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The resurgence of the New Zealand Phillips curve.

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Key findings

- This *Note* assesses how the Phillips curve, which describes the relationship between inflation and economic activity, has evolved over time. A steeper Phillips curve can help explain why inflation increased so sharply in the COVID-19 period and would also imply that inflation should decrease quickly as capacity pressures ease.
- In general, the slope of the Phillips curve (across a range of inflation and activity indicators) drifted upwards during the pandemic and beyond, from the relatively lower levels observed between 2008 and 2019. This indicates a stronger relationship between activity and inflation since 2020.
- The most noticeable steepening of the Phillips curve in the post-2020 period has been observed when job-to-job labour flows and a QSBO labour shortage measure are used as activity measures. Both indicators have been shown in previous work to correlate well with inflation. In contrast, we find that the changes in the slope of Phillips curve featuring the unemployment rate have been relatively mild.

1 Introduction

The statistical relationship between price or wage inflation and measures of economic activity, otherwise known as the Phillips curve, is a cornerstone of modern macroeconomics. The sensitivity of inflation to activity or slack appeared to wane during and after the Global Financial Crisis (GFC). In New Zealand, as in other countries, the sustained economic recovery that followed the GFC did not provide a strong impetus to inflation, and inflation persisted at low levels for many years.

The apparent disconnect between inflation and economic activity was labelled as the 'flattening' of the Phillips curve by several commentators, and some even announced the demise of the Phillips curve (see, *inter alia*, Hall (2013), Krugman (2015) and Cochrane (2019)).[1] The correlation between inflation and activity measured in the data that drives the slope of the estimated 'reduced-form' Phillips curve, may be determined by several underlying causal factors including the slope of the underlying aggregate supply curve.[2] If the diminishing slope indeed reflected a flattening of the underlying aggregate supply curve, it would imply that stronger demand-side stimulus from monetary policy would be required to achieve the inflation targets stipulated by central bank mandates. In other words, central banks manage aggregate demand by moving policy rates, and when the aggregate supply curve is flat, firms' move prices less for a given change in demand. This implies that, other things constant, monetary policy has a lower impact on price inflation when the supply curve is flat.

[1] See Figure 2 in Jacob and van Florenstein Mulder (2019) that depicts how the correlation between inflation and the RBNZ output gap fell during the GFC period.

[2] The correlation between price inflation and real activity in the data will decrease if the effects of supply shocks dominate that of demand shocks (see *e.g.* Jacob and van Florenstein Mulder 2019) due to structural features of the economy. Del Negro *et al.* (2020) quantify the contributions of different potential sources of the flattening of the Phillips curve for the United States - (1) mismeasurement of either inflation or economic slack; (2) inelastic aggregate supply due to the muted response of wages and prices to labour and goods demand; and (3) a flatter aggregate demand relationship, induced by an improvement in the ability of policy to stabilise inflation. Their results suggest that a flatter aggregate supply curve due to stickier prices may have been the main driver of the diminishing correlation.

However, by mid-2021, the public health restrictions which accompanied the arrival of COVID-19, and related impediments to global supply chains, together with expansionary fiscal and monetary policy, rekindled inflationary pressures that had been subdued for long. Constrained global supply was worsened by the Russian invasion of Ukraine in early 2022.

Consequently, inflation rose above central bank targets in many developed economies, including New Zealand, and remained high as economic activity improved. This motivated suggestions in the more recent literature that the Phillips curve was no longer flat, and even steepening (see Benigno and Eggertsson (2024, 2023) and Bonam, den Haan and van Limbergen (2021)) If the steepening of the Phillips curve signals a steepening of the underlying aggregate supply curve, then as long as the aggregate supply curve remains steep, central banks can lower inflation to target while only mildly restraining economic activity.

Against this backdrop, this *Note* assesses the evolution of the Phillips curve in New Zealand during the inflation targeting era using time-varying parameter models. In particular, we assess if the elasticities of various measures of inflation to various measures of economic activity have changed over time using single- and multiple-equation techniques.

We find that the time-varying parameter Phillips curves estimated for most inflation-activity measure combinations in New Zealand, have considerably steepened during the COVID-19 pandemic, and beyond. However, there is considerable variation in the Phillips curve slopes estimated across inflation-activity combinations. Strikingly, it is not the traditional unemployment rate, but rather, less conventional measures of slack such as the job-to-job transition rate and the Quarterly Survey of Business Opinion (QSBO) labour shortage indicator, that have correlated better with *all* the inflation measures during the pandemic era. This key result, which is robust across our single- as well multiple-equation estimations, complements the findings of Ball (2024) who finds that these two indicators outperform other labour market indicators, in predicting price and wage inflation. The time-varying parameter econometric frameworks presented in this *Note* enriches the discussion around the importance of monitoring a wider range of labour market indicators to assess inflationary pressures.

The rest of the *Note* proceeds as follows. Section 2 describes the methodologies that underpin our empirical strategy as well as the data we use. The estimation results are presented in the section 3 and the main conclusions are drawn in section 4.

2 Empirical strategy

We adopt a two-pronged approach to assess the correlation between inflation and real economic activity in New Zealand. The first empirical strategy involves estimating a reduced-form Phillips curve equation with time-varying parameters. The second strategy utilises a vector autoregression (VAR) featuring time-varying parameters and stochastic volatility, estimated on inflation and activity/slack data. In this manner, we ascertain that the two techniques yield results of the same flavour. Both models are estimated using Bayesian techniques as the quarterly macroeconomic datasets for New Zealand are typically quite short, and in the latter case of the VAR, the number of estimated parameters is also quite large.

Conditional on the parameters, the time-varying parameter models that we use are linear. However, since the parameters evolve as random walks through time, the overall model (in both methodologies) is highly non-linear in the sense that the regression slopes can change. It is entirely possible that the New Zealand Phillips curve is inherently non-linear; for example, a convexity or bend in the curve would mean that inflation is more responsive at higher levels of activity (see Benigno and Eggertsson (2024, 2023)). Even though the assumption of the random walk behaviour of regression slopes in our models appears restrictive on the surface, it provides a flexible way of capturing various forms of non-linearity (Lubik and Mathes 2012). When the Phillips curve is convex rather than linear, its slope changes along the curve. If a fixed non-linear Phillips curve gets increasingly convex over time, the random walk processes assumed for the regression slopes in our models can detect these changes, and the results will indicate a steepening of the Phillips curve through time.

2.1 A time-varying parameter Phillips curve

We first follow the approach of Bonam, den Haan and van Limbergen (2021) who use an augmented reduced-form Phillips curve specification and allow all parameters to vary over time. The state-space model defined as below:

$$\pi_t = \mu_t + \rho_t \pi_{t-1} + \gamma_t z_t + \alpha_t \pi_t^e + e_t = \boldsymbol{x}_t \boldsymbol{\beta}_t' + e_t, \qquad e_t \sim N(0, R), \tag{1}$$

where the vector of parameters $\boldsymbol{\beta}$ follows a random walk,

$$\boldsymbol{\beta}_t = \boldsymbol{\beta}_{t-1} + \boldsymbol{v}_t, \qquad \boldsymbol{v}_t \sim N(0, Q). \tag{2}$$

$\boldsymbol{v}_t$ is the vector of error terms. In Equation (1), $\boldsymbol{\pi_t}$ is the inflation measure, measured as the annual percentage change in the price level in every quarter $\boldsymbol{t}$, $\boldsymbol{\pi_{t-1}}$ is its one quarter lag capturing inflation persistence, $\boldsymbol{z_t}$ is the activity/slack measure, and $\boldsymbol{\pi_t^e}$ is the one-year ahead inflation expectations measure from the RBNZ Survey of Expectations (Business).[3] $\boldsymbol{\mu_t}$ is a time-varying intercept term and $\boldsymbol{e_t}$ is the error term that follows a Normal distribution.

Our main object of interest is γ_t, which captures the effect of economic activity/slack on inflation; in the other words, the slope of the reduced-form Phillips curve. The first $\boldsymbol{T_0 = 10}$ quarters are used as a training sample to initialise the parameters $\boldsymbol{\beta}$ and covariances R and Q. The prior distribution for the error variance R in Equation (1) is an Inverse Gamma distribution $\left(R \sim IG(\frac{T_0}{2}, \frac{D_0}{2})\right)$ with the scaling parameter initialised at $\boldsymbol{D_0 = 1}$. The covariance matrix Q for the error term in Equation (2) is an Inverse Wishart distribution. The Gibbs sampling algorithm is used to obtain 12,000 draws and the parameter estimates are computed after discarding the first 10,000.[4]

2.2 A time-varying parameter bivariate vector autoregression with stochastic volatility

There is no unique definition for the slope of the Phillips curve. The original curve in Phillips (1958) indicated a static relationship between unemployment and nominal wage growth, and more modern econometric specifications have emphasised the role of inflation expectations and inflation persistence. As such, the second lens that we use to assess the inflation-activity relationship is quite distinct from the methodology explained in the previous subsection. We employ the Bayesian vector autoregression with time-varying parameters and stochastic volatility (TVP-BVAR-SV) presented in Chan and Eisenstat (2018). As in Karlsson and Österholm (2020), who examine the Swedish Phillips curve using a similar BVAR, the slope of the Phillips curve is measured as the sum of the coefficients on the activity variables and its lags in the inflation equation.

[3] The specification presented here is the same as in Bonam, den Haan and van Limbergen (2021). Our results are qualitatively similar when we use an additional import price variable to control for the influence of supply shocks.

[4] For more information on the estimation, see Bonam, den Haan and van Limbergen (2021).We thank Dennis Bonam for providing us with the MATLAB code, that served as the starting point for this segment of our analysis.

Relative to the single-equation methodology described earlier, the multivariate approach allows for a richer lag structure and interaction between the variables. In addition, the stochastic volatility component controls for heteroskedasticity and enables the BVAR to better fit episodes of high volatility.

The quarterly TVP-BVAR-SV model for annual inflation (π_t) and activity/slack (z_t) is given below. A vector of variables $\boldsymbol{y}_t = [z_t \quad \pi_t]'$ follows the law of motion:

$$\boldsymbol{B}_{0t}\boldsymbol{y}_t = \boldsymbol{\tau}_t + \boldsymbol{B}_{1t}\boldsymbol{y}_{t-1} + \cdots + \boldsymbol{B}_{pt}\boldsymbol{y}_{t-p} + \boldsymbol{\varepsilon}_t, \quad (3)$$

such that

$$\boldsymbol{\varepsilon}_t \sim N\big(0, diag(\boldsymbol{h}_t)\big), \quad (4)$$

$$\boldsymbol{h}_t = \boldsymbol{h}_{t-1} + \boldsymbol{\zeta}_t\,, \quad (5)$$

$$\boldsymbol{\theta}_t = \boldsymbol{\theta}_{t-1} + \boldsymbol{\eta}_t\,, \quad (6)$$

where $\boldsymbol{\theta}_t$ contains the time-varying parameters $\boldsymbol{\tau}_t$ and $\boldsymbol{B}_{it}$, and $\boldsymbol{\eta}_t$ and $\boldsymbol{\zeta}_t$ follow multivariate Normal distributions.

The relevant lags p (up to a maximum of 8 lags) of the TVP-BVAR-SV are selected according to the AIC, the BIC, and the HQ information criterion.[5] The time-varying slope of the reduced-form 'Phillips curve' embedded in the TVP-BVAR-SV is obtained by summing the coefficients of the activity/slack measure in the inflation equation. Specifically,

$$slope_t = b_{21t}^1 + b_{21t}^2 + b_{21t}^3 + \cdots + b_{21t}^p, \quad (7)$$

where b_{21t}^k represents the coefficient on the k^{th} lag of the slack measure in the inflation equation (subscript 21) in the TVP-BVAR-SV.

The estimation of the model is computationally demanding, and we use the MCMC sampler of Chan and Eisenstat (2018) to obtain the full conditional posterior distributions of all parameters. The algorithm uses 20,000 replications and discards the first 5,000 iterations, before the parameter estimates are computed.

2.3 Data

It is not merely the definition of the slope of the Phillips curve and the associated estimation strategy that is dependent on the econometrician's view. Even selecting the appropriate measures of inflation and activity to study the Phillips curve involves a judgement call. Therefore, to ensure the robustness of our findings, we use a range of inflation-activity combinations in our estimations.

Table 1 lists the 7 inflation (π) and 7 activity/slack (x) measures that are used in our estimations. The quarterly dataset is compiled using standard time-series from Statistics New Zealand, the Ministry of Business, Innovation and Employment, and the Inland Revenue Department, as well as estimates of core inflation and economic slack produced by the Reserve Bank. Each inflation-activity combination $\{\pi_a, x_b\}$ is used to estimate both the reduced-form Phillips curve in equations (1) and (2), and the TVP-BVAR-SV in equations (3) through (6). Thus, we estimate 98 model

[5] In general, we choose the lag recommended by most of the criteria. When the recommendations differ, the most parsimonious lag specification selected by the BIC is accepted. In contrast, Karlsson and Österholm (2020) fix the number of 'relevant' lags at 4.

specifications in total, and a distinct measure of the time-varying slope of the Phillips curve is obtained in each case.

We first consider headline CPI and its tradable and non-tradable components (adjusted for changes in GST) as price inflation measures. We also look at core inflation estimates from the RBNZ sectoral factor and core factor models. Wage inflation is captured both by the productivity-adjusted Labour Cost Index (LCI) data and the Quarterly Earnings Survey (QES) series.

The only measure of 'overall' slack is the RBNZ output gap, and the rest of the indicators relate to the labour market. These include the unemployment rate and employment as a proportion of working age population from the quarterly Household Labour Force Survey. As in Benigno and Eggertsson (2023) who examine the case of the United States, we include the vacancy-unemployment ratio relying on vacancy data from the MBIE. We use aggregate job-to-job flows constructed by RBNZ staff from the administrative Linked Employer and Employee Data (LEED) from the IRD (see Ball *et al.* 2024, Karagedikli 2018). Finally, along the lines of Bonam *et al.* (2021), we use a labour shortage indicator which measures the net proportion of New Zealand firms reporting that labour is the factor most limiting output, taken from the Quarterly Survey of Business Opinion (QSBO).

All our measures of inflation are expressed in annual percent changes. In contrast, the economic activity/slack indicators that we consider have different scales or units in their primary measurement. If they were to be fed into our Phillips curve estimations in their original units, the associated slope coefficient estimates would also have different units. To facilitate comparison across Phillips curve slopes (within each methodological framework), the activity measures are standardised, *i.e.* demeaned, and scaled by their respective standard deviations. All the series used in the estimations end in 2023Q4.

Table 1: Inflation and activity/slack measures

Inflation measure	Activity/Slack measure
CPI (GST-adjusted) – 1990Q1	Unemployment rate – 1990Q1
RBNZ sectoral factor model for core inflation – 1996Q2	RBNZ unemployment rate gap – 1990Q1
RBNZ factor model for core inflation – 1994Q3	RBNZ output gap – 1994Q3
Tradables CPI (GST-adjusted) – 1990Q1	Employment to working age population ratio – 1990Q1
Non-tradables CPI (GST-adjusted) – 1990Q1	Vacancy-unemployment ratio – 1992Q4
Labour cost index (LCI) wage (adjusted for productivity changes) – 1996Q3	QSBO labour as a limiting factor indicator – 1998Q3
Quarterly employment survey (QES) wage – 1992Q4	Job-to-job transition rate – 2002Q1

3 Results

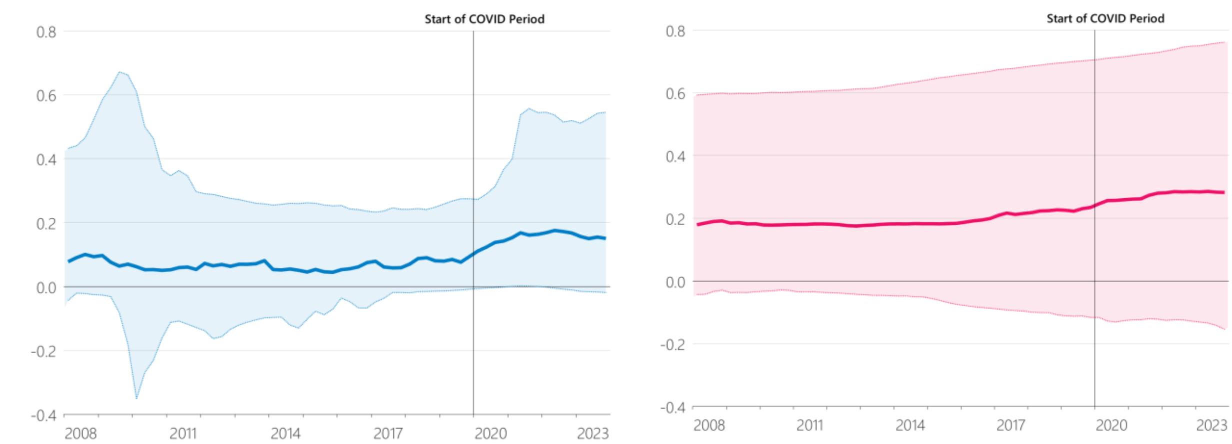
We estimate 98 time-varying-parameter regressions in total: 49 for the single-equation case and 49 for the bivariate case. The samples used for each regression may also differ depending on data availability, with the shortest samples relating to the specifications that use job transition rate data, since the latter series only begins in 2002Q1. Given the large number of model specifications with different sample periods, we focus our discussion on selected cases, and restrict our attention to the period beginning 2008. The entire set of results are available on request.

3.1 The empirical distribution of Phillips curve slopes

In Figure 1, we present the slopes estimated for all 98 model specifications for the post-GFC period; that is, the left panel plots the minimum and maximum of slope estimates at each point in time across all 49 inflation-activity combinations for the single-equation method while the right panel presents the same for the TVP-BVAR-SV. The Phillips curve slopes obtained from slack measures are multiplied by -1 to compare them to those obtained from activity measures. The signs for most of the mass of estimates are positive. However, a small proportion of the slopes from either methodology are counter-intuitively negative at some points over the sample period.

Figure 1: The distributions of Phillips curve slopes from both methodologies

(a) Single equation (b) TVP-BVAR-SV



Note: In both panels, the boundaries of the shaded area represent the minimum and maximum of the range of the Phillips curve slopes estimated at each point in time. The solid line indicates the median. Note that the median, or any percentile, of the distribution of slopes may not be associated with a specific inflation-activity combination. It is possible that the slope from a specific inflation-activity combination can traverse different percentiles of the distribution through time.

Figure 1 establishes that the range of estimated Phillips curve slopes trended upward during the pandemic and beyond. For the single-equation method which focusses on the commonly analysed contemporaneous effects of activity/slack on inflation, the time-variation through the sample period is starker. The maxima of the empirical distribution in Panel (a) fell after the GFC and remained low for nearly a decade – an observation that is consistent with the vast literature associated with the flattening of the Phillips curve.[6] After remaining at just above 0.2 for much of the 2010s, the maxima escalated to just below 0.6 by 2021, and remained in the 0.5-0.6 range through the end of 2023.

[6] See Jacob and van Florenstein Mulder (2019) and the references therein.

Panel (b) shows that the steepening began during the mid-2010s in the case of the TVP-BVAR-SV estimates which allows for more persistent effects of activity on inflation.

The definition of the Phillips curve slope in the TVP-BVAR-SV framework involves the sum of the coefficients on the lags of the activity variable. This contributes to the persistence in the time-varying slopes from this framework. If its constituent lag coefficients do not offset each other, the slope from the TVP-BVAR-SV method may also be higher in magnitude than its analogue from the single-equation method. The increase in the estimated slopes in the pandemic era for the TVP-BVAR-SV specifications (not exhibited) is much gentler than in the case of the single-equation method. While Figure 1 displays the overall patterns in the evolution of the estimated Phillips curves since the GFC, Table 2 displays the results for each specification, but focusses on a narrower period, 2020-2023. It verifies whether the estimated time-varying slope for each specification (in both methods) increased from its pre-pandemic level and the associated 68% credible intervals rose above 0 in at least one quarter during 2020-2023. Table 2 demonstrates that the Phillips curves across almost all inflation-activity combinations steepened during the pandemic era.

Table 2: Steepening of the Phillips curves during 2020Q1-2023Q4 for all inflation-activity combinations in both methodologies

Slack measures ↓	RBNZ sectoral factor model for core inflation	RBNZ factor model for core inflation	Tradables CPI (GST-adjusted)	Non-tradables CPI (GST-adjusted)	CPI (GST-adjusted)	LCI wage (adjusted)	QES wage
Unemployment rate	✓✓	✓✓	✓✓	✓✓	✓✓	✓ (blue)	✓✓
RBNZ unemployment rate gap	✓✓	✓✓	✓✓	✓✓	✓✓	✓ (blue)	✓✓
RBNZ output gap	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Employment to working age population ratio	✓ (pink)	✓✓	✓✓	✓ (blue)	✓✓	✓✓	✓✓
Vacancy-unemployment ratio	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
QSBO labour as a limiting factor indicator	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Job-to-job flows	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓

Note: The tick mark indicates that the time-varying slope of the Phillips curve specification increases from the pre-pandemic level and the 68% credible intervals rise above 0 in at *least* one quarter during the period 2020Q1-2023Q4. The symbol ✓ represents results from the single-equation model while ✓ indicates the same for the TVP-BVAR-SV.

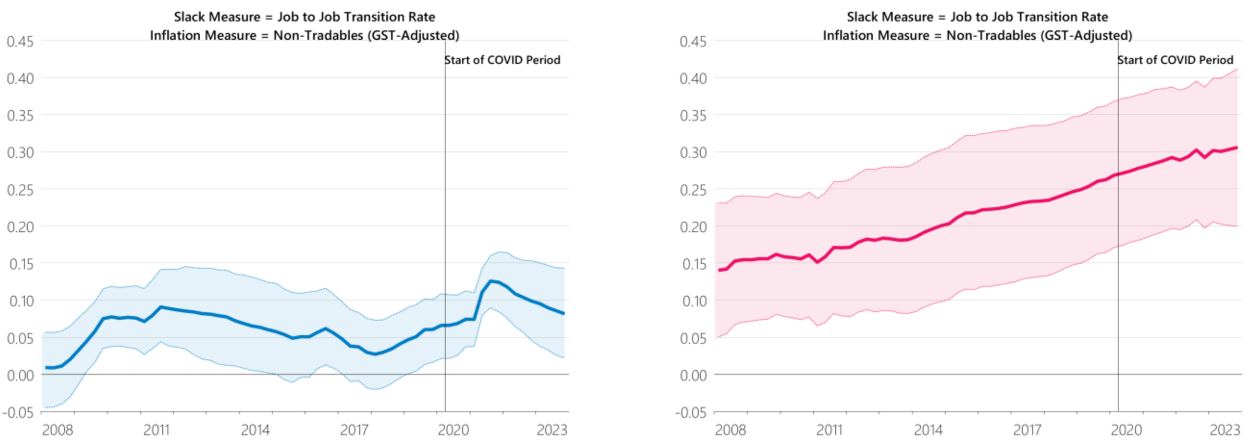
3.2 Phillips curves explaining non-tradables CPI inflation

We now consider Phillips curves explaining annual inflation in the non-tradables component of the CPI. Relative to tradables inflation, non-tradables inflation is expected to be more responsive to monetary policy settings. We compare non-tradables inflation Phillips curves featuring two less conventional measures of activity, job-to-job flows data and the QSBO labour shortage measure ('QSBO labour as a limiting factor indicator' in tables 1 and 2), to the specification that uses the traditional unemployment rate.

As mentioned earlier, the slopes from the single-equation method are typically more volatile than those from the TVP-BVAR-SV, likely due to the richer lag structure and the stochastic volatility component built into the latter modelling framework. Figure 2 shows that in both cases, the sensitivity of non-tradables inflation to job-to-job flows had been increasing much before the pandemic, and the steepening continued through the pandemic years. In fact, the slope from the single-equation method, went up to statistically significant levels by 2019 and kept rising through 2021-22 and the credible interval remained above 0 through 2023. For the TVP-BVAR-SV, the relevant slope measure has been trending upward steadily, the median slope even doubling in magnitude by the end of the sample period.

Figure 2: Slopes of Phillips curves featuring non-tradables CPI inflation and job-to-job labour flows.

(a) Single equation (b) TVP-BVAR-SV



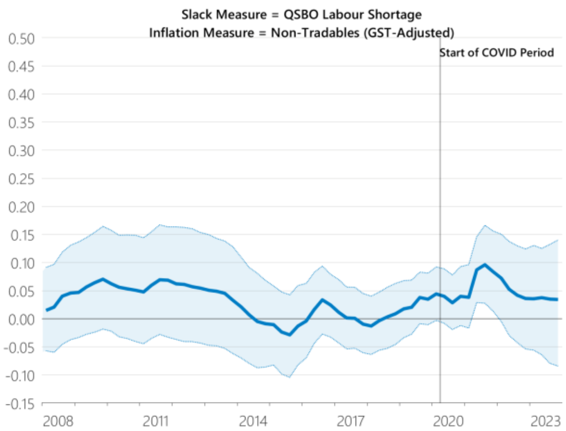
Note: In both panels, the bands represent the 16th and 84th percentiles of the posterior distributions of the estimated slopes while the solid lines indicate the median estimates.

Figure 3 presents the slopes from the models featuring the QSBO labour shortage indicator. For this indicator, the contemporaneous slope measured by the single-equation method was statistically insignificant through much of the sample period but rose to statistically significant levels around 2021. In contrast, the slope from the TVP-BVAR-SV approach is seen to be trending upwards since the GFC, albeit more gently than in the case of the non-tradables Phillips curve featuring the job transition rate.

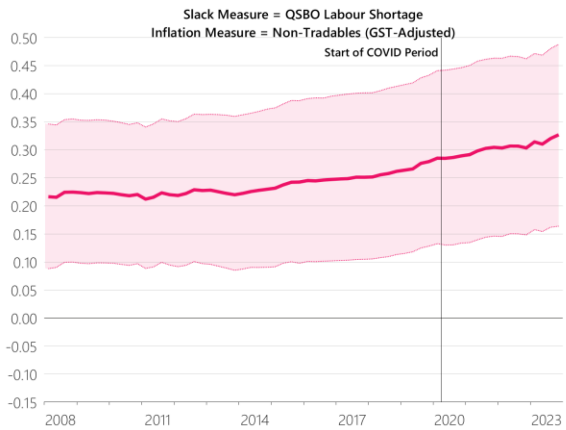
Just as in the case of the QSBO indicator, the estimations featuring the unemployment rate yield mixed results. In Figure 4, the slope estimates from the single-equation method are statistically insignificant for almost the entire post-GFC period, a pattern consistent with the dominant narrative of the demise of the Phillips curve during the 2010s. A gradual resuscitation is observed from about 2016. But even with the steepening of the curve during the pandemic, the slope remains in the vicinity of 2020Q1 level. In the case of the bivariate TVP-BVAR-SV, the slope remains statistically significant and negative throughout the post-GFC period. The change in the TVP-BVAR-SV slope over time is mild, and more consistent with the results for the QSBO indicator than for the job-to-job transition rate.

Figure 3: Slopes of Phillips curves featuring non-tradables CPI inflation and the QSBO labour shortage indicator.

(a) Single equation



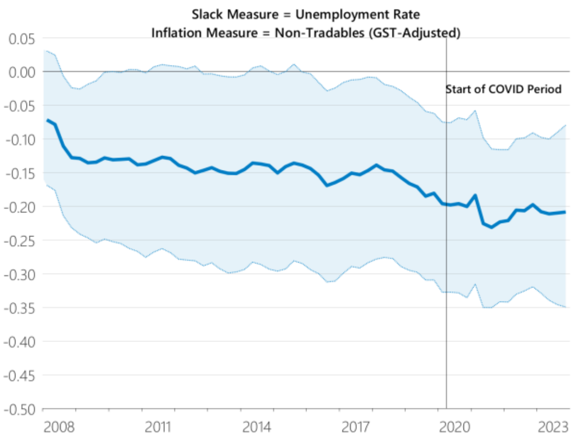
(b) TVP-BVAR-SV



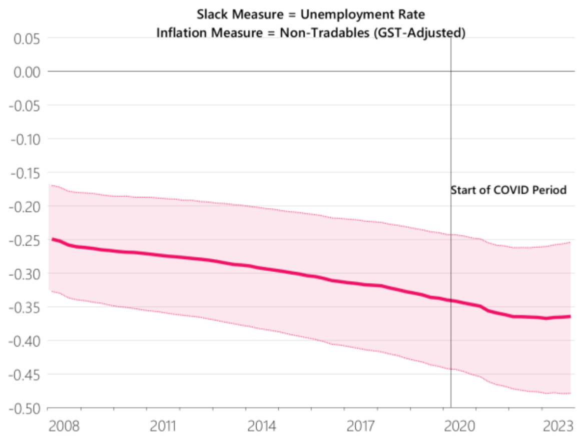
Note: In both panels, the bands represent the 16th and 84th percentiles of the posterior distributions of the estimated slopes while the solid lines indicate the median estimates.

Figure 4: Slopes of Phillips curves featuring non-tradables CPI inflation and the unemployment rate.

(a) Single equation



(b) TVP-BVAR-SV



Note: In both panels, the bands represent the 16th and 84th percentiles of the posterior distributions of the estimated slopes while the solid lines indicate the median estimates.

To sum up, for the Phillips curves explaining the non-tradables CPI inflation, the contemporaneous slopes associated with the job transition rate and the QSBO labour shortage measure increased more starkly from its immediate pre-pandemic levels, relative to slopes estimated for the specifications featuring and the unemployment rate. The alternative non-tradables Phillips curve slopes from the TVP-BVAR-SV strengthened much more slowly after the GFC for all three indicators, with the estimates from the job transition rate specification rising the most.

3.3 Phillips curve slopes across all inflation measures

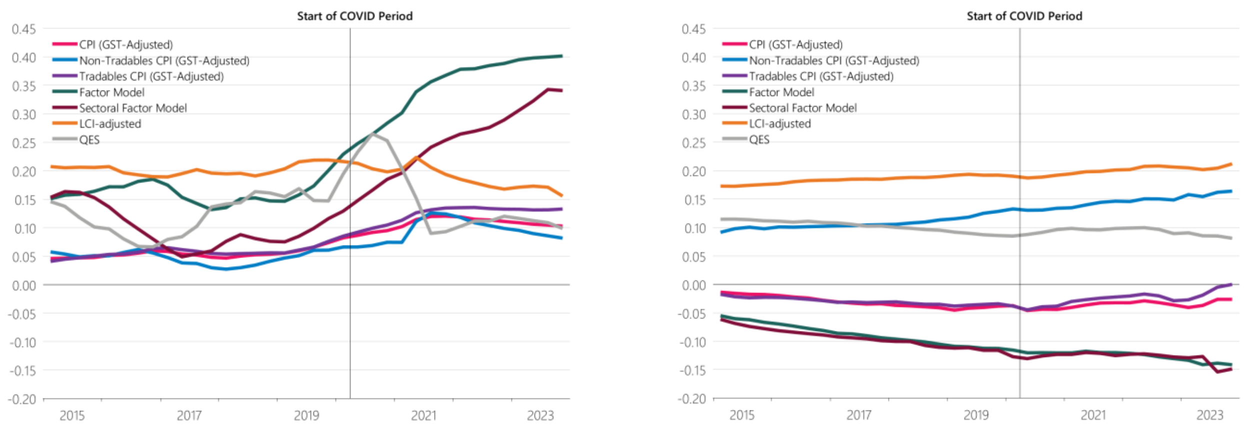
The steeper rises in the slopes of the Phillips curves using the job-transition rate and the QSBO measure, *vis-à-vis* those related to the traditional unemployment rate, become more apparent when we examine specifications across *all* inflation measures. Figure 5 and Figure 6 present the median Phillips curve slopes estimated for each of the two activity indicators across all the inflation measures since 2015, while Figure 7 does the same for the unemployment rate.[7]

The starkest increases in the contemporaneous slopes are observed for the Phillips curves featuring the RBNZ's core inflation measures from the factor models, and the job transition rate and the QSBO indicator as activity measures (Panel (a) in Figure 5 and Figure 6). In fact, during the pandemic era, the contemporaneous sensitivities of the RBNZ factor model and sectoral factor model core inflation measures to the job transition rate and the QSBO measure are larger in magnitude than those for non-tradables inflation. The escalation in the slopes for these specifications since 2020 has also been much more dramatic than in specifications involving non-tradables inflation. As seen earlier in other cases, the increases in the Phillips curve slopes from the TVP-BVAR-SV are much gentler through the pandemic era.

Figure 5: Phillips curve slopes for job-to-job transitions across inflation rates

(a) Single equation

(b) TVP-BVAR-SV



In contrast, while most Phillips curves involving the traditional unemployment rate do exhibit a steepening (*i.e.* median slopes becoming more negative) during the pandemic era, the changes are much milder. That is reflected in the results from both methodologies (Figure 7).

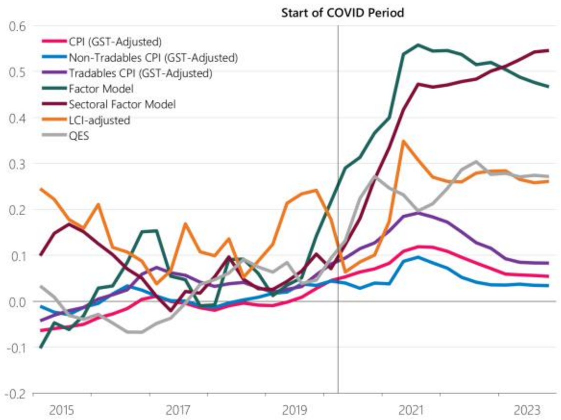
The generally higher magnitudes and the steeper upward trends in the Phillips curve slopes estimated for the job-to-job transitions data and QSBO labour shortage indicator are not entirely surprising. Analogous to the QSBO measure that records the net proportion of New Zealand firms that find labour as the factor most limiting production, is the European Commission's quarterly survey measure for European firms (see *e.g.* European Commission 2022). Bonam, den Haan and van Limbergen (2021) find that the labour shortage indicator helps resolve the low wage growth puzzle in several economies in the euro area. This finding may point to the labour shortage

[7] Admittedly, the choice of 2015 is quite arbitrary. We focus on the variation in the slopes in the window beginning just before the onset of the pandemic. When we use a longer time-period, distinguishing between the line graphs in the figures becomes more difficult.

indicator's ability to capture dimensions of economic slack that more traditional measures such as the unemployment rate do not.

Figure 6: Phillips curve slopes for the QSBO labour shortage indicator across inflation rates

(a) Single equation



(b) TVP-BVAR-SV

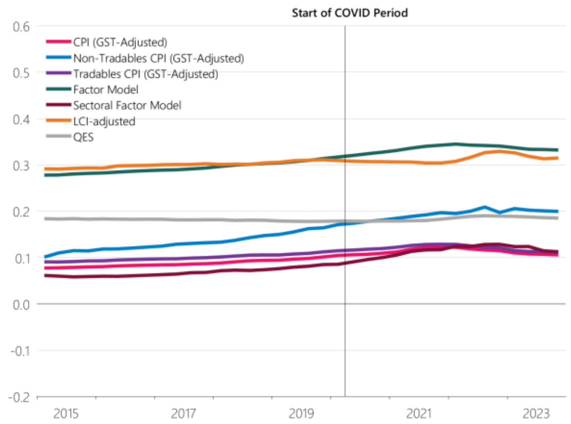
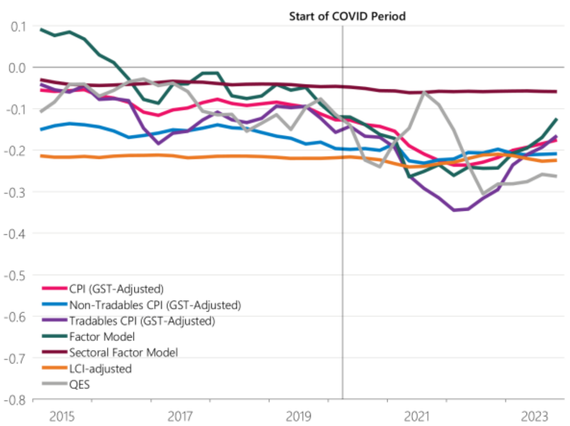
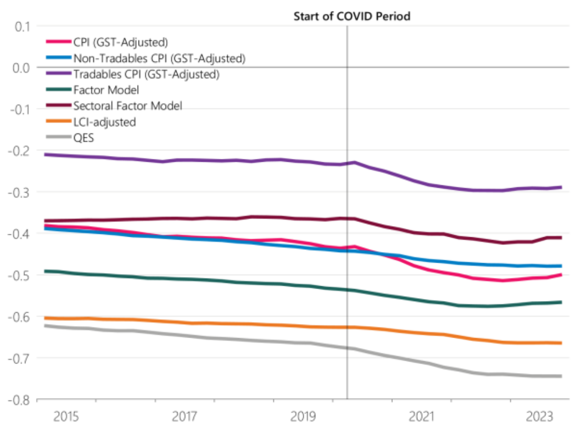


Figure 7: Phillips curve slopes for the unemployment rate across inflation rates

(a) Single equation



(b) TVP-BVAR-SV



Note: Since the unemployment rate is a slack measure, a fall rather than a rise in the slope indicates the steepening of the Phillips curve. In other words, when the Phillips curve involving the unemployment rate steepens, the negative slope becomes more negative.

Karagedikli (2018) was the first to point out that, relative to the unemployment rate and the cyclical gaps produced by the RBNZ for output and unemployment, job-to-job transitions perform the best as a measure of cyclical pressure in an out-of-sample forecasting exercise for non-tradables inflation and LCI wage inflation. In a wage and price inflation prediction horserace featuring multiple labour market indicators, Ball (2024) finds that the job transitions rate and the QSBO labour shortage indicator outperform all other indicators, including the unemployment rate.

Moving jobs is one way to ensure higher wage increases because on-the-job searchers typically have more bargaining power, unlike unemployed workers looking for jobs. Higher wages feed into the marginal costs of firms, and finally price inflation. Since they use constant parameter regressions tailored to the specific issues they delve into, Ball (2024) and Karagedikli (2018) do not directly focus on the evolution of the sensitivity of inflation to activity indicators. The time-varying parameter frameworks in this *Note* provide another lens on the inflation-activity relationship. The sensitivities of most measures of New Zealand inflation to most activity measures that we consider have increased during the pandemic era. And importantly, the inflation sensitivity to the less conventional measures of activity has been increasing even more than that to the traditional unemployment rate.

4 Conclusion

This *Note* assessed how the sensitivity of inflation to economic activity/slack, otherwise known as the slope of the reduced-form Phillips curve, has evolved over time in New Zealand. To this end, it experimented with 49 combinations of inflation and activity indicators in two distinct econometric frameworks featuring time-varying parameters.

We find that the New Zealand Phillips curve steepened during the COVID-19 pandemic era. This is confirmed by the slope estimates obtained from most inflation-activity combinations across both econometric methodologies. However, there are differences between patterns estimated for various inflation-activity combinations, with some Phillips curves steepening more than others from their pre-pandemic levels, and others beginning to steepen much before the pandemic began. The Phillips curve specifications that exhibit the most noticeable steepening during recent years, involve the RBNZ measures of core inflation, and the job-to-job transition rate and the QSBO labour shortage measure as activity measures. In contrast, there has been less steepening of the Phillips curves based on the traditional unemployment rate.

The results in this *Note* carry several lessons for monetary policy. The persistent rise in the sensitivity of New Zealand inflation to less conventional activity measures such as the job transition rate and the labour shortage index implies that the Reserve Bank of New Zealand should continue to monitor a wider range of indicators – beyond the traditional unemployment rate – to assess inflationary pressures. *If* the steepening of the estimated Phillips curve is due to the steepening of the aggregate supply curve, it implies that small changes in economic activity triggered by fiscal and monetary policy can contribute to bigger changes in inflation, as experienced recently. On the flip side, if the Phillips curve remains steep, current and future macroeconomic policy settings can bring about larger changes in inflation with small changes in activity.

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