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Labour shortages and wage growth

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Abstract

Tight labour markets are usually accompanied by mounting wage pressures. Yet, in the past decade, wage growth has remained subdued despite the appearance of widespread labour shortages. This paper re-examines labour market conditions since 2007 through the lens of a novel indicator, relative labour shortages (RLS), based on data from a large representative business survey in Sweden. Four main results emerge from the analysis: (1), the time-series average of RLS suggested much weaker labour market conditions during the 2013–2019 recovery from the Great Recession and during the Covid-19 pandemic in 2020 than qualitative surveys or the vacancy-unemployment ratio. (2), the reason is that RLS contains a time-varying intensive margin of labour shortages not recorded in most surveys, which has been trending downwards since the Great Recession. (3), fixed-effects regressions with several aggregate-, sector, region and establishment-level controls confirm that RLS is strongly and positively correlated with annual wage growth at the establishment-level. (4), sector-level wage Phillips curves show that the subdued level of RLS can help explain the sluggish wage growth in Sweden since the Great Recession.

Keywords: Wage inflation, labour markets, survey data.

JEL codes: C80, E31, E60, J23, J31.

Non-technical summary

Until the outbreak of the Covid-19 crisis, wage growth had remained sluggish in many advanced economies, while labour markets appear to have tightened substantially and with signs of broad-based labour shortages. This paper re-examines labour market conditions since 2007 through the lens of a novel survey-based indicator, relative labour shortages (RLS). The establishment-level measure utilizes survey respondents' quantitative assessments of labour shortages and employment from a large representative business survey in Sweden and points to markedly weaker labour market conditions than typically assumed during the recovery from the Great Recession.

The reason why RLS deviates from other survey-based indicators of labour shortages is that it includes an intensive margin (average labour shortages per establishment) that have trended downwards since 2007. By including this innovation yields markedly more muted labour market conditions than other indicators. It also highlight a bias inherent in most survey indicators: that the underlying quantities that the indicators aim to represent might vary over time, which diminishes their usefulness in real-time. As survey-based indicators are commonly used by central banks to cross-check estimates of "slack" or "gaps" and to assess labour market conditions, the findings in this paper are highly relevant for policymakers. Although surveys are timely and usually not revised, they are no panacea for tracking unobserved variables in real-time as they too can give biased signals of economic developments.

RLS and annual wage growth is also positively correlated and the relationship is robust to a number of controls at the sector, region or establishment-level. Moreover, forecast comparisons derived from sector-level wage Phillips curves indicate that RLS did a better job in explaining the post-crisis wage developments than other indicators. The comparatively low level of RLS can therefore help explain why wage growth in Sweden has been subdued in the years following the Great Recession.

1. Introduction

Until the outbreak of the Covid-19 crisis, wage growth had remained sluggish in many advanced economies, despite the appearance of tight labour markets and broad-based labour shortages. Jerome Powell, chairman of the Federal Reserve Board in the United States referred to the absence of higher wage growth as a "puzzle"[1] and similar sentiments have been expressed by Andrew Haldane, Chief Economist of the Bank of England[2] and former European Central Bank (ECB) Executive Board member Benoît Cœuré.[3] Powell's puzzle of high resource utilization and subdued nominal wage growth has also been prominent in Sweden, a small, open and inflation-targeting economy (Sveriges Riksbank, 2017).

Several explanations have been suggested for the apparent disconnect between labour market conditions and wages: the "flattening" of the wage Phillips curve.[4] These include the globalization of production (Borio et al., 2018), automation (Leduc and Liu, 2020), lower matching efficiency in the labour market (Jonsson and Theobald, 2019) or weaker bargaining power of labour (Krueger, 2018). Other strands of the literature argue that traditional measures of labour market conditions underestimate true labour market slack (see for example Hong et al. 2018, Barnichon and Mesters 2018 and Abraham et al. 2020) or that the relationship between wage growth and slack is non-linear (Daly and Hobijn 2014 and Lindé and Trabandt 2019).

This paper makes several contributions to the literature. First, it presents a novel

[1] *"But there is still a bit of a puzzle in that we're hearing about labour shortages now all over the country in many, many different occupations in different geographies. And one would have expected, I would have expected, that wages would move up a little bit more."*, see Powell (2018).

[2] *"We have seen an unusual pattern emerge here over recent years. Jobs growth has been strong, with over 2 million new jobs created since the end of 2012. But pay growth has remained weak by historic standards, averaging around 2% annually."*, see Haldane (2018).

[3] *"Despite a rapid fall in the unemployment rate, wages have remained stubbornly low. Annual growth in compensation per employee hovered around 1.2% since mid-2014 and only increased to 1.5% at the end of last year – substantially below its historical average of 2.1%"*, see Coeuré (2017).

[4] For example, Galí and Gambetti (2019) document changes to the wage Phillips curve in the United States, with reduced form as well as conditional estimates. They find a declining slope with conditional estimates, albeit somewhat less than reduced form estimates would suggest.

survey-based measure of labour shortages to track labour market slack, derived from respondents' quantitative assessment in a large, representative, business survey in Sweden, the Public Employment Service's interview survey (the AFU).[5] The new indicator, relative labour shortages (RLS), is the ratio of respondents' assessment of labour shortages over the past six months and total employment at the establishments. It has the advantage over other indicators that it is direct measure as perceived by respondents themselves and is not dependent on statistical filtering techniques or judgement that cause real-time estimates of "gaps" to be fraught with uncertainty (Orphanides and van Norden 2002 or Berge 2020).[6]

Second, according to RLS, there was markedly more slack in the Swedish labour market during the 2013–2019 recovery from the Great Recession and during the Covid-19 pandemic in 2020 than what was indicated by conventional qualitative survey based measures (QS) or the standard vacancy-unemployment (V/U) ratio, see Figure 1. The reason why RLS deviates from the conventional survey indicator of labour shortages (QS) is that it provides a picture of the intensive margin of labour shortages (i.e. the average RLS per establishment) and not only the extensive margin (i.e. the proportion of respondents experiencing labour shortages) that is commonly captured in business surveys.[7] As seen in the Figure, this innovation turns out to be important. By including the intensive margin of labour shortages yields markedly more muted labour market conditions since the Great Recession and shields RLS from the "New Modesty" that can bias survey indicators based purely on qualitative responses (Gayer and Marc 2018 and National Institute of Economic Research 2018a).[8]

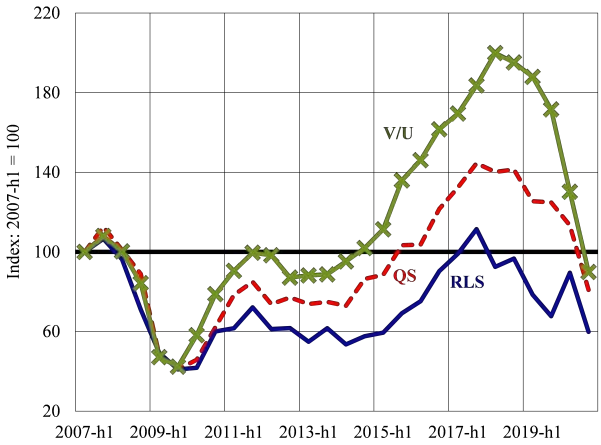
[5] Frohm (2019) provides an earlier account of how the new-survey based measure could be used.

[6] One promising way of circumventing the problem with large revisions to output gap measures is outlined in Beckworth (2020). Instead of making assumptions about the potential level of demand, past projections by professional forecasters are used to infer a "neutral" level of aggregate demand that can be used to calculate a nominal GDP gap.

[7] That the quantitative signal from qualitative indicators can vary over time also applies to other indicators of economic slack, some of which are used in Frohm (2020).

[8] "New Modesty" refers to a psychological or cognitive effect: that respondents' answers to qualitative survey questions are relative to a 'normal' benchmark. After a severe recession for example, respondents may have lowered their underlying reference standard to a lower level of economic ac-

Figure 1: A new indicator of labour shortages



Note: QS (the dashed line) is simply the share of respondents that responded "Yes" to whether or not they experienced labour shortages in connection to recruitment over the past six months. V/U (the crossed line) is the vacancy-unemployment ratio measured as total number of vacancies as percent of the labour force, over unemployed persons as percent of the labour force in the age group 15-74 years retrieved from the Swedish National Institute of Economic Research. RLS (the solid line) is the average ratio of number of positions where respondents experienced labour shortages to total employment at the establishment. All series are indexed to 2007h1 for comparison. For more details, see Section 3.

Third, the paper provides evidence that labour shortages are correlated with wage growth at the establishment-level and the positive relationship is robust to a range of controls, such as fixed-effects for sector×time (controlling for sector-level productivity shocks or negotiated wages) and region×time (controlling for regional labour market conditions) or respondents specific expectations of demand conditions or future employment, as well as heterogeneity by considering establishment fixed-effects.

Fourth, results from estimated wage Phillips curves (similar to Nickel et al. 2019) at the sector-level show that the subdued level of RLS, contrary to other measures of labour market slack, can help explain the sluggish wage growth in Sweden since

tivity or labour shortages. RLS on the other hand uses quantitative information on labour shortages to mitigate such biases.

the Great Recession.

The findings in this paper are highly relevant for policymakers at central banks as qualitative survey-based indicators are often used to assess labour market conditions in real-time and to cross-check other estimates of "slack" or "gaps" (see for example Nyman 2010 for Sweden, ECB 2015 for the euro area and Tito 2018 for the United States). Survey indicators are also used to inform policy decisions. For example, several members of the Executive Board of the Swedish central bank highlighted record-level labour shortages as a motivation for the decision to begin tightening monetary policy at the December 2018 Monetary Policy Meeting (Sveriges Riksbank, 2018a).

The analysis in this paper suggest that labour markets were not as tight as other measures indicated during the recovery and they would likely have to tighten more substantially to provide impetus to wage growth and inflation, in line with the theoretical analysis of Daly and Hobijn (2014) and Lindé and Trabandt (2019) and aggregate empirical analyses by Byrne and Zekaite (2018) and Nickel et al. (2019) for the euro area.

The rest of this paper is organized as follows: Section 2 describes the Swedish Public Employment Service's interview survey and the data used. Section 3 presents the measure of relative labour shortages, Section 4 estimates the relationship between RLS and wage growth at the establishment-level and Section 5 estimates sector-level wage Phillips curves and illustrate how RLS compares to other measures of economic slack in explaining wage growth in the recovery from the Great Recession. Section 6 concludes.

2. The Public Employment Service's Interview Survey

The backbone of this paper is detailed micro data from the Swedish Public Employment Service's interview survey (the AFU), which has existed in different constellations since the 1960s and been an important tool for the Swedish Public Employ-

ment Service's regional and national labour market forecasts.[9] Before 2007, however, the micro data were not kept in a systematic manner and cannot be retrieved.

The dataset used in this paper covers more than 250,000 responses and around 10,000 establishments are included in each biannual survey wave. The sample in the survey is drawn from Statistics Sweden's Business Register and is stratified by establishment sizes (employment at establishments), sectors (SNI 2007/NACE Rev.2.) and Swedish regions ("län"). The sample frame includes establishments with more than five employees and all establishments with more than 100 employees are included, see Table A.1. The survey is representative for Sweden as a whole and at the regional level.

To increase the weight of small sample units that also represent many small units in the population that were not included in the sample, sample weights are included from 2013h1 and onward.[10] When greater weight is given to small sample units (column 3 in Table A.1), the respective sector employment shares in the survey are closer to the population. For example, industry accounts for a slightly smaller share in the sample with 18.8% (31.2% unweighted), compared to 20.4% in the population. The weighting also improves the representatives among size-classes: for small establishments (0-19 employees), the weight increases from 6.2% to 34.1%, closer to 33.7% in the population. With weights, large establishments account for 30.2% instead of 71.2% unweighted and compared to 44.9% in the population.

As sample weights are not available prior to 2013h1, I use simple averages to calculate the aggregate time-series. This means that the time-series are not necessarily representative for the population as a whole, although the total number of employees covered by the sample alone accounts for more than a fourth of total Swedish

[9] See for example the Swedish Public Employment Service report, Arbetsmarknadsutsikter hösten 2019-2020. ("Prospects of the Swedish labour market 2019-2020, fall").

[10] The sample weights are simply $w = (N - O)/n$, where N is the number of establishments in the population, O is oversampling and n the sampled units. When the Swedish Public Employment Service report their figures, they utilize sample weights from 2013h1 onward and equally weighted data from before then.

business employment.[11]

2.1 Design and survey questions

Respondents in the survey are typically the CEO, CFO or senior managers at the establishments and the interviewers are local employment officers at the Public Employment Service. The survey is conducted face-to-face or by phone, which allows the interviewers to ask more detailed questions than in mail-out questionnaires or web surveys. This is precisely what makes this survey unique: besides gathering qualitative Likert-scale type responses for assessments and expectations (that is, ”Increase”, ”Unchanged”, ”Decreased”), it also gathers quantitative assessments (of for example labour shortages, employment and wage growth) and expectations (of employment).

Participation in the survey is voluntary. Nonetheless, the response rate is markedly high, on average above 80 percent. According to the Swedish Public Employment Service, the high response rate is a result of long-standing relationships between interviewers and interviewees.

The questions from the survey used in this paper reads as follows:[12]

- *The number of employees at the establishment (excluding contract staff). Provide the number of persons and your expectations for the future:*
  A year ago: Currently: In a year: In two years:

- *Have you experienced labour shortages in connection with recruitment over the past six months?*
  Yes, No or Have not needed to recruit

  If yes:

[11] In more detail, for 2014h1, the total number of employees covered by the survey sample was 732,329 as compared to 3,251,000 in the population for 2014. This is roughly equal across survey waves.

[12] The full questionnaire is available at https://arbetsformedlingen.se/om-oss/statistik-och-analyser.

– *Provide the number of positions where you experienced labour shortages:*

- *Quantify by how much the average salary (per employee) has increased at the establishment over the last year:*
  Less than 1%, 1%-2%, 2%-3%, 3%-4%, 4%-5%, 5%-6%, 6%-7% and above 7%

2.2 Change in survey mode and provider in 2020

At the beginning of 2020, the responsibility for the AFU-survey was outsourced by the Public Employment Service to Statistics Sweden (SCB). Following the change, the survey mode was altered from face-to-face and telephone interviews to a web-based survey. In the two waves conducted in 2020, the response rate fell from the previous highs of around 80 percent to around 30-40 percent. The fall in the response rate can partially be attributed to the Covid-19 crisis, but it cannot be excluded that the change in survey mode and survey supplier have (strongly) affected the response rates.

As such, the time-series after 2019 should be taken with more caution than the period 2007h1–2019h2.[13] In the econometric analysis in Section 4, only data from 2007h1-2018h1 will be used as identifiers for regions, sectors and establishments (from 2013h1), are available. Time-series computations and the analysis in Section 5 as well as simple correlations will utilize data for the full period (2007h1-2020h2).

2.3 Comparison with other sources

One important aspect when dealing with non-standard sources is to ensure that the data corresponds to other statistics, when applicable. In the following, I compare variables available from the AFU with other official sources. For example, the proportion of respondents in the AFU who report labour shortages is compared with the same figure from the National Institute of Economic Research (NIER) Economic

[13] Instead of having a responses for around 10,000 establishments, the 2020h1 and 2020h2 waves had only around 4,000 responses respectively.

Tendency Survey, and wage growth is compared with short-term statistics from the National Mediation Office (NMO), which is the main source used to track nominal wage developments in Sweden.

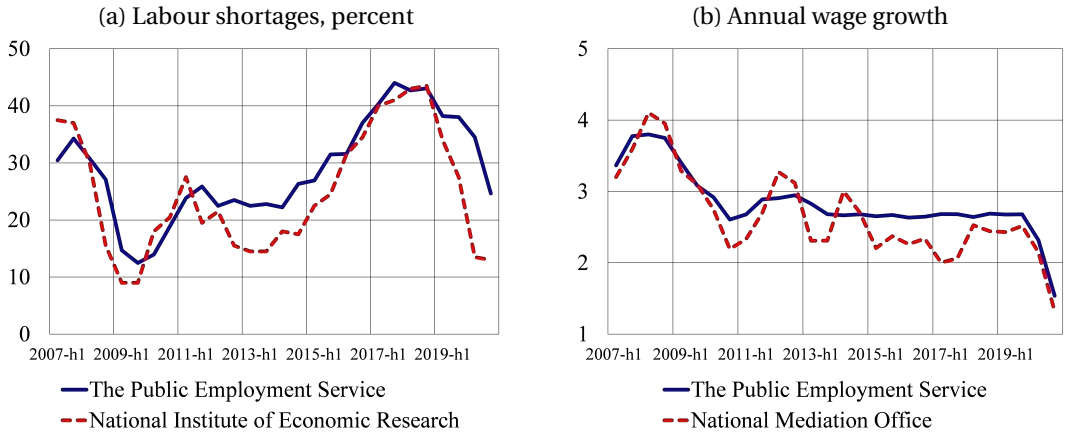
To compare labour shortages from the AFU with the NIER-survey, I calculate the proportion of respondents that respond *"Yes"* to whether they have experienced labour shortages. There are a couple of differences between the two surveys. First, the AFU survey is conducted bi-annually whereas the NIER survey is conducted quarterly. Second, the NIER survey simply asks their respondents to answer the statement: *"Labour shortages at present?"* with the response alternative *"Yes"* or *"No"* whereas the AFU asks respondents to answer the question: *"Have you experienced labour shortages in connection with recruitment over the past six months?"* with the response alternatives *"Yes"*, *"No"* or *"Have not needed to recruit"*. To enable comparisons, I calculate the average of the NIER labour shortages for the first and second quarter when comparing to the AFU:s first half of the year observation, and the third and fourth quarter for the second half of the year.

Nominal annual wage growth computed from the AFU is compared with data from the NMO. I use the mid-point of answers to the wage question in the AFU survey. That is, 0.5% represents responses that are in the bin "less than 1%", 1.5% if the bin is "1%-2%" and 2.5% if the bin is "2%-3%" and so on. Nominal annual wage growth from the National Mediation Office is the wage sum divided by the number of hours worked. Overall, qualitative labour shortages and aggregate wage growth are very similar to those obtained from other sources in Sweden, see Figure 2. The comparability is also matched for broad sectors of the economy: industry, construction, retail trade and services, see Figure A.1 and A.2 in the Appendix.

3. A measure of relative labour shortages (RLS)

In search models of the labour market (see for example Shimer 2005), tightness is defined as the vacancy-unemployment ratio. A higher ratio of vacancies to unem-

Figure 2: Comparison with other sources



Note: (a) shows the share of respondents that are experiencing labour shortages in the Public Employment Service (solid line) and the National Institute of Economic Research (dashed line). (b) shows the annual growth in nominal wages from the Public Employment Service (solid line) and the National Mediation Office (dashed line). The midpoint for each response category has been used in the AFU. This means that wage growth is 0.5 percent if respondents answer less than 1 percent, 1.5 if they answer between 1.0 and 2.0 percent, 2.5 if they answer between 2.0 and 3.0 percent and so forth. Nominal annual wage growth from the NMO is the nominal hourly wages in businesses.

ployment entail a larger number of jobs that employers would like to fill relative to the number of unemployed people available to fill them and implies a tighter labour market. In the AFU survey, respondents take a stand on how many positions they experienced shortages when they recruited over the past six months, S. One could conceivably think of this as points on the vacancy-unemployment curve, where few shortages indicate many applicants for each position (high unemployment and few vacancies) and more shortages corresponds to a small pool of applicants (low unemployment and several vacancies).

The number of shortages vary with the size of the establishment, however. Large establishments tend to have greater absolute number of shortages than smaller establishments and if the establishment is growing, it is natural that the number of shortages increase as well. Fortunately, the AFU-survey also collect information about establishments' current number of employees, E. To obtain an

establishment-level measure of relative labour shortages, the number of labour shortages S_{it} are divided by the total number of employees at the establishment E_{it} as in (1):

$$RLS_{it} = \frac{S_{it}}{E_{it}} \tag{1}$$

Here, i is a establishment and t a survey round. This establishment-level measure of relative labour shortages (RLS) is continuous and relative: a higher value means that the number of positions where establishments experience labour shortages are increasing relative to the size of the establishment and is what one would expect when the labour market tightens. Similarly, a lower value means that establishments are experiencing less shortages and indicate a looser labour market.[14] Establishments with no labour shortages or have not needed to recruit have a RLS value of zero.

3.1 The evolution of RLS over time

The aggregate measure of RLS is simply the average of the establishment-level indicator over time:

$$RLS_t = \frac{1}{Y_t} \sum_{i=1}^{Y_t} \frac{S_{it}}{E_{it}} \tag{2}$$

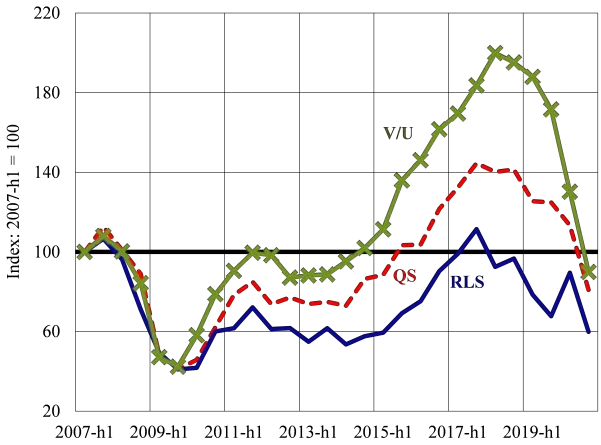
where Y is the total number of responses to the question: *"Have you experienced labour shortages in connection to recruitment over the past six months?"*. Figure 3 plots the time-series average of RLS with the conventional survey-based indicator for labour shortages (QS) as well as the vacancy-unemployment ratio (V/U), indexed to 100 in 2007h1 for comparison.[15] From 2011h1 and onward, RLS

[14] To deal with very extreme values reported in the survey, I winsorize the number of shortages and employment at the 99.5^{th} percentile. The measures is however robust in choosing both higher and lower percentile values for winsorizing. See Figure A.6 in the Appendix.

[15] The series are also calculated the broad sectors of the economy (industry, construction, retail trade and services) in Figure A.3 and is also replicated for Swedish regions (NUTS1) in Figure A.7 in

was markedly lower than QS and the vacancy-unemployment ratio (V/U). Moreover, and contrary to these other indicators, RLS was only above its 2007h1 level in 2017h2 and fell back below it in 2018h1. Differently, the QS indicator and the V/U was above the 2007h1 level already in 2015 and thus signalled stronger labour market conditions than RLS.

Figure 3: Relative labour shortages (RLS) and other indicators



Note: QS (the dashed line) is simply the share of respondents that responded "Yes" to whether or not they experienced labour shortages in connection to recruitment over the past six months. V/U (crossed line) is the vacancy-unemployment ratio measured as total number of vacancies as percent of the labour force, over unemployed persons as percent of the labour force in the age group 15-74 years retrieved from the Swedish National Institute of Economic Research. RLS (the solid line) is the average ratio of number of positions where respondents experienced labour shortages to total employment at the establishment. All series are indexed to 2007h1 for comparison.

The reason why RLS indicate more labour market slack than the other survey-based measure is that the indicator provides information on the supply and demand of labour from a recruiting firm's perspective, rather than providing merely the direction of labour market tightness in case of QS (i.e. the proportion of respondents experiencing labour shortages). The fact that RLS and QS diverge tells us that an increasing number of respondents (the extensive margin) perceived labour shortages during the recovery, but that their quantitative assessment of labour

the Appendix and with sample weights from 2013h1-onward in Figure A.5.

shortages (the intensive margin) was decreasing.

That the intensive margin is important to take into consideration can be shown with (3), which decomposes (2) into two parts: the extensive margin, which is simply the the proportion of respondents that experience labour shortages, y/Y, where y is the number of respondents responding "Yes" to if they experience labour shortages and Y is all responses.[16] The second part of the expression is the average labour shortages per establishment, i.e the intensive margin.

$$RLS_t = \underbrace{\frac{y_t}{Y_t}}_{\text{extensive margin}} \times \underbrace{\frac{1}{y_t}\sum_{i=1}^{y_t}\frac{S_{it}}{E_{it}}}_{\text{intensive margin}} \tag{3}$$

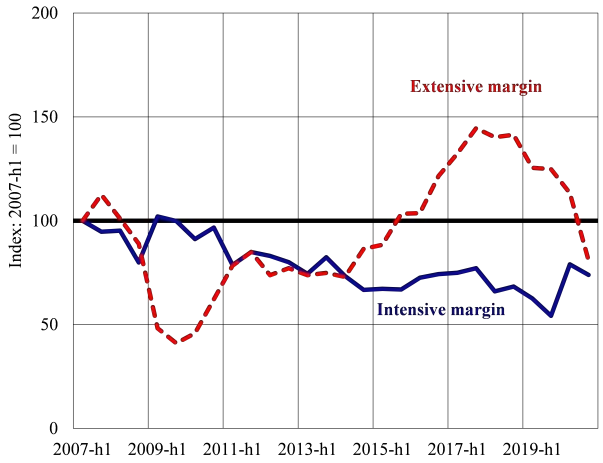
Most business surveys record only the first part of (3) and implicitly assume that the second part is fixed, or not varying much, over time. This assumption has clear downsides. If, for example, a large fraction of establishments experience shortages of specialized competencies, they may report a shortage of labour or perceive labour as an important factor limiting production in a survey (increasing y), even though the number of positions and wages for those staff are only a small part of the total employment and wage bill at the establishment. If this behaviour is pervasive across many respondents, rising qualitative labour shortages, or the extensive margin, may not indicate that the labour market has tightened in overall terms, but simply that many establishments are experiencing shortages of a narrow set of skills and competencies.[17] Figure 4 shows that the intensive margin of labour shortages has indeed been trending downward and been far below the 2007h1 level all through the recovery from the Great Recession in Sweden.[18]

[16] That is, the sum of responses of "Yes", "No" and "Have not needed to recruit".

[17] In the Riksbank Business Survey, a small-scale interview survey conducted by the Swedish Central Bank, respondents have highlighted that labour shortages have mainly been acute for specialized competencies rather than for broad groups of staff, see Sveriges Riksbank (2018b).

[18] Figure A.4 in the Appendix shows the evolution of the extensive and intensive margin over time for also the four broad sectors of the economy, industry, construction, retail and services. Across all sectors, the intensive margin measure is markedly lower in the 2013-2020 period than before the Great Recession.

Figure 4: Intensive and extensive margin of RLS



Note: The extensive margin (the dashed line) is the share of respondents that responded "Yes" to whether or not they experienced labour shortages in connection to recruitment over the past six months. The intensive margin (the solid line) is the average ratio of number of positions where respondents experienced labour shortages relative to total employment at the establishment. Both series are indexed to 2007h1 for comparison.

That the intensive margin is trending downwards suggests that the quantitative signal from purely qualitative surveys of labour shortages becomes less reliable as a gauge of labour market conditions or "slack". This problem with qualitative survey data has also been highlighted for other indicators by Gayer and Marc (2018) and National Institute of Economic Research (2018a). It should be noted, as shown by Müller (2009), Lui et al. (2011) and Frohm and Hokkanen (2019) that qualitative survey data do tend to reflect movements in matched quantitative statistics at the firm-level. The purpose of this paper is not questioning this basic finding, but rather to point out that the quantitative signal might vary over time which is indeed the case in the AFU.

Although the split of labour shortages into an intensive and extensive margin in this paper cannot readily be replicated for other countries or jurisdictions, due to the specifics of the AFU survey, it is unlikely that Swedish respondents behave very differently from those in other advanced economies when answering qualita-

tive surveys. If the results are specific to Sweden alone, it would imply that survey results in general (such as those from the DG-ECFIN Economic Tendency Survey or the Purchasing Manager Indices) are not comparable cross jurisdictions and countries.[19]

Asking respondents directly about quantitative assessments is one way of dealing with the problems inherent in qualitative survey data. Recent examples, other than the AFU, are business surveys developed by the Federal Reserve Bank of Atlanta (Survey of Business Uncertainty) see, Altig et al. (2020a) or Altig et al. (2020b) and the Bank of England (Decision Maker Panel), see Bloom et al. (2018). These surveys ask respondents' about their quantitative assessment of the current situation and future developments for a number of economic variables, with promising results for assessing, for example, the evolution of business uncertainty.

3.2 Sectors driving the evolution of RLS

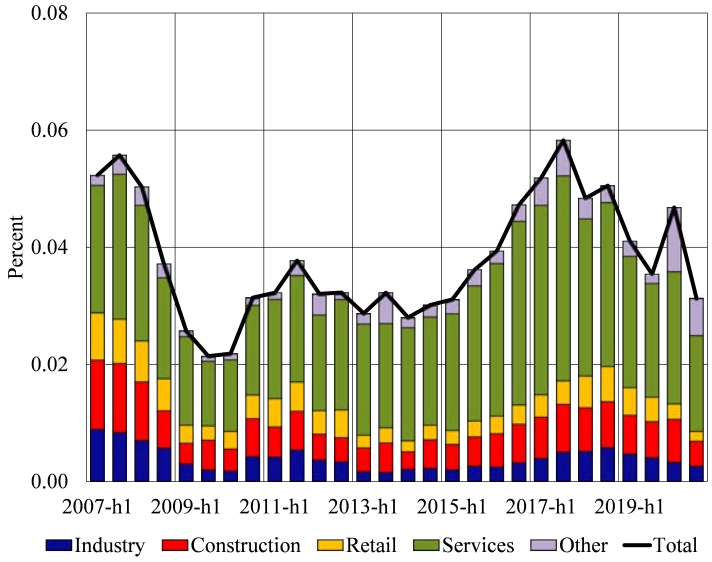
With the detailed data in the AFU, RLS is decomposed into the contributions from the main (NACE Rev.2.) economic sectors to gain more insights into whether the drivers of aggregate labour shortages have changed over time. Ideally, the survey would collect information on which specific occupations or roles are in shortages *and* the current composition of the occupations or roles within the establishment. This would enable a more detailed analysis of how shortages of certain occupations *within* sectors evolve over time. Nonetheless, the current structure of the survey suffices to break down labour shortages into narrow economic sectors (5-digit NACE Rev. 2).

Figure 5 shows the decomposition which reveals that the relatively high labour shortages in 2007–2008 were driven roughly equally by traditional blue-collar sectors such as industry, construction and retail trade, and the heterogeneous services

[19] Figure A.8 shows that the percentage of responses that labour shortages are a main factor limiting production in the European DG-ECFIN Economic Tendency Survey in Sweden and the euro area are strongly correlated.

sector. In contrast, labour shortages during the recovery from the crisis, and especially after 2013, were largely driven by shortages in the services sectors, whereas those in industry, construction and retail trade only increased slowly. By 2017–2018, these same sectors only contributed to about one third of the aggregate labour shortages.

Figure 5: Relative labour shortages (RLS) and contribution of sectors

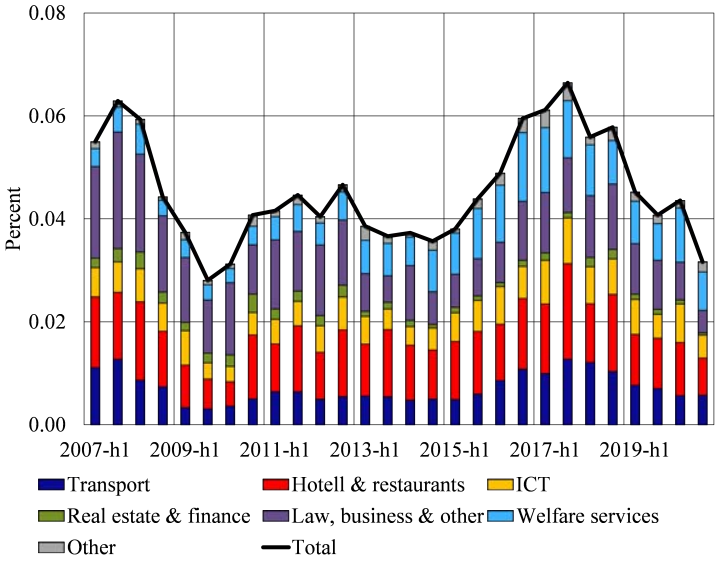


Note: RLS (the solid black line) is the average ratio of number of positions where respondents experienced labour shortages to total employment at the establishment. It is decomposed into the contributions from industry (blue bars), construction (red bars), retail trade (yellow bars), services (green bars) and other sectors (gray bars).

A further decomposition within the services sector reveal that labour shortages in primarily the ”welfare” sectors (health and elderly care, and to a lesser extent education services), drove the increase after the crisis in Sweden, see Figure 6.[20] These services sub-sectors are very different from other types of services or sectors. The reason is that health and elderly care, as well as education, is almost entirely funded by the Swedish government, either nationally, regionally or from the municipalities.

[20] In Sweden, welfare services are usually defined as those in health care, elderly care and education. Welfare services are defined as NACE Rev.2. 5-digit codes above 85000 and below 90000

Figure 6: Relative labour shortages (RLS) in services, the contribution of sub-sectors



Note: RLS (the solid black line) is the average ratio of number of positions where respondents experienced labour shortages to total employment at the establishment in the services sector. It is decomposed into the contributions from services sub-sectors.

Even though many providers of welfare services are subject to competition and the services are open to the entry of new providers, revenues (per patient or student) are determined by political decisions (Svanborg-Sjövall, 2014).

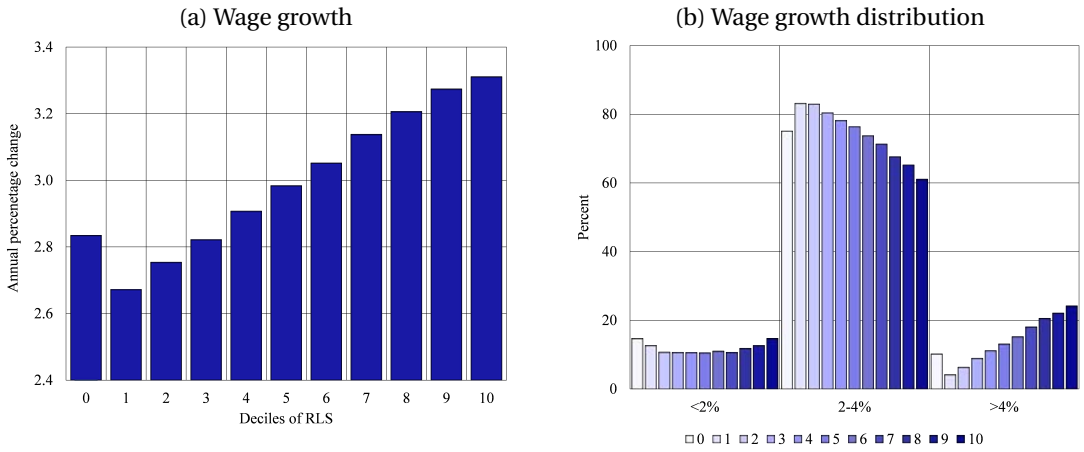
The scope to adjust wages to economic conditions, such as labour shortages, is hence smaller for firms in these sectors than firms in other sectors where revenues and profits are determined by market processes. In Section 4 I explore empirically whether wage growth at establishments in the welfare sectors do indeed respond differently to RLS than other establishments.

4. Relationship between RLS and wage growth

Since the AFU both collects respondent's assessment of their average annual nominal wage growth and RLS, it is possible to examine how wage growth varies across

levels of RLS. This is done in Figure 7 by computing deciles of RLS and average wage growth at each decile. Here, decile = 0 is all firms with no labour shortages and the rest of the deciles are computed for firms with positive values of RLS.[21] Average wage growth is slightly higher for establishments with no labour shortages than establishments with labour shortages below the 3^{rd} decile. From the 4^{th} decile of RLS and onward, average wage growth is higher than when RLS $= 0$. For establishments at decile 10 for example, wage growth is 0.4 percentage points higher than if RLS $= 0$.

Figure 7: Wage growth across deciles of labour shortages



Note: The figure in (a) shows the average annual nominal wage growth for each decile of RLS. The group "0" is all establishments without any labour shortages. RLS at decile 1 for all establishments is 0.006, at 2 0.016, at 3 0.030, at 4 0.045, at 5 0.066, at 6 0.914, at 7 0.120, at 8 0.159, at 9 0.230 and at 10 0.657.

Panel (b) in Figure 7 shows that also the distribution of wage growth varies across deciles of RLS. For establishments in the first decile of RLS, more than 80 percent respond that wages increase in the 2-4 percent range, which can be contrasted with around two thirds of establishments in the 10^{th} decile. Changes in the distribution of RLS is also largely accompanied by a higher share of responses that wages in-

[21] Again, the same Figures are available for establishments in industry, construction, retail trade and services in Figure A.9 and A.10 in the Appendix.

creases by more than 4 percent annually.

Figure 7 are however only cross-sectional correlations that do not controls for potential confounders or omitted variables. The next section proceeds to investigate whether the relationship between RLS and wage growth is robust to further controls.

4.1 Fixed-effects regressions

To further control for observable and unobservable factors that affect wage growth at the establishment, a dynamic lag panel fixed-effects regression is employed. The dynamic structure allows for both current and past levels of RLS to affect wage growth, as wages might respond with a lag to labour shortages. The estimated regression is:

$$w_{i,t} = \gamma + \lambda_t + \sum_{k=0}^{3} \beta_k RLS_{i,t-k} + \beta_X X_{i,t} + \varepsilon_{i,t} \tag{4}$$

where, w is nominal annual wage growth and RLS is relative labour shortages. k denotes the number of lags used which are set to three, informed by the fact that the correlation coefficient between different measures of economic slack and aggregate wage growth is usually the highest between 3-6 quarters, see National Institute of Economic Research (2018b). X is a vector of additional controls for expectations of demand conditions, γ is either a sector$\times$region or establishment fixed-effect, λ is a time (or sector$\times$time or region$\times$time) fixed-effect and ε is the error term. i is an establishment and t a survey wave.

The wage variable used in this paper is ordinal, with responses being grouped in several bins of wage growth (less than 1%, 1-2% and so forth). When the left side of the equation is on an ordinal scale, it is usually advised to use a ordered logit estimator. However, there is no consensus in the literature on how to implement an fixed-effects estimator for the ordered logit model (see Dickerson et al. 2014) and ignoring observational heterogeneity could severely bias the estimates. As shown by

Riedl and Geishecker (2014) in Monte Carlo simulations linear fixed-effects models delivers essentially the same results as several proposed ordinal logit fixed-effects models. I will thus proceed to use linear fixed-effects models in the main text. The results are however robust to use ordered logit fixed-effects and estimates with the "Blow-Up and Cluster" (BUC) estimator presented in Baetschmann et al. (2015) are included in Table A.4 in Appendix A.

First the baseline results examine the coefficient and significance of RLS is examined with sets of fixed-effects for region, sector and time. Second, establishment-level controls are added for expected demand conditions and forward-looking behaviour. Third, the relationship between wage growth and RLS is investigated when also controlling for heterogeneity with establishment fixed-effects.[22]

4.2 Baseline results

Column (1) in Table 1 shows the baseline estimates with year fixed-effects (controlling for, for example, the aggregate business cycle or national economic policy). The baseline estimates in column (1) confirms the positive relationship outlined in Figure 7. Higher RLS is associated with an increase in wage growth. Column (2) further controls for negotiated wages and sector-level productivity with sector×time fixed-effects, column (3) adds fixed-effects for sector×region to control for time-invariant differences across sectors in certain regions and column (4) adds region×time fixed-effects, to control for regional economic conditions. In this specification, RLS has an 0.47 percentage point impact on wage growth after 1.5 years. Note that this effect is the effect on wage-drift, as negotiated wages are controlled for with the sector×time fixed-effects.[23]

[22] Recall that the AFU is an unbalanced panel with a large number of respondents only participating one, two or three times and not necessarily in a row. This means that the estimates will contain about 30% of the sample observations.

[23] About 9/10 employees in Sweden are affected by sector-level collective bargaining agreements. See https://www.mi.se/other-languages/about-the-mediation-office-the-swedish-model-and-wage-statistics-in-english/

Table 1: Wage growth and RLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	2.777***	2.786***	2.780***	2.780***	2.773***	2.754***	2.648***
	(0.007)	(0.006)	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)
RLS_t	0.212***	0.205**	0.209**	0.210**	0.191**	0.204**	0.849***
	(0.082)	(0.085)	(0.091)	(0.092)	(0.088)	(0.091)	(0.155)
RLS_{t-1}	0.089	0.084	0.089	0.086	0.067	0.083	0.086
	(0.070)	(0.063)	(0.061)	(0.060)	(0.055)	(0.059)	(0.161)
RLS_{t-2}	0.248***	0.162**	0.162**	0.163**	0.165**	0.166**	0.009
	(0.068)	(0.067)	(0.067)	(0.067)	(0.070)	(0.068)	(0.140)
RLS_{t-3}	0.171***	0.074	0.062	0.065	0.060	0.061	0.105
	(0.065)	(0.051)	(0.050)	(0.050)	(0.050)	(0.051)	(0.070)
Total effect	0.721***	0.525***	0.522***	0.524***	0.483***	0.514***	1.049***
	(0.131)	(0.126)	(0.136)	(0.137)	(0.133)	(0.136)	(0.313)
Obs	65,997	63,352	61,780	61,780	57,929	60,898	61,780
R^2	0.128	0.263	0.345	0.351	0.359	0.354	0.496
Clusters	6,001	5,716	4,293	4,293	4,208	4,277	4,293
FE			S-R	S-R	S-R	S-R	S-R
Time-FE	T	T-S	T-S	T-S, T-R	T-S, T-R	T-S, T-R	T-S, T-R

Note: *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. S = sector, R = region and T = time. Standard errors are clustered at the sector×region level. The total effect refers to the linear combination of parameter estimates ($k = 0$, $k = 1$, $k = 2$ and $k = 3$). Column (5) includes respondent's expectations of employment growth at the establishment next 24 months as a measure of expectations and Column (6) a qualitative measure if the level of demand is expected to increase in the next 12 months. (7) includes weights for employment at the establishment.

4.3 Additional controls

column (5)-(7) in table 1 adds additional establishment-level controls. Column (5) adds respondents' expectations of employment growth at the establishment the next two years (a proxy for future demand conditions). It is calculated by using the (log) difference of answers to the question on the number of employees currently and expectations of number of employees in the next 24 months.

Column (6) swaps this variable with another proxy for forward-looking wage-setting, namely answers to the question "*Do you judge demand for your goods and or services to increase, decrease or remain unchanged over the next 6-12 months?*". Column (7) weighs the results by the number of employees at the establishments. The results are also replicated for the broad sectors of the economy with sector×region, as well as sector×time and region×time fixed-effects in Table A.2 in Appendix A. Note that the sector×time fixed-effects are calculated for NACE Rev. 2 5-digit sectors, so they can still be used in the broad sector-level regressions. Results remain significant and of the same magnitude as in the baseline regressions.

4.4 Establishment fixed-effects

In this section, only the within-establishment variation is used to estimate the effect of RLS on wage growth. The results are in Table 2. Overall, the effect of RLS is significant and positive, meaning that RLS can also help explain wage growth within establishments. The total effect of RLS on wage growth is between 0.38-0.48 percentage points depending on whether additional controls for future demand conditions are included. Note that this is the effect when heterogeneity, sector shocks (sector productivity and negotiated wages) and regional shocks are controlled for.

As seen in section 3.2, labour shortages in services and in particular welfare services increased sharply during the recovery from the Great Recession and was one important factor behind the rise in the aggregate RLS. With welfare services being largely funded by national, regional or municipal governments, the impact of labour

Table 2: Establishment fixed-effects

	(1)	(2)	(3)	(4)	(5)
RLS_t	0.231***	0.203***	0.231***	0.557***	0.305***
	(0.065)	(0.065)	(0.067)	(0.161)	(0.062)
RLS_{t-1}	0.132***	0.113**	0.131***	0.081	0.180***
	(0.049)	(0.048)	(0.050)	(0.126)	(0.047)
RLS_{t-2}	0.047	0.021	0.054	0.059	0.054
	(0.083)	(0.086)	(0.084)	(0.105)	(0.062)
RLS_{t-3}	0.062	0.046	0.065	0.074	0.080*
	(0.053)	(0.052)	(0.055)	(0.056)	(0.043)
Total effect	0.472***	0.382**	0.482***	0.771***	0.619***
	(0.157)	(0.158)	(0.159)	(0.250)	(0.149)
Total effect×welfare					0.007
					(0.323)
Obs	50,733	47,260	49,922	50,733	53,791
R^2	0.573	0.582	0.576	0.620	0.480
Clusters	3,664	3,560	3,640	3,664	8,752

Note: *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. All regressions include establishment, section-time and region×time fixed-effects, except for column (5) that includes establishment and region×time fixed-effects. Standard errors are clustered at the sector×region level. Column (2) includes respondent's expectations of employment growth at the establishment next 24 months as a measure of expectations and Column (3) a qualitative measure if the level of demand is expected to increase in the next 12 months. (4) includes weights for employment at the establishment and (5) includes a dummy for the welfare sectors and interactions with the lags. The total effect refers to the linear combination of parameter estimates ($k = 0$, $k = 1$, $k = 2$ and $k = 3$).

shortages on wage growth might be different than for establishments in other industries.

To explore this possibility, a dummy variable is defined as = 1 if an establishment is in one of the welfare services sectors and zero otherwise. Next, the dummy is

interacted with the measures of RLS. As sector×region or sector×time fixed-effects would absorb the effect of the dummy, these are dropped. Only region×time fixed-effects are thus included to control for regional labour market conditions and the specification reported in column (5) is therefore less comprehensive than the other establishment-level regressions.[24]

The results suggest again that for all establishments, the total effect of RLS on wage growth is 0.62 percentage points and statistically significant at the 0.01 percent level. However, for establishments in the welfare services sector wage growth does not appear significantly related to labour shortages. Comparing the point estimates across the lags of RLS shows that labour shortages have no statistically significant effect on wage growth for these sectors.

That wages seem to respond differently for establishments in welfare services than for other sectors can be a (compositional) reason to why an increase in the aggregate RLS has not led to wage pressures in the 2013-2019 period.

5. Wage forecasts in the recovery

Until now, the aggregate RLS indicator has been presented and been compared with other measures of labour market conditions. The positive relationship between RLS and wage growth at the establishment-level has also been highlighted. What is important for macroeconomic policy however is the aggregate implications. That is, can RLS help explain the low wage growth in the economic recovery from the Great Recession and does it do a better job than conventional indicators?

To answer this question, disaggregated wage Phillips curves are employed, in the spirit of McLeay and Tenreyro (2020) and Hazell et al. (2020). Whereas these earlier studies focus on regional price Phillips curves, I utilize the sectoral dimension in the AFU by aggregating the establishment-level data to NACE Rev. 2. 2-digit sectors, yielding 71 observations for each period. This level of aggregation ensures enough

[24] The full regression table with interactions is in Appendix A in Table A.3.

observations to be able to construct a stable comparison index QS (the qualitative survey measure of labour shortages) as well as RLS.

The estimated wage Phillips curve outlined in (5) is similar in spirit of Nickel et al. (2019) and Sveriges Riksbank (2017), although the specification is estimated for the cross-section of sectors in the AFU.

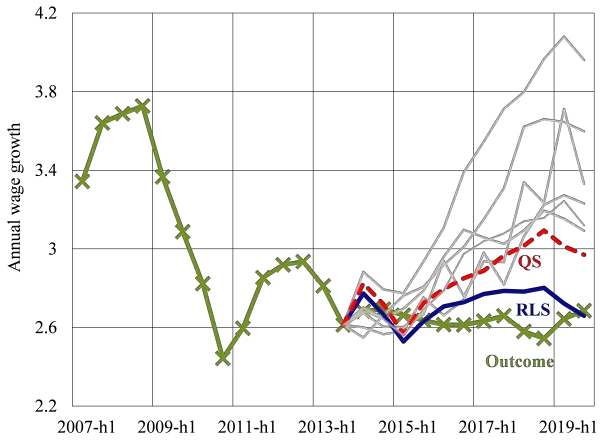
$$\pi_{i,t}^{w} = c + \beta_y y_{i,t-2} + \beta_\pi E\pi_t^{w} + \beta_X X_{i,t} + \varepsilon_{i,t} \tag{5}$$

where c is a constant, y is the sector-specific measure of labour shortages (QS or RLS), or an aggregate measure of economic slack (then dropping subscript i). Specifically, the vacancy-unemployment ratio (V/U), the Riksbank measure of resource utilization (RU indicator), Hours-gap or GDP-gap, the National Institute of Economic Research (NIER) percentage of respondents in industry indicating that labour is the main factor limiting production and the unemployment rate. The time-lag for the slack measures is one year (as in the previous section estimating the effect at the establishment-level). $E\pi_t^{w}$ is a measure of expected wage growth or the expected annual change in the CPI in two years (k), from the Swedish survey of professional forecasters, Prospera. $X_{i,t}$ are a vector of additional sector-level controls (expectations of future demand conditions, approximated with expected employment growth the next or next two years).

To gauge how the different measures of labour market slack capture Swedish wage dynamics in the economic recovery, the simple specification is estimated with data covering 2008h1-2013h2. The coefficients from this regression are then used to forecast wage developments up until the end of 2019 with the outcomes of the variables in the specification. The baseline regressions utilize expectations of wage growth for the next two years, as wages in Sweden are usually renegotiated every 2-3 years (see Figure 8).

These baseline results show that RLS outperforms the sector-level indicator QS (that is based solely on qualitative survey data). On average, the estimated wage

Figure 8: Forecasts of wage growth



Note: Standard errors are clustered at the sector-level. The estimates includes wage growth expectations in the next two years and the regression is estimated over the period 2008h1-2013h2, including 826 observations. The outcome of wage growth is then predicted by using the estimated coefficients and the evolution of the slack measures and wage expectations.

Phillips curve in 2008h1-2013h2 that include RLS pointed to annual wage growth at 2.7%, on average over 2014–2019. QS on the other hand predicted annual wage growth to be 2.9% over the same period, whereas the outcome was 2.6%.

While other measures of labour market slack are not available at the sector-level, I also use commonly used aggregate measures of economic slack to see how well they explain average sectoral wage growth since the beginning of 2014 in Figure 9. First, RLS outperforms all the conventional indicators available in real-time, like (a) the vacancy-unemployment ratio, (b) the RU-indicator, (c) labour as a limit to production and (d) the unemployment rate. The outperformance is a bit smaller against (e) the hours-gap and (f) the GDP-gap, but keep in mind that these gaps refer to Riksbank's current estimates (as of the April 2021 Monetary Policy Report) for the period covered and not real-time measurements.

Second, albeit to a less extent, QS also improves on the aggregate measures of

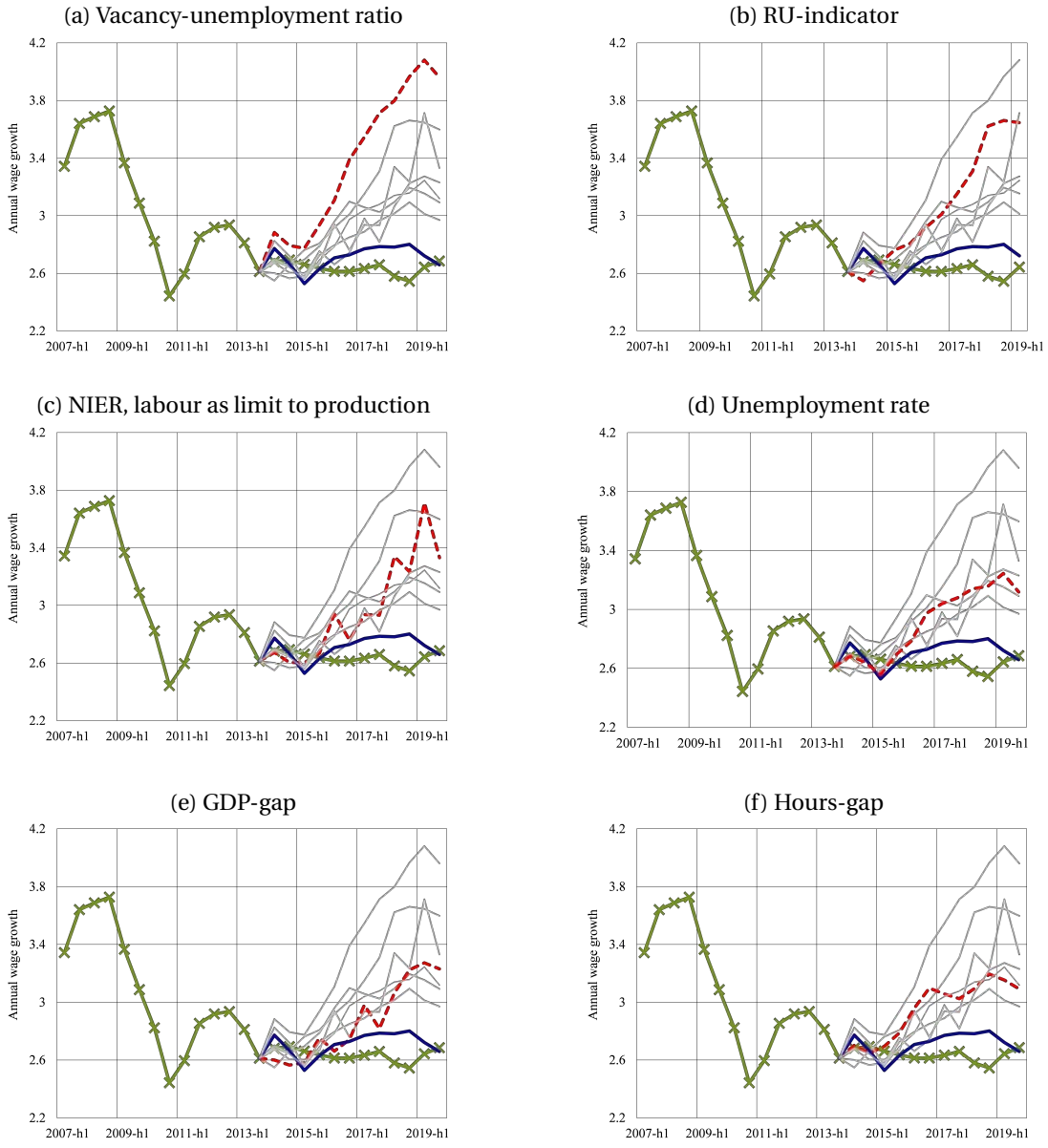
labour market slack, indicating that the idiosyncratic sector-specific variation in the slack measures (RLS or QS) are important to take into consideration when estimating wage Phillips curves.

Are the baseline results from the cross-sectional regression robust to other expectations processes? To examine this, 11 different wage Phillips curves are estimated including expectations for the annual growth of CPI the next two years, past wage growth at the sector-level and annual growth in consumer prices (or consumer prices with fixed mortgage-rates) in the past year, similar to Galí (2011), as well as different combinations of backward and forward-looking variables. The swath of wage growth estimates confirm the conclusions from the baseline regression: RLS outperforms other measures in explaining wage growth since the end of 2013 and the range of estimates are fairly compact, see Table A.11 in Appendix A.

Are the results also robust to additional controls? For example, the regression in (5) does not control for sector-specific intercepts (sector fixed-effects) nor sector-level labour productivity. For example, Nickel et al. (2019) also add controls for labour productivity in their aggregate specifications, whereas Sveriges Riksbank (2017) includes trend productivity growth (as assumed by Sveriges Riksbank). Sector-level data on labour productivity growth (value added / employment) are therefore added to the regressions and is retrieved from annual sectoral figures from Statistics Sweden and are interpolated linearly to match the bi-annual frequency in the AFU.

In addition, other aggregate factors that might affect the relationship between labour shortages and wage growth that cannot fully be captured with explicit controls. To more fully control for such factors, time fixed-effects are included. The aggregate measures of slack are thus omitted as they are perfectly co-linear with the time fixed-effects. As Table A.5 in Appendix A shows, the baseline results are also robust to the inclusion of these controls, although the overall fit of the regressions improves with lags of wage growth. However, QS becomes insignificant with these additions while RLS remains significant in explaining wage growth at the sector-

Figure 9: Forecasts of wage growth



Note: Standard errors are clustered at the sector-level. RLS is the solid blue line, the comparison measures (denoted in the title) are highlighted in dashed red lines.

level.

Overall, the establishment and sector-level empirical evidence supports the no-

tion that labour markets would have to tighten more significantly for wages to increase at a faster rate, in line with the theoretical analysis of Daly and Hobijn (2014) and Lindé and Trabandt (2019) and aggregate empirical analyses by Byrne and Zekaite (2018) and Nickel et al. (2019) for the euro area.

6. Concluding remarks

This paper has presented a novel measure of labour market conditions in Sweden based on data from a large-scale business survey, relative labour shortages (RLS). The indicator pointed to markedly more slack in the Swedish labour market during the economic recovery from the Great Recession (2013–2019) as well as during the Covid-19 pandemic (in 2020) than other qualitative survey indicators or the vacancy-unemployment ratio.

By decomposing RLS into an extensive margin (number of establishments with labour shortages) and an intensive margin (average labour shortage per establishment) provides insights into why conventional qualitative survey based measures of labour market conditions, that are based on the percentage of respondents answering ”Yes” or ”No” to whether they experience labour shortages or if labour is perceived as a limit to production, have overstated labour market conditions after the Great Recession. The analysis in this paper cautions about how to interpret the level of these type of qualitative indicators (as described in Nyman 2010, ECB 2015 and Tito 2018) and what they imply for wage growth.

One solution to this issue with purely qualitative survey data is to ask respondents directly about quantitative assessments, as in the Swedish AFU. Other recent examples are business surveys developed by the Federal Reserve Bank of Atlanta (Survey of Business Uncertainty) see, Altig et al. (2020a) and Altig et al. (2020b) and the Bank of England (Decision Maker Panel), see Bloom et al. (2018).

Importantly, the analysis in this paper shows that RLS is positively correlated with establishments' wage growth, also when adding establishment-level controls

and fixed-effects. In addition, forecast comparisons derived from sector-level wage Phillips curves indicate that RLS did a better job in explaining the post-crisis developments in wage growth than other indicators. Nonetheless, the paper does not provide causal evidence that RLS *lead* to higher wage growth. Future research could examine the existence of a causal relationship with either the use of instruments or regional or sector-level shocks.

Overall, the weak developments of RLS during the economic recovery from the Great Recession is evidence that the Swedish labour market was not as tight as conventional measures suggested and can help explain why wage growth was muted over this period and will remain low during the Covid-19 pandemic. Looking ahead, the results suggest that labour markets would have to tighten substantially to give impetus to wage growth.

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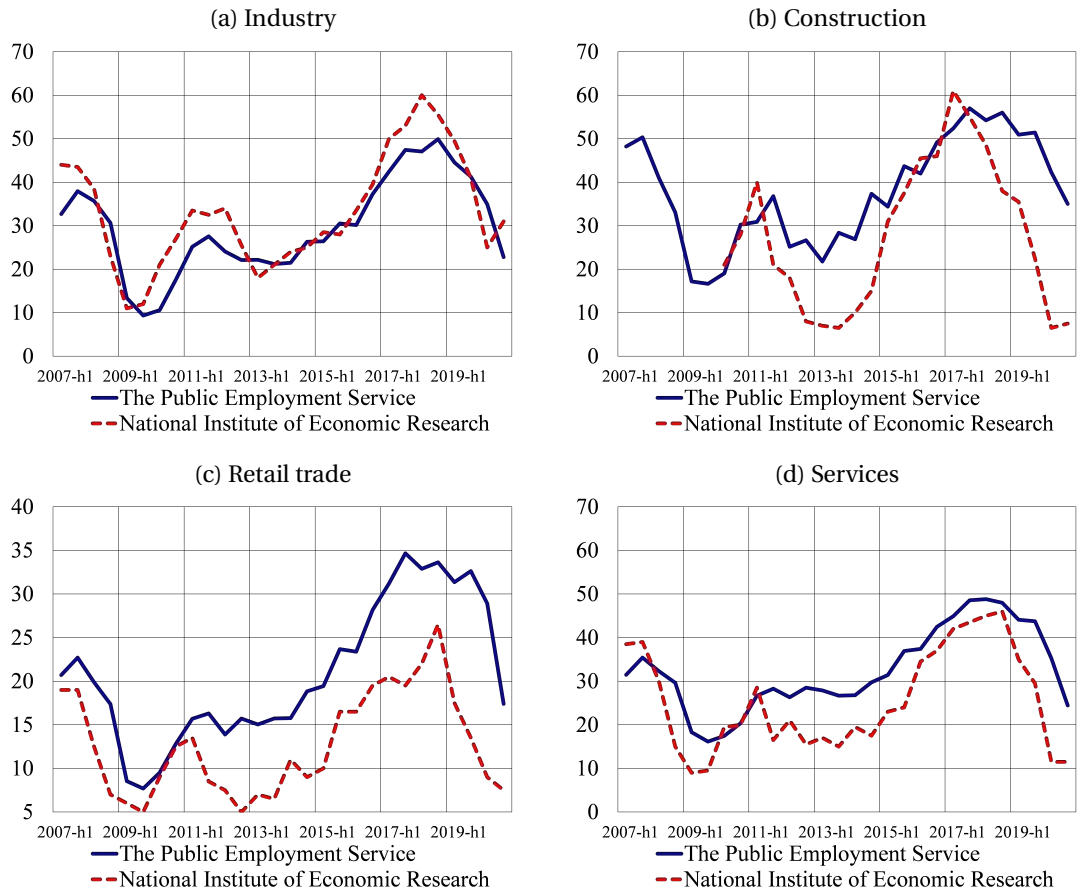
A. Appendix: Figures and tables

Figure A.1: Comparison of qualitative labour shortages with the NIER-survey

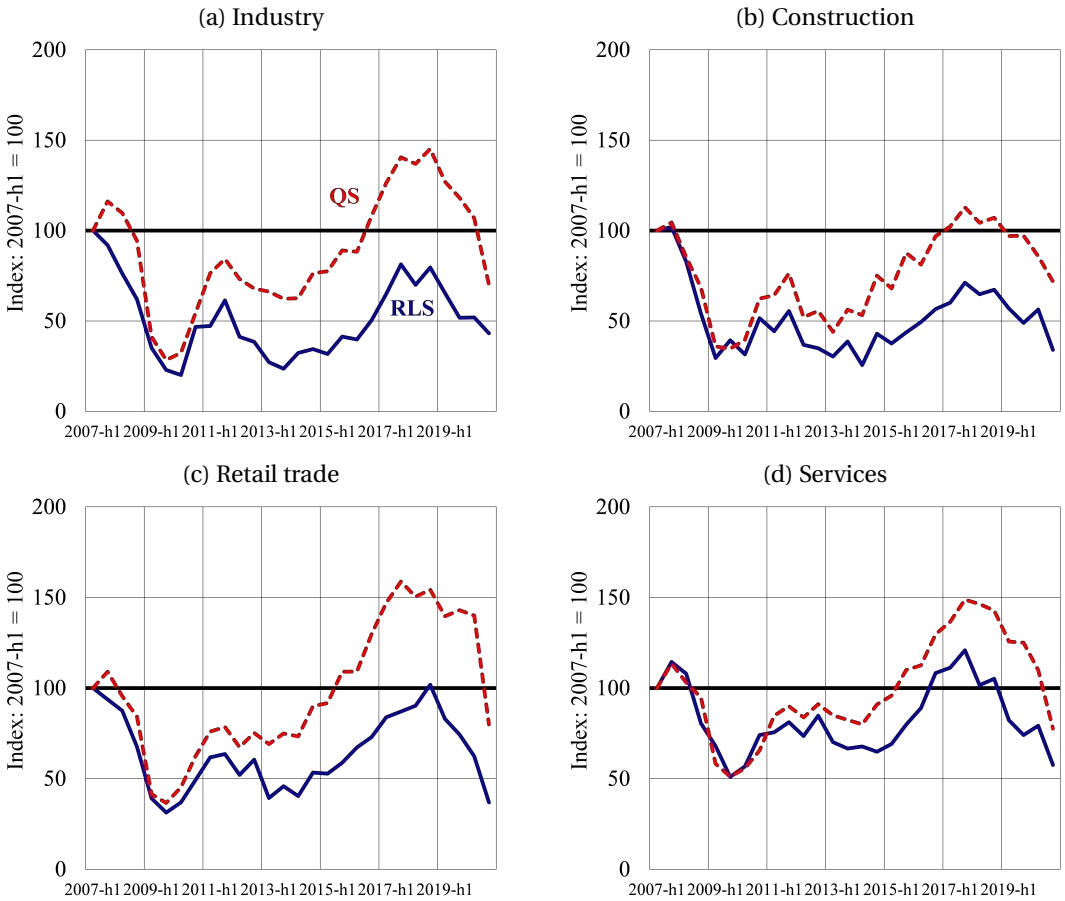


Note: The solid lines in the Figure are calculated as the share of respondents responding *"Yes"* to whether they experience labour shortages or not in the AFU. The dashed lines are data from the NIER. For construction, the comparison is made with answers to the question: *What are the greatest impediments for more construction* and the response alternative *"labour shortages"*.

Figure A.2: Comparison of annual wage growth with the NIER/NMO

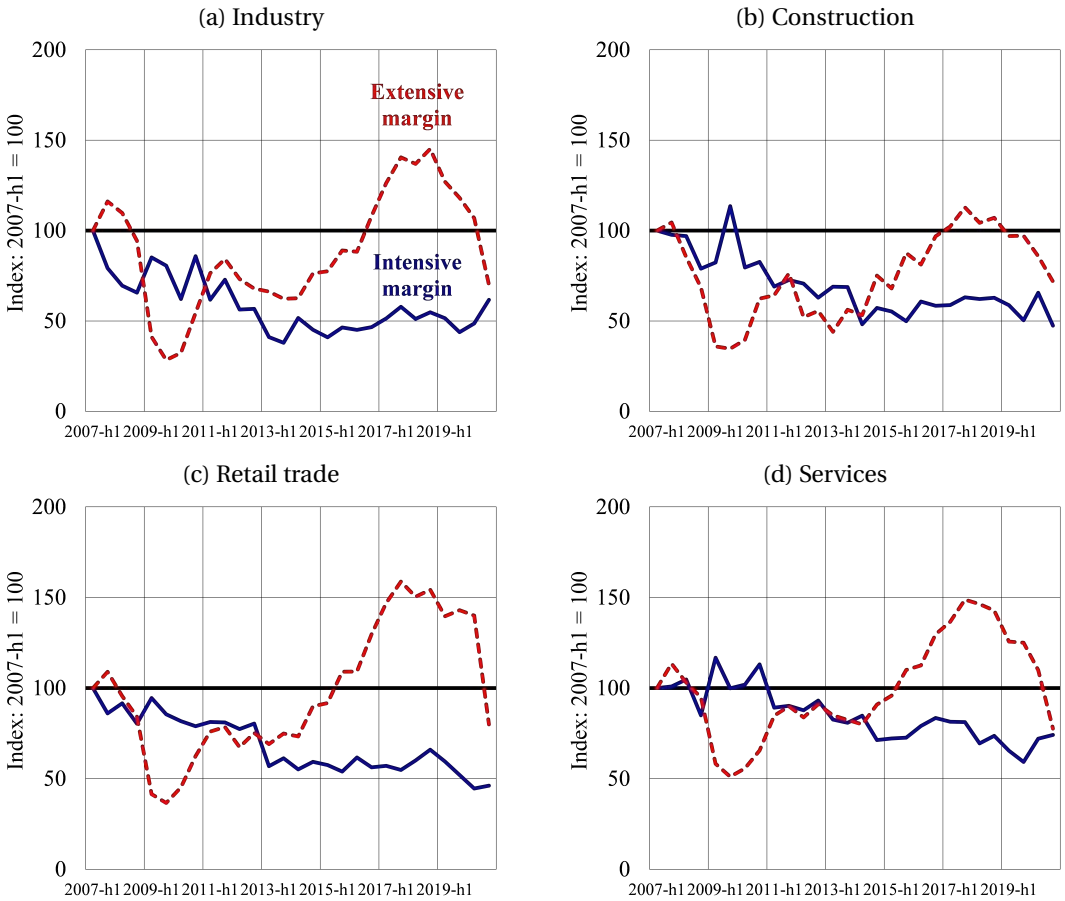
Note: The Figure shows the annual nominal wage growth from the AFU (solid lines) and estimates for three sectors by the National Institute of Economic Research and the National Mediation Office (NMO) (dashed lines). The midpoint for each response category has been used for wage growth from the AFU. This means that wage growth is 0.5 percent if respondents answers less than 1 percent, 1.5 if they answer between 1.0 and 2.0 percent, 2.5 if the answer between 2.0 and 3.0 percent and so forth. Nominal wage growth from the National Institute of Economic Research and the NMO is wage growth per hour worked. Services sector includes retail trade. Data is annual.

Figure A.3: Relative labour shortages, RLS



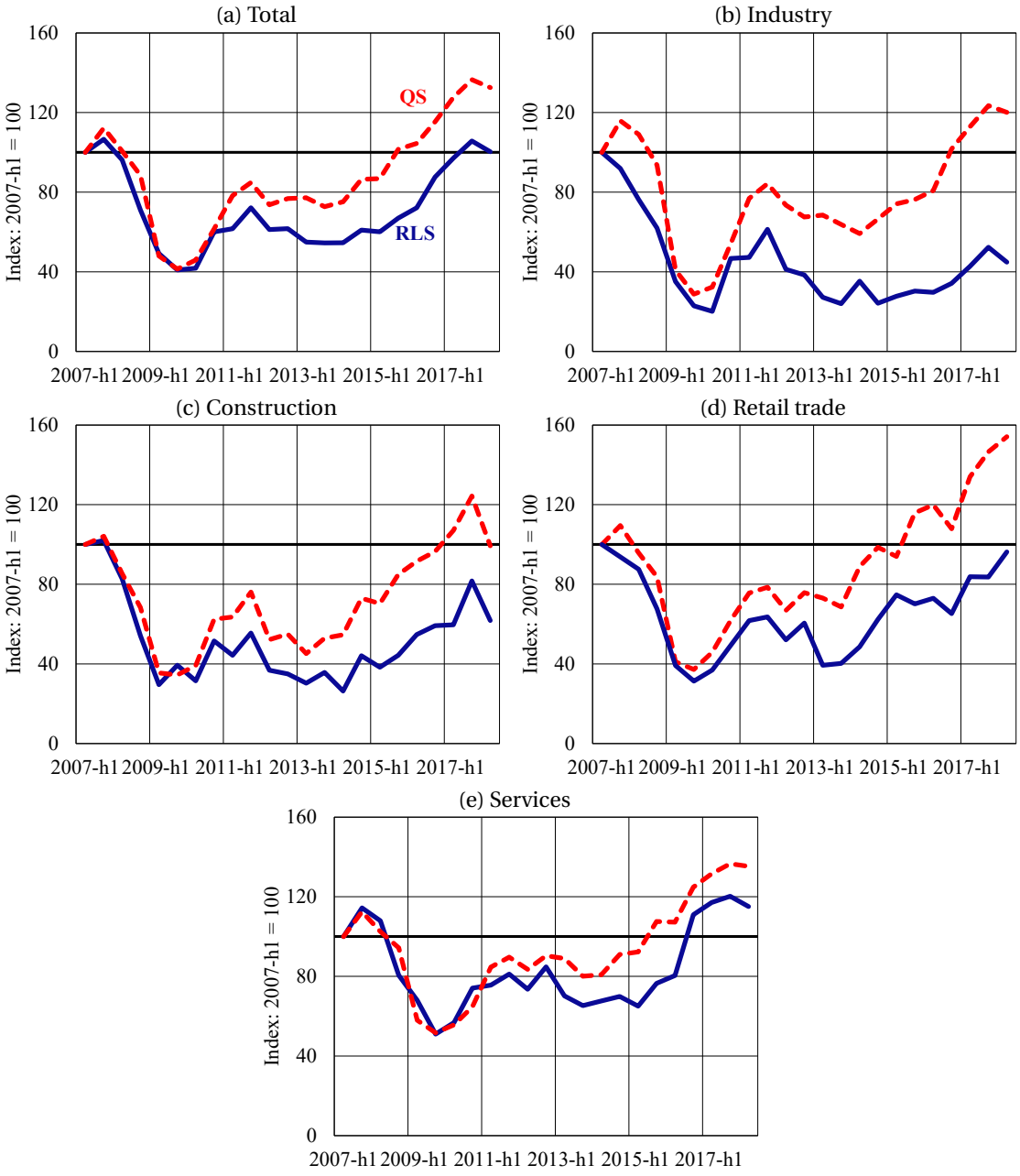
Note: NACE Rev. 2. codes corresponding to industry is 10-33, construction is 41-43, retail trade 45-47 and services all NACE Rev. 2. codes above 47.

Figure A.4: Relative labour shortages, RLS: extensive and intensive margin



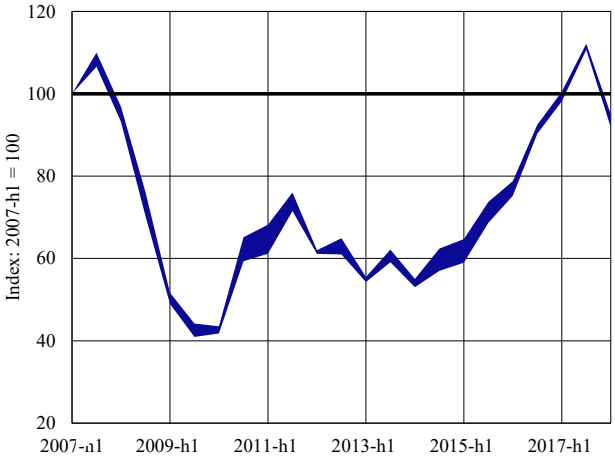
Note: NACE Rev. 2. codes corresponding to industry is 10-33, construction is 41-43, retail trade 45-47 and services all NACE Rev. 2. codes above 47.

Figure A.5: Labour shortages, sample weights from 2013h1-onward



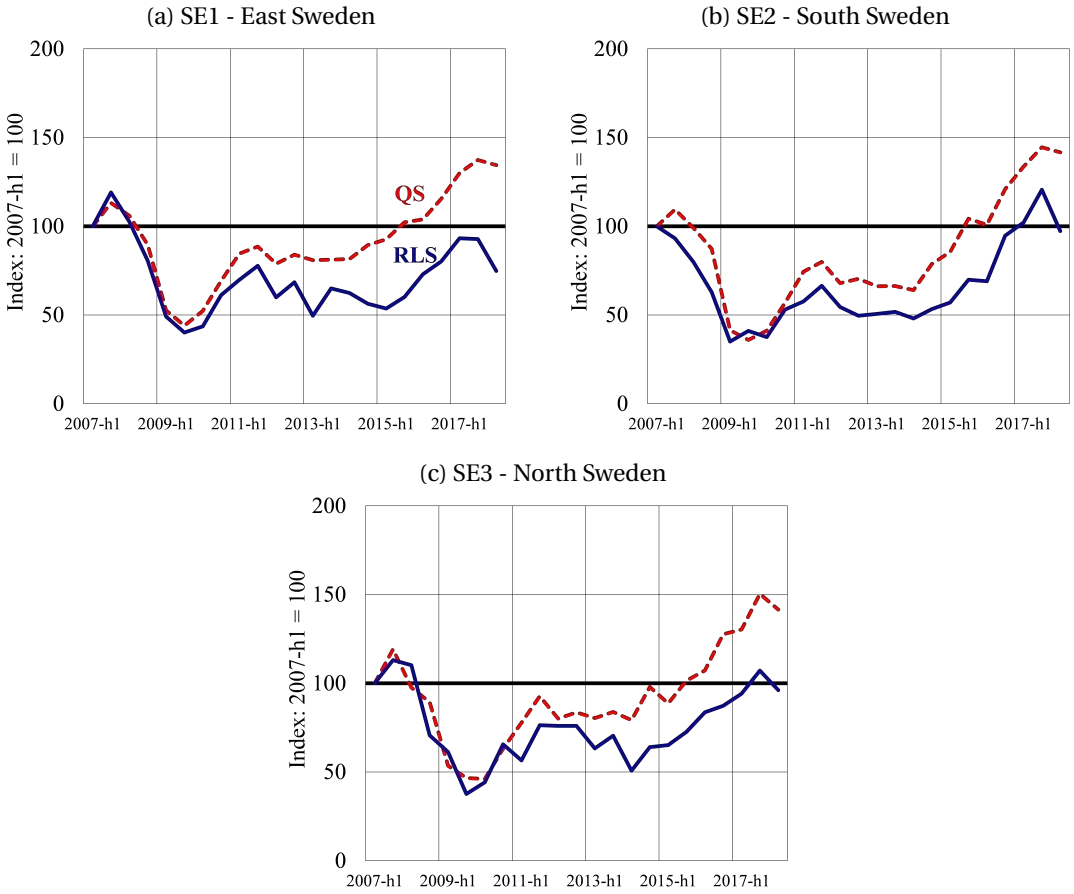
Note: NACE Rev. 2. codes corresponding to industry is 10-33, construction is 41-43, retail trade 45-47 and services all NACE Rev. 2. codes above 47. The series uses sample weights from 2013h1 onward and utilizes the non-weighted averages to back-link the series.

Figure A.6: RLS across various winzorizing percentiles



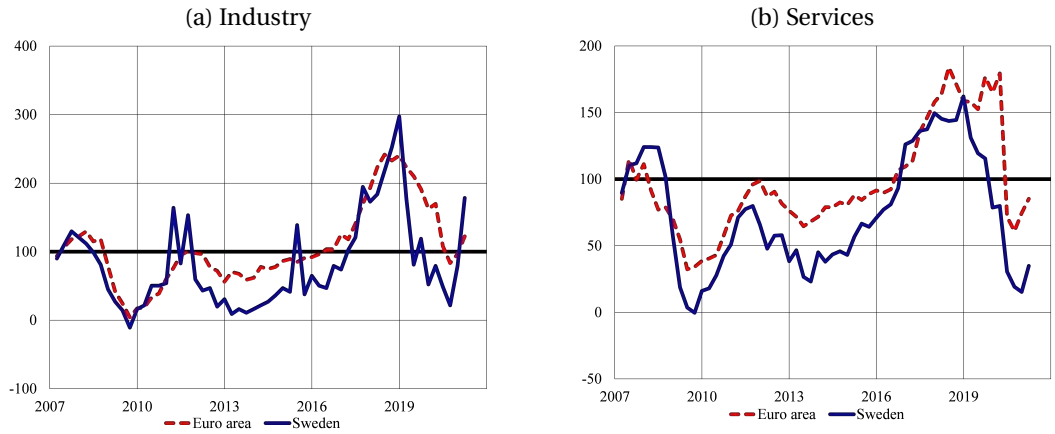
Note: The figure shows the RLS measure computed for various choices of winzorizing percentile, indexed to 2007-h1 = 100. The bands cover the 99.9th to 85th percentile.

Figure A.7: Labour shortages for regions (NUTS1)



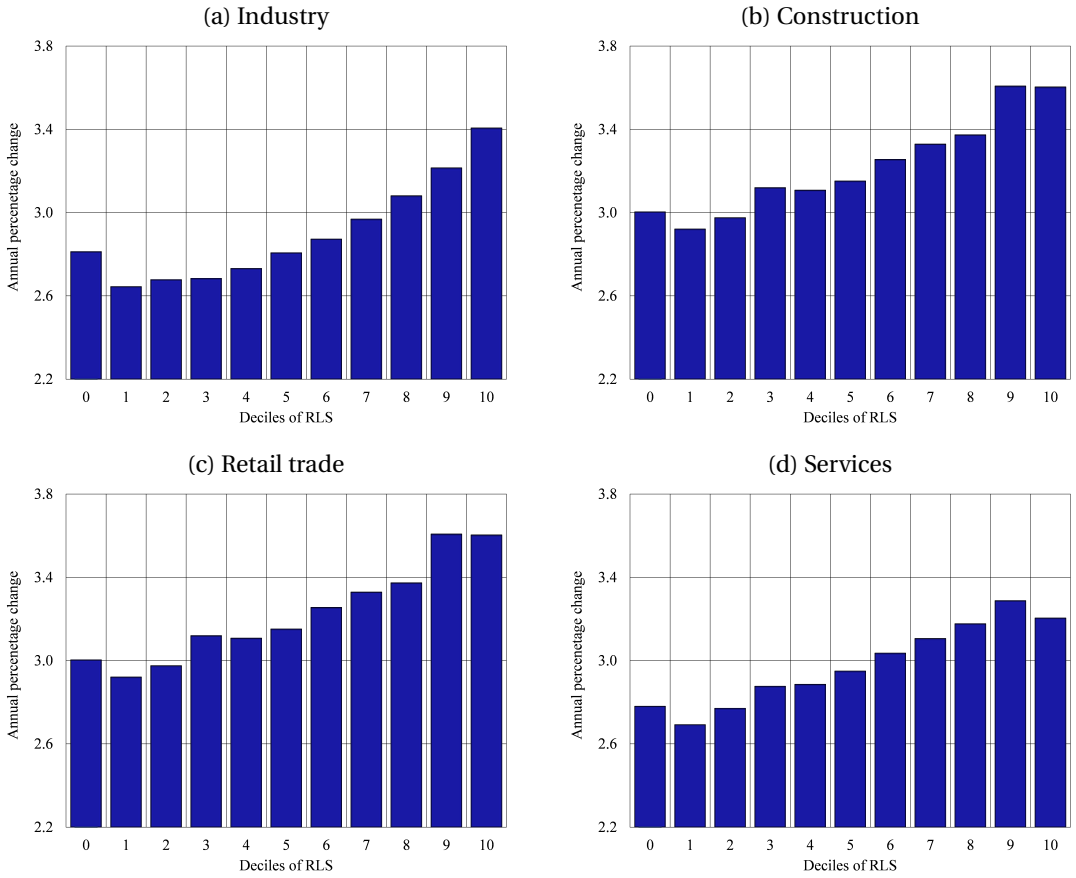
Note: NUTS1 SE1 correspond to East Sweden, which includes the "län" Stockholm, Uppsala, Södermanland, Östergötland, Örebro and Västmanland. SE2 - South Sweden includes Jönköping, Kronoberg, Kalmar, Gotland, Blekinge, Sk, Halland and Västergötland. SE3 - North Sweden includes Värmland, Dalarna, Gävleborg, Västernorrland, Jämtland, Västerbotten and Norrbotten.

Figure A.8: Sweden and euro area



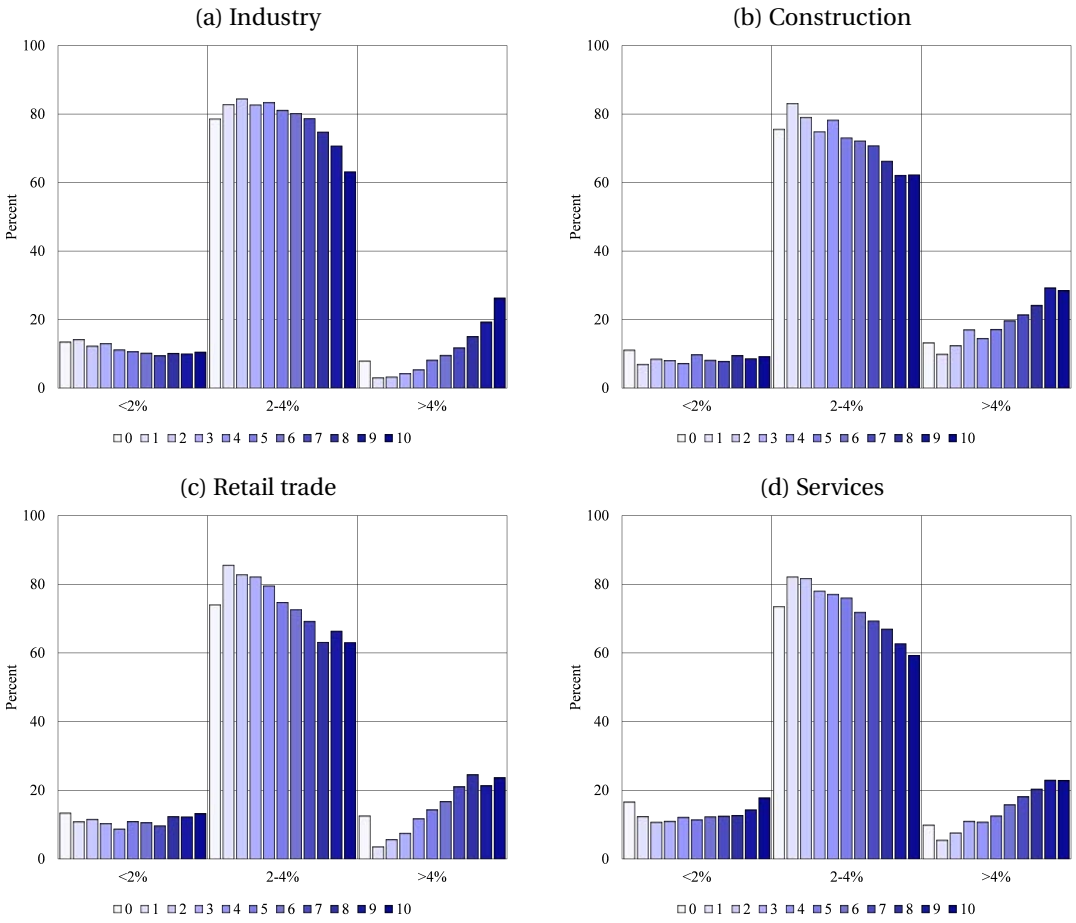
Note: The dashed (solid) lines are the % of responses, indexed to 100 in 2007h1, for the euro area (Sweden) that answer "labour shortages" to the question: "What main factors are currently limiting your production?" in the DG-ECFIN Economic Tendency Survey.

Figure A.9: Wage growth across deciles of labour shortages



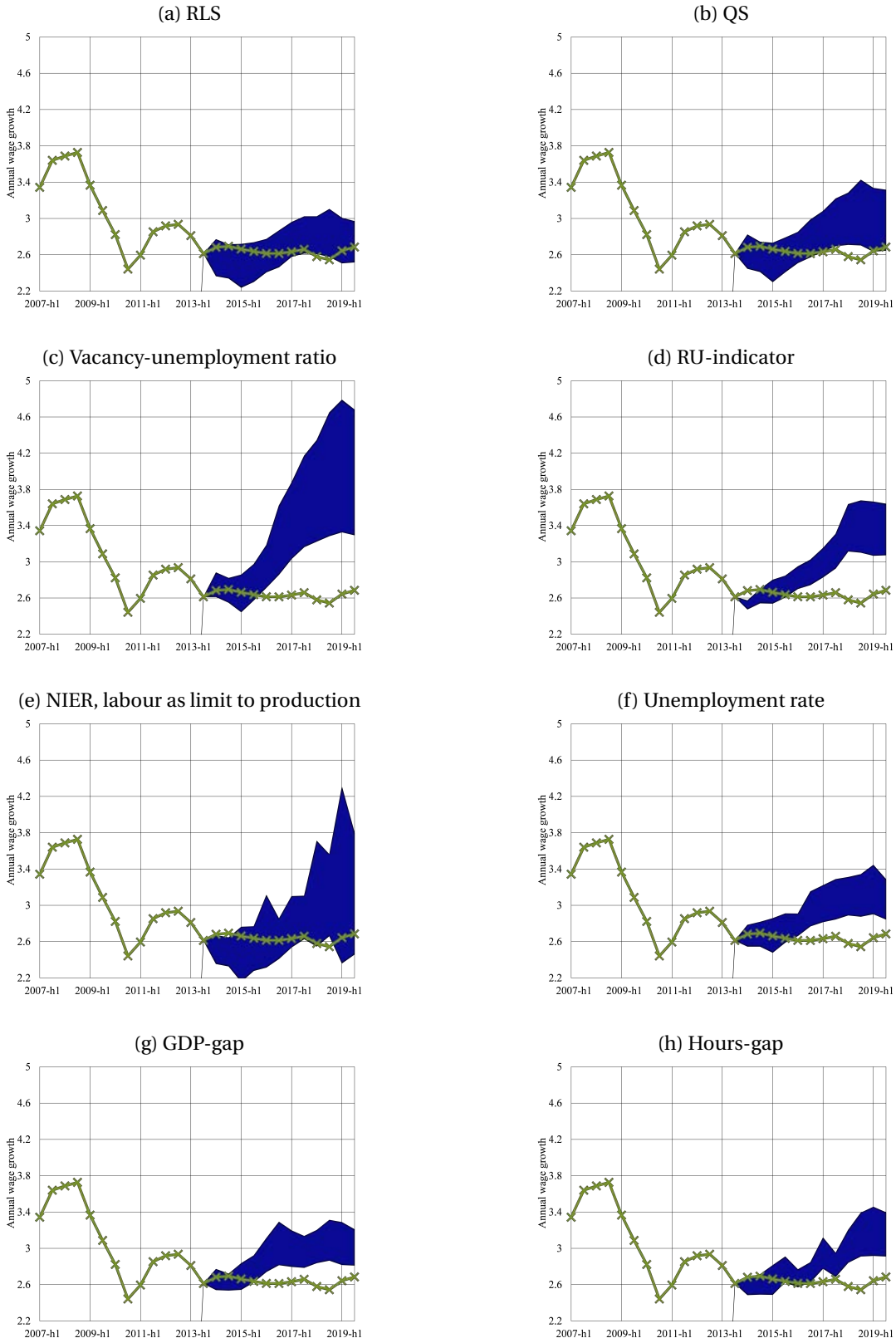
Note: The figure shows the average annual nominal wage growth for each decile of RLS across sector groupings, which corresponds to NACE Rev. 2. Industry (10-33), construction (41-43), retail trade (45-47) and services (all sectors above 47). The group "0" is all establishments without any labour shortages. RLS at decile 1 for industry are 0.003, 0.007, 0.011, 0.018, 0.025, 0.038, 0.059, 0.093, 0.143 and 0.368. For construction, its 0.013, 0.032, 0.050, 0.070, 0.093, 0.117, 0.150, 0.200, 0.283, 0.684. For retail trade, 0.007, 0.017, 0.0299, 0.045, 0.066, 0.092, 0.127, 0.166, 0.221, 0.489. For services, 0.009, 0.023, 0.037, 0.054, 0.074, 0.010, 0.131, 0.179, 0.251 0.699.

Figure A.10: Wage growth distribution across deciles of labour shortages



Note: The figure shows the distribution of wage growth across deciles of RLS. The group "0" is all establishments without any labour shortages. See Figure A.9 for the RLS values for the various deciles.

Figure A.11: Swathe of wage growth forecasts



Note: Standard errors are clustered at the sector level. The swaths shows the range of estimates from wage Phillips curves with different specifications.

Table A.1: Employment in the AFU sample and total population, in 2014

	Emp, smpl	Emp, pop	Emp, smpl*
Industry	31.2%	20.4%	18.8%
Construction	6.8%	11.0%	9.8%
Retail trade	11.3%	18.7%	17.7%
Services	50.6%	49.9%	53.7%
0-19 employees	6.2%	33.7%	34.1%
20-49 employees	9.3%	12.7%	21.7%
50-99 employees	13.3%	8.7%	14.0%
100+ employees	71.2%	44.9%	30.2%
Stockholm	23.0%	26.1%	27.6%
Västergötland	16.8%	16.9%	17.1%
Skåne	10.3%	12.4%	14.3%
Östergötland	3.5%	4.3%	3.9%
Jönköping	3.8%	3.7%	3.8%
Uppsala	2.8%	3.4%	2.6%
Halland	3.0%	3.0%	2.7%
Örebro	3.5%	2.8%	2.6%
Dalarna	3.1%	2.6%	2.7%
Västerbotten	2.8%	2.6%	2.2%
Gävleborg	3.0%	2.6%	2.5%
Norrbotten	2.9%	2.5%	2.2%
Västmanland	3.6%	2.5%	2.5%
Värmland	2.9%	2.4%	2.2%
Södermanland	2.7%	2.4%	2.1%
Västernorrland	2.9%	2.4%	2.2%
Kalmar	2.7%	2.2%	2.2%
Kronoberg	3.0%	2.0%	2.0%
Blekinge	1.9%	1.5%	1.3%
Jämtland	1.1%	1.2%	0.9%
Gotland	0.6%	0.6%	0.4%

Note: The percentages are calculated for the establishments in the AFU (sample) and the population (pop) and are aggregated across broad industry classifications according to NACE Rev. 2. The figures for the population are obtained from Statistics Sweden. * denotes employment figures with sample weights.

Table A.2: Sector-level estimates

	All establishments	Industry	Construction	Retail trade	Services
Constant	2.780***	2.729***	2.949***	2.853***	2.747***
	(0.004)	(0.005)	(0.014)	(0.008)	(0.006)
RLS_t	0.210**	0.983***	0.598***	0.474*	0.251***
	(0.092)	(0.265)	(0.212)	(0.284)	(0.093)
RLS_{t-1}	0.086	0.030	0.273	0.261	0.039
	(0.060)	(0.240)	(0.184)	(0.313)	(0.052)
RLS_{t-2}	0.163**	-0.309	0.060	0.383	0.197**
	(0.067)	(0.268)	(0.077)	(0.374)	(0.092)
RLS_{t-3}	0.065	0.070	0.283	-0.082	0.079
	(0.050)	(0.171)	(0.212)	(0.162)	(0.054)
Total effect	0.524***	0.774*	1.214***	1.036**	0.566***
	(0.137)	(0.396)	(0.321)	(0.513)	(0.154)
Obs	6,1780	16,468	6,443	9,960	25,968
R^2	0.351	0.458	0.281	0.381	0.326
Clusters	4,293	1,244	305	829	1,590

Note: *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. Standard errors are clustered at the sector×region level. All regressions include sector×region, sector×time and region×time fixed effects.

Table A.3: Establishment fixed-effects

	(1)	(2)	(3)	(4)	(5)
RLS_t	0.231***	0.203***	0.231***	0.557***	0.305***
	(0.065)	(0.065)	(0.067)	(0.161)	(0.062)
RLS_{t-1}	0.132***	0.113**	0.131***	0.081	0.180***
	(0.049)	(0.048)	(0.050)	(0.126)	(0.047)
RLS_{t-2}	0.047	0.021	0.054	0.059	0.054
	(0.083)	(0.086)	(0.084)	(0.105)	(0.062)
RLS_{t-3}	0.062	0.046	0.065	0.074	0.080*
	(0.053)	(0.052)	(0.055)	(0.056)	(0.043)
$RLS_t \times$welfare					-0.313**
					(0.123)
$RLS_{t-1} \times$welfare					-0.237
					(0.147)
$RLS_{t-2} \times$welfare					0.131
					(0.137)
$RLS_{t-3} \times$welfare					-0.193
					(0.135)
Total effect	0.472***	0.382**	0.482***	0.771***	0.619***
	(0.157)	(0.158)	(0.159)	(0.250)	(0.149)
Total effect$\times$welfare					0.007
					(0.323)
Obs	50,733	47,260	49,922	50,733	53,791
R^2	0.573	0.582	0.576	0.620	0.480
Clusters	3,664	3,560	3,640	3,664	8,752

Note: *, **, and *** denote p $<$ 0.10, p $<$ 0.05, and p $<$ 0.01, respectively. All regressions include establishment, section-time and region$\times$time fixed effects, except for column (5) that includes establishment and region$times$time fixed-effects. Standard errors are clustered at the sector$\times$region level. Column (2) includes respondent's expectations of employment growth at the establishment next 24 months as a measure of expectations and Column (3) a qualitative measure if the level of demand is expected to increase in the next 12 months. (4) includes weights for employment at the establishment and (5) includes a dummy for the welfare sectors and interactions with the lags. The total effect refers to linear combinations of parameter estimates ($k = 0$, $k = 1$, $k = 2$ and $k = 3$).

Table A.4: Ordered logit fixed-effects (BUC)

	(1)	(2)	(3)
RLS_t	0.101	0.022	0.100
	(0.136)	(0.143)	(0.134)
RLS_{t-1}	0.195	0.122	0.193
	(0.146)	(0.140)	(0.146)
RLS_{t-2}	0.384***	0.325**	0.381***
	(0.144)	(0.148)	(0.146)
RLS_{t-3}	0.352**	0.311*	0.350**
	(0.171)	(0.170)	(0.172)
Obs	110,329	100,592	110,329

Note: *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. All regressions include establishment fixed effects. Standard errors are clustered at the establishment-level. Column (2) includes respondent's expectations of employment growth at the establishment next 24 months as a measure of expectations and Column (3) a qualitative measure if the level of demand is expected to increase in the next 12 months.

Table A.5: NACE 2-digit sector regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	QS	QS	QS	QS	RLS	RLS	RLS	RLS
$y_{i,t-2}$	0.288*	-0.024	0.029	0.079	1.140***	1.337***	0.945***	0.463**
	(0.146)	(0.158)	(0.094)	(0.139)	(0.411)	(0.403)	(0.227)	(0.189)
$E\pi^w$	0.793***				0.758***			
	(0.041)				(0.041)			
$E\pi^p$		0.333***				0.320***		
		(0.026)				(0.027)		
w_{t-1}			0.609***	0.214**			0.599***	0.215**
			(0.060)	(0.090)			(0.060)	(0.094)
$\Delta \ln prod_{i,t}$	-0.290*	-0.289*	0.054	-0.096	-0.269*	-0.283*	0.052	-0.095
	(0.153)	(0.155)	(0.066)	(0.061)	(0.147)	(0.149)	(0.065)	(0.059)
Obs	1,039	1,039	1,034	1,034	1,039	1,039	1,034	1,034
R^2	0.418	0.251	0.511	0.699	0.421	0.267	0.519	0.700

Note: *, **, and *** denote $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively. All regressions include sector fixed-effects. Standard errors are clustered at the sector level. Column (1)-(4) utilizes QS and (5)-(8) utilizes QS as measure of labour shortages. Column (4) and (8) includes time fixed-effects.

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