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Cyclicality of real wages in the USA and Germany: New insights from wavelet analysis ☆

Martyna Marczak [a,*], Víctor Gómez [b]

[a] University of Hohenheim, Germany
[b] Ministry of Finance and Public Administration, Madrid, Spain

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ABSTRACT

This article provides new insights into the cyclical behavior of consumer and producer real wages in the USA and Germany. We apply two methods for the estimation of the cyclical components from the data: the approach based on the structural time series models and the ARIMA-model-based approach combined with the canonical decomposition and a band-pass filter. We examine the extracted cycles drawing on two wavelet concepts: wavelet coherence and wavelet phase angle. In contrast to the analysis in the time or frequency domains, wavelet analysis allows for the identification of possible changes in cyclical patterns over time. From the findings of our study, we can infer that the USA and Germany differ with respect to the lead–lag relationship of real wages and the business cycle. In the USA, both real wages are leading the business cycle in the entire time interval. The German consumer real wage is, on the other hand, lagging the business cycle. For the German producer real wage, the lead–lag pattern changes over time. We also find that real wages in the USA as well in Germany are procyclical or acyclical until 1980 and countercyclical thereafter.

1. Introduction

The question of real wage behavior in the course of the business cycle has been the subject of one of the most lively and long-lasting debates in macroeconomics. Keynesian economists, for example, postulate anticyclical real wages by arguing that nominal wages are rigid, at least in the short run. The same cyclical behavior arises according to Barro (1990) and Christiano and Eichenbaum (1992), but in this case it is explained with the mechanism of the intertemporal labor–leisure substitution. In contrast, as shown by Kydland and Prescott (1982) or Barro and King (1984), real business cycle models predict procyclical real wages resulting from shifts in labor demand caused by technological shocks. A procyclical or acyclical pattern may also occur in New Keynesian models and is justified by the assumption of a countercylical mark-up of monopolistic firms; see Rotemberg and Woodford (1991).

To check the empirical relevance of different theoretical approaches, an empirical investigation might be helpful by providing a clearer picture on the cyclical behavior of real wages. This could also contribute to a better understanding of wage and price dynamics in the economy which can be of great relevance for monetary policy. The importance of this research question is reflected in the extent to which it has been analyzed in the empirical business cycle literature. However, outcomes of different studies are very heterogeneous which will become evident from the subsequent brief literature overview. As this study focuses on the US and Germany, and is based on aggregate data, the brief summary will refer to works also employing aggregate data for these both countries only.[1]

Empirical research on real wage cyclicality in the US using aggregate data has a long history which was initiated by the works of Dunlop (1938) and Tarshis (1939) proclaiming procyclical real wages. Since then, the findings of US studies have been ambiguous. Bodkin (1969) finds that the results are sensitive to the deflator used. Chirinko (1980) and Neftci (1878) conclude that real wages are countercyclical, whereas Geary and Kennan (1982) do not find any consistent relationship between real wages and employment. Studies by Sumner and Silver (1989) and Mocan and Topyan (1993) are examples of works paying particular attention to the different behavior of real wages in the presence of demand and supply shocks. In periods dominated by demand shocks, prices move procyclically and real wages show countercyclical tendencies.

As regards Germany, procyclical and leading real wages can be found in the work by Brandner and Neusser (1992), whereas according to Pérez (2001) real wages are acyclical or procyclical, and lagging.

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* Corresponding author at: University of Hohenheim, Department of Economics (520G), Schloss, Museumsfluegel, D-70593 Stuttgart, Germany.
E-mail address: marczak@uni-hohenheim.de (M. Marczak).

[1] For the outcomes of micro data studies see, e.g., Bils (1985) or Keane et al. (1988), Solon et al. (1994), Devereux (2001), Shin and Solon (2007), and Elsby et al. (2013).

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Procyclical real wages result also from the analysis by Messina et al. (2009). In contrast, Lucke (1997) concludes that real wages are weakly anticyclical in the expansionary phase, and in the contractionary phase no clear-cut pattern emerges. Marczak and Beissinger (2013) distinguish between consumer and producer real wages, and show that for shorter time periods up to about four years, the consumer real wage shows an anticyclical behavior, whereas for longer time spans a procyclical behavior can be observed. For the producer real wage, however, the results remain inconclusive.

It is to be noted that for each of both countries, the studies differ in various respects, such as the time span of the data, the method used for the investigation of the cyclical relationship, and the price deflator used for the construction of real wages. This fact combined with the ambiguity of outcomes shows the necessity of further research on this topic, with a special focus on the question under which circumstances particular outcomes – procyclical, anticyclical, acyclical, leading, lagging behavior – may be observable.

This study contributes to the empirical literature on real wage cyclicality from several points of view. First and foremost, it offers methodological advances for revisiting the old question. Traditionally, the majority of works concentrated on the time-domain analysis. A disadvantage of common time-domain comovement tools as, for example, sample cross-correlations or regression coefficients of some cycle reference measure is that they are incapable of identifying detailed patterns of cyclicality since they do not differentiate between horizons at which comovement could be detected. To overcome this shortcoming of the time domain analysis, some studies consider the comovements in the frequency domain where one is able to assess the relative importance of components with different periodicities for the observed behavior. The frequency-domain approach in the investigation of real wage cyclicality is followed in the aforementioned works of Marczak and Beissinger (2013), Messina et al. (2009), and additionally in, e.g., Hart et al. (2009). Standard multivariate spectral techniques, such as cross-spectrum, coherency or phase angle, are, however, time-invariant. In order to additionally take time information into account, we propose to use wavelet analysis as an alternative tool to measure comovements between time series. Applications based on wavelet measures are already widespread in such disciplines as physics, meteorology, geology, medicine, oceanography or engineering. In economics, wavelet analysis was first considered in articles by, e.g., Ramsey et al. (1995), Ramsey and Lampart (1998), and Gençay et al. (2001), but its advantages, in contrast to other sciences, have not been extensively exploited yet. A review of different wavelet concepts with a focus on economic applications is given by Crowley (2007). Recent applications of wavelet analysis to economic questions can be found in, e.g., Aguiar-Conraria et al. (2012), Ahamada and Jolivaldt (2013), Benhmad (2013), Reboredo and Rivera-Castro (2013), Aloui and Hkiri (2014), Andrieş et al. (2014), and Tiwari et al. (2014). Wavelet functions which are the building block of the wavelet approach are, unlike the sine and cosine functions used in spectral analysis, local in both the time and frequency domains, which makes wavelets suited to capture changes in behavior patterns. Wavelet analysis can therefore reveal how the relationship between different periodic components of time series evolves over time.

This study is the first one which employs wavelet analysis in the context of real wage cyclicality, and the advantage of this approach is at least twofold. First, it enables us to obtain a more comprehensive picture of real wage cyclicality than in previous studies. In contrast to an overall cyclical pattern in the time-domain related works, or a cyclical pattern depending on the time horizon in the frequency-domain related works, the cyclical behavior of real wages in this study is tracked in the frequency and time dimension simultaneously. Second, the more comprehensive outcome of wavelet analysis may thus encompass those of previous studies referring to different time spans of the data. In this respect, this study might partly explain the confusion created by the heterogeneity of outcomes in the empirical literature on this topic.

This article is also an attempt to provide a reliable and consistent comparison of the real wage cyclicality in the USA and Germany which has not been done so far in the literature. The particular choice of both countries is motivated by the fact that they are both two large economies with strongly differing labor market institutions. In comparison to the flexible US labor market, the German labor market may be characterized as more rigid because of strong unemployment protection rules, strong unions and a relatively generous unemployment compensation system. Our analysis can thus reveal whether the differences in labor market characteristics are reflected in different patterns of real wage cyclicality in the USA and Germany.

To assess the real wage behavior over the business cycle, wavelet analysis is applied to the real wage cycle and a business cycle indicator represented here by the cycle of the industrial production. In empirical studies dealing with real wage cyclicality, as well as in other macroeconomic applications, the most popular approaches to obtain the cyclical component from the underlying series are to consider the growth rate of the respective series, or to apply ad hoc filters, like those proposed by Hodrick and Prescott (1997) or Baxter and King (1999). For the application of these methods, the underlying data is seasonally adjusted either by an official statistical office or by the analyst prior to cycle estimation. Instead, in this article we take advantage of using raw data and employ two univariate model-based approaches which allow for a simultaneous treatment of the seasonal component next to the trend and cycle. In this way, all components of the series can be estimated in a coherent manner. These two methods are: the structural time series (STS) model proposed by Harvey (1989), and the ARIMA-model-based (AMB) approach (see, e.g., Box et al., 1978) combined with the canonical decomposition (see Hillmer and Tiao, 1982) and the application of a band-pass filter based on a Butterworth tangent function (see Gómez, 2001). Apart from removing seasonality from the data, they can also take into account the stochastic properties of the data as opposed to ad hoc filtering methods. Considering two model-based methods which differ in the way how individual components are modeled – either explicitly or derived from the reduced form – gives us the possibility to check the robustness of the findings.[2] Since the results may also be affected by the price deflator used to compute real wages, we distinguish between consumer real wages and producer real wages.

The remainder of the article is organized as follows. In Section 2 we apply two decomposition methods to the industrial production index (IPI), consumer real wages and producer real wages in the USA and Germany. In Section 3.1 we set out the most important wavelet concepts. More detailed explanations of one of them, the wavelet phase angle, are provided in Section 3.2. In Section 3.3 it is shown how the previously introduced concepts are implemented in our study. In Section 4 we examine the comovements between the particular IPI cycle and the corresponding real wage cycles in the time–frequency domain using wavelet analysis. In Section 5 the results of the analysis are interpreted and explained. Section 6 summarizes the results and concludes.

[2] Recent empirical literature on business cycles shows an increasing appreciation of multivariate model-based approaches to cycle extraction; see, e.g., Azevedo et al. (2006), Cubadda et al. (2013), Narayan and Thuraisamy (2013), and Cendejas et al. (2014). As the focus of this study lies in wavelet analysis, we resort to univariate models instead of using relatively more elaborate and complex multivariate methods. Whereas the univariate and multivariate methods mentioned so far pertain to integrated processes, another strand in the literature draws on the assumption that macroeconomic time series are fractionally integrated, i.e. they exhibit strong persistence (long memory); see Ariño and Marmol (2004), Morana (2007), and Caporale and Gil-Alana (2014). It is, however, to be noted that both, multivariate approaches and those particularly designed for long-memory processes, are in the major part of the literature applied to seasonally adjusted series. In contrast, in this study we can exploit the advantage of raw data by resorting to decomposition methods that explicitly model the seasonal component.