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# Beyond the Headlines: Swedish Inflation and Labour Market Tightness During 2020-2022

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**Abstract:** This thesis explores Swedish inflation and labour market tightness during 2020-2022. We decompose headline inflation into core inflation, captured by the weighted median inflation, and headline shocks. We use the modified Phillips curve as presented in Ball et al. (2022), where core inflation is determined by labour market tightness, long-term inflation expectations and pass-through from headline shocks. We construct a measure of vacancies to effective searchers (V/ES) based on the generalised labour market tightness measure proffered in Abraham et al. (2020). We find that our Phillips curve utilising V/ES performs better than the model using vacancies to unemployment in explaining Swedish inflation from 2001-2022. Our V/ES Beveridge curve is also more stable than the traditional Beveridge curve and experiences no shifts. Headline shocks during 2020-2022 in Sweden are then analysed and energy price is deemed to be the only statistically significant variable, accounting for slightly over half of the variation. We use the Swedish Riksbank unemployment projection to forecast inflation, finding that our model predicts inflation above the 2% target regardless of assumptions about inflation expectations. We suggest that a strong stance should be taken by the Riksbank to rein in inflation and prevent further de-anchoring of inflation expectations.

Keywords: Inflation, Labour Market Tightness

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# 1 Introduction

Persistent high inflation in Sweden and around the world has shifted the focus of monetary policy discussions and macroeconomic research towards the question of why inflation has risen so suddenly, and perhaps most importantly, where inflation might be heading in the near future. While significant economic work has focused on how to decompose, model, and forecast inflation, there is still much debate on the optimum measures and methods to achieve this. The unprecedented shocks from the Covid-19 pandemic and the following recovery, augmented by the Russian invasion of Ukraine, have created increased uncertainty in this space. Understanding how models can be adapted for this environment is of importance to both economists and policy makers as they grapple with reining in inflation while limiting the toll on economic growth. This thesis seeks to contribute to this discussion by presenting an altered Phillips curve model with a novel measure of labour market tightness, which may shed more light on current inflation dynamics. We use this model to decompose inflation in Sweden and then provide perspective on what might lie ahead.

We investigate Swedish inflation by breaking down the headline rate into *core inflation*, the slow-moving common component of inflation, and *headline shocks*, which are idiosyncratic deviations from the core. Based on current empirical evidence on the performance of different core inflation measures, we measure core inflation as weighted median CPIF and define headline shocks as the deviation of headline CPIF from the median. Our interpretation of core inflation is according to the modified Phillips curve as presented in Ball et al. (2022), where core inflation is determined by labour market tightness, long-term inflation expectations, and pass-through effects from headline shocks. To account for autocorrelation and heteroskedasticity, the core inflation model uses Newey-West estimation. We also analyse the impact of disruptions to specific industries in Sweden by assessing which disruptions are most connected to headline inflation shocks. Finally, our estimated Phillips curve is used in a forecasting exercise which utilises projections for unemployment to derive a forecast for core inflation, given a set of assumptions about headline shocks and inflation expectations.

A key feature of our contribution to current thinking in this field is that we develop a measure of labour market tightness that goes beyond the vacancies to unemployment ratio used in previous research. Instead, a ratio of vacancies to effective searchers is constructed, based on the generalised labour market tightness measure proffered in Abraham et al. (2020). Importantly, this measure incorporates new hires who were already employed or currently out of the labour force. As we will show, these represent a majority of new hires in Sweden. The Swedish labour market also provides a particularly interesting case since while Sweden is currently experiencing high inflation, like many other developed economies, it is not facing record low unemployment. Simultaneously, Sweden has seen a large movement into the labour force from those previously outside it, leading to a record-high employment rate (Sveriges Riksbank, 2023).

By combining recent contributions to macroeconomic theory and adapting them to the unique Swedish context, this thesis aims to shed new light on the current labour market tightness and inflationary pressure in Sweden.

We find that the Phillips curve model utilising our vacancies to effective searchers measure performs better than the model using vacancies to unemployment in explaining Swedish inflation from 2001 to 2022. The Phillips curve is found to be linear in its parameters as opposed to cubic as found by Ball et al. (2022) for the US. This is, however, in line with previous research on the Euro area Phillips curve. Our modified Beveridge curve of vacancies to effective searchers is substantially more stable, and unlike the traditional Beveridge curve it experiences no shifts throughout the examined time period. Since the Beveridge curve is used in our forecast, having a stable curve allows us to reduce the amount of assumptions needed for the forecast. With the vacancies to unemployment model we must make an assumption on whether the Beveridge curve will stay elevated or revert to its pre-pandemic position.

Using the Swedish Riksbank's unemployment forecast, our model predicts that core inflation will be more persistent than expected, stabilising at slightly above 3% in Q3 2024 if inflation expectations revert to pre-Covid levels. This is in contrast with the Swedish Riksbank's own forecast, in which CPIF is expected to reach the 2% target from year-end 2023. Under less optimistic assumptions, with inflation expectations continuing to drift according to their current trend or worse, our forecasts predict that core inflation will be between 4% and 5% in 2024, more than double the official CPIF forecast. The difference between our forecast and Riksbanken's forecast may be due to several reasons. First, the size of the deviation and the inherent uncertainty to forecasting imply that they likely fall within each other's margin of error. Additionally, we do not model any future headline shocks, and it is possible that the Riksbank includes negative shocks, e.g. to energy prices, during 2023. In general, we do not have full insight into the Riksbank's forecasting methodology and as such can not precisely determine the reason for the divergence between the forecasts.

The rest of this thesis is structured as follows. Section 2 reviews the literature on core inflation, labour market tightness, and the recent high-inflation environment. Following that, section 3 describes the theoretical background that underpins the methodology, formalising the inflation decomposition. It also extends the equilibrium unemployment theory based on the one presented in Pissarides (2000) to reach our measure of V/ES. Section 4 outlines the empirical methodology, discussing the data used and the econometric specifications that form the model. The results are presented in section 5, which begins by explaining core inflation in Sweden, focusing on the period 2020-2022. Then the drivers of headline inflation shocks are explored. Finally, the estimated model is used to forecast core inflation using a set of assumptions regarding inflation expectations and headline shocks. Section 6 concludes by discussing the results, including their monetary policy implications, limitations, and avenues for future research.

# 2 Literature Review

The following section reviews the current state of the literature on decomposing inflation and measuring labour market tightness. It explores different measures of core inflation and their tradeoffs, different measures of labour market tightness and the Beveridge curve, and finally inflation during the Covid era.

## 2.1 Measures of Core Inflation

The concept of core inflation has played a significant role in macroeconomic analysis and monetary policy since the 1970's, and while measures and definitions of core inflation still vary greatly; they all seek to capture some measure of underlying or trend inflation (Wynne, 1999; 2008). The usual starting point for analysis of core inflation is the idea that inflation can be decomposed into a common lasting smoother component and temporary disturbances caused by shocks to specific industries. While there is significant variance across measures of core inflation used in research, there are a few largely accepted criteria on what a good measure of core inflation should achieve. Firstly, a good measure of core inflation should indicate the current underlying inflation trend and should only track persistent price changes to allow short and medium-term inflation forecasting (Blinder 1997; Bryan and Cecchetti, 1994). Secondly, a good core inflation measure should move in contrast to economic slack, in accordance with the Phillips curve (Schembri, 2017; Dolmas and Koenig, 2019). Finally, some researchers also argue that a good measure of core inflation should be relatively non-complex and easy to understand, to allow the central bank to effectively communicate it to the public if required (Wynne, 1999; Clark, 2001).

From a monetary policy perspective, the need for an accurate measure of core inflation stems from the desire to be able to react to persistent price changes efficiently while avoiding overcorrection by changing interest rates in response to temporary shocks. However, there is still much debate on which measure of inflation central banks should target. Nessén and Söderström (2001) review tradeoffs of targeting different measures of inflation in Sweden and find that targeting headline inflation may lead to unnecessary monetary policy changes due to temporary shocks, while targeting core inflation may miss pass-through effects from headline shocks and therefore lead to a costly delayed response. This highlights the importance of considering how temporary shocks can pass through into core inflation when decomposing and forecasting inflation, particularly for monetary policy decisions.

### 2.1.1 Types of Core Inflation Measures

While measures of core inflation are varied, they can be broadly categorised into three groups: specific exclusion measures, stochastic measures, and structural vector autoregression (SVAR) measures. Specific exclusion measures attempt to smooth headline inflation by excluding specific industries which experience high price volatility. The traditional and most widely used measure of core inflation is the specific exclusion measure *CPI excluding food and energy* (also known as XFE). Another popular measure is the *CPI excluding energy*, which has increased in usage due to the general stabilisation of food prices. The popularity of these measures can generally be traced to their relative simplicity and their strong performance in predicting historical inflation data.

However, since these measures rely on post-hoc exclusion of industries on a somewhat arbitrary basis, they suffer some disadvantages. Importantly, since they are exposed to price shocks to *other* industries, they are vulnerable to structural changes to the economy (Roger, 1998). A number of empirical studies have found that exclusionary methods are worse at forecasting inflation than stochastic or SVAR measures (e.g. Detmeister, 2011; Crone et al., 2013; Dolmas and Koenig, 2019). Various other measures have therefore been proposed to measure core inflation while staying robust over time without continuous adjustment. In the context of this thesis, the limitations of CPI excluding food and energy may be amplified by the high price volatility in many other sectors during the Covid pandemic (Ball et al., 2021).

Stochastic measures, on the other hand, mechanically filter out the tails of the price change distribution and therefore allow for price shocks in all industries. The first such proposed measure was most likely by Jevons (1865), which argues that inflation should be calculated by the geometric mean. As noted in a number of papers (e.g. Bryan et al., 1997; Wynne, 2008) the distribution of price changes is subject to significant skewness and kurtosis, which renders the arithmetic mean a problematic indicator of core inflation. More recent stochastic measures address this departure from a normal distribution by weighting industries by price change variability or constructing weighted trims.

Broadly, there are two common stochastic measures used. First, the *trimmed mean* is constructed by removing a fixed percentage from both ends of the price-change distribution[1]. One such model is the Trim85, published by the Swedish Riksbank, which trims 7.5% from each tail. Secondly, there are *(weighted) median* inflation estimators such as the one used in this thesis. An example of this is the Trim1 measure published by the Swedish Riksbank. This measure is constructed by trimming 49.5% from each tail of the weighted distribution, keeping only the middle 1% (for more details see Johansson et al., 2018). In essence, weighted median inflation

[1] There are also examples of asymmetric trims such as the Dallas Fed's trimmed-mean PCE inflation rate, that trims 24 percent of the weight from the lower tail and 31 percent of the weight from the upper tail, but as these measures operate similarly to symmetric trims we don't discuss them for brevity.

is an extreme trim that gives a weighting of zero to all price changes apart from the median price change. In the presence of significant skewness in price changes it may be a more accurate measure of the underlying, longer-term part of inflation.

There are several theoretically appealing aspects of the stochastic measures of core inflation. Generally, the existence of asymmetrically sticky prices supports the idea of skewness in the price change distribution. Moreover, as stochastic measures don't exclude specific industries, they can handle a wide range of shocks and are not as vulnerable to structural changes in the economy (Roger, 1998). Roger also highlights that they are not revised retroactively, which can improve their credibility. Finally, stochastic measures are relatively simple to calculate and communicate if the central bank wishes to do so. On the other hand, Roger (1998) notes that stochastic measures still include generalised, transient shocks, even if Roger's definition of transient can be argued to be somewhat arbitrary in this case.

The *modelling approach*, or *SVAR* measures, stems from the research of Quah and Vahey (1995) which disaggregates inflation time series into two parts. Relying on the assumption of a vertical long-run Phillips curve, the part of inflation that impacts real output in the medium or long term is removed. The remaining part, which does not impact real output in the medium or long term, is interpreted as core inflation. However, Roger (1998) notes that the distinction between transient, cyclical, and long-term influences is "somewhat artificial" (p.6), and suggests that the time horizon of the policy question at hand should guide the selection of core inflation measure. Researchers who have built upon the SVAR model include Blix (1995), Dewachter and Lustig (1997), Gartner and Wehinger (1998), Stock and Watson (2016), and Meyer and Zaman (2019). Each contribution addresses different criticisms of the SVAR literature or its use as a measure of core inflation.

A commonly cited benefit of SVAR models is that they are grounded in explicitly stated economic theory (e.g. Gartner and Wehinger, 1998; Wynne, 1999; Mankikar and Paisley, 2004; Silver, 2007). However, they have been criticised as being sensitive to the specific econometric assumptions used (Wynne, 1999; Silver, 2007), with restrictions that are "rarely uncontroversial" (Mankikar and Paisley, 2004, p.22). Additionally, Gartner and Wehinger (1998) contend that any measure based on economic theory also runs the risk of being fallacious. Wynne (1999) further notes that each time new data enters the model, previous estimates are revised, which can complicate communication efforts. Folkertsma and Hubrich (2001) investigated the performance of five different SVAR specifications on European data, finding that all measures were imprecise and therefore unlikely to be useful for monetary policy.

### 2.1.2 Performance of Core Inflation Measures

While all three categories of core inflation estimators have their relative advantages and disadvantages, there is some evidence that certain estimators perform better - particularly in high inflation environments and in the case of new economic shocks. Gamber et al. (2015) find that, in general, measures of core inflation perform better when monetary policy is expansionary. However, there is also growing evidence that specific exclusion estimators perform quite poorly, despite their extensive usage, e.g. with Dolmas (2005) finding that an optimally selected asymmetric trim tracks inflation significantly better than PCE ex food & energy. Similarly, Detmeister (2011) found that trim measures outperform exclusionary indexes in tracking ex-post inflation trends as well as in forecasting future inflation. Finally, a review from the Swedish Riksbank of their own measures of core inflation found that *CPIFPC*, *UND24* and *Stock and Watson* have the most predictive power in a low inflation environment (Johansson et al., 2018). Neither of these are simple exclusionary measures, as CPIFPC uses principal component analysis to capture common trends in subgroups, UND24 re-weights the basket according to price variability, and Stock & Watson follows the statistical model presented in Stock and Watson (2016).

Some scholars have found empirical support for the usage of different versions of the trimmed mean estimator. Bryan et al. (1997) investigate different levels of trim and find that 18% trim is the most efficient, and that as the kurtosis of the distribution increases, so does the optimal trim. Clark (2001) reviews a set of core inflation measures and finds that the trimmed mean performs best, while the median performs adequately. Gamber et al. (2015) find that a 16% trimmed mean is "virtually unaffected by shocks to headline inflation" (p.52). Finally, Dolmas and Koenig (2019) compare PCE trimmed mean to CPI ex food & energy and find that trimmed mean is a better policy- and communications tool since it is a less biassed real-time estimator of inflation.

Simultaneously, growing evidence suggests that weighted median inflation may be one of the strongest measures of core inflation, particularly in periods of high inflation or large shocks. Early on, Bryan and Cecchetti (1994) tested the performance of core inflation measures, finding that median CPI performs best in virtually all the examined criteria. Additionally, Wynne (1999) is critical to more advanced measures of core inflation and supports using the median since it's robust, easy to communicate, and less impacted by kurtosis and skewness. Higgins and Verbrugge (2015) find that median CPI (with or without seasonal adjustment) performs well in measuring trend inflation, and Smith (2004) finds that weighted median is best for predicting inflation. Meyer and Pasaogullari (2010) find that median and 16% trim forecast headline as well as inflation expectations and outperform simple forecasting models. Crone et al. (2013) find that on horizons over 2 years, the median yields significantly better forecasts than what headline or CPI ex food and energy does. Also, Meyer and Zaman (2019) combine two estimators to show that median CPI is also useful in multivariate BVAR-models and even helps forecast PCE, in addition to CPI.

More recently, the work of Laurence Ball and others have further highlighted the potential of the weighted median inflation rate as a measure of core inflation, particularly during the volatile economic situation over the last few years. Ball and Mazumder (2020) compare the use of weighted median inflation and XFE inflation as a measure of core inflation in a Phillips curve for the US in 1985-2017, and find that the model accuracy is more than doubled when using the weighted median. Ball et al. (2021) review the performance of core measures during Covid's high volatility and find that median CPI best measures core inflation and is most related to labour market tightness. Finally, Ball et al. (2023) create weighted median inflation rates for 38 countries - including Sweden - over 1990-2021 and find that the median is less volatile than other measures of core inflation, that it has a closer relationship to economic slack, and that it is a better predictor of headline inflation over the following year.

In light of the preceding literature review, the weighted median is selected as the appropriate measure of core inflation in this thesis for three main reasons: 1) It is relatively easy to calculate and communicate to the public. 2) It is adaptive to novel shocks and changing economic structures. 3) There is growing empirical evidence that it may be the most accurate measure of underlying inflation.

## 2.2 Causes of Core Inflation

Similar to the specification in Ball et al. (2022), we define core inflation as influenced by three main factors: labour market tightness, inflation expectations, and pass-through effects from headline shocks.

### 2.2.1 Labour Market Tightness and the Beveridge Curve

The relationship between labour market tightness and inflation stems from conventional economic theory, with the standard Phillips curve suggesting that there is a tradeoff between the tightness of the labour market and the rate of inflation. While measures of labour market tightness vary, the most common proxy and the one used in the original Phillips curve is the simple unemployment rate. However, Staiger et al. (1997) suggest that the non-accelerating inflation rate of unemployment (NAIRU) is often imprecise and therefore central banks should respond to changes in, rather than the level of, unemployment.

The Diamond–Mortensen–Pissarides search and matching model (Diamond, 1982; Blanchard and Diamond, 1989; 1992; Mortensen and Pissarides, 1994; Pissarides, 2000) has become a standard way of incorporating labour market frictions in macroeconomic models. Its aggregate function has the useful property that the aggregate job-finding rate only depends on a labour market tightness variable, namely the vacancy-unemployment ratio[2] (henceforth referred to as the *V/U ratio*). This is constructed by dividing the vacancy rate, defined as the number of vacancies per person in the labour force, by the unemployment rate. The intuition behind this structure is that a higher ratio of available jobs per unemployed person makes it more difficult to hire workers and easier for the unemployed to find jobs. This increases the bargaining power of workers and should therefore put upwards pressure on wages, leading to an increased core inflation when the labour market is tighter. From another perspective, a higher number of vacancies can also indicate that firms are expanding, which can indicate that they have more access to capital and hence are more willing to increase wages.

The Beveridge curve maps the relationship between vacancies and unemployment, with this negative relationship being an established feature of macroeconomics first presented by William Beveridge in 1944. In general, outward shifts in the Beveridge curve implies that a greater decrease in unemployment is required to reduce inflation. There is growing evidence that the Beveridge curve may have shifted during economic crises, for example Diamond and Şahin (2015) find that there was a notable outward shift in the Beveridge curve in October 2009. Similarly, Consolo and da Silva (2019) find that the Euro area Beveridge curve shifted during the 2010's due to a decrease in matching efficiency. Additionally, Bova et al. (2018) find that a higher share of long-term unemployed reduces matching efficiency and shifts the Beveridge curve outwards. Recent evidence suggests the Beveridge curve may have shifted during the Covid era with Ball et al. (2022) finding the US Beveridge curve shifted outwards in April 2020. Briggs (2022) suggests that this is due to decreased search intensity of unemployed workers during Covid.

However, Abraham et al. (2020) find that their alternative Beveridge curve of vacancies to effective searchers is more stable than the traditional Beveridge curve, suggesting that the composition of job searchers and their relative job-finding rates may explain changes in match efficiency. Furman et al. (2021) review labour market tightness measures and find that after the pandemic, the unemployed-to-job openings rate and the quits rate are best at predicting inflation. However, while the V/U ratio is most likely a more accurate measure of labour market tightness than the simple unemployment rate, it may fail to capture the impact of labour market heterogeneities and matching efficiencies that impact the job-finding rate.

A fundamental shortcoming of the use of V/U as a measure of labour market tightness is that unemployment may be a poor proxy for the number of available and willing workers that can fill vacancies (Abraham et al., 2020). There is an extensive literature on how the unemployment rate can be extended to account for the number of *effective searchers*. Based on the seminal work of Perry (1970) a number of papers have explored changes in the demographics of the unemployed and how this can be adjusted for (Shimer, 2001; Aaronson et al., 2015; Barnichon

[2] For a formal definition of this matching function and our extension of it, see section 3.2.

and Mesters, 2018). Additionally, following Kaitz (1970), research has looked at the proportion of long-term and short-term unemployment within the pool of unemployed (Krueger et al., 2014; Abraham et al., 2020) as the long-term unemployed have significantly lower job-finding rates. There is also some research suggesting that the reasons behind someone becoming unemployed may play a role as the job-finding rates of laid off employees differ from other groups (Katz 1986; Katz and Meyer, 1990; Fujita and Moscarini, 2017; Abraham et al., 2020). Additionally, the search intensity of the different groups may also vary over time (Krueger and Mueller, 2010, 2011; Davis et al., 2012; Hall and Schulhofer-Wohl, 2018), for example on-the-job search is likely to decrease during economic downturns.

From a broader perspective, many new hires come from outside the labour force or from other employment (for an example, see Figure 1). Additionally, within the subset that comes from outside the labour force, individuals who say they *want* employment are more likely to get a job (Blanchard and Diamond, 1989; Hornstein et al., 2014; Kudlyak, 2017; Hall and Schulhofer-Wohl, 2018). Incidentally, the labour force has developed particularly strongly in Sweden in the past few years with employment rate at record-levels despite unemployment not being at historical lows (Sveriges Riksbank, 2023). This may suggest that the effect of those outside the labour force has been more pronounced. In addition to this, the unemployment rate does not take into account on-the-job search. Hence, the V/U ratio may underestimate labour market tightness by not including employed searchers (Black, 1980; Blau and Robins, 1990; Faberman et al., 2017). Faccini and Melosi (2021) create an alternative measure of slack including on-the-job search and find this measure is countercyclical and helps explain missing inflation.

Using statistics from Statistics Sweden's Labour Force Survey (the LFS), Figure 1 shows that a majority of hires in the Swedish labour market are people who are not currently unemployed. Additionally, Figure 1 also reveals the seasonal variation in hiring that stems from summer employment, which is adjusted for in Figure 2 where rolling 4-quarter averages for the same data is shown. Here, the business cycle-related trends are more readily apparent. Specifically, one can observe that on-the-job hires decreased after the 2008 crisis as well as during the onset of the pandemic. This corroborates the assertion that a notable part of the variation in the tightness of the labour market is left out when only considering job seekers who are categorised as unemployed.

While it is important to ensure all job searchers are included to better capture labour market tightness, a generalised model of effective searches should also incorporate their relative search intensity. A number of different approaches have been taken to measure or proxy for search intensity. Several papers use the proportion of time spent on job search as a measure of search intensity (e.g. DeLoach and Kurt, 2013; Gomme and Lkhagvasuren, 2015; Mukoyama et al., 2018) with no consensus on whether the search intensity of unemployed people is procyclical or countercyclical. Other search intensity proxies include the number of search methods (Shimer,

**Figure 1.** Amount of Externally Recruited People in Sweden (adapted from SCB, 2023a)

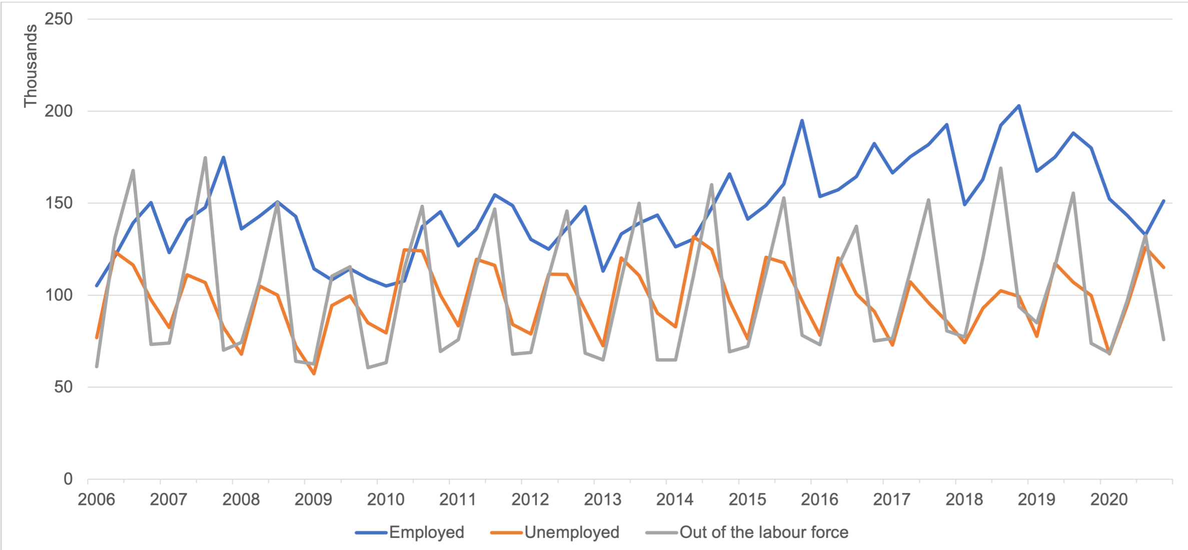
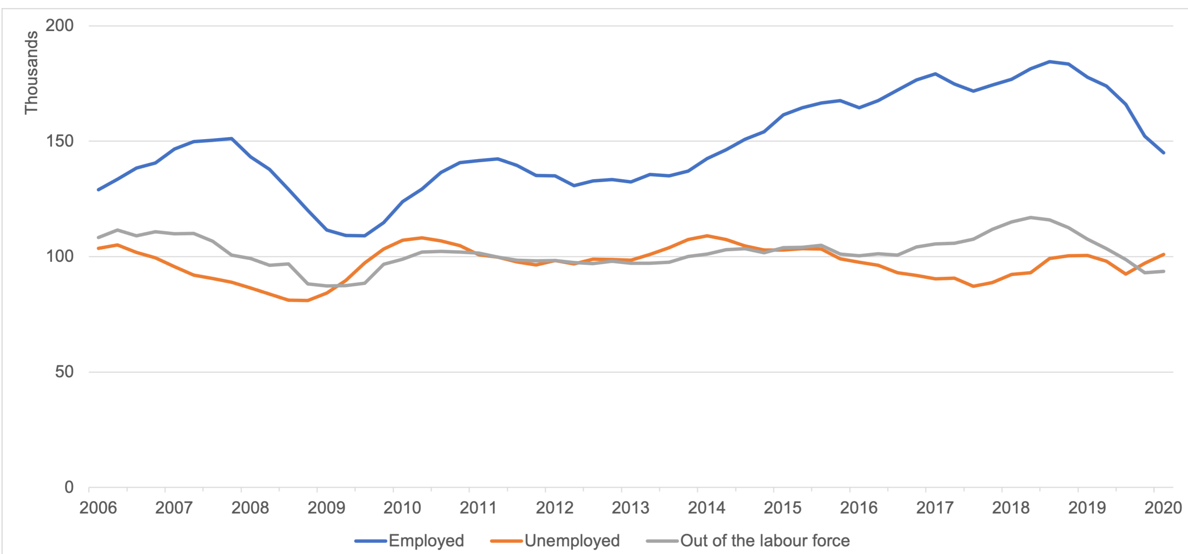



**Figure 2.** Amount of Externally Recruited People in Sweden, rolling 4-quarter averages (adapted from SCB, 2023a)




2004) and the difference between desired and actual working hours (Faberman et al., 2020). An alternative proxy for within-group search intensity is the use of job-finding rates to measure effective searchers. The Hornstein-Kudlyak-Lange Non-Employment Index (NEI) published by the Federal Reserve Bank of Richmond uses a weighted average of all non-employed people and their long-run average job-finding rates to measure effective searchers (Hornstein et al., 2014).

A number of studies (e.g Veracierto, 2011; Hornstein and Kudlyak, 2016; Sedláček, 2016) have used changes in relative job-finding rates between groups to proxy for group search intensities. Hall and Schulhofer-Wohl (2018) expand this approach to sixteen different groups of job finders across the employed, unemployed, and those outside the labour force. Abraham et al. (2020) build on this to create a generalised measure of labour market tightness, *vacancies to effective searchers* (V/ES), using the population shares and relative job-finding rates of twenty-two groups of job searchers. As unemployed individuals tend to have the highest job-finding rates, increased unemployment during economic downturns provides procyclical effects on inflation. Simultaneously, movement from unemployment to outside the labour force and a general decrease in job-finding rates during downturns may counteract this with a concurrent countercyclical effect. Hence, this measure is expected to be less cyclical than the simple unemployment rate.

Based on the aforementioned theoretical contributions, we develop a measure of vacancies to effective searchers which aims to capture the inflationary impact of labour market tightness. Due to data limitations, and the fact that Abraham et al. (2020) note that most of the variation can be captured by a few large groups, we use a simplified version of their V/ES measure. Specifically, our measure includes the three main groups of labour market participants: the employed, the unemployed, and those outside the labour force.

### 2.2.2 Inflation Expectations

A key principle of modern mainstream macroeconomics is that inflation expectations impact future inflation. This is captured in the New Keynesian Phillips Curve (Nason and Smith, 2008), which is central to the monetary policy choices of many central bankers. While different ways of modelling price stickiness lead to slightly different transition methods between inflation expectations and future inflation, most models concur that an upwards de-anchoring of inflation expectations will lead to higher future inflation and will limit the impact of monetary policy responses (Reis, 2022).

Due to the stable and low inflation experienced in almost all developed economies over the past 20 years, the debate on inflation expectations has largely focused on how to avoid entrenching them. Coibion et al. (2018) suggest that due to the extreme level of inflation anchoring over this period, any changes in expectations only reflected noise, and therefore central bank forecasters could ignore inflation expectations in their models. As recently as 2021, the ECB was discussing how monetary policy could be used to avoid below-target inflation becoming entrenched due to low expectations (European Central Bank, 2021).

Now, with high inflation facing most economies around the world, research has instead turned to whether inflation expectations can stay anchored and whether central banks can reduce inflation before a costly de-anchoring occurs. Georgarakos et al. (2023) find that recent inflation expectations in the ECB have become less well anchored around 2%, as per the Consumer Expectations Survey. Reis (2021) suggests that the distribution and skewness of long-term inflation expectations is also important and finds that the data may point towards a partial de-anchoring of expectations.

Due to the importance of inflation expectations to monetary policy, a number of different measures are collected, ranging from short-term inflation expectations such as the one-year ahead inflation expectations, which typically experience higher variance, to long-term measures such as the ten-year ahead inflation expectations, which have remained consistently stable over the past two decades (Coibion et al., 2018). Clark and Davig (2009) find that changes to long-term inflation expectations can have pass-through effects to underlying inflation in an economy, while shocks to short-term expectations are likely to be more temporary. In order to filter out temporary fluctuations without filtering out the more persistent price changes, this thesis uses a *five-year ahead* measure of inflation expectations.

### 2.2.3 Pass-Through Effects from Headline Shocks

There is a long history of research studying the pass-through to core inflation from price shocks in specific industries. This research has typically focused on pass-through from oil prices (e.g. Valcarcel and Wohar, 2013; Álvarez et al., 2011; Choi et al., 2018), commodity prices (e.g. Gelos and Ustyugova, 2017) and food prices (e.g. Fuceri et al., 2016). As reflected in the stability of inflation in many advanced economies before Covid, pass-through from headline shocks may have decreased over time. Tiwari et al. (2019) find that oil price pass-through to core inflation in the US has decreased and Fuceri et al. (2016) find that food price shocks' impact on inflation has declined in advanced economies. Blanchard and Gali (2007) suggest that while oil price shocks contributed to high inflation in the 1970's, its role as a source of economic fluctuations has decreased since then due to the reduced use of oil in production, increased flexibility of labour markets, and improved monetary policy.

On the other hand, Gelos and Ustyugova (2017) find that commodity price shocks have a greater pass-through to domestic inflation when inflation is already at a relatively high level. Thus, the abundance and simultaneous nature of the price shocks stemming from Covid and Russia's invasion of Ukraine may lead to greater pass-through from headline inflation to core inflation. For example, Carrière-Swallow et al. (2023) find that the recent increases in global shipping costs led to increases in core inflation, with second round pass-through effects peaking 12 months after the rise in shipping costs. Blanchard et al. (2022) suggests that the current high inflation period can only realistically be compared to that of the 1970's and warns against treating high inflation as transitory.

The salience of price shocks may also influence their pass through, with Georganas et al. (2014) finding that consumers experience frequency bias towards price changes and Trehan (2011) suggesting that consumers are excessively sensitive to certain price changes in certain goods. Distorted consumer expectations of inflation may also influence wage setting, leading to greater pass-through effects to core inflation, which are not captured by our labour market tightness measure. Lorenzoni and Werning (2023) further suggest that an initial spike in an input price can cause persistent price inflation and a small but persistent increase in wage inflation.

In this thesis, the pass-through from headline shocks to core inflation is included for three main reasons: 1) The concurrent nature and size of the recent headline shocks suggest that even with low pass-through they may have significant effect on core inflation. 2) The salience of shocks, in particular price shocks as a result of Covid and the Ukraine war, may lead to greater pass-through due to wage-price spirals. 3) New and relatively unstudied shocks as a result of Covid, such as car prices in the US or increased shipping costs, may experience different pass-through mechanisms and second round effects compared to previous findings.

## 2.3 Inflation During the Covid Era

The Covid Era - which we define as the period 2020-2022 - represented a new challenge for the current monetary policy regime around the world, which had been so successful at controlling inflation in the two decades prior (Miles et al., 2017). Reis (2022) characterises the period as consisting of 3 consecutive sets of shocks. In this characterisation, the first shock is the onset of the pandemic along with the unexpectedly rapid recovery. At this stage, monetary and fiscal policy was kept loose due to legitimate fears of a deep recession. Second came the supply disruptions, characterised by increases in shipping times, reaching of capacity constraints, and resulting delays in global supply chains. Finally, the third set of shocks stem from the Russian invasion of Ukraine which, among other things, sharply increased the already rising global energy prices.

Throughout these shocks, monetary policy remained loose around the world, with Sweden's central bank in 2021 forecasting a decrease in inflation during 2022 (Sveriges Riksbank, 2021). The two central predictions made by the Riksbank in this forecast were that global supply chains would clear up and that energy prices would decrease during 2022. When inflation instead continued to rise, the Riksbank was forced to initiate an increase in the interest rate starting in May 2022 (Sveriges Riksbank, 2022b). The ECB and US Federal Reserve were similarly slow to react, as they also interpreted the initial price increases as transitory shocks that did not necessitate a monetary policy response.

A range of explanations have already been proposed for why persistent high inflation was unexpected, many of which may have worked in tandem. Ball et al. (2022) suggest that the structural changes of the labour market during Covid led to unexpected tightening, which in combination with price shocks and supply bottlenecks led to the rise of inflation in the US.

They also argue that the role of labour market tightness has risen over time. Additionally, Di Giovanni et al. (2022) suggest that supply chain bottlenecks led to expansionary policies having an outsized impact on inflation. Looking ahead, Reis (2022) highlights the risk that a de-anchoring of inflation expectations can lead to persistently high inflation. Against the backdrop of the widespread misinterpretation of the initial rise in inflation during the Covid era, this paper contributes to the growing literature that attempts to untangle the causes of this persistently high inflation, and why it came as such a surprise to most economists and central bankers.

# 3 Theoretical Background

This section first explores the theoretical background behind our inflation decomposition and Phillips curve, then expands the Diamond–Mortensen–Pissarides search and matching model to include on-the-job and out-of-labour-market search. This results in our measure of labour market tightness, *vacancies to effective searchers.*

## 3.1 Decomposing Inflation

For the purpose of our analysis we define headline inflation as a combination of core inflation and headline shocks. We interpret core inflation as a relatively steady component of inflation that is determined by long term inflation expectations, pass-through of past headline shocks through wage setting or other input costs, and labour market tightness. Core inflation moves in the opposite direction from economic slack in accordance with the Phillips curve, while headline shocks are idiosyncratic deviations from this core caused by large price fluctuations in specific markets, industries, or sectors of the economy. It should be noted that we make no distinction between demand and supply shocks in this analysis. We formalise this mathematically in its most simplified form as in Wynne (2008):

$$\pi_{i,t} = \Pi_t + x_{i,t} \tag{1}$$

Where the price change $\pi_{i,t}$ of good or service $i$ in time $t$ is determined by the aggregate inflation component $\Pi_t$ (the core level of inflation) and a relative price change component $x_{i,t}$ (the headline shock to that specific good or service). We aggregate this to obtain the overall core inflation level. Weights are applied to price changes 1 to i such that the cumulative weight is:

$$W_{i,t} = \sum_{j=1}^{i} w_{(j)t} \tag{2}$$

Where $w_{(j)t}$ denotes the sorted $jth$ weight from smallest to largest and define the set:

$$I_\alpha = \{i : \alpha < W_{i,t} < 1 - \alpha\} \tag{3}$$

The $\alpha$ parameter represents the degree of trimming and core inflation is therefore equal to:

$$\pi_t^C(\alpha) = \frac{1}{1 - 2\alpha} \sum_{i \in I_\alpha} w_{(i)t} \pi_{(i)t} \tag{4}$$

With the weighted median inflation rate taking the limit case where $\alpha$ *approaches* 0.5:

$$\pi_t^C = \sum_{i \in I_{0.5}} \pi_{(i)t} \tag{5}$$

Where:

$$I_{0.5} = \{i : W_{i,t} = 0.5\} \tag{6}$$

The weighted median inflation rate is selected as the inflation rate at time $t$ for the good or service $i$ at which the sum of the ordered weights are at the $50th$ percentile. The core component of inflation is therefore equal to the median price change, which is given 100% weighting. As we define headline shocks as the difference between core inflation and headline inflation we obtain the following final decomposition:

$$\pi_t = \pi_t^C + \pi_t^H \tag{7}$$

Where:
$\pi_t = Headline\ Inflation$
$\pi_t^C = Core\ Inflation$
$\pi_t^H = Headline\ Shocks$

## 3.2 Measuring Labour Market Tightness

We underpin the theoretical background to our measure of labour market tightness by building on the model of unemployment equilibrium theory as presented in Pissarides (2000)[3]. We begin with the basic matching function of:

$$m = m(v,\ u + e) \tag{8}$$

$Where:$
$v = vacancies\ rate$
$u = unemployment\ rate$
$e = employed\ jobseekers\ rate \leq 1 - u$

We assume this matching function and ones later on are increasing in all arguments, concave, and homogeneous of degree 1. Jobs and job seekers are randomly matched from the sets $vL$, $uL$

[3] As our analysis focuses on and only requires labour market tightness we neglect other portions of the model, but for a full set of equilibrium conditions (without our inclusion of effective searchers) see Pissardes (2000).

and $eL$ where $L$ is the total labour force. Since the change in vacant jobs is assumed to follow a Poisson distribution with rate $m(vL, uL, eL)/vL$ and the matching function is homogeneous of degree one, the rate at which workers arrive to vacancies is a function of the ratio of vacancies to all job seekers:

$$q(\theta) \equiv m(1, \frac{u+e}{v}) \tag{9}$$

$Where:$

$$Labour\ Market\ Tightness = \ \theta \ = \ \frac{v}{u+e} \tag{10}$$

We start developing this model by including job search from individuals outside of the labour market:

$$m = m(v,\ u+e+o) \tag{11}$$

$Where:$
$v = vacancies\ rate$
$u = unemployment\ rate$
$e = employed\ jobseekers\ rate \leq 1-u-o$
$o = outside\ jobseekers\ rate \leq 1-u-e$

$$Labour\ Market\ Tightness = \ \theta \ = \ \frac{v}{u+e+o} \tag{12}$$

This model makes the implicit assumption that individuals that are employed, unemployed, or outside of the labour market all search with the same intensity and are equally likely to find a job. This is likely to be an unrealistic assumption given the empirical evidence on relative job-finding rates. To incorporate this in our analysis, we develop the model to include how effective job searchers are, instead of just the proportion of each group. The number of effective searchers in each group is given by their population share and their respective job-finding rate. Formally:

$$U = Effective\ unemployed\ searchers = f_u u$$
$$E = Effective\ employed\ searchers = f_e e$$
$$O = Effective\ outside\ searchers = f_o o$$
$$V = Vacancy\ rate = v$$

$Where:$
$f_g = job\ finding\ rate\ for\ group\ g$

Incorporating this into our matching function:

$$m = m(V,\ U + E + O) \tag{13}$$

$$q(\theta) \equiv m(1, \frac{U + E + O}{V}) \tag{14}$$

$Where:$

$$Labour\ market\ tightness = \theta = \frac{V}{U + E + O} \tag{15}$$

$$Total\ effective\ searchers = ES = U + E + O \tag{16}$$

$Therefore:$

$$\theta = \frac{V}{ES} \tag{17}$$

$$Where:\ V > 0\ and\ ES > 0$$

In this specification, labour market tightness is given by the ratio of vacancies to effective searchers. Naturally, labour market tightness is then increasing in the number of vacancies and decreasing in the number of effective searchers. This is a quite intuitive result since when there are more vacancies, workers have greater bargaining power and when there are less effective searchers (i.e. less competition for jobs), workers will correspondingly have greater bargaining power. Nevertheless, despite being more sophisticated than a simple measure of the unemployment rate, this specification does not capture *all* aspects of the labour market. Specifically, this model does not incorporate any variation in the intensity by which the *employers* are searching for workers, which likely also impacts the wage setting process. However, due to data limitations and the potentially diminishing returns of including additional subgroups, the V/ES specification used is deemed sophisticated enough to contribute with a new perspective on the research question at hand.

# 4 Data and Methodology

This section describes the data collection and econometric methodology of this thesis. First, the selection of data sources is reviewed along with the transformations made on the data. Then, the identification strategy is described, focusing on the regressions used and the subsequent forecasting exercise.

## 4.1 Data Collection and Transformation

This section describes the reasoning behind the data selection, the methodology in the construction of the composite measurements, and discusses the data quality.

### 4.1.1 Construction of V/ES

The main data source we use for constructing the ratio of vacancies to effective searchers in Sweden is the Labor Force Survey (LFS), which is published by Statistics Sweden on a quarterly basis. This is a comprehensive panel data set with certain variables reaching back to the 1970's (Statistics Sweden, 2023a). Following the methodology used by SCB when measuring the unemployment ratio (Statistics Sweden, 2022), all labour market statistics are derived from samples of people aged between 15 and 74. Using this relatively wide age range also includes effects such as delayed retirement or early entry into the labour market, which can be relevant for wage formation during different stages of the business cycle. Since the LFS is based on stratified sampling of the total population, there is a degree of uncertainty in the measurements. However, the LFS follows ILO conventions as well as EU and UN requirements and is approved for calculating Sweden's official unemployment rate (Statistics Sweden, 2023b).

Using the recruitment tables in the LFS, we compute job-finding rates (JFR) for three labour market groups: the employed, the unemployed, and those not in the labour force. Here, the job-finding rate is defined as the amount of people in each group that is externally recruited to a job each quarter, divided by the total number of people in the group that quarter. Using the LFS, it is possible to compute JFR for these groups from Q1 2006 to Q4 2022. These job-finding rates are then multiplied by the seasonally adjusted population shares for each group in the corresponding time period. For each time period, these values are summed to form a single composite measure of effective searchers in the labour market. We use *seasonally adjusted* population shares since the Swedish labour market exhibits strong seasonality, as previously shown in Figure 1. This measure of effective searchers is dubbed *rolling*, since the job-finding rate of each group is allowed to roll from period to period.

However, there are two central drawbacks to the rolling measure of effective searchers. First, it is only available for a relatively short time period (2006 to 2022). Second, it is problematic for forecasting since future job-finding rates are unknown. Therefore, a second measure of effective searchers is also computed. For this measure, the average job-finding rate over the whole period is taken as fixed, instead of allowing the JFR to roll between time periods. Hence, the variation in effective searchers instead purely stems from population shifts between labour market states (employed, unemployed, or not in the labour force). Using the fixed JFR:s, it is possible to create a measure of effective searchers that span from 2001-2022. This measure is dubbed *fixed.* Despite the difference in job-finding rates, the two measures follow a highly similar trend over time (see Appendix 1 for details).

The vacancy ratio is defined as the number of vacancies reported by SCB divided by the number of people in the country aged between 15 and 74. This data is also based on stratified random sampling, and is defined in a way that is consistent with the data on unemployment (SCB, 2022). Since the data on vacancies is only compiled on a quarterly basis, this data is extended to a monthly measure by linear interpolation when monthly data is required. In this interpolation, the quarterly data point is assumed to represent the month in the middle of the quarter. Finally, the ratio of vacancies to effective searchers ($V/ES$) is computed by dividing the vacancy ratio by the composite measure of effective searchers for each time period.

This specification differs somewhat from the one proposed by Abraham et al. (2020). Importantly, their measurement decomposes the labour market into 22 separate groups instead of three. However, as Aysegül Sahin notes in the comments to Abraham et al. (2020, p.141), the inclusion of 22 subgroups might be excessive, and the results are likely driven by shifts between a few larger groups. Still, the optimal decomposition might include more than three subgroups. Specifically, the measurement can potentially be improved by separating the unemployed into short and long-term unemployed and separating those not in the labour force by whether they would like to work or not. However, data of that granularity does not exist in Sweden. While it would be possible to use the *relative* job-finding rate split between these groups in another country to decompose the results in Sweden, this does not account for the differences in labour market structure between the countries. Instead, this thesis opts for a more conservative model that purely uses data from Sweden.

### 4.1.2 Estimation of Inflation

The measurement of headline inflation used in this thesis is the CPIF. This measures the price change in a basket of consumer goods while keeping interest rate costs constant, and is the target measure used by the Swedish Riksbank (Sveriges Riksbank, 2018). Based on the discussion of core inflation measurements in the literature review, the weighted median inflation is selected as the main measure for core inflation in this thesis. The year-on-year 1% weighted median CPIF is calculated by the Riksbank and published five times per year in their Monetary Policy Reports (Sveriges Riksbank, 2022a).

In addition to the standard year-on-year measurement of weighted median CPIF, we have computed quarter-on-quarter (QoQ) and month-on-month (MoM) changes of weighted median CPIF. These measures are computed using the full set of underlying price indexes and the rolling weightings published by SCB in the *Riksbankstabeller* (Riksbank Tables). To adjust these measures from CPI to CPIF, the interest rate component is replaced with the *Kapitalstockindex* (capital stock index), which is also published by SCB[4]. As our results will show, the shorter measures of inflation are noisier but capture the pass-through of headline shocks faster than the year-on-year measurement. It is also worth noting that some degree of noise is automatically filtered out by calculating the weighted median instead of using standard headline inflation.

The inflation gap is defined as core inflation minus expected inflation. Inflation expectations in Sweden are collected by Prospera and published each month through Kantar Sifo (Kantar Sifo, 2023). From the Prospera surveys, the average 5-year Money Market Participant CPIF expectation is used as the general measure of inflation expectations[5]. While this survey has a somewhat smaller scope, it surveys professional money market participants whose expectations are relatively well-informed.

### 4.1.3 Selection of Headline Shock Variables

The second regression in this thesis attempts to explain the drivers behind headline shocks to Swedish inflation during the pandemic era. The headline shock variable is, as previously discussed, constructed by removing the weighted median inflation from headline CPIF. The output variable of the regression is the measure of headline shock in month-on-month annualised terms. A set of seven candidate regressors are collected based on different sources of disruption to the Swedish economy related to the concurrent crises following the outbreak of Covid-19. In accordance with the specification outlined in the theoretical background, the candidate regressors are derived from both supply-side and demand-side sources of disruption.

Two arguably obvious candidate regressors are energy- and food-price inflation, both since they are the traditionally volatile sectors excluded in XFE and since they have experienced large price increases in the Covid era. These sectors have been especially impacted in Europe as the war in Ukraine disrupted both fossil fuel exports from Russia and agricultural exports from Ukraine. To correspond to the output variable, these variables are expressed in month-on-month annualised terms. To remove the common component of inflation and isolate the relative shock for the specific sector, our measure of core inflation is subtracted from both variables.

[4] For more details on our calculations of the weighted median CPIF, see Appendix 2

[5] For time periods before September 2017, CPI expectations are used instead of CPIF expectations. This aligns with Riksbankens changing of their target variable. Prior to September 2017, Prospera did not survey expectations of CPIF.

Another widely reported effect of the pandemic is disruption to supply chains. For example, Reis (2022) characterise this as the second of three shocks in this era, Di Giovanni et al. (2022) argue that this exacerbated the impact of expansionary monetary policy, and Carrière-Swallow et al. (2023) find that it led to increases in core inflation. We use two measures to estimate this: the Baltic Dry index and supply delivery times as measured in the Swedish SILF PMI. The Baltic Dry index is a measure of the *price* of moving raw materials by sea. The second variable measures the average supply delivery *time* for companies in Sweden, as reported by purchasing managers.

Furthermore, multiple international organisations have identified the large impact that the war in Ukraine has had on commodity markets, including the World Bank (2022) and OECD (2022). As a result of major domestic access to minerals and a strong industrial manufacturing sector, the metal consumption per capita in Sweden is generally much higher than for the average EU country (Statistics Sweden, 2017). Since most of this consumption relates to iron products, we include an index of iron prices in Europe published by the ECB as a candidate regressor.

Naturally, the governmental response to the pandemic is another potential source for shocks to the Swedish economy. While the Swedish response to the pandemic was notable in its relatively lenient approach, it still included significant restrictions compared to the status quo. Therefore, while this impact is likely smaller in Sweden than for comparable countries, the broad impact of the Covid-19 lockdown still renders it a relevant candidate regressor. To measure this, the Covid-19 policy stringency index computed by the Oxford Coronavirus Government Response Tracker (OxCGRT) project is used. This tracks government policies related to closure and containment, health, and economic policy for more than 180 countries to quantify the severity of Covid lockdowns (Hale et al., 2021). This index is published on a daily basis, which we aggregate to find average values for each time period.

Lastly, the Swedish housing market has also experienced turbulence in the wake of the pandemic. According to the Swedish Riksbank (2023), housing prices in Sweden rose "fairly substantially" after the pandemic (p.43), to a peak in 2021. Since then, however, they note that prices have dropped back to pre-pandemic levels. To measure the price level in the Swedish housing market, the HOX Sweden price index for tenant-owned apartments and houses is used.

## 4.2 Identification Strategy

The identification strategy of this thesis is divided into three parts. The first part attempts to explain the core inflation gap using labour market tightness, inflation expectations and headline shocks. The second part aims to explain the sources of headline shocks in Sweden during the pandemic. Lastly, the third part makes use of the previously estimated models to conduct a forecasting exercise for core inflation in the coming years.

### 4.2.1 Explaining Core Inflation

As discussed in the literature review, we model core inflation as a function of $V/ES$ (our measure of labour market tightness), 5-year inflation expectations, and pass through effects from headline shocks. This forms the basis for our regression framework. Some previous research has suggested that the US Phillips curve may be nonlinear in its parameters, with Blanchard (2022) suggesting large shocks have greater salience and therefore a greater impact on inflation, and Owyang and Vermann (2014) proposing a "rocket and feathers" model where core inflation rises quickly but falls slowly. However, we instead follow the assumption that the Swedish Phillips curve is closer to that of the Euro area, which Ball and Mazumeder (2021) find is best modelled as linear in its parameters. This also reduces the risk of overfitting which may be the case with quadratic or cubic parameters. Our regression framework therefore (in the case of monthly data) takes the first form:

$$\pi_t^C - \pi_t^* = C + \kappa \frac{1}{12} \sum_{i=0}^{11} \frac{V_{t-1}}{ES_{t-1}} + \eta \frac{1}{12} \sum_{i=0}^{11} (\pi_{t-i} - \pi_{t-i}^C) \tag{18}$$

$Where:$
$\pi_t^C$ $(core\ inflation\ measured\ by\ Median\ CPIF)\ is\ dependent\ on:$
$\pi_t^*$ $(expected\ inflation)\ measured\ by\ Prospera\ 5\ year\ inflation\ expecations$
$\frac{V}{ES}$ $(labour\ market\ tightness)\ using\ a\ 12\ month\ lag$
$\pi_t - \pi_t^C = \pi_t^H$ $(headline\ shocks)\ using\ a\ 12\ month\ lag$

The output variable of the regression is the inflation gap, defined as core inflation minus expected inflation. The remaining two parts of core inflation enter as regressors, with labour market tightness represented by V/ES, and headline shocks represented by headline inflation minus core inflation. Since time series data of inflation and the labour market are naturally autocorrelated and exhibit shifting variation over time, normal OLS estimation will not provide satisfactory estimates. Therefore, to account for the autocorrelation as well as heteroskedasticity of the errors, our specification uses Newey-West standard errors with four-quarter or 12-month lags (Newey and West, 1986). Kolokotrones et al. (2023) note that Newey-West standard errors is the dominant method used for heteroskedasticity and autocorrelation-robust time series modelling, and find justification for its continued use.

To account for the time lag of the effect of labour market tightness on inflation, four-quarter or 12-month averages of V/ES are used. This choice is made for several reasons. Firstly, the stickiness of wages has strong empirical support (Taylor, 1998), along with its theoretical relevance for monetary policy in small open economies (Campolmi, 2012). This implies that a tighter labour market will not immediately lead to higher wages. Secondly, due to the prevalence of seasonal summer employment in Sweden, all labour market measurements used in this thesis exhibit significant seasonal variation (see Figure 1). This variation is removed by constructing rolling yearly averages (see Figure 2). Thirdly, wage negotiations are commonly only conducted once per year in Swedish workplaces. Lastly, empirical support for this method has been found in several previous studies (Ball et al., 2022).

Similarly, the regression also uses four-quarter or 12-month averages of headline shocks to account for the time it takes for the price shock to pass through to core inflation, following the specification used by Ball et al. (2022). While choosing appropriate lags is always difficult and pass-through time may vary, four-quarter and 12-month averages have a number of advantages. Firstly, they automatically control for seasonal variation in headline shocks which is likely to be important when demand and prices experience seasonal variation, such as in the energy market. Secondly, this is in line with results for a number of the most high profile shocks experienced in the Covid era, with Carrière-Swallow et al. (2023) finding the pass through from higher shipping costs peak after 12 months and data from ECB (2014) suggesting that the effect of oil price changes on other HICP components peaks after approximately one year. Finally, it allows for the indirect effects on industries with slower price setting, such as consumer and business services (ECB, 2019), to be captured.

### 4.2.2 Explaining Headline Inflation Shocks

The second step of this thesis aims to explain the headline shocks during the pandemic era using a set of variables which proxy for different disturbances to the Swedish economy. In a first step, separate bivariate regressions are computed for each candidate regressor to find which of the selected variables provide the highest explanatory power. Second, the most salient shocks are combined in multivariate regression to find the best overall specification. These regressions are, however, based on relatively short data sets (three calendar years), and simulations have shown that Newey-West standard errors can perform poorly in small samples (e.g. Smith and McAleer, 1994; Sul et al., 2005). Therefore, for these regressions, the Newey-West standard errors are exchanged for the Eicker-Huber-White standard errors, which are based on contributions from Eicker (1967), Huber (1967), and White (1980). These errors do not rest on the same underlying assumptions as the Newey-West model, and are robust when the errors are heteroskedastic.

### 4.2.3 Forecasting Exercise

The third and final step of this thesis takes Riksbankens published forecast for unemployment in Sweden, and uses our estimated models to translate this into a forecast of inflation. We adapt the forecast method of Ball et al. (2022) to fit the data and setting of this thesis. The most significant difference is that our estimation uses V/ES instead of V/U as the measure for labour market tightness, which results in an adjusted Beveridge curve that responds differently to the economic cycle compared to the traditional model.

In a first step, Riksbankens forecasts for unemployment and employment are used to calculate a projected level of effective searchers for each quarter from Q1 2023 to Q1 2026. Using our estimated Beveridge curve, each value of effective searchers can be matched with the expected level of vacancies. This value is then plugged into the preferred Phillips curve relationship found in the first regression exercise (column 1 of Table 1). We assume that no new headline shocks will occur, and let the previous shocks ring out for the first three quarters of the forecast. While no future shocks is an unrealistic assumption, the unpredictable nature of headline shocks makes predicting them prone to great uncertainty. For example, a deteriorated security situation in Europe, a mild summer, or a more pronounced wage-price spiral as the lagged effect of past inflation transmits through the economy are all plausible reasons for future positive or negative headline shocks to Swedish inflation.

After computing the inflation gap measure from our Phillips curve, the forecast takes different assumptions for inflation expectations to arrive at a final forecast for median inflation for each quarter. As inflation expectations in Sweden have begun to de-anchor in the last few quarters, a key question is whether they will continue to do so or if the Riksbank can successfully rein them in. Therefore, we use three different scenarios for inflation expectations in our forecast. The first one is quite optimistic, where Riksbanken succeeds in reverting inflation expectations back to its pre-pandemic level (1.786%) in mid 2023. Specifically, this assumes that inflation expectations revert half of the way each quarter and then stay fixed at the pre-pandemic level. The second scenario is more pessimistic, where inflation expectations continue to drift in response to actual inflation in the same way as they have done so far during 2020-2022. The third scenario is the most pessimistic, where inflation expectations drift as they did between 1981 and 1998 in the US, as calculated by Ball et al. (2022). They refer to this as the period "before anchoring" (p.25). While it would be preferable to calculate this drift parameter separately for Sweden, there is no data on inflation expectations that allow us to do this.

In scenario two and three, inflation expectations are assumed to follow the process in equation 19, from which the drift parameter $\gamma$ is estimated. Here, the gamma parameter indicates the level of anchoring in inflation expectations. At $\gamma = 1$, expectations are perfectly anchored and stay fixed at their current level. At $\gamma = 0$, expectations drift fully and respond one-for-one to the previous quarter's value of CPIF. We substitute equation 19 into itself for the time period 2020-2022 to form a single equation for the entire time period. Finally, we add an error term and estimate $\gamma$ - the only unknown parameter in the equation - by nonlinear least-squares fitting. This results in a drift parameter of $\gamma = 0.979$, which is used in the second forecast scenario. In the third scenario expectations instead drift with $\gamma = 0.945$.

$$\pi_t^e = \gamma\pi_{t-1}^e + (1-\gamma)\pi_t \tag{19}$$

$Where:$
$\pi_t^e = expected\ inflation\ in\ time\ t$
$\pi_t = headline\ inflation\ in\ time\ t$
$\gamma = drift\ parameter$

Lastly, our forecasted paths for inflation are compared to Riksbanken's official forecast for CPIF. This comparison is used to discuss the plausibility of Riksbanken's forecast, given their projection for employment and unemployment. Potential sources of variation between the forecasts are also discussed.

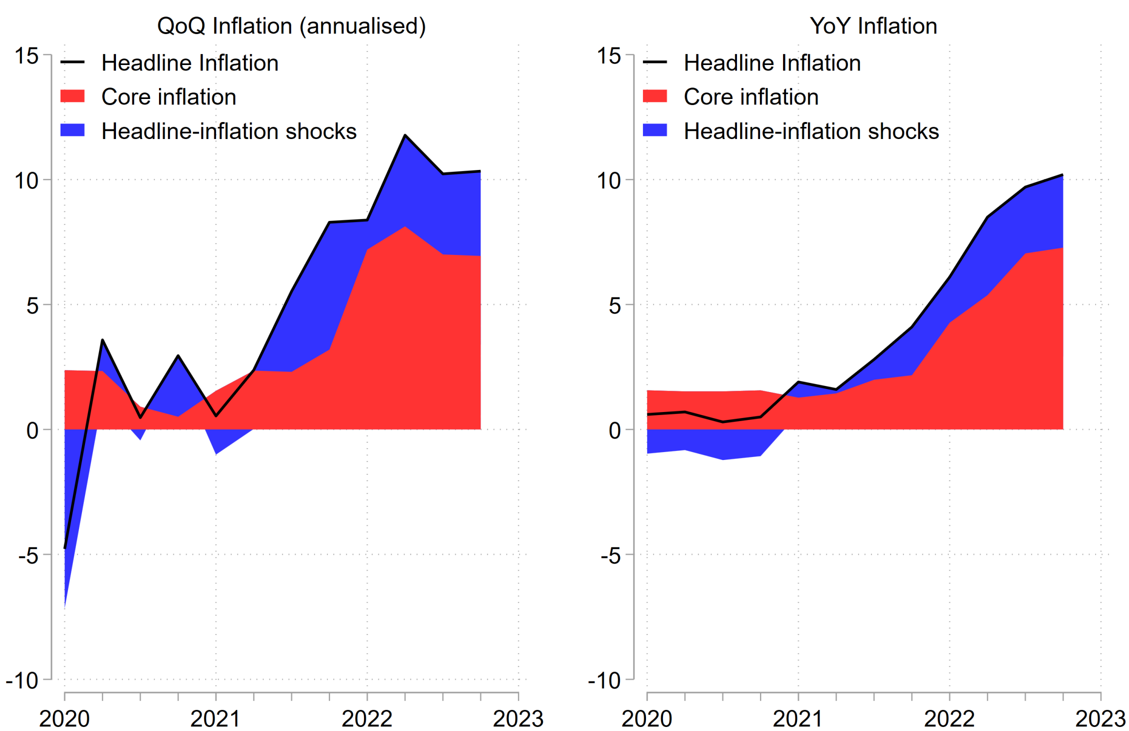
# 5 Results

The results section of this thesis seeks to, in turn, decompose the recent inflation situation in Sweden and then explain the results for both core inflation and headline inflation. The final section then conducts a forecast for Swedish inflation in the coming years and compares these results to official forecasts published by the Riksbank.

## 5.1 Decomposing Inflation

We begin our analysis with a simple decomposition of Swedish inflation into core inflation and headline shocks. Figure 3 shows this decomposition from 2020 onward in two stacked line charts. The left graph shows quarter-on-quarter inflation in annualised terms and the right graph shows year-on-year.

**Figure 3.** CPIF Inflation: Headline, Core, and Headline Inflation Shocks, 2020-2022




When visually analysing the results in Figure 3, a few key insights emerge. First, it is evident that core inflation is a key driver of headline inflation, especially from the end of 2021 onwards. Also, the comparison reveals that QoQ inflation is more volatile and responds quicker to disruptions in the economy. Notably, an immediate negative shock of - 7.15% is found at the onset of the pandemic. Following that, QoQ headline rises sharply from the start of 2021, and the measure for core inflation follows along towards the end of the same year. After that, both headline and core inflation level out, and 2022 ends with QoQ headline at 10.33% and QoQ core at 6.94%. The year-on-year measurement displays a similar overarching trend, while the short-term fluctuations are significantly less pronounced. Due to the relatively slower reaction of YoY inflation to current events, the YoY measures do not level out in 2022 in the same way the QoQ measures do. Instead, the yearly inflation series continue rising through the end of 2022, with YoY headline ending up at 10.17% and YoY core at 7.94%. This side-by-side comparison speaks to the difficulties in uncovering the effect of short-term disruptions to the economy when focusing only on the standard year-on-year inflation measure.

## 5.2 Explaining Core Inflation

Table 1 shows the results for the Phillips curve estimations using our four main specifications. The specifications differ in two ways - whether quarterly or monthly data is used and if V/ES or V/U is used to estimate labour market tightness. The table shows Newey-West standard errors in parentheses and denotes conventional statistical significance levels with stars. Since the specifications with fixed job-finding rates and a longer time period provide a stronger model than those with rolling job-finding rates and a shorter time period, *fixed* is the preferred specification of the V/ES measure. For comparison, the corresponding table with rolling job-finding rates can be found in Appendix 2.

**Table 1**

Phillips Curve Regressions with $V/ES$ and $V/U$, Monthly and Quarterly Data

| VARIABLES | (1)<br>VES Quarterly 2001-2022 | (2)<br>VU Quarterly 2001-2022 | (3)<br>VES Monthly 2001-2022 | (4)<br>VU Monthly 2001-2022 |
|---|---|---|---|---|
| V/ES | 10.806*** | | 7.681** | |
| | (3.915) | | (3.376) | |
| V/U | | 5.180** | | 2.755 |
| | | (2.378) | | (2.050) |
| Headline Shocks | 0.631** | 0.727** | 0.490*** | 0.572*** |
| | (0.286) | (0.351) | (0.139) | (0.199) |
| Constant | -1.409*** | -1.269*** | -1.470*** | -1.220*** |
| | (0.444) | (0.446) | (0.323) | (0.337) |
| Observations | 85 | 85 | 251 | 251 |
| R-squared | 0.348 | 0.328 | 0.200 | 0.180 |
| Rbar-squared | 0.332 | 0.312 | 0.194 | 0.174 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In general, the results show strong statistical significance as almost all coefficients have a p-value of less than 0.05. Hence, labour market tightness and headline shocks appear to be good explanatory variables for core inflation. However, the new model using our estimate of V/ES gives slightly higher statistical significance and R-squared compared to the traditional version, both in the quarterly and the monthly specifications. This indicates that, as predicted by the theoretical model, a composite measure of effective searchers might more accurately reflect the inflationary pressure that arises from the wage-setting process in the labour market. However, one should note that the traditional specification with V/U still provides strong statistical significance, albeit slightly weaker compared to the new version.

Incidentally, Table 1 also reveals that the specifications with quarterly data have stronger statistical significance and higher R-squared, both for the V/ES model and the V/U model. This corresponds to the results found in the Phillips curve estimates made by Ball et al. (2022). This can be viewed as an indication that for this type of inflation gap estimation, monthly data adds noise rather than precision.

## 5.3 Explaining Headline Inflation

We then turn our analysis to the remaining portion of headline inflation - headline shocks - defined as the difference between core inflation and CPIF. The main results for this analysis are shown in Table 2. In this table, bivariate regressions are conducted between the headline shock variable and the seven candidate regressors, using data from 2020-2022. As explained in the methodology, all regressors are expressed in levels except for energy- and food-price inflation. In the second step, a multivariate regression is made using the regressors with the highest statistical significance from the bivariate regressions.

Of the measures chosen, only energy price and the iron price index are significant to at least the 10% level. Therefore, they are selected to move on to a multivariate regression. Here, the significance of the iron price index disappears and there is a small decrease to adjusted R-squared compared to the specification using only energy price. Thus, we do not consider the iron price index to meaningfully contribute to the explanation of headline shocks. Consequently, the energy price is deemed to be the only successful explanatory variable which helps explain the headline shocks during 2020-2022.

The energy price variable in itself has high explanatory power (0.535) and is able to explain a majority of the variation in headline shocks during the examined time period. This is in line with the large attention energy price inflation has received in Swedish and international media as a result of the Russian invasion of Ukraine. Given that our model suggests that a 1% increase in 12-month lagged headline shocks corresponds to a 0.631% increase in core inflation, the impact of energy prices and headline shocks in general should not be discounted.

**Table 2**

Headline Inflation Shocks 2020-2022

Dependent variable: Headline shocks = CPIF - Core inflation (Monthly annualised)

A) Bivariate Regression

| VARIABLES | (1) Baltic Dry | (2) Energy Price | (3) Food Price | (4) Housing Market | (5) SILF Supply Chain Delay | (6) Stringency Index | (7) Iron Price Index |
|---|---|---|---|---|---|---|---|
| | 0.001 | 0.055*** | 0.152 | 2.614 | 0.069 | -0.033 | 0.074* |
| | (0.001) | (0.006) | (0.368) | (4.618) | (0.093) | (0.056) | (0.040) |
| Constant | -1.064 | -0.344 | 1.595 | 1.535 | -3.034 | 2.954 | -8.033 |
| | (2.588) | (0.919) | (1.171) | (1.286) | (6.884) | (3.021) | (5.088) |
| Observations | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| R-squared | 0.051 | 0.535 | 0.007 | 0.011 | 0.018 | 0.014 | 0.105 |
| Rbar-squared | 0.0226 | 0.521 | -0.0231 | -0.0188 | -0.0115 | -0.0161 | 0.0779 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

B) Multivariate Regression

| VARIABLES | (1) |
|---|---|
| Energy Price | 0.0524*** |
| | (0.00760) |
| Iron Price Index | 0.0249 |
| | (0.0314) |
| Constant | -3.529 |
| | (4.329) |
| Observations | 35 |
| R-squared | 0.546 |
| Rbar_squared | 0.518 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

However, roughly half of the variation in headline shocks during this period remain unexplained in this analysis. For this, we posit three possible explanations, all of which may be working in tangent. 1) Omission of headline shock variables that would help explain the remaining variation. 2) A broad set of small and varying shocks to several industries, which individually are too small to be detected by our regression. 3) Noise or error in the inflation measures and/or headline shock variables.

Compared to the results found in Ball et al. (2022), we find only one statistically significant explanatory variable whereas they find three: energy price inflation, backlogs of work, and auto-price shocks. This may be due to the differing infrastructure and Covid policy response of the two countries. For auto-price shocks, it was not selected as a candidate regressor in this thesis for several reasons. First, Sweden has not seen the same reports of disturbance to the car market as the US. Second, there is generally a lower dependence on personal cars in Sweden. Lastly, the more lenient Covid lockdown in Sweden likely allowed for a less pronounced shift away from public transport. As a test of this hypothesis, a bivariate regression of headline shocks and car prices in Sweden is presented in Appendix 4, and as expected there is no statistical significance found.

For energy price, however, we find broadly similar results as Ball et al. (2022). Yet, despite it being our only significant headline shock, we find slightly lower explanatory power than what was found in the US (0.535 as opposed to 0.657). This is unexpected due to the relatively larger impact the decrease in Russian fossil fuel exports has had on Europe compared to the US. However, as noted earlier, this may simply be due to increased noise in our data. For example, the Swedish CPI is based on a survey of approximately 1 000 points of sale (SCB, 2023b), whereas the US CPI collects data from roughly 23 000 retail and service establishments (US Bureau of Labor Statistics, 2023).

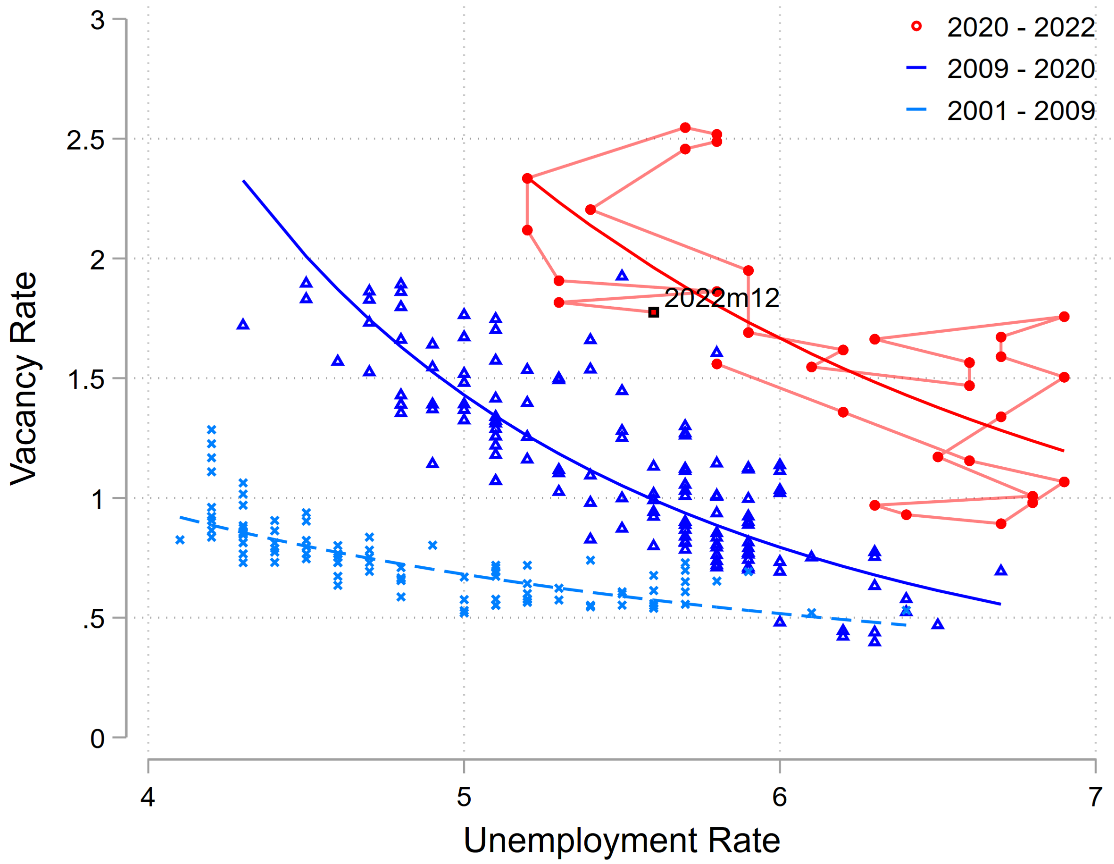
As a robustness test, we also rerun the regression with an alternative measure of energy prices - average wholesale electricity prices in Sweden per megawatt-hour. Results for this are found in Appendix 5. The electricity price variable remains statistically significant, but the explanatory power decreases by approximately half. This is generally in line with our expectations, since electricity prices only represent a certain subset of the overall changes in energy prices.

## 5.4 Forecasting Future Inflation

The third part of our analysis makes use of official projections for unemployment and labour force participation to derive a forecast for core inflation. The main unemployment projection used was published in February 2023 in the Swedish Riksbank's monetary policy report (Sveriges Riksbank, 2023). This projection is combined with our estimated Beveridge curve and preferred Phillips curve to derive a path for core inflation, conditional on a set of assumptions about inflation expectations.

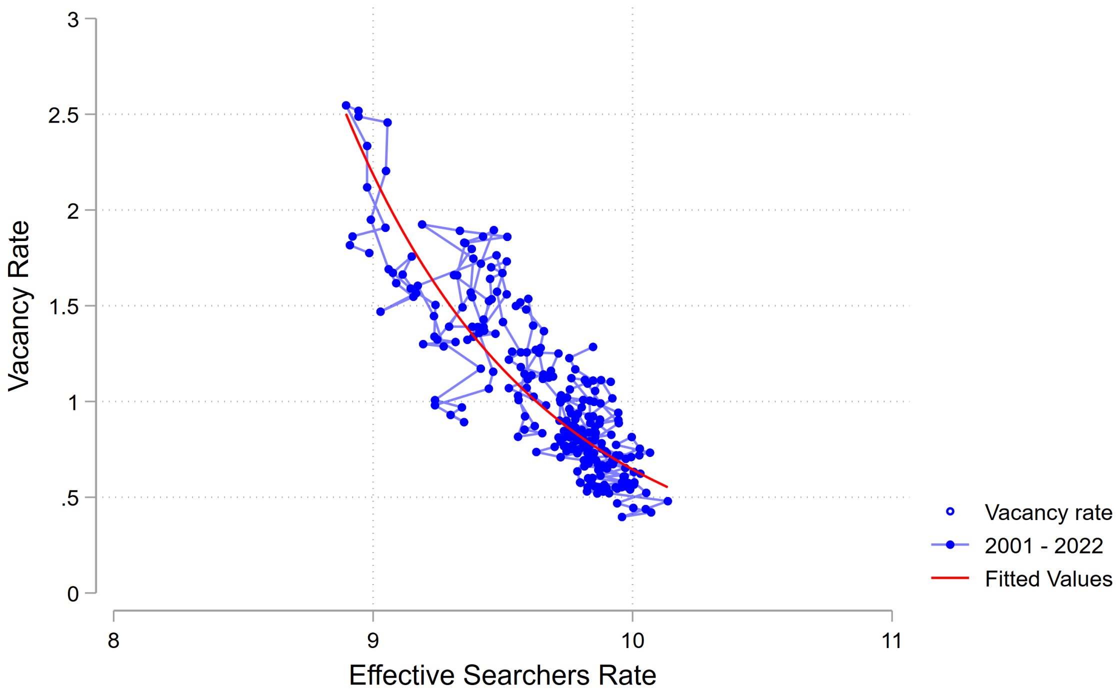
As discussed in the literature review, several economists have found outward shifts in the Beveridge curve during economic downturns, specifically after the financial crisis of 2008 and after the onset of the pandemic in 2020. As shown in Figure 4, we find similar results in Sweden, with the Beveridge curve shifting outwards and steepening after both aforementioned crises. This specification therefore implies that Sweden currently has an unusually high vacancy rate at any given unemployment rate, which pushes up the V/U ratio. Given the assumed relationship between V/U and inflation, this means that unemployment would currently need to increase by a larger amount than normal in order to bring down inflation to target.

**Figure 4.** Beveridge Curve Unemployment, 2001 - 2022



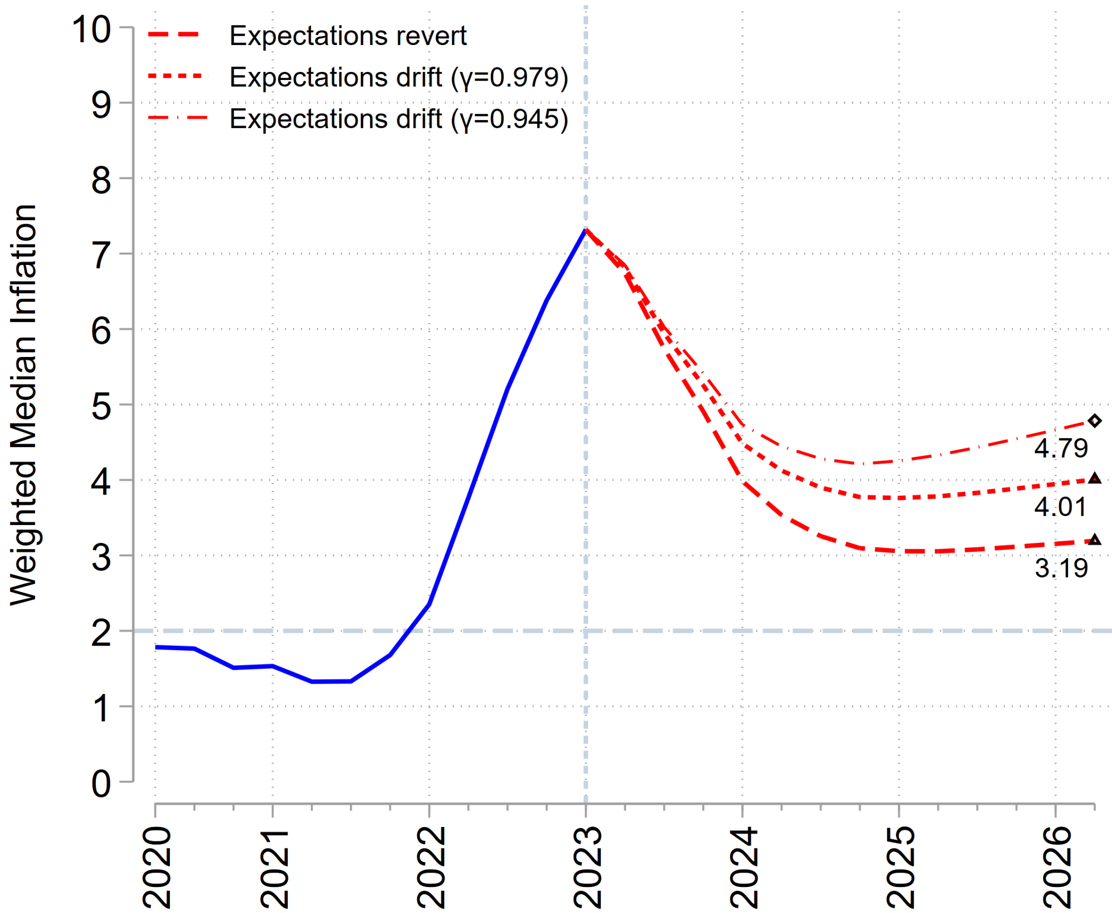

However, when assessing the alternative Beveridge curve which uses our estimate of effective searchers instead of unemployment, a different picture emerges. In Figure 5, we see that this curve does not exhibit any significant shifts over the same time period, despite the two crises. This result corresponds to the result found by Abraham et al. (2020), as they conclude that their measure of effective searchers provides a more stable Beveridge curve compared to the traditional model. The Beveridge curve in Figure 5 is also significantly steeper than those found in Figure 4, and the majority of the observations are found at the lower end of the curve. One reason for this is the narrower range of values that ES takes compared to U, which exemplifies the decreased cyclicality of the new measure. During the last few years, the Swedish economy has moved unusually far up along this curve, which results in the currently high level of V/ES. Hence, this figure conveys that the fundamental relationship between vacancies and effective searchers has not shifted. Instead, the economy is just at unusually high levels of labour market tightness.

**Figure 5.** Beveridge Curve Effective Searchers, 2001 - 2022




In Figure 6, our alternative Beveridge Curve is used to forecast inflation for 2023-2026. A key benefit of our model compared to the traditional V/U model is that since our Beveridge curve experiences no shifts, we do not have to make any assumptions regarding the future position of the Beveridge curve. We do, however, still have to make assumptions regarding inflation expectations. For this, we construct three forecasts as described in section 4.2.3. Our first 'optimistic' forecast assumes that 5-year ahead inflation expectations linearly revert to their pre-Covid levels of 1.789 during the first half of 2023. Our second, arguably more realistic, forecast assumes that expectations continue to drift according to their current trend ($\gamma = 0.979$). If the pace of de-anchoring is currently increasing, this forecast still errs on the optimistic side. In the third and most pessimistic simulation, expectations are assumed to drift according to a pre-anchoring estimation ($\gamma = 0.945$). For all simulations, we set headline shocks after year-end 2022 to zero but let the headline shocks that have occurred until that point impact core inflation for the coming three quarters.

**Figure 6.** Inflation Forecast




As demonstrated in Figure 6, all simulations indicate that core inflation will stay above target for the coming three years. This is in contrast to the most recent forecast from the Riksbank, where they expect CPIF to reach below the 2% target in December 2023. Under the assumption that inflation expectations revert to their pre-Covid levels, our model predicts that inflation stabilises slightly above 3% in Q4 2024, ending on 3.19% in Q1 2026 - the end of the forecasting period. The results are similar, but with slightly higher levels, when expectations continue to drift according to their current trend. In this simulation, core inflation stabilises around 4% in 2024, double the Riksbank's CPIF forecast. It should be noted that in this model, the drift of expectations is still relatively conservative with 5-year inflation expectations only reaching a maximum of 2.6%. In the third scenario, where expectations drift more than their current trend, core inflation never reaches below 4% and the forecast period ends with core inflation at 4.79% and rising. It should be noted that while all 3 of our forecasts are higher than the official forecast, due to the inherent uncertainty in any forecast, they are not necessarily contradictory.

Table 3 contains a set of scenarios for future inflation, where each row represents one scenario. The scenarios assume five different levels of core inflation, four different levels of inflation expectations, and use our estimated models to translate these to corresponding levels of unemployment. This estimation assumes that all new unemployed individuals flow from those who are currently employed, holding the size of the labour force constant. Lastly, the fourth column calculates how much more unemployment the scenario requires compared to the scenario in the row below, which has 0.5 higher core inflation and the same inflation expectations.

**Table 3**

Scenario Analysis: Unemployment required for different levels of core inflation and inflation expectations

| Core inflation | Inflation expectations | Unemployment | Unemployment Added |
|---|---|---|---|
| 2 | 1.786 | 9.96% | 1.13 |
| 2.5 | 1.786 | 8.83% | 0.87 |
| 3 | 1.786 | 7.96% | 0.71 |
| 3.5 | 1.786 | 7.25% | 0.60 |
| 4 | 1.786 | 6.66% | |
| 2 | 2 | 10.56% | 1.29 |
| 2.5 | 2 | 9.28% | 0.97 |
| 3 | 2 | 8.31% | 0.77 |
| 3.5 | 2 | 7.54% | 0.64 |
| 4 | 2 | 6.90% | |
| 2 | 2.32 | 11.68% | 1.63 |
| 2.5 | 2.32 | 10.05% | 1.15 |
| 3 | 2.32 | 8.90% | 0.89 |
| 3.5 | 2.32 | 8.01% | 0.72 |
| 4 | 2.32 | 7.30% | |
| 2 | 2.6 | 13.00% | 2.12 |
| 2.5 | 2.6 | 10.88% | 1.38 |
| 3 | 2.6 | 9.50% | 1.02 |
| 3.5 | 2.6 | 8.48% | 0.80 |
| 4 | 2.6 | 7.68% | |

Table 3 indicates two main results: 1) Drifting inflation expectations are very costly, and 2) Each additional reduction in inflation requires a greater increase in unemployment at a given level of expectations. To exemplify the cost of drifting expectations, reaching the 2% target with expectations at 1.786% only requires approximately 10% unemployment, but with expectations at 2.6% the necessary unemployment rises to 13%. To exemplify the greater unemployment increase for each additional reduction of core, if expectations revert to 1.786%, reducing core inflation from 4% to 3.5% requires an additional 0.60% of unemployment, whereas reducing core inflation from 2.5% to 2% requires an additional 1.13% unemployment - almost twice as much.

# 6 Discussion

This section turns to the discussion of our results, first focusing on inflation during 2020-2022, why the rise was broadly misinterpreted, and what we can learn from this. Then focus turns to the future and what our results indicate should be done, or not done, to rein in inflation. Finally, we discuss some limitations of this paper and possible avenues for future research.

## 6.1 Looking to the Past

We first turn to the discussion of what has caused the recent rise in inflation, why the Swedish central bank was slow to react, and what we can learn from it. It is worth noting that we have something the central bank does not have when setting interest rates - the benefit of hindsight. In any case, we propose that the current period of high inflation came as a surprise due to four main factors.

The first reason, and the one given the most media attention, is the large shocks to headline inflation, of which we find energy prices to be the largest driver. To expect central banks to predict shocks such as this is naturally illogical. However, the common assumption that previous shocks would not feed into core inflation is likely to have contributed to why this current period of inflation came as a surprise. The generally found fall in pass-through since the 1970's is likely a root cause for this school of thought. Indeed, our Phillips curve estimation suggests that the pass-through effect should still be accounted for, particularly during periods of large and concurrent headline shocks. Therefore, we conclude that prudent central bankers ought to include the pass-through from headline shocks when forecasting medium-term inflation and setting interest rates.

Second, we contend that the tightness of the labour market was not fully captured or appreciated due to a general focus on the simple unemployment rate[6]. Meanwhile, both the V/U rate and our V/ES measure would have shown that the labour market had been generally tightening since 2010, with high rates for the entire pandemic era - despite the initial economic downturn. This is made even clearer by the Beveridge curve of our V/ES measure, which shows a steady movement up the curve during 2021. Since the V/ES measure provides a more stable Beveridge curve, this measure communicates a less ambiguous picture of the labour market and might therefore be preferable. With fewer shifts in the Beveridge curve, the central bank and other stakeholders might more accurately assess the relative tightness of the labour market. Hence, we suggest that more attention should be given to labour market tightness measures that capture both sides of the labour market - job vacancies and job searchers. While our measure is still relatively new and may require further adjustment, the results here suggest that *vacancies to effective searchers* performs better than the standard *vacancies to unemployment*.

[6] For a comparison in the trend of the simple unemployment rate and V/ES see Appendix A.1

Third, we turn to the *measure* of core inflation. As covered in the literature review, different measures of core inflation have their distinct advantages and disadvantages. However, the overreliance on exclusionary measures seems archaic. At the end of 2021, out of the 7 measures of underlying inflation reported by the Swedish Riksbank, their two exclusionary measures (CPIF excluding energy and unprocessed food and CPIF excluding energy) were the only ones that remained below 2%. Since growing evidence suggests that exclusionary measures perform worse than other measures, it may be time for them to be cast away. While a range of core inflation measures should be tracked and considered by central banks, previous literature and our results suggest that weighted median inflation should certainly be one of them. Additionally, during periods of large shocks to a broad range of industries - such as in the Covid Era - there is perhaps more reason it should be the leading measure of core inflation.

Finally, we turn to inflation expectations. Since the drift in expectations came relatively slow, it would likely not require significant action when considered in isolation. However, inflation expectations do not form in a vacuum. In essence, the drift to slightly above 2% that occurred during the end of 2021 should have been taken as another warning sign of persistently elevated inflation rates. Still, more work is needed to understand the drift or de-anchoring of inflation expectations, with the work of Reis (2021; 2022) already making strong contributions. What is abundantly clear is that the de-anchoring of inflation expectations can be very costly, especially when the labour market is tight and there are concurrent headline inflation shocks.

## 6.2 Looking to the Future

Next, we turn to the future and what should be done about inflation. Here there is significant uncertainty, or to borrow the words of Furman (2022, p.86): *"Predicting inflation is hard, understanding what to do about it is even harder"*. To briefly exemplify some of this uncertainty, it is not clear what impact spillovers from foreign central banks' interest rate hikes will have, whether the krona will remain weak (which complicates inflation reduction), or whether energy prices will decrease substantially. In addition, Sweden has high household indebtedness and a high share of floating mortgage rates compared to many other countries (Sveriges Riksbank, 2023), which may suggest that Sweden is more sensitive to rising interest rates. Hence, interest rate comparisons across countries are difficult to make. Given these sources of uncertainty, any forecast in the current environment should be interpreted with caution.

Still, our results indicate that inflation may be substantially higher than what the Swedish Riksbank predicts in the coming years. As a counterargument, one might note that the Riksbank has the power to set the interest rate, and might therefore be more confident that they can bring inflation down to 2%. Additionally, they might be influenced by signalling purposes, where instilling confidence in the central bank is key to success. However, our forecast is based on the Riksbank's own projections for unemployment and finds a potential discrepancy between their forecasts, which may not be fully justified by the aforementioned counterarguments.

One advantage we have over previous contributions such as Ball et al. (2021) is that our V/ES Beveridge curve does not shift. Therefore, we are able to make our forecast with one less assumption. Given this, our forecast suggests one general result: regardless of whether inflation expectations return or drift, unemployment may have to increase by more than what the Riksbank predicts if they seek to actualize their forecast of inflation. This likely means hiking interest rates by more than what is currently planned. Still, significant uncertainty remains and we do not attempt to estimate which interest rate is required to bring inflation to target. What is clear, however, is that high inflation is costly and we suggest it is better to err on the side of doing too much rather than too little. As demonstrated by the results in Table 3, the de-anchoring of expectations is costly as allowing further drift will require higher unemployment to bring inflation back to target. Therefore, the risk of excessive interest rate hikes may be preferable to the risk of drifting expectations.

We now shift focus to a question which will, at first, seem contradictory to the previous discussion - whether the Riksbank should even try to reduce inflation to 2% or if this is an opportune time to change the inflation target to 3%. There has been much debate on whether the inflation target should be increased. Blanchard et al. (2010) initially proposed a 4% inflation target, though Blanchard has more recently suggested a 3% target (Blanchard, 2022). A higher target will correspond to higher average nominal interest rates, which gives central banks and policy makers more room to decrease interest rates without being restricted by the zero lower bound. In the presence of downward sticky wages, a higher average inflation rate will also expedite reductions in real income during economic downturns. Blanco (2021) finds the optimal inflation target in an economy with menu costs and a zero lower bound to be 3.5%. One argument for increasing the target to 3% is that it may be low enough to be less salient and cause a limited reaction in wage and price setting. Korenok et al. (2022) use internet search data to estimate inflation attention thresholds[7] in 37 countries and estimate that Sweden has a threshold of 3.1%.

On the other hand, one might argue that the current period of high inflation is an odd time to propose an increase in inflation target since it potentially increases inflation expectations. However, it may be an opportune time to approach the target ‘from above’ as letting inflation settle at 3% will require less economic slowdown than reducing it to 2%, as suggested by our results. Also, the IMF (2023) predicts that once the current high inflation period ends, natural interest rates around the world are likely to return to their pre-pandemic low. This would once again lead to the risk of the zero lower bound restricting monetary policy.

[7] The rate of inflation at which households and businesses start focusing on it, and therefore potentially start internalising it.

Still, the effect of increasing the target is ambiguous since increased inflation expectations or reduced trust in the central bank potentially worsens the current de-anchoring trend. If the inflation target is changed while inflation is still high, and this signal is deemed credible (thus increasing long term inflation expectations to 3%), it is likely that heightened inflation will be more persistent. Therefore, any change in the target should not be enacted or communicated until inflation is at or near 3%. Also, as Lucas (1976) argues, a changed target might shift expectations of the policy process and therefore change the parameters of previously estimated models. Since our model is based on historical data, such a scenario would compromise its validity. Therefore, further research on the impact of a changed inflation target is warranted so central banks can seriously consider whether this is an opportune time for a 3% inflation target.

## 6.3 Limitations and Avenues for Future Research

Finally, we turn to the limitations of our work and where we think some of the most promising avenues for future research may lie. First, a central feature of our inflation forecast is the assumption of no future headline shocks. If one, for example, believes a substantial and persistent reduction of energy prices is likely to occur during 2023, this would cause a negative headline shock and pull down core inflation further. Thus, it is important to remember the assumptions that our forecast is based on when interpreting it and incorporating it with one's own projections for future headline shocks.

Next, we turn to our measure of vacancies to effective searchers. While we believe it is an improvement on the standard V/U measure, there may still be significant benefit from conducting further separations within the population. Specifically, one could separate the long-term and short-term unemployed. Abraham et al. (2020) find that long-term unemployed people have significantly lower job-finding rates than the short-term unemployed, which means that the composition of unemployment influences labour market tightness and may alter the optimal monetary policy response. A second avenue for improvement of V/ES could be to distinguish between those outside the labour force who have given up their job search but would still like to have a job, and those who do not want a job even if offered one. Abraham et al. (2020) find different job-finding rates between these two groups, and Ayşegül Şahin notes in her comments that this is one of the main drivers of heterogeneity in their measure of effective searchers. However, as far as we are aware, there does not currently exist data in Sweden that would allow us to make these distinctions.

Furthermore, our data required the use of *fixed* job-finding rates to capture a longer time period. Using rolling job-finding rates may capture changes in search intensity between groups that are not accounted for in our model. This might however have limited use for forecasting purposes since assumptions will have to be made regarding future job-finding rates. From a broader perspective, our data only goes back to 2001 - a period with generally low and stable inflation. Future research may be able to find novel ways to construct comparable data from earlier time periods, for example including the high inflation in Sweden during the 90's. A more varied set of observations on inflation might then assist in uncovering potential nonlinearities in the impact of labour market tightness and headline shocks on core inflation.

There are also some potential limitations of our forecasting model's drift parameter. In our specification, the drift of inflation depends on the headline CPIF in the previous period. However, there are no indications that this is the specific measure of inflation that the surveyed money market managers consider when forming their expectations for the future. It may be the case that other indicators of inflation are tracked more closely by the surveyed individuals. This is especially a problem during periods of volatile inflation, when divergence between inflation signals increase. Therefore, we might be ignorant of the true process of how inflation expectations form. However, as 5-year expectations are relatively stable, this effect may be relatively small.

Lastly, it might be possible to improve the lag selection in the Phillips curve specification. Our model uses 4-quarter lags for both labour market tightness and pass through from headline inflation, which in our view are reasonable assumptions. These lags have support in previous literature, and for both variables there is likely to be a delay before they impact core inflation. Additionally, using 4-quarter lags brings the added benefit of removing seasonal variation. However, there may be a better way to model this lagged effect. Eeckhout (2023) suggests that inflation should be reported *instantaneously*, with higher weights on more recent observations and where recent observations have an even greater weight under periods of increased volatility. A similarly lagged model may be reasonable for labour market tightness and pass through from headline inflation, and may improve future Philips curve models. However, this would require assuming appropriate weights, which may be difficult and subjective. This especially holds for inflation forecasting, where future shock variability is unknown.

# 7 Conclusion

This thesis studies inflation in Sweden, focusing on the rise in inflation during the pandemic era. Following the work of Ball et al. (2022), we decompose inflation into one common, slow-moving part - core inflation - and one part representing short-term idiosyncratic fluctuations - headline shocks. We estimate an adapted Phillips curve model using a long time series data set, where core inflation is explained by labour market tightness, inflation expectations, and headline shocks. In this model, we follow the work of Abraham et al. (2020) among others, to construct a refined measure of labour market tightness - the vacancies to effective searchers ratio (V/ES). This goes beyond the vacancies to unemployment ratio (V/U) to incorporate on-the-job search and out-of-labour-market entry. Then, we estimate a second model for headline shocks, using a shorter data set with explanatory variables representing disruptions to the Swedish economy during the pandemic era. Lastly, we use our estimated Phillips curve, and corresponding Beveridge curve, to translate Riksbanken's employment projections to forecasts of core inflation, and investigate how they differ to official forecasts of CPIF.

Our decomposition of inflation shows that while short-term fluctuations are more readily visible in the quarter-on-quarter measure than in the year-on-year measure, both indicate that core inflation represents a majority of current headline inflation. Our Phillips curve estimation reveals that both labour market tightness and previous headline shocks are strong explanatory variables for core inflation. Additionally, our novel V/ES measure provides stronger results than the traditional V/U measure when explaining core inflation. In explaining headline shocks, we only find energy price to be sufficiently statistically significant. We posit that the remaining unexplained headline shocks could stem from an omission of relevant regressors, the existence of a broad set of small-magnitude shocks, or the presence of noise in the data. Lastly, our forecasts of core inflation in the coming years suggest that given the current (un)employment projections, core inflation will remain above target for several years even under optimistic assumptions about inflation expectations. This stands in contrast to official forecasts, which indicate that CPIF will reach its target at year-end 2023. Even with our most optimistic assumption, unemployment will need to increase to 9.96% to bring inflation back to target, which is significantly more than Riksbanken's forecast where unemployment peaks at 8.27%.

Based on our research, we argue that the rise in inflation came as a surprise due to overlooked pass-through effects from headline shocks, oversimplified measures of labour market tightness, outdated measures of core inflation, and a lack of insight into the formation of inflation expectations. Looking forward, we contend that in the absence of large negative headline shocks, unemployment will need to increase by more than the current Riksbank forecast if inflation is to reach its target within the next three years. A potential strategy to alleviate some of the pain that this will cause could be to approach a new inflation target of 3% 'from above'. However, the effects of a changed target are ambiguous and risk seriously de-anchoring inflation expectations if enacted before inflation has stabilised. Finally, we suggest that there are several promising avenues for future research, such as conducting a more granular division of the labour market or accessing data from longer time periods.

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# Appendices

## A.1 Vacancies Over Effective Searchers - Comparison

**Figure A.1.** Vacancies Over Effective Searchers, 2006-2022

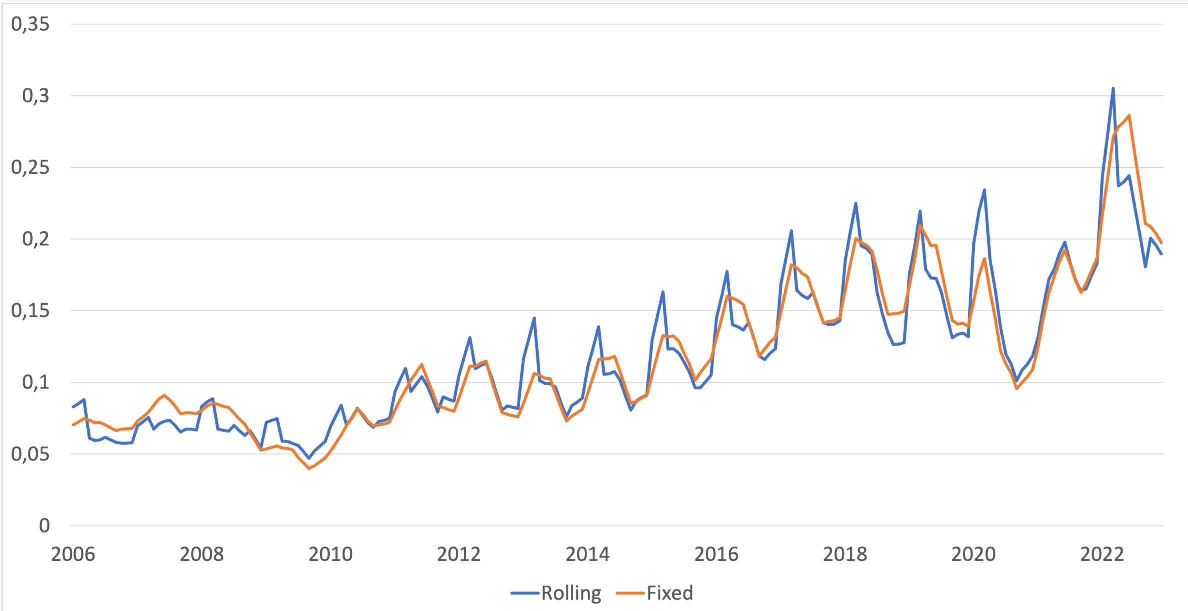



**Figure A.2.** Vacancies Over Effective Searchers, 2006-2022, 12-month averages

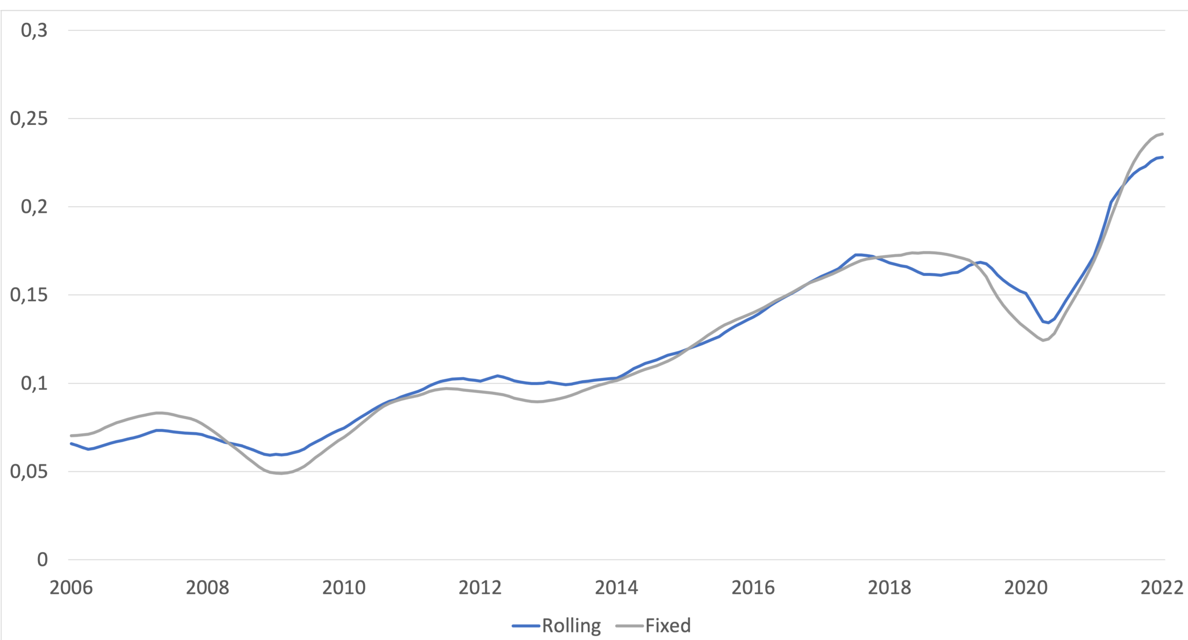
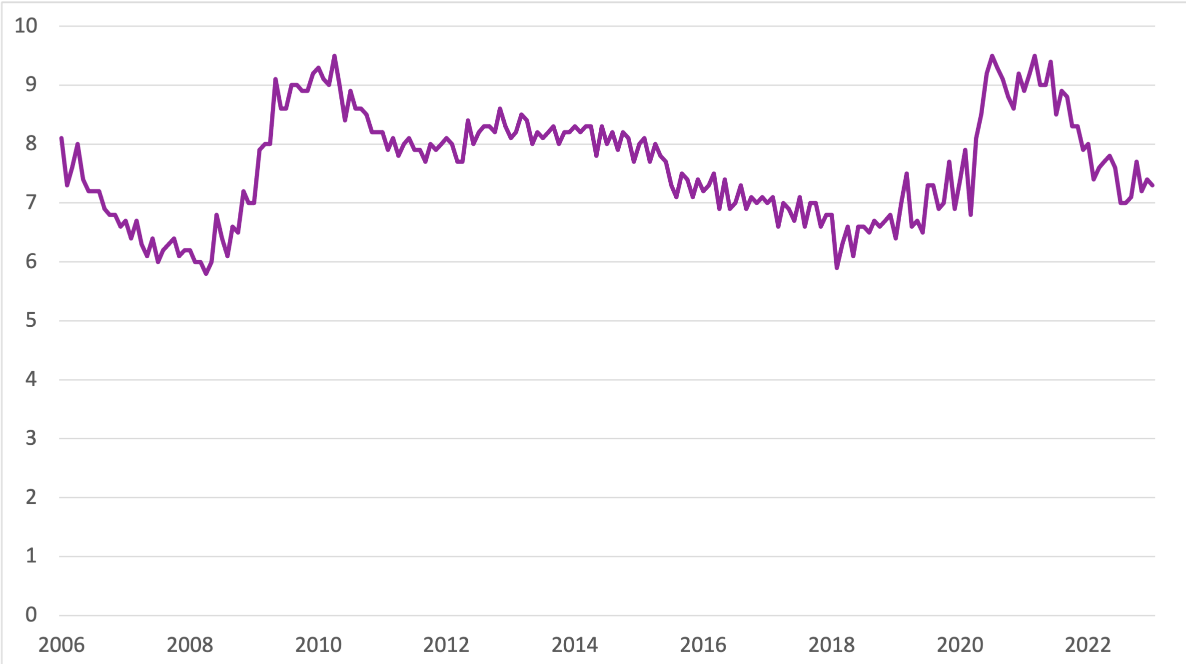


**Figure A.3.** Seasonally Adjusted Unemployment in Percent, 2006-2022




Data for unemployment collected from Statistics Sweden's LFS.

## A.2 Phillips Curve with Rolling JFR

**Table A.1**

Phillips Curve Regressions With Rolling Job-Finding Rates

| VARIABLES | (1)<br>VES Rolling Quarterly 2006-2022 | (2)<br>VES Fixed Quarterly 2006-2022 | (3)<br>VU Quarterly 2006-2022 | (4)<br>VES Rolling Monthly 2006-2022 | (5)<br>VES Fixed Monthly 2006-2022 | (6)<br>VU Monthly 2006-2022 |
|---|---|---|---|---|---|---|
| V/ES | 7.035 | 8.177* | | 5.033 | 5.331 | |
| | (5.439) | (4.717) | | (4.260) | (3.972) | |
| V/U | | | 3.258 | | | 1.141 |
| | | | (2.676) | | | (2.392) |
| Headline Shocks | 0.853** | 0.804** | 0.912** | 0.574*** | 0.555*** | 0.647*** |
| | (0.322) | (0.308) | (0.359) | (0.162) | (0.169) | (0.217) |
| Constant | -1.006 | -1.123* | -0.852 | -1.143*** | -1.164*** | -0.814** |
| | (0.717) | (0.626) | (0.550) | (0.437) | (0.401) | (0.397) |
| Observations | 65 | 65 | 65 | 193 | 193 | 193 |
| R-squared | 0.395 | 0.404 | 0.389 | 0.211 | 0.213 | 0.202 |
| Rbar-squared | 0.376 | 0.385 | 0.369 | 0.203 | 0.204 | 0.193 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

## A.3 Calculation of Weighted Median CPIF

Price indexes and corresponding weights of 71 subgroups of goods and services are collected from SCB:s Riksbankstabeller. To adjust these measures from CPI to CPIF, the interest rate component is replaced with the Kapitalstockindex. From the indexes, month-on-month and quarter-on-quarter changes are calculated for each sub-group over the full time period. The dataset with weights, month-on-month changes, and quarter-on-quarter changes is then imported to R where a loop applies the weighted median function from the matrixStats package to each row. The argument ties is set to weighted which means that if two values both satisfy the median criteria, a weighted average of them is returned. This is the ties argument that most closely resembles the methodology of the Riksbank's Trim1 measure.

## A.4 Headline Shocks and Car Prices in Sweden

**Table A.2**

Bivariate Regression of Headline Shocks on Car Prices

| VARIABLES | Car Price |
|---|---|
| | 0.398 |
| | (0.267) |
| Constant | -42.38 |
| | (29.19) |
| | |
| Observations | 35 |
| R-squared | 0.089 |
| Rbar-squared | 0.0615 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CarPrice refers to car prices as measured by the Harmonised Index of Consumer Prices for Sweden, collected from Eurostat.

## A.5 Headline Shocks and Electricity Prices in Sweden

**Table A.3**

Bivariate Regression of Headline Shocks on Alternative Measure of Electricity Prices

| VARIABLES | Electricity Price |
|---|---|
| | 0.0745*** |
| | (0.0182) |
| Constant | -3.017* |
| | (1.496) |
| | |
| Observations | 34 |
| R-squared | 0.268 |
| Rbar-squared | 0.246 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Electricity price is measured by average monthly electricity wholesale price in Sweden in Euro per megawatt-hour, collected from Statista.