Forecasting inflation: Phillips curve effects on services price measures

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A R T I C L E   I N F O

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A B S T R A C T

We estimate an empirical model of inflation that exploits a Phillips curve relationship between a measure of unemployment and a sub-aggregate measure of inflation (services). We generate an aggregate inflation forecast from forecasts of the goods sub-component, separate from the services sub-component, and compare the aggregated forecast to the leading time series univariate and standard Phillips curve forecasting models. Our results indicate marked improvements in point and density forecasting accuracy statistics for models that exploit relationships between services inflation and the unemployment rate.

1. Introduction

Forecasting models of aggregate inflation, including those that employ a Phillips curve, have been unable to outperform univariate statistical models of aggregate inflation consistently (Faust & Wright, 2013).1 Peach, Rich, and Linder (2013) suggest that the empirical estimates of a Phillips curve may be diluted when they are applied to aggregate inflation, because the influence of resource gap factors (such as the difference between the measured unemployment and its “natural” rate) may affect the costs of services (services as non-tradable) more directly and substantially than the costs of goods. Similarly, Hargreaves, Kite, and Hodgetts (2006) use data from New Zealand to demonstrate how a Phillips curve relationship is important for modeling inflation for non-tradable prices, and therefore model the prices of tradeables and non-tradeables separately. In each case, the supporting intuition centers on how the key factors that influence tradeables (or goods) can differ materially from those that affect prices in non-tradeables (services). Following on from these ideas, we hypothesize that a resource gap measure will have an important effect on services price determination, and not on goods price inflation.

This paper builds a composite model for inflation that consists of a bivariate state space model (unobserved components) of services inflation and the unemployment rate, combined with a parsimonious univariate model for goods inflation. The services inflation model adapts the bivariate state space model as per Stella and Stock (2015), and exploits the empirical relationship between services inflation and the unemployment gap.2 The forecasting model for aggregate inflation in this paper captures the apparent relationship, in that unemployment rate deviations from the trend (a latent variable estimate of the ‘natural rate’) appear to be useful for predicting services inflation.

We estimate an inflation in parts model that measures services inflation and goods inflation separately. Using these two inflation series separately, the model isolates a

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1 We interpret the Phillips curve here as being the correlation between deviations of unemployment from its natural rate and deviations of inflation from its trend or expected rate.

2 See Peach et al. (2013), who employ an empirical approach to the data that differs from our methods.

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durable statistical relationship between services inflation and the unemployment rate. The bivariate state space model of services inflation exploits the empirical Phillips curve correlation suggested by Peach et al. (2013). We then use the estimated model to generate forecasts of services inflation, which we combine with the goods inflation forecast from an estimated trend in goods inflation (i.e., trend cycle decomposition with stochastic volatility along the lines of Stock & Watson, 2007) in order to compute a composite forecast of the aggregate inflation.\(^4\) We then evaluate the forecasts of aggregate inflation, services inflation (from the bi-variate state space model), and goods inflation (parsimonious model).

We find that modeling the inflation sub-components separately (goods as a univariate time series model and services in a state space form with unemployment) achieves significant improvements in both point and density forecast accuracies for aggregate inflation relative to a forecasting application of Stella and Stock’s bivariate model for total inflation.\(^5\) The latter provides a good benchmark because it modestly outperforms relatively accurate univariate approaches such as those of Atkeson and Ohanian (2001) and Stock and Watson (2007).\(^6\) Similarly, our “inflation in parts” framework performs well in terms of the forecast accuracy for aggregate inflation relative to the common univariate benchmarks that are usually the most accurate in terms of root mean squared errors and other point-based accuracy criteria. We also demonstrate forecast accuracy improvements for density forecasts using our inflation in parts framework, which is consistent with the work of Ravazzolo and Vahey (2014), who generate inflation forecasts that are aggregated from sub-components of inflation.\(^7\)

Our empirical model estimates a Phillips curve relationship between services inflation and the unemployment rate, as indicated by a relatively stable and negative estimate of the slope, a result that is consistent with the findings of King and Watson (1994), Lee and Nelson (2007), and Stella and Stock (2015).\(^8\) Our results are in contrast to those of Atkeson and Ohanian (2001) and Stock and Watson (2007), for example, as those papers documented the failure of standard Phillips curve models in forecasting aggregate inflation relative to simple univariate benchmarks in the post-1990 period.

The results employ the (headline) personal consumption expenditures price deflator (PCE) as the measure of inflation, and the unemployment rate as the measure from which we infer economic slack. We focus on the headline PCE inflation because the Federal Reserve’s long-run objective for inflation is defined in terms of this measure. We also generate results for four additional combinations: (i) PCE inflation and the short-term unemployment rate (results provided in online Appendix A.1),\(^9\) (ii) (headline) consumer price index (CPI) inflation and the unemployment rate (provided in online Appendix A.2), (iii) CPI inflation and the short-term unemployment rate (available from the authors on request), and (iv) CPI inflation excluding food and energy (core CPI) and the unemployment rate (provided in online Appendix A.3). Our finding of forecast accuracy improvements extend to these combinations (i.e., headline CPI inflation, using either the overall unemployment rate or the short-term unemployment rate) too, with one exception: the results are mixed for “core” CPI inflation. The metrics for forecast accuracy (for both point and density) support the notion that the model remains among the most accurate forecasting models under consideration. However, an alternative model that exploits the Phillips curve relationship between aggregate core inflation and the unemployment rate can forecast about as accurately as the model in parts.

The paper is organized as follows: Section 2 describes the relevant literature, Section 3 outlines the data and the empirical strategy, Section 4 discusses the estimation and forecasting results, and Section 5 concludes.

### 2. Review of the relevant literature

Existing research has indicated the potential for improvements in forecasting accuracy as a result of distinguishing between the inflation of goods and of services in models of inflation. Peach, Rich, and Antoniades (2004) used a vector error correction model to estimate goods inflation and services inflation separately, while also imposing a long-run relationship between the two measures. They demonstrated that the short- to medium-run dynamics of the two inflation series depend on the deviation of the long-run equilibrium between the two inflation rates. Their empirical model consisted only of the lags of goods and services inflation as explanators, meaning that they did not investigate the Phillips Curve.

Clark (2004) provided a qualitative analysis of the behaviors of core goods and core services inflation, as

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\(^3\) The goods inflation trend estimated using five-year averages or an exponential smoothing method with \(\alpha = 0.05\) leads to much more accurate point forecasts of goods inflation, and therefore of aggregate inflation. The results are presented in online Appendix A.4.

\(^4\) Of the various alternative models for goods inflation, we estimated one that specifically extends the bivariate UC state space model to three variables. The resulting tri-variate unobserved components state space model consists of the unemployment rate, services inflation, and goods inflation. Separate models for services inflation and goods inflation produce substantially more accurate forecasts than a single model of the aggregate. These results are consistent with the work of Peach et al. (2013).

\(^5\) Stella and Stock’s (2015) specification exploits the Phillips curve relationship between the total unemployment rate and total inflation. We apply their specification to services inflation with the unemployment rate.

\(^6\) We note that the forecast accuracy improvements for the Stella and Stock model forecasts are limited mainly to short horizons.

\(^7\) Ravazzolo and Vahey (2014) disaggregated PCE into 16 sub-components, each of which they modeled as a univariate autoregressive process. They then combined the forecasts of these sub-components to form forecasts of aggregate inflation, and showed that the density forecasts of their model out-performed those from a univariate integrated moving average specification of aggregate inflation (their focus was on headline PCE inflation).

\(^8\) Each of these works estimated a negative correlation between aggregate inflation and the unemployment rate at business cycle frequencies.

\(^9\) Ball and Mazumder (2014) and Gordon (2013) suggest that the short-term unemployment rate is a more appropriate measure from which to infer economic slack.
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