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## Predicting US inflation: Evidence from a new approach

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## ABSTRACT

In this paper, we further subject to empirical scrutiny the conclusion of Stock and Watson (1999) that commodity prices do not improve the traditional Phillips curve-based inflation forecasts. Thus, a multi-predictor framework for US inflation is constructed by augmenting the traditional Phillips curve with symmetric and asymmetric oil price changes. We show that the underlying predictors of US inflation exhibit persistence, endogeneity and conditional heteroscedasticity effects which have implications on forecast performance. Thus, we employ the Westerlund and Narayan (WN hereafter) (2012, 2015) estimator which allows for these effects in the predictive model. Also, we follow the linear multi-predictor set-up by Makin et al. (2014) which is an extension of the bivariate predictive model of WN (2012, 2015). Thereafter, we extend the former in order to construct a non-linear multi-predictor model that allows for asymmetries based on Shin et al. (2014) approach. Using historical monthly and quarterly data for relevant variables ranging from 1957 to 2017, we demonstrate that the oil price-based augmented Phillips curve will outperform the traditional version if the inherent effects in the predictors are captured in the predictive model. In addition, we also construct a Dynamic Model Averaging version for the augmented Phillips curve, as well as linear time-series models as Autoregressive Integrated Moving Average (ARIMA) and Fractionally Integrated versions (ARFIMA). The WN-based approach is found to outperform the alternative models that ignore the inherent effects. Our results are robust to different measures of inflation, data frequencies and multiple in-sample periods and forecast horizons.

## 1. Introduction

Undoubtedly, the literature on inflation forecasting is impressive when measured by its size and level of sophistication. Attempts have been made in the literature to document various channels and methodologies for improving inflation forecasts. For example, in order to produce accurate inflation forecasts, Stock and Watson (1999) recommend a generalized Phillips curve based on an aggregate real activity index (of 168 economic indicators) other than unemployment. Similarly, McAdam and McNelis (2005) document the significance of linear and neural network-based “thick” models for forecasting inflation based on Phillips-curve formulations; Altavilla and Ciccarelli (2010) suggest using combination inflation forecasts from many models; Capistrán et al. (2010) propose the use of disaggregated CPI data with multi-horizon evaluation techniques; Koop and Korobilis (2011, 2012) find evidence in favour of dynamic model averaging and dynamic model selection; Ibarra (2012) argues for the use of disaggregated CPI data but with factor models; Ögüncü et al. (2013) suggest the use of models which incorporate more economic information in the predictive model for inflation; and Kichiana and Rumler (2014) suggest a semi-structural New Keynesian

Phillips Curve approach. (see Figs. 4–6)

Also, monetary policy authorities' and analysts' need to constantly produce accurate inflation forecasts is a major incentive for the revision of existing models to achieve more accurate and reliable inflation forecasts. As a tool for forecasting inflation, the Phillips curve framework has indeed played a prominent role, to the extent that it is widely regarded as stable, reliable and accurate, at least when compared to the alternative models (Stock and Watson, 1998). However, the Phillips curve appears restrictive as it only captures the demand-side of the economy. Thus, inflation risk arising from supply shocks, for example, those due to unanticipated changes in the international commodity prices among others, are not captured in the model (see, Pain et al., 2008; Vogel et al., 2009; Ajmera et al., 2012; and IMF, 2012). In essence, the exclusion of the supply-side may render the forecast from the curve less optimal, particularly when compared to its augmented version which captures both (see, Chen, 2009; Chou and Lin, 2013; Coibion and Gorodnichenko, 2015; Salisu et al., 2017; among others).

Thus, in this paper, we hypothesise that the inclusion of the international oil price reflecting the supply-side of inflation in the Phillips curve will enhance its forecast performance. We do agree that there are

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several papers on inflation forecasting using a Phillips curve-based inflation model (see, for example, [Stock and Watson, 1996, 1998, 1999, 2008, 2009, 2010](#); [Ascari and Marrocu, 2003](#); and papers cited therein). However, we are motivated by the desire to challenge the conclusion of [Stock and Watson \(1999\)](#) that commodity prices do not improve the traditional Phillips curve-based inflation forecasts. In our favour, [Bec and De Gaze \(2016\)](#) find that oil price forecast errors contribute significantly to the explanation of inflation forecast errors in the USA, France and UK. Thus, our focus is to justify the significance of commodity prices, using oil price as a proxy,<sup>1</sup> in the traditional Phillips curve model, unlike [Stock and Watson \(1999\)](#) paper that constructs an all-indicator predictive regression for inflation forecasts.

The transmission mechanism for the oil price–inflation nexus is succinctly described in the paper by [Coibion and Gorodnichenko \(2015\)](#). The paper argues that changes in crude oil prices reflect visibly in domestic gasoline prices and result in a revision in household inflation expectations. It also shows that, contrary to expectations, the upward inflationary trend in the 2007–2009 financial crisis era was largely driven by the increase in oil prices, implying that the response of inflation to the oil price can be asymmetric. Thus, our contribution to the literature is two-fold. First, we investigate the role of oil price asymmetries in inflation forecasting. While a number of previous studies forecast inflation using non-linear models (see, [Moshiri and Cameron, 2000](#); [Ascari and Marrocu, 2003](#); and [Marcellino, 2008](#)), to our knowledge, none has paid attention to the role of oil price asymmetries. Consequently, we augment the traditional Phillips curve model with oil prices and, thereafter, we test whether the proposed revision will render better inflation forecasts. In addition, augmenting the traditional Phillips curve in this way allows for both the demand- and supply-side in inflation forecasting. A number of the extant studies ignore the supply-side variables in the specification of the Phillips curve for fear of potential simultaneity problems. In order to circumvent this problem, we allow for any inherent endogeneity bias in the predictors. Since we are using high-frequency data for analyses, it becomes imperative to test for the presence of conditional heteroscedasticity and persistence and to account for them, if they exist, in the estimation process. This forms the second motivation for this study.

We employ the Feasible Quasi Generalized Least Squares (FQGLS) estimator by [WN \(2012, 2015\)](#) which simultaneously captures any potential endogeneity, persistence and conditional heteroscedasticity effects in the predictive model.<sup>2</sup> Although, [Lewellen \(2004\)](#) [LW hereafter] appears to be the first attempt to account for both persistence and endogeneity in a predictive model, however, the estimator does not account for conditional heteroscedasticity which is a major feature of most high frequency series.<sup>3</sup> Thus, the FQGLS estimator is an improvement on the LW estimator as the former accounts for conditional heteroscedasticity effect in addition to those effects captured in the latter case. The FQGLS estimator was first developed by [WN \(2012\)](#) where they find that the choice of estimator matters when forecasting. More specifically, they demonstrate that the FQGLS estimator outperforms the LW (2004) and Ordinary Least Square (OLS) estimators particularly in the presence of conditional heteroscedasticity. On the basis of the findings of LW (2004) and [WN \(2012, 2015\)](#), ignoring these effects when in fact they are present will bias the predictive regression estimates. As demonstrated in the results section of our paper, the considered predictors exhibit all the

<sup>1</sup> Several papers have established a strong connection between oil price and other commodity prices (see, for example, [Nazlioglu, 2011](#); [Ji and Fan, 2016](#); [Rafiq and Bloch, 2016](#)).

<sup>2</sup> This approach is gaining increasing recognition in the literature. For instance, the approach has been used to model economic series such as stock returns (see, [Bannigadmath and Narayan, 2015](#); [Narayan and Bannigadmath, 2015](#); [Narayan and Gupta, 2015](#); [Phan et al., 2015](#); [Devpura et al., 2017](#)); inflation-gold nexus (see, [Sharma, 2016](#)) and borrowing and expenditure (see, [Makin et al., 2014](#)).

<sup>3</sup> Nonetheless, the estimator, described as bias-adjusted OLS estimator, is found to outperform the standard OLS in the presence of persistence and endogeneity.

mentioned effects and therefore we favour the [WN \(2015\)](#) over the [LW \(2004\)](#) and OLS estimators. Although [Makin et al. \(2014\)](#) is the first and only paper to extend the bivariate predictive model of the [WN \(2015\)](#) estimator to a linear multi-predictor framework, we further extend the latter by building a non-linear multi-predictor set-up that allows for asymmetries, using the approach of [Shin et al. \(2014\)](#).

In addition, our paper seems to be the first to demonstrate simultaneously the role of asymmetries, persistence, endogeneity and conditional heteroscedasticity effects in producing a more accurate forecast for US inflation. In the immediate section, we offer justification for the consideration of these effects in the predictive model for US inflation. For completeness, we also construct the [Koop and Korobilis \(2011, 2012\)](#) Dynamic Model Averaging version for the augmented Phillips curve as well as the linear time-series models as an Autoregressive Integrated Moving Average (ARIMA) and Fractionally Integrated version (ARFIMA) without controlling for the inherent effects in the predictors. Their forecast results are compared with the proposed [WN-based augmented Phillips curve](#) that accounts for these effects using standard forecast measures.

Why the choice of the USA as our case study, despite the fact that inflation forecasting has long been a major interest in the country, and where many economic decisions, whether made by policymakers, firms, investors or consumers, are often based on inflation forecasts? The underlying motivation follows from the findings of [Gordon \(2013\)](#) and [Rusnak et al. \(2013\)](#), which show that a number of US studies of inflationary phenomena relying on domestic cyclical factors, such as unemployment, the gap between potential and actual output as well as labour costs, could not explain why the sharp rise in the country's unemployment rate in recent years has not pushed the rate of inflation towards zero or even into negative territory. The accuracy of inflation forecasting is important for the effectiveness of US monetary policy pursuit of price stability; ignoring the puzzle of “missed deflation”, which according to [Rusnak et al. \(2013\)](#) is created by model mis-specifications, and foremost by the omission of commodity prices, can introduce substantial biases in the prediction of future inflation. Thus, for the USA whose consumption of oil was about 6.95 billion and 7.19 billion barrels in 2014 and 2016, respectively (see, [Neely, 2015](#); and [EIA international energy outlook, 2017](#)), it is imperative to examine the usefulness of crude oil prices in forecasting US inflation. To achieve this, we further advance the debate on whether monetary authorities should incorporate commodity and asset prices in the design of monetary policy rules, by proposing a revision to the Phillips curve that reflects the supply-side of inflation proxy by international crude oil prices. In addition, as previously noted, we are mindful of the potential bias that may result from ignoring the inherent statistical properties of the predictors of US inflation.

Contrary to the findings of [Stock and Watson \(1999\)](#), we find that commodity prices using oil price as a proxy can actually improve the traditional Phillips curve-based model if some inherent properties such as asymmetries, conditional heteroscedasticity, persistence and endogeneity are captured in the predictive model. We also find that the [WN-based approach](#) tends to outperform the alternative models that ignore the inherent effects.

The remaining part of this paper is structured as follows: Section 2 provides a literature review covering the motivation for asymmetries, persistence, conditional heteroscedasticity and endogeneity effects in the predictive model for inflation. Section 3 provides the underlying theoretical model, while the estimation procedure is discussed in Section 4. Section 5 deals with data and preliminary analysis, and empirical results are presented and discussed in Section 6. Section 7 concludes the paper.

## 2. Motivation for the study

### 2.1. Why oil price in the traditional Phillips curve model?

The increasing evidence in favour of the significant role of oil price in an economy, whether developed, developing, emerging, net oil-

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