1 Introduction

The outward shift of the Beveridge curve in a number of OECD countries after the Great Recession constitutes a puzzle. In this paper, I argue that measurement problems can be part of the story in Sweden. Using a novel dataset, I show that vacancies are poorly related to subsequent hiring on the plant-level. Moreover, I show that the fit of the relationship can improved by accounting for plant size and the distribution of vacancies. Informed by this, I construct a new measure for job openings in the aggregate. According to this new measure, the shift in the Beveridge curve after the Great Reccesion is less clear.

Job openings are a key component in labor market analysis within the search-matching framework. On the micro level a hire is made when a job-opening and an unemployed worker are matched, and exogenous shocks to the model propagate via their impact on firms' job-posting behavior.

Thus, to take the search-matching model to the data we require a mapping from the theoretical concept of a job-opening to an empirical counterpart. To achieve this, the literature relies on data for job vacancies. Either via survey data, where the sampled companies are asked to report how many jobs they currently are trying to fill, or via register data on job vacancies made in newspapers or public employment centers. Evaluating the model using such data shows that the model is able to reproduce some key features of the data - at least qualitatively. [1] Little is however known about the relationship between vacancies and hires on the plant level. Insofar that the our empirical measures for vacancies capture job-openings well, we should expect to see a tight relationship between vacancies and subsequent hiring on the plant level.

To assess this, I construct a new dataset with vacancies and hires on the plant level. Specifically, I construct a database with monthly hires and vacancies on the plant level in Sweden during the period 2001-2012. Data on hires is constructed using both data from Swedish tax-records and survey data from Statistics Sweden. Data on vacancies is compiled using survey data from Statistics Sweden and register data on vacancies from the Swedish Public Employment Service (PES).

Using this data, I investigate the relationship between vacancies and hires on the plant level. First, I show that the relationship between vacancies and hires on the plant level is weak and concave in contrast to linear as predicted by the standard model. That is, additional vacancies predicts less and less hiring. Second, I show that the fit of the hiring regression on the plant level can be improved by aprox. 40 % by allowing plants' willingness to hire to depend not only on listed vacancies but also on plant size.

Building on these findings, I propose an alternative measure for the aggregate number of

[1] There is however debate about whether the model is account quantitatively for the variations seen in the data. Specifically,Shimer (2005) has however argued that the textbook model is unable to account for the observed business cycle fluctuations in unemployment and vacancies.

job openings in economy. Motivated by the concave relationship between vacancies and hires, 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 job openings in the economy. I show, that this measure has the appealing feature of providing a better fitting aggregate matching function.

This alternative measure also provides a new perspective on the apparent outward shift in the Swedish Beveridge curve following the Great Recession. In the wake of the Great Recession Sweden, like other OECD countries, saw an outward shift in the Beveridge Curve. One interpretation of this shift is that matching quality has declined. Another interpretation is that the traditional vacancy measure has become a less good measure for aggregate job-openings. Indeed, using the alternative measure the shift in the Swedish Beveridge curve after the Great Recession becomes less clear.

Finally, I also provide some new evidence on the relationship between two often used empirical measures of job-openings: (i) survey data compiled by statistical agencies and (ii) register data on vacancies registered in databases maintained by public job-centers. The former type is preferable, as this avoids the selection problems that can be present in the latter data, as not all companies rely on public job-centers as their recruitment source. Due to limited availability of a survey based measure data from public job-centers are still often used as proxy, (Berman, 1997; Carlsson et al., 2013; Albaeck and Hansen, 2004; Wall and Zoega, 2002; Yashiv, 2000). However, there are two obvious concerns with the latter measure. First, postings at the job-centers may not be representative for all job-openings in the economy. Second, the propensity of firms to use the job-centers as a recruitment channel may vary over time. Not accounting for these problems may lead to spurious conclusions about matching efficiency on the labor market. Although these concerns are well-known the size of the problem has not previously been documented on the firm level. I show that the relationship between openings registered at the Swedish Public Employment Service (PES) and vacancies reported in the survey is weak on the firm level. Not surprisingly 47 % percent of the vacancies reported in the survey do not have a counterpart in the PES. More surprisingly is, however, that 37 % of all vacancies reported in the PES do not have a counterpart in the survey. Across firms there is also substantial heterogeneity in the use of PES opening, with the public sector and firm in the middle of the turnover and valueadded distribution having the largest share of PES to survey openings. During 2004-2012 the aggregate share of PES openings to survey openings in the sample varies in the interval 28-47 %.

My study relates to a number of papers in the literature. Closest is the paper by Davis et al. (2013) who analyze the relationship between hires and a survey based measure of vacancies (JOLTS) on the plant level in the US. They find that changes in the recruitment intensity of firms partly explains the recent breakdown in the standard matching function. Previously a vast

literature has related the aggregate number of job-openings, unemployed and hires through the canonical search matching model *e.g.* Blanchard and Diamond (1990). Especially relevant here are papers using job-openings from centralized registers (Coles et al., 1996; Albaeck and Hansen, 2004; Yashiv, 2000; Sunde, 2007). Also related is the literature that analyzes the determinants of job-opening durations (Ours and Ridder, 1991; Burdett and Cunningham, 1998; Barron et al., 1997; Holzer, 1990). This paper adds to this literature in a number of ways. First, it finds evidence that the number of plants with a positive number of vacancies, weighted by size, provides a better measure of job-openings on both the micro and macro level. Second, no paper has previously provided evidence on the relationship between the survey based vacancy measure and the measure based on register data from the PES. Third, it is the first paper to analyze the relationship between vacancies and hires on the plant level outside the US.

The paper proceeds as follows. In section 2, I describe the data sources and how the database is constructed. In section 3, I document the relationship between vacancies and hires on the plant level. However, to analyze this relationship properly one has to take the issue of time-aggregation into account. I do this in section 4, and show that this does not overturn the basic findings. In Section 5, I build on my findings from the previous two sections and propose a new measure of aggregate job-openings in the economy. In Section 6, I document the relationship between the survey and register based measure of vacancies on the firm level. Section 7 concludes.

2 Data

2.1 Job vacancies

For micro-data on job-vacancies I draw on two data sources: the Swedish Job Vacancy Survey and the database from the Swedish Public Employment Service (PES).

The Swedish Job Vacancy Survey is administered by Statistics Sweden and has been collected on a quarterly basis since 2001. In the survey a vacancy is defined as "a position which has been made available for external job-seekers via the newspapers, internet or another media". The survey further contains information on how many of the open positions that are currently manned and unmanned, respectively, and how many of the positions that are available immediately. The respondents are asked to report the number of vacancies medio of the reference month.[2] For the private sector the sampling is done on the establishment level with approx. 16 700 work places sampled each period. For the public sector the sampling was also done on the work places 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

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

are asked to do the reporting for each month of the relevant quarter, whereas units with less than 100 employees only are asked to report in the reference month. Reporting takes place either via letter or online. Non-respondents are reminded via email, letter or a phone call. Until 2004 reporting was voluntary and the share of non-reporting units was 20 % (40 %) in the private (public) 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 database for vacancies administered by the Swedish Public Employment Service (PES) is the other source for job-openings. The PES maintains a database containing the universe of job-postings made at the agency since 2001. Specifically, the database contains a row for each posting made at the agency with information on the start and end date of the posting along with information on the number of workers the firm is searching for and information on job and firm type. In principle the database contains data on both the firm and plant level. However, for the majority of the observations plant identifiers are missing, why the database in practice only contains useful information on the firm level. To make the PES data comparable with the survey data, I compute the number of open positions at the PES medio each month.

The aggregate number for the two types of job openings is reported in Figure 2. As expected the the level of vacancies in the survey are consistently above the level of vacancies reported at the PES, and the share of PES to survey vacancies varies in the range 30-50 %.

2.2 Hires

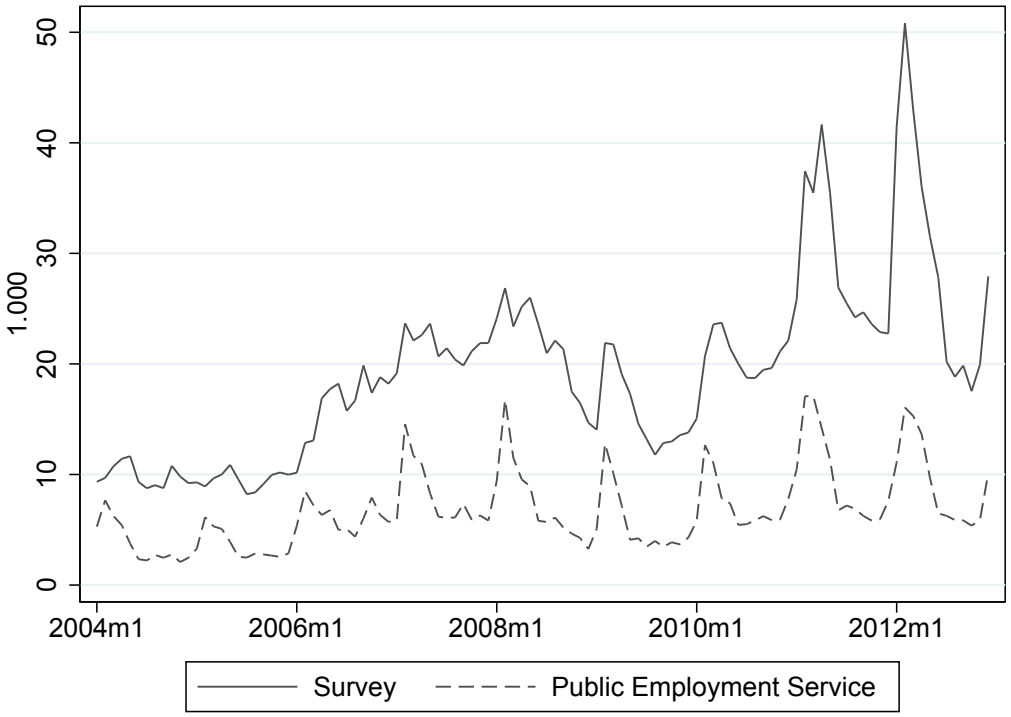
For hires I also have access to two data sources: a survey based measure from Statistics Sweden and a register based measure from the Swedish tax registry.

The survey based measure of hires stems from the *Short-term employment statistics* (Kortperiodisk sysselsätningsstatistik) as 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 and firms. This survey contains the number new hires as well as the number of workers currently employed at each plant.

The second measure for hires is register based and stems from the Swedish tax authorities. Specifically, IFAU[3] 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 establishment. From this data I compute the number of monthly hires as the number of spells that starts in an establishment in a given month. To discard repeated, or interrupted, spells I remove all spells where the individual has been employed in the last 12 months. Moreover, I restrict the sample to the establishments also available in survey based measure of hires in the given month.

[3]Institute for Evaluation of Labour Market and Education Policy

Figure 1: Monthly job openings in Sweden, 2004-2012



Notes: The figure shows the aggregate number of job openings in the survey and PES, respectively. The sample of firms is restricted to the firms sampled in the survey.
Source: The Swedish Public Employment Service and Statistics Sweden.

In most months the register and survey based measure of hires are closely related (Figure 2). However, the general exception is January, where the register based measure always exceeds that of the survey based. This is likely to be caused by mis-measurement in the former, as establishments reports spells as lasting for entire years instead of the correct duration in months.

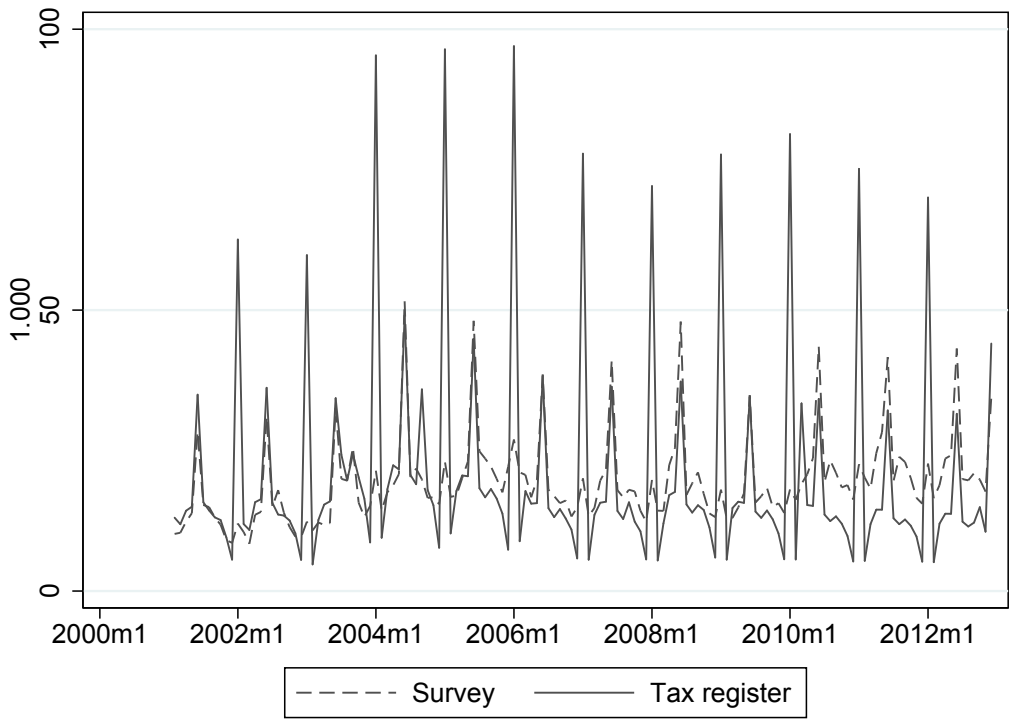
2.3 Plant and firm background variables

From the *Short-term employment statistics* survey and the Swedish Firm Register (both administered by Statistics Sweden) I furthermore have access to background information on each plant and firm in the survey. In particular, this background information contains information on the number of employees and industry of each plant, while turnover and value-added is availiable on the firm level is from the firm register. A summary of these variables is presented in Table 1.

2.4 Data selection

Below I will work with two different selections of the data above.

Figure 2: Monthly hires in Sweden, 2001-2012



Notes: The figure shows the aggregate number of hires in the survey and tax data, respectively. The sample of firms is restricted to the firms sampled in the survey.
Source: IFAU and Statistics Sweden.

Table 1: Descriptive statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Employees	159	450	0	14.368	693.417
Turnover	2.084.064	7.298.369	0	107.805.024	482.750
Valueadded	525.587	1.890.874	-12.151.558	39.204.988	482.750

In section 3, I relate the number of vacancies to the number of subsequent hires on the plant level. Here I use the data from the vacancy survey, and augment with hires in the next month from the tax register data. To ensure data quality of the hiring data, I cross-check the tax register data with the survey-based measure of hires in the *Short-Term Employment Statistics*. In particular, I restrict the sample to plants where the number of hires in the tax-register and survey data is the same for the month of vacancy measurement.[4]

In section 6, I relate the number of vacancies in the survey with the PES. This is straightforward for the public sector after 2006Q2, as collection of both measures is done on the firm level. However, for the private sector and the public sector before 2006Q2 the comparison is challenged by the fact that the survey data only is available on the plant level, while the latter

[4]I don't impose this restriction in the subsequent month, in which the relevant measurement of hiring is made, as the survey-data for hiring only is available in the same month as vacancies are measured.

only is available on the firm level. I address this problem by restricting the dataset to the sub-sample where only one plant per firm exists.

3 Relationship between vacancies and hires on the plant level

Basic search-matching theory assumes a linear relationship between hiring and vacancies on the plant level. In the standard search and matching model aggregate hiring is given by the input of unemployed workers (U) and job-openings (V) to an aggregate matching function with constant return to scale $H = M(U, V)$. Given homogeneity of firms hiring in a firm j will thus be a function of the aggregate vacancy yield and the number of job-openings on the firm level.

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

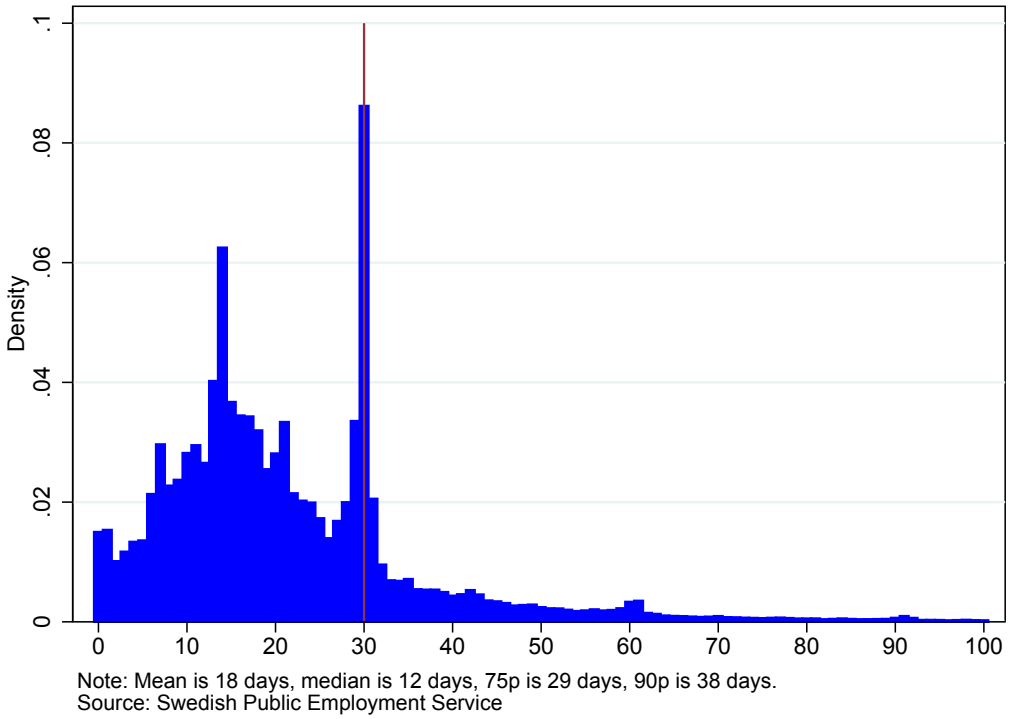
Two predictions follows from this equation. First, in the cross-section of firms the hiring should be linear in the number of job-openings posted at the firm level. The coefficient on firm vacancies will in turn be a decreasing function of aggregate labor market tightness (V/U). Second, we should only see hiring in firm with a positive number of job-openings.

When investigating the relationship between hires and vacancies in the data one initial challenge is to specify the correct interval between vacancy and the relevant hire. To guide the choice of this interval, I draw the histogram of the distribution between start- and end-date of vacancies posted at the Public Employment Service (Figure 3). The mean duration of a vacancy is 18 days, and 85 % of the durations are less than a month. On the back of this I set the interval between vacancy and hire to one month, but I will investigate the robustness with respect to this choice below.

A first look at the data speaks against the predictions of a linear relationship between hiring and vacancies. Figure 4 shows the raw relationship between vacancies and hires on the plant level. Each dot represent the average number of hires for the given number of vacancies represented on the x-axis. This figure points to a concave rather than a linear relationship between the two variables. This depicted relationship clearly suffers from the deficiency of not holding the aggregate conditions on the labor market constant. Therefore, I also depict the relationship for all years in Figure 10 in the Appendix. For most year the concave relationship is still found, although the relationship for some years is more linear in some years.

Moreover, a substantial share of all hires are made without any vacancies in the preceding month. This is witnessed by the by the dot at zero vacancies being non-zero in Figure 4. Moreover, Figure 5 shows that the share of hires made without any vacancies over time varies between 40 % - 50 %. Some of this can be accounted for via time-aggregation issues as I will

Figure 3: 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.

explain in section 5.

Across plant and firm characteristics a given number of vacancies are associated with different amount of hiring. Table 2 shows average hiring and vacancy rates as well as the average number of hires per vacancy. Across all plant groups there are more hires than vacancies. Moreover, there exist a substantial amount of heterogeneity in the number of hires per vacancy. Across industries it varies from 1.97 in the farming sector to 3.43 in the manufacturing sector. Across both number of employees and turnover we see that the vacancy yield is increasing with size.

I now turn to the specific relationship between vacancies and hires on the plant level. As mentioned, we should, according to the basic search and matching model, expect the relationship between vacancies and hires to be characterised by the relationship in (1). To test whether this is in fact the case, while allowing for the possibility of a non-linear relationship, I will estimate the following equation using the plant-level data.

$$H(t+1) = \alpha_t V(t)^{\gamma} \tag{2}$$

Here α_t is a time-fixed effect and γ should be estimated to be one insofar that the data is

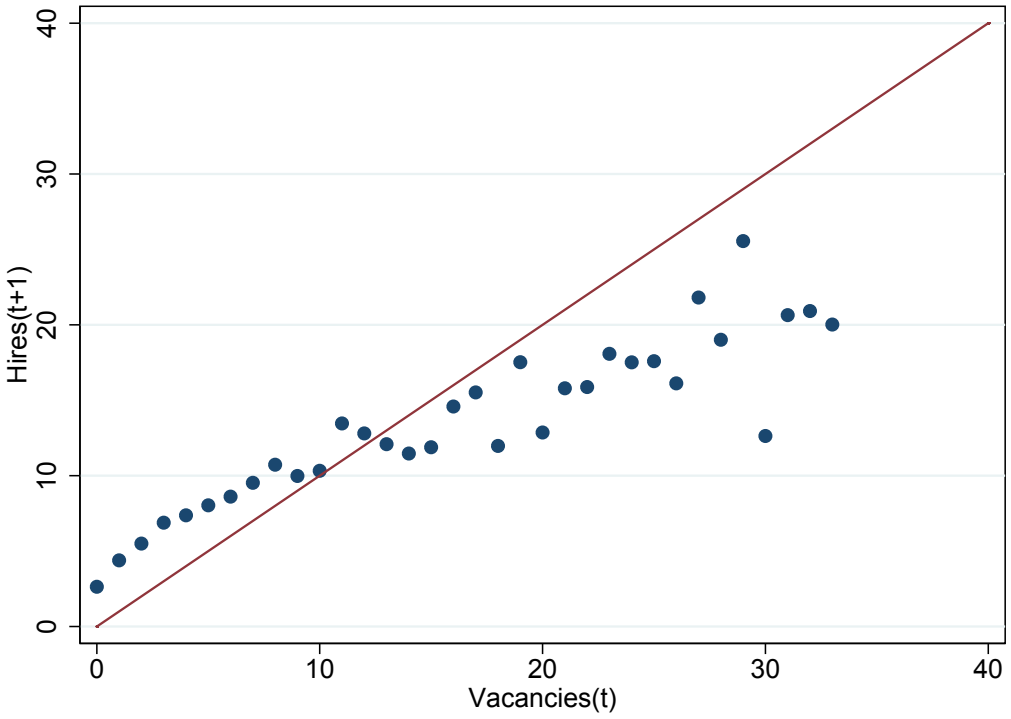
Table 2: Hiring rate, vacancy rate and vacancy yield across industries, plant size and firm turnover, 2001-2010

	Hiring rate (%)	**Vacancy rate** (%)	**Vacancy yield**
		By industry	
Farming	10.26	1.96	1.97
Manufactoring	3.61	0.87	3.43
Energy	3.91	1.14	1.73
Construction	4.71	1.40	1.37
Trade, hotel and restaurants	7.07	1.38	2.80
Transportation, mail and telecom	4.05	1.14	2.24
Finance and business service	6.45	1.72	2.04
Public and personal services	9.72	1.75	2.89
Total	6.22	1.42	2.31
		By number of employees (deciles)	
1	12.64	2.41	0.30
2	6.69	1.64	0.34
3	5.16	1.51	0.52
4	4.27	1.34	0.73
5	4.09	1.25	1.07
6	3.35	1.07	1.40
7	2.67	1.01	1.64
8	2.44	0.97	2.05
9	2.29	0.89	2.62
10	1.93	0.66	4.02
Total	4.55	1.27	1.47
		By turnover (deciles)	
1	6.17	1.55	1.90
2	7.40	1.87	0.33
3	5.96	1.63	0.53
4	4.80	1.41	0.79
5	4.24	1.21	1.41
6	2.98	1.06	1.75
7	2.90	0.98	1.87
8	2.58	1.02	2.25
9	2.58	0.86	2.67
10	2.96	0.90	3.03
Total	4.26	1.25	1.65

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 fraction of vacancies to plant size. Public sector has been dropped in tabulation by turnover.

Source: Own calculation from Statistics Sweden

Figure 4: Relationship between number of vacancies and hires, 2001-2012



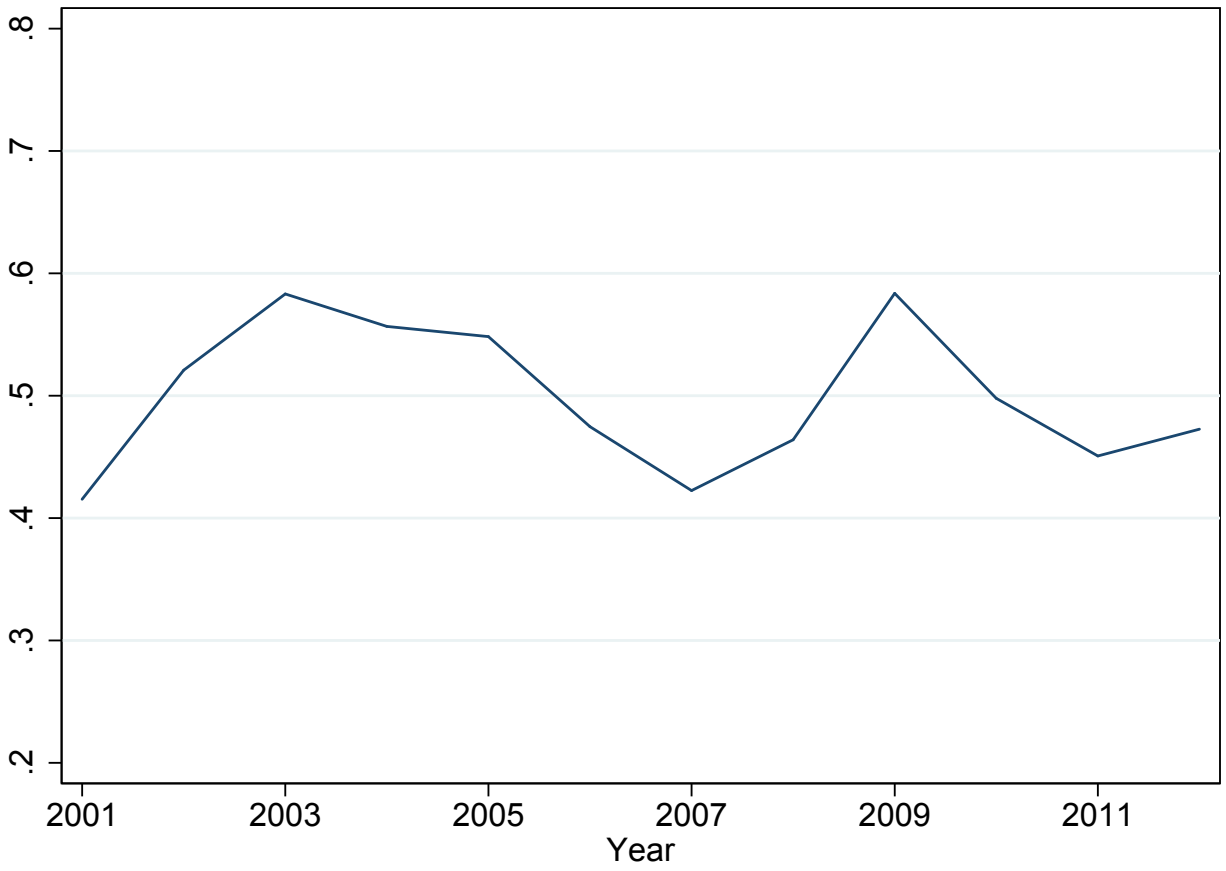
Notes: The figure shows the average number of hires (y-axis) for each number of vacancies in the previous month (x-axis). TBD: Insert standard deviations.
Source: Own calculation on data from Statistics Sweden.

consistent with the model.

Estimating (2) involves a choice of estimation strategy. One option is to estimate (2) in logs using OLS. This, however, comes at the cost of loosing all observations with zero hires and/or vacancies. Another option is to estimate (2) using non-linear least squares. This allows for the inclusion of all observations in the regression. However, one should note that the model in any case restricts hires to be zero when vacancies are zero. Therefore, including observations with zero vacancies is likely only to decrease the fit of the model - not change the estimated parameters. On the other hand including observations with zero hires is likely to change the estimated parameters. In this section I will estimate the the model in logs (using ordinary least squares), but I include the model in levels (using non-linear least squares) as robustness in the Appendix.

The basic relationship between vacancies and hires (2) is estimated in column 1 of Table 3. The estimation is done using ordinary least squares and time fixed effects. Notice that the exponent on vacancies is below unity, which speaks against a linear relationship between vacancies and hires. Also notice that the fit of the model is poor with a R^2 of only 0.27. Similar results are found in the model estimated in levels (Table 6). However, here the fit is substantially worse which partly can be explained by the fact that the observations with zero

Figure 5: Share of all hires without vacancies in the preceding month, 2001-2012



Source: Own calculation on data from Statistics Sweden.

vacancies have been omitted.

Next I will consider whether it is possible to improve the fit of the model by allowing willingness to hire to depend plant level characteristics characteristics as well as vacancies. So far we have assumed that the only variable that matters for plants willingness to hire is the number of posted vacancies. However, as we saw above the number of hires per vacancy (the vacancy yield) varies plant characteristics. In particular, we saw that the number of hires per vacancy was increasing in the plant size. Below we will allow for this by letting the willingness to hire be a function of not only vacancies but also a number of plant and firm level characteristics.

$$H_{j,t+1} = \frac{M(U_t, V_t)}{V_t} F\left(V_{jt}, \mathbf{x}_t\right) \tag{3}$$

$$F(V_{jt}, \mathbf{x}_t) = V_{jt}^{\gamma_1} \times S_{jt}^{\gamma_2} \times T_{jt}^{\gamma_3} \times Va_{jt}^{\gamma_4} \tag{4}$$

here S_{jt} is size, T_{jt} is turnover and Va_{jt} is valueadded.

In column (2)-(4) of Table 3 (and 6 in the Appendix) I gradually allow the willingness to hire to depend on these additional plant level characteristics. Two results stand out from this

Table 3: Plant level hiring regression, Ordinary Least Squares, 2001-2012

	(1)	(2)	(3)	(4)	(5)
	Hires(t+1)	Hires(t+1)	Hires(t+1)	Hires(t+1)	Hires(t+1)
Vacancies(t)	0.272***	0.0489***	0.0495***	0.00430	0.00170
	(0.0142)	(0.0112)	(0.0110)	(0.00956)	(0.00947)
Plant size (t)		0.410***	0.400***	0.489***	0.496***
		(0.0120)	(0.0119)	(0.0194)	(0.0196)
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	123819	123788	123788	79097	79097
Adjusted R^2	0.275	0.406	0.411	0.373	0.374
AIC	360422.9	335545.9	334656.6	205583.9	205425.5

Notes: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

exercise. First, the fit of the model is substantially improved by allowing firm characteristics to affect the willingness to hire. Second, including these additional variables decrease the exponent on vacancies towards 0. This is especially the case for plant size: when including this variable the fit of model increase substantially and the coefficient on vacancies decrease substantially. Relatively little additional fit is achieved from including the other background variables.

The take-away from this is that we can improve the prediction of hiring on the plant level by taking firm characteristics as well as vacancies into account. Indeed, just including plant size substantially improves the fit of predicted hires on the plant level. Specifically,

$$F(V_{jt}, size_{jt}) = V_{jt}^a size_{jt}^b \tag{5}$$

where a is effectively zero and b is between 0.4 and 0.5, is a superior measure of firms j's willingness to hire *vis-a-vis* V. 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 a positive number of vacancies. This binary variable is then multiplied with $size_{jt}^b$ which is a concave function of plant size.

4 Dealing with time-aggregation and other robustness checks

A problem with the analysis so far is that it does not take the issue of time-aggregation into account. Indeed, above I associate hiring in month $t+1$ with number of vacancies posted medio month t. This may be problematic for both reasons. First, vacancies could be filled before the start of the next month. Second, some of the hiring done in next month may be associated

with vacancies that were created after vacancies were counted in month t.

To address this problem, I take the approach developed by Davis et al. (2013). They set up a model for the daily dynamics of vacancies, and using a calibrated version of this model one can compute (1) the number of vacancies in the end of each period and (2) the number of hires next period that are made via the filling of newly created vacancies. In particular, the daily dynamics of hires and vacancies is modeled using the following system of equations.

$$h_{s,t} = f_t v_{s-1,t} \tag{6}$$

$$v_{s,t} = (1 - f_t)(1 - \delta_t) v_{s-1,t} + \theta_t \tag{7}$$

here $h_{s,t}$ is the number of hires at day s in month t, $v_{s,t}$ is the number of vacancies at day s in month t, f_t is the daily job-filling rate, δ_t is the daily and θ_t is the inflow of new vacancies each day. Both f_t, δ_t and θ_t are assumed to be constant throughout each month.

Solving 6 and 7 forward yields the following expressions.

$$v_t = (1 - f_t - \delta_t + \delta_t f_t)\, v_{t-1} + \theta \sum_{s=1}^{\tau} (1 - f_t - \delta_t + \delta f_t)^{s-1} \tag{8}$$

$$h_t = f_t v_{t-1} \sum_{s=1}^{\tau} (1 - f_t - \delta_t + \delta_t f_t)^{s-1} + f_t \theta_t \sum_{s=1}^{\tau} (\tau - s)\, (1 - f_t - \delta_t + \delta_t f_t)^{s-1} \tag{9}$$

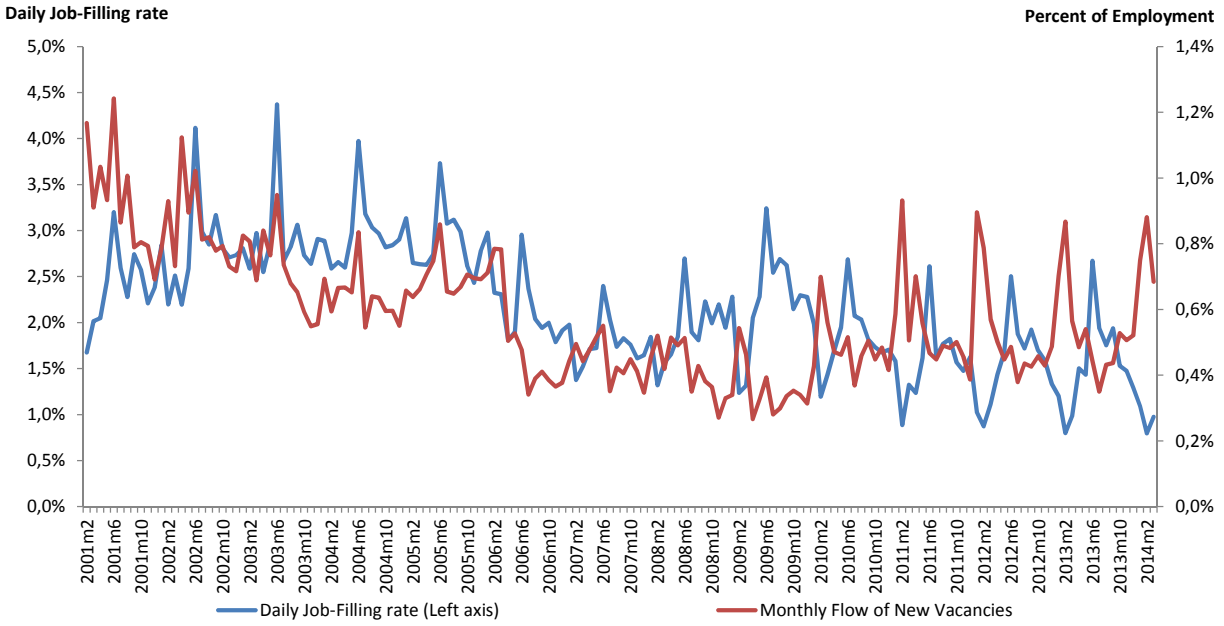
where θ is the number of days per months. Given τ and time series for the triplet $\{\delta_t, h_t, v_t\}$ one can solve this equation system numerically the time series for $\{f_t, \theta_t\}$. h_t and v_t is available from the data and I set $\tau = 26$ (working days per month). δ_t is less obvious how to compute, but as of now I follow Davis et al. (2013) and $\tau\delta_t$ equal to monthly job-destruction rate.[5] TBD: However, as robustness I vary $\tau\delta_t$ in the interval $[0, 10\%]$ and show that this impacts very little on the calibrated values for f_t and θ_t.

Figure 6 shows the calibrated time-series for f_t and θ_t. The calibrated monthly inflow of new vacancies is 0.6% of the labor force on average and varies in the interval $0.2 - 0.8\%$. The daily fill-rate of vacancies has an average of 2.5%, which corresponds to an average duration of 40days, and varies in the interval $1 - 3.5\%$.

Using these calibrated values I now attempt to address the time-aggregation problem. Specifically, I use the calibrated job-filling and vacancy creation rates to compute (1) the predicted number of vacancies at each plant in the end of each month and (2) the number of hires in the following month corrected for the predicted hires caused by filling of newly created vacancies. According to the model the predicted number of vacancies in the end of the month

[5] Specifically, I set $\tau\delta_t$ equal to the monthly probability of not staying in a regular contract. This data is available the Swedish labor market survey.

Figure 6: Daily Job-Filling Rates and Flow of New Vacancies, 2001-2012



Source: Own calculations on data from Statistics Sweden.

can be written

$$v_{t,ultimo} = (1 - f_t - \delta_t + \delta_t f_t)^{\tau/2} v_{t,medio} + \theta \sum_{s=1}^{\tau/2} (1 - f_t - \delta_t f_t)^{s-1} \tag{10}$$

whereas the number of hires corrected for hires associated with newly created vacancies in a given month reads

$$h_{t,corr} = h_t - f_t \theta_t \sum_{s=1}^{\tau} (\tau - s) (1 - f_t - \delta_t + \delta_t f_t)^{s-1} \tag{11}$$

To compute $v_{t,ultimo}$ and $h_{t,corr}$ on the plant-level, I use values for f_t calibrated on the industry level and to compute a plant-specific value for θ_t I weight the θ_t computed on the industry-level with the plant's employment share in the industry.

Having computed $v_{t,ultimo}$ and $h_{t,corr}$ I now redo the analysis from above. In Table 7 in the Appendix I re-estimate the relationship between hiring and vacancies and gradually increase the number of plant and firm -level characteristics. The pattern is unchanged: The relationship between hires and vacancies is concave, not linear, and the coefficient on vacancies goes towards zero as I increase the number of plant-level characteristics.

I also conduct a couple of additional robustness checks. First, I relate the number of vacancies in a given month with the *average of hires hires over the next two months* (Table 8). Second, I restrict my sample to plants where I have at least three observations for a given

year. Using this sample I relate the average number hires with the average number of vacancies (Table 9). None of these robustness checks overturn the results.

5 Aggregate implications

What are the aggregate implications of our findings on the plant level? Our plant level findings suggest that an indicator variable for whether a plant is recruiting or not, multiplied with the plant size, is a superior measure of firm willingness to hire compared to the pure number of vacancies. On the aggregate level this suggests that the number of plants, weighted by they respective size, provides a better of the aggregate willingness to hire.

One way to test this hypothesis in the aggregate data is via estimated matching function. Specifically, I assume that the aggregate matching function has constant returns to scale and takes the following form

$$M(U_t, V_t) = AU_t^{\alpha} V_t^{1-\alpha} \tag{12}$$

Consequently, the job-finding rate can be written as

$$\frac{H_t}{U_t} = AU_t^{\alpha-1} V_t^{1-\alpha} \tag{13}$$

which in log terms takes the following form

$$\log\left(\frac{H_t}{U_t}\right) = \log(A) + (1-\alpha)\log\left(\frac{V_t}{U_t}\right) \tag{14}$$

I estimate this relationship on Swedish data during the period 2001Q1-2012Q4. I take unemployment and job-finding probabilities from the Swedish Labor Market Survey. As measure for job-openings I rely both on (1) the total number of vacancies in the economy and (2) the number of plants with a positive number of vacancies weighted by their size.

Interestingly, the alternative measure for job-openings yields a better fitting matching function. Table **??** shows the matching function estimated using (1) the total number of vacancies, (2) the number of plants with a positive number of vacancies and (3) the number of plants with a positive number of vacancies weighted by the plant size. The three models yields roughly similar coefficients, but the fit is improved by approx. 30 % when using number of recruiting plants weighted by size instead of the total number of vacancies.

This finding also have potentially implications on how we should think about the labor market development in the wake the Great Recession in 2008/09. After 2008/09some countries, including Sweden, saw an outwards shift in the Beveridge Curve (Figure 7) which have let some analysts to suggest that matching efficiency has declined (Sveriges Riksbank, 2012; Hå kanson,

Table 4: Regression table

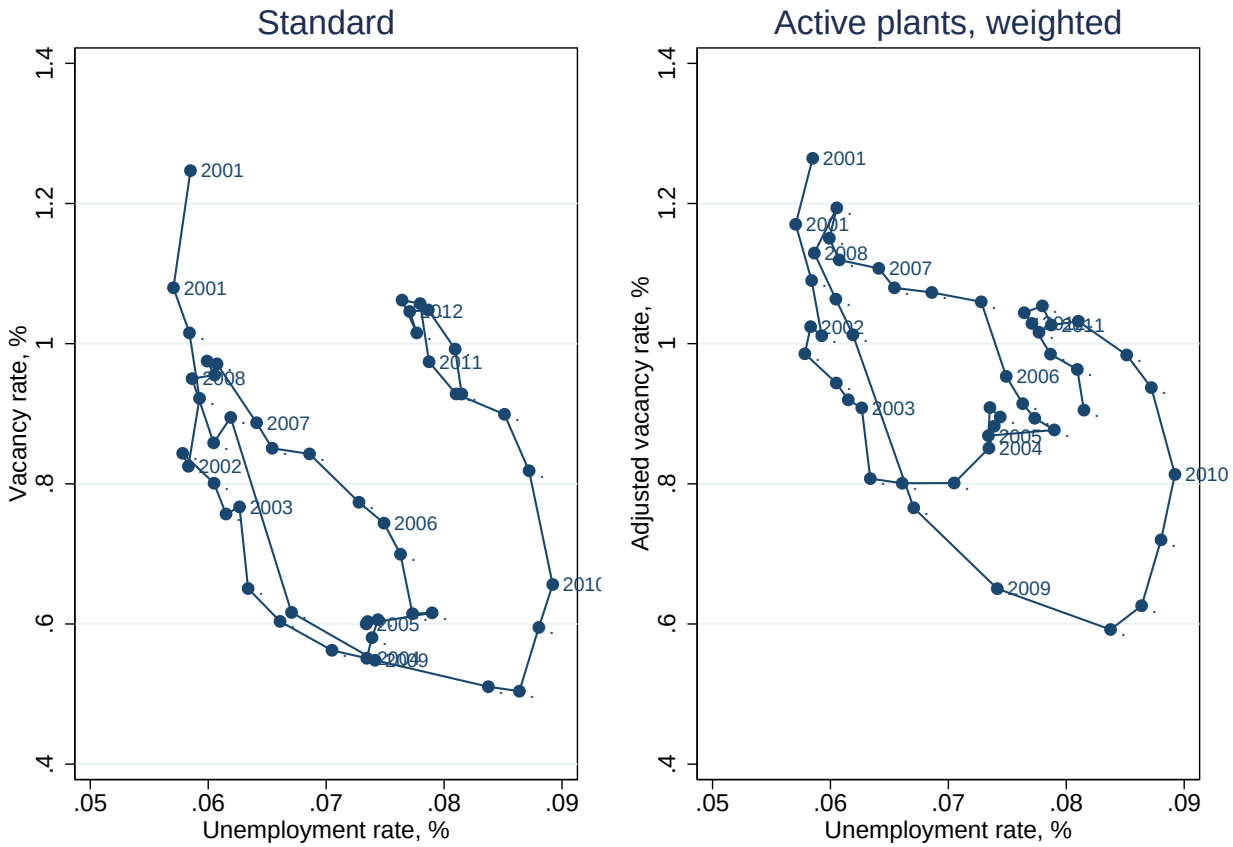
	(1) log(jfr)	(2) log(jfr)	(3) log(jfr)
log(v/u)	0.39**		
	(0.07)		
log(plants/u)		0.41**	
		(0.09)	
log(plants, weighted/u)			0.46**
			(0.08)
Observations	48	48	48
R^2	0.15	0.17	0.21

Standardized beta coefficients; Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

2014). However, if we look at the labor market through the lens of the alternative measure of job-openings the marked outwards shift is less clear (Figure 7, left). Using this measure there was also an outward shift after 2008/09, but it is less marked and does in fact only bring the Beveridge curve back to a level where it was operating before 2006.

Figure 7: Beveridge curves



Source: Own calculation on data from Statistics Sweden.

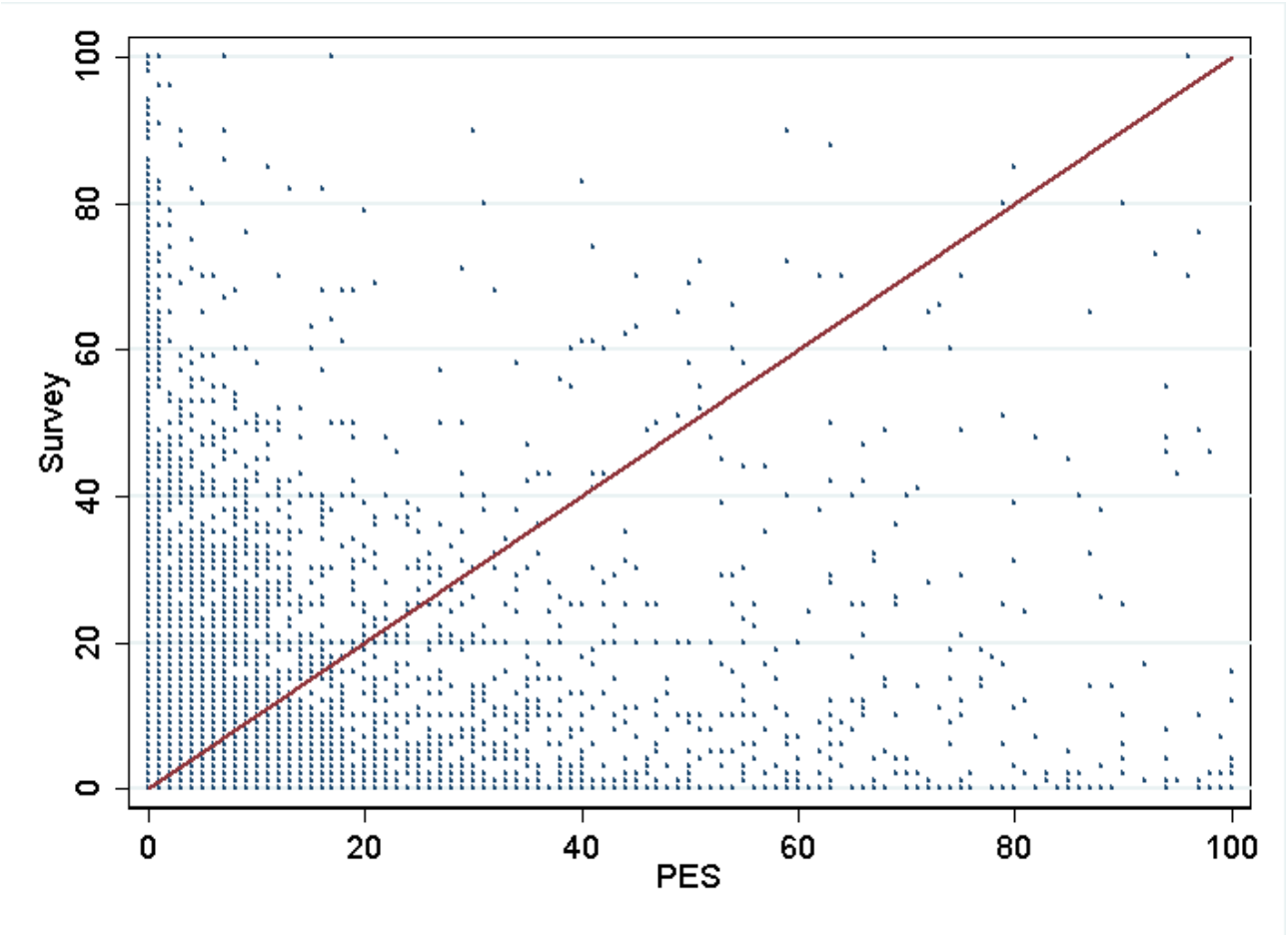
6 Relationship between vacancies in survey and PES

In this section, I document the relationship between vacancies as measured in the (i) survey and in the (ii) register of the PES on the firm level.

Figure 9 shows a cross-plot between these two measures on the firm level. If the two measures are identical, we should see the observations line up on the 45-degree line. Evidently, this is not the case. Instead, regressing the two measures on each other yields a R^2 of only 0.06. Moreover, 47 % of the vacancies registered in the survey are not registered in the PES. This is unsurprising given that not all firms can be expected to use the Public Employment Service as recruitment channel, which creates the problem of selection in the PES data. What is, however, more surprising is that 37 % of the vacancies registered at the PES are not counted in the survey.

Table 5 documents the heterogeneity in the ratio of vacancies registered the PES to the number counted in the survey. Overall, this table suggests at the use of the PES as recruitment channel varies substantially across firm characteristics. The share of PES to survey vacancies

Figure 8: Cross plot of vacancies registered in the survey and the PES register, firm-level, 2004-2012



Notes: The sample is restricted to firms with only one plant.
Source: Own calculation on data from Statistics Sweden and Swedish Public Employment Service.

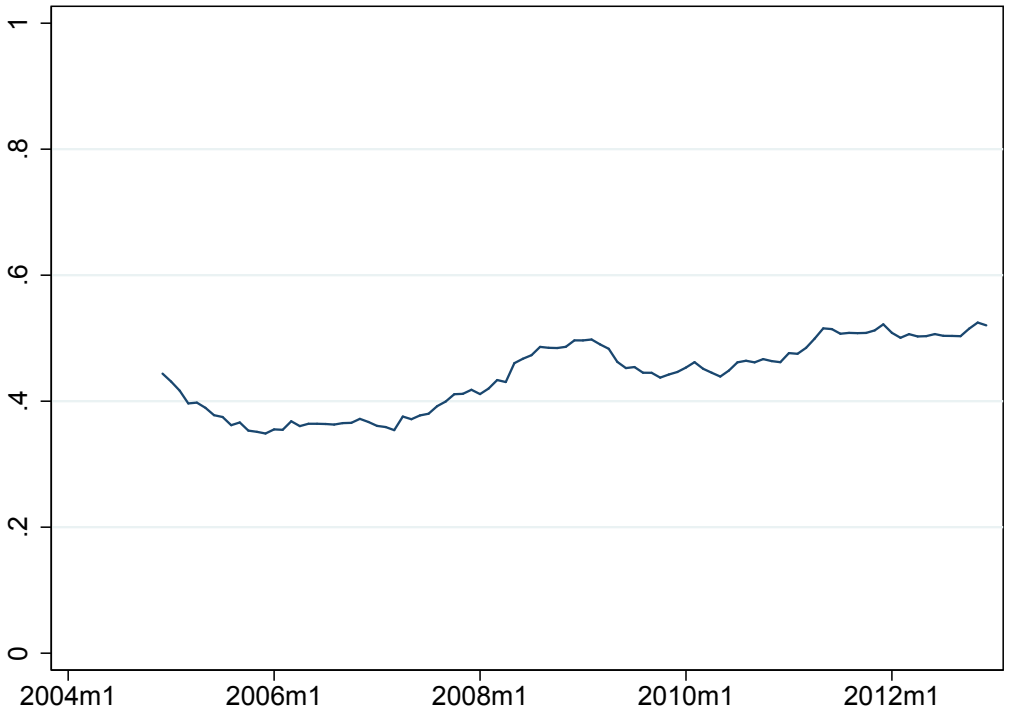
is largest within *Public and personal services* and smallest within construction. Indeed, the former industry accounts for 42 % of all vacancies at the PES. Across plant size there is not clear pattern, while the use across the turnover and value-added deciles peaks in the middle of the distribution.

Finally, Figure 9 documents the time-series for the aggregate share of vacancies registered at the PES *vis-a-vis* the number in the survey. From 2004-2012 this share has varied in the interval $28 - 47$ % and has displayed a increasing trend over time.

Table 5: Survey and Public Employment Service vacancies on the firm-level,2004-2012

	PES share (%)	Average PES (#)	Average Survey (#)	Share of PES (%)	Share of survey (%)
			By industry		
Farming	42.12	0.43	1.02	0.70	0.77
Manufactoring	23.70	0.70	2.96	16.72	32.65
Energy	18.33	0.76	4.14	0.94	2.39
Construction	17.26	0.17	0.96	0.63	1.70
Trade, hotel and restaurants	32.68	0.50	1.54	5.66	8.02
Transportation, mail and telecom	35.51	1.37	3.86	6.33	8.25
Finance and business service	57.48	1.68	2.93	26.12	21.04
Public and personal services	78.90	3.29	4.16	42.90	25.18
			By number of employees (deciles)		
1	51.60	0.05	0.09	0.39	0.35
2	66.36	0.09	0.14	0.66	0.46
3	52.01	0.13	0.26	0.99	0.88
4	46.93	0.25	0.53	1.78	1.75
5	49.50	0.51	1.04	3.81	3.56
6	35.47	0.53	1.49	3.82	4.99
7	36.89	0.71	1.93	5.27	6.61
8	41.20	1.27	3.07	9.36	10.52
9	37.16	1.59	4.28	11.68	14.55
10	51.15	8.35	16.32	61.51	55.69
			By turnover (deciles)		
1	19.10	0.21	1.09	1.29	3.12
2	54.28	0.09	0.17	0.57	0.49
3	77.49	0.23	0.29	1.39	0.83
4	82.34	0.62	0.76	3.84	2.16
5	87.95	1.19	1.35	7.34	3.86
6	66.18	1.12	1.70	6.93	4.85
7	58.43	1.12	1.91	6.89	5.46
8	45.66	1.17	2.55	7.18	7.28
9	36.69	1.46	3.99	9.01	11.37
10	28.91	3.49	12.07	21.48	34.41
			By valueadded (deciles)		
1	20.42	0.28	1.35	1.70	3.85
2	51.91	0.08	0.16	0.50	0.45
3	51.24	0.13	0.25	0.79	0.72
4	50.74	0.24	0.47	1.48	1.35
5	72.85	0.67	0.91	4.10	2.60
6	58.60	0.82	1.40	5.06	4.00
7	59.60	1.11	1.86	6.82	5.29
8	55.02	1.29	2.35	7.96	6.70
9	38.03	1.48	3.88	9.08	11.06
10	34.82	4.62	13.26	28.43	37.81

Figure 9: Ratio Public Employment Service to survey vacancies, 2004-2012



Notes: The figure shows a 12-month moving average of the aggregate ratio of PES to survey vacancies in the sample.
Source: Own calculation on data from Statistics Sweden and Swedish Public Employment Service.

7 Conclusion

This paper studied the relationship between vacancies and hires on the plant level using Swedish data. According to basic search-matching theory we should see no hiring without job-openings and we should expect the relationship between hiring and job-openings to be linear. When taking these predictions to the data we first need to translate the theoretical concept of a job-opening into an empirical counterpart. The preferred way to this in the empirical literature is via a survey based measure of vacancies. To the extent that this measure captures the concept of job-openings well, we should expect to see a tight relationship between vacancies and subsequent hires. I show that the relationship in the data is concave, rather than linear as predicted by the model, as one additional vacancy associated with less and less hiring. I also show the prediction of hiring on the plant level can be improved substantially by allowing plants' willingness to hire to depend not only on posted vacancies but also on plant size.

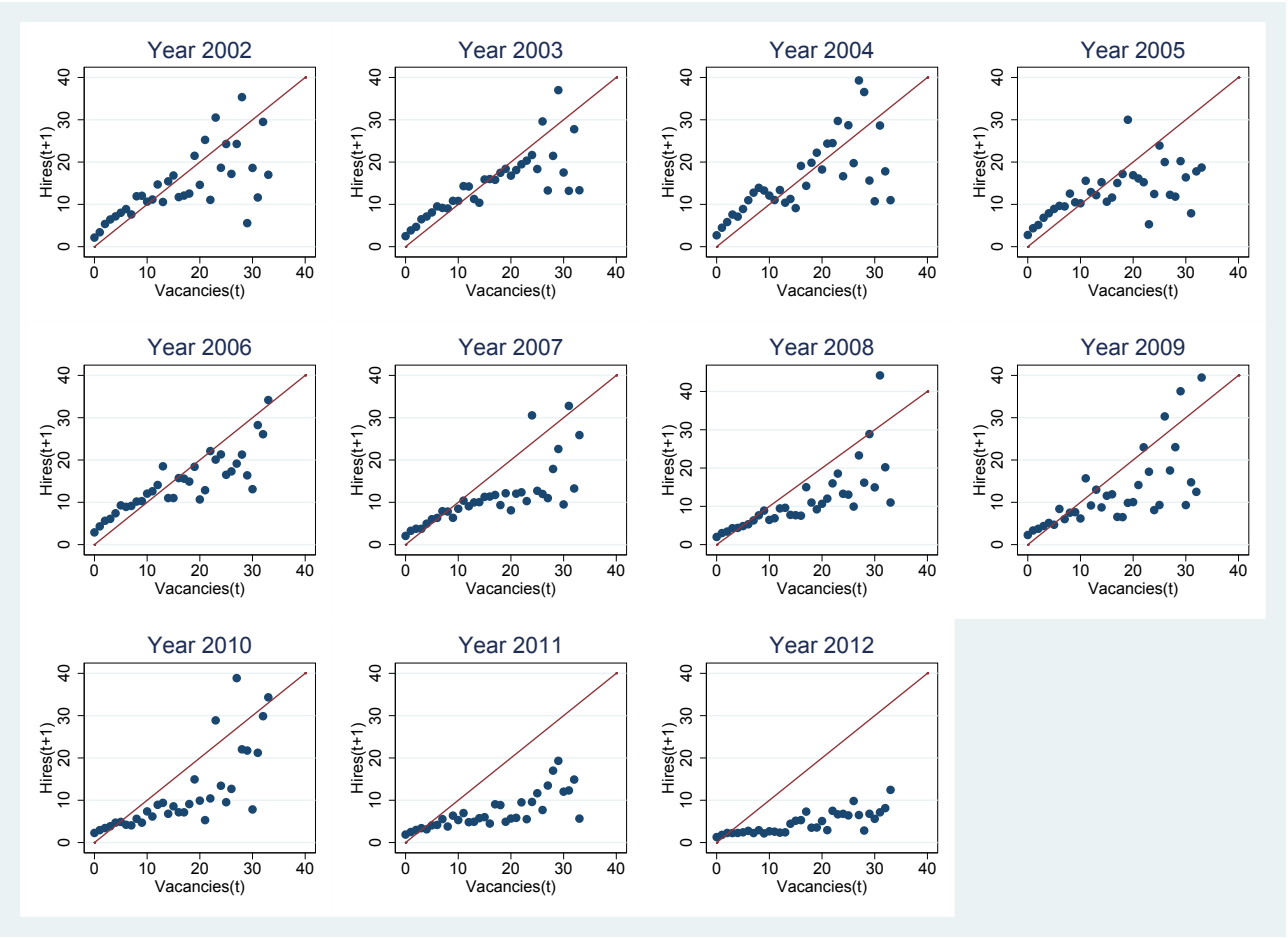
These observations motivates the formulation of an alternative measure of aggregate job-openings. Instead of using the sum of all vacancies, I use the the sum of all plants with a positive number of vacancies weighted by their size. This measure has the attractive feature of providing a better fitting aggregate matching function. The alternative measure also provides a

new perspective on the outward shift in the Swedish Beveridge curve observed in the wake of the Great Recession. Some have suggested that this was caused by a deterioration of the matching efficiency. The findings in this paper however puts this hypothesis into doubt. Indeed, an alternative explanation is that the traditional vacancy measure has become a less good measure for the number of job-openings in the economy.

Overall, this paper suggests that more work is needed on how to best measure job-openings in the economy. Indeed, the finding that a substantial amount of hiring happens without vacancies in the preceding month, and that 37 % of all vacancies registered at the PES do not have a counterpart in the survey data point to a reliability problem in our vacancy data. Better understanding the hiring that happen without vacancies is a first step towards addressing this problem.

1 Appendix

Figure 10: Relationship between number of vacancies and hires, 2001-2012



Notes: The figure shows the average number of hires (y-axis) for each number of vacancies in the previous month (x-axis). TBD: Change background color.
Source: Own calculation on data from Statistics Sweden.

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

	(1)	(2)	(3)	(4)	(5)
	Hires(t+1)	Hires(t+1)	Hires(t+1)	Hires(t+1)	Hires(t+1)
Vacancies(t)	0.495***	0.0371***	0.0102	4.33e-09	2.35e-09
	(0.00721)	(0.00603)	(0.00608)	(0.00863)	(0.0214)
Plant size (t)		0.664***	0.684***	0.905***	0.905***
		(0.00505)	(0.00533)	(0.0102)	(0.0102)
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	693451	693451	693451	482784	482784
Adjusted R^2	0.028	0.046	0.047	0.078	0.034
AIC	6036235.1	6022939.6	6022387.7	3686250.0	3708815.2

Notes: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Plant level hiring regression, corrected for time-aggregation, Ordinary Least Squares, 2001-2012

	(1)	(2)	(3)	(4)	(5)
	Hires (t+1)	Hires (t+1)	Hires (t+1)	Hires (t+1)	Hires (t+1)
Vacancies (t)	0.234***	-0.000359	0.0120	-0.0259***	-0.0278***
	(0.00650)	(0.00801)	(0.00781)	(0.00912)	(0.00886)
Plant size (t)		0.329***	0.302***	0.362***	0.373***
		(0.0120)	(0.0123)	(0.0156)	(0.0157)
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	307872	307841	307841	211773	211773
Adjusted R^2	0.245	0.281	0.289	0.251	0.253

Notes: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Hires: hiring in month $t + 1$ corrected for hires associated with newly created vacancies. Vacancies: Vacancies computed at the end of month t.

Table 8: Plant level hiring regression, corrected for time-aggregation, Ordinary Least Squares, 2001-2012

	(1)	(2)	(3)	(4)	(5)
	Hires (t+1)	Hires (t+1)	Hires (t+1)	Hires (t+1)	Hires (t+1)
Vacancies(t)	0.327***	0.0408***	0.0441***	-0.0157	-0.0209**
	(0.0146)	(0.0114)	(0.0116)	(0.0107)	(0.0106)
Plant size (t)		0.497***	0.489***	0.611***	0.621***
		(0.0120)	(0.0126)	(0.0212)	(0.0213)
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	154542	154492	154492	100443	100443
Adjusted R^2	0.243	0.421	0.423	0.382	0.384
AIC	478696.5	437069.3	436659.9	273805.9	273364.0

Notes: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Hires: The average number of hires in month t and $t + 1$.

Table 9: Plant level hiring regression, average hires and vacancies during a year, Ordinary Least Squares, 2001-2012

	(1)	(2)	(3)	(4)	(5)
	Hires(t)	Hires(t)	Hires(t)	Hires(t)	Hires(t)
Vacancies(t)	0.209***	0.00486	0.00537*	0.00400	0.00266
	(0.00350)	(0.00302)	(0.00304)	(0.00353)	(0.00354)
Plant size(t)		0.420***	0.419***	0.466***	0.469***
		(0.00296)	(0.00308)	(0.00499)	(0.00501)
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	41298	41237	41237	27038	27038
Adjusted R^2	0.263	0.541	0.541	0.434	0.435
AIC	95989.2	76323.5	76322.1	48289.6	48239.9

Notes: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Hires/vacancies: The average number of monthly hires/vacancies in year t.

Sample is all plants with more than 3 observations per year.

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