Common and country specific factors in the distribution of real wages

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Abstract

We use a dynamic factor model to consider if real wage growth in the US, UK and Germany at different percentiles of the distribution can be explained by factors that are common across countries or specific to each country. Our results suggest that common factors explain a large proportion of the movement in wages when considering the left tail of the distribution indicating that shocks that are common across countries are important for low wage households.

Key words: Household wages, dynamic factor model.
JEL codes: C5, E1, E5, E6

1 Introduction

Wage inequality has risen over the last three decades in industrialised countries such as the US, the UK and Germany with different patterns of changes highlighted in different periods (e.g. Autor *et al.* (2008)) and across different advanced countries (e.g. Dustmann *et al.* (2009)). This trend has been attributed to a wide range of factors. These include domestic economic policy (see for e.g. Coibion *et al.* (2017) and Mumtaz and Theophilopoulou (2017)) and institutional factors such as labour market rigidities (e.g. Machin and Reenen (2007)). The literature has also considered the effects of common factors such as globalisation (e.g. Epifani and Gancia (2008)) and skill-biased technological upgrade, especially the impact of computerization (see e.g. Autor *et al.* (2003)). The behaviour of wages has been under fresh scrutiny by policy makers in recent years with their level displaying a persistent decline in the aftermath of the great recession.

In this paper, we contribute to the investigation of the factors behind the evolution of the real wage distribution by adopting a cross-country perspective. In particular, we use a dynamic factor model to consider if real wage growth in the US, UK and Germany at different percentiles of the distribution can be explained by factors that are common across countries or specific to each country. Our approach is related to the analysis in Otrok and Pourpourides (2008). However, while Otrok and Pourpourides (2008) investigate the presence of wage factors within the US, our interest lies in estimating the importance of factors that drive cross-country co-movements.

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Our results indicate that global factors, i.e. factors that are common across countries, explain a large proportion of the movement in wages when considering the left tail of the distribution. This suggests that shocks that are common across countries are important for low wage households. Country-specific factors make a moderate contribution throughout the distribution. There is some evidence that this contribution is larger towards the right tail of the distribution.

The importance of global factors for low wage households is consistent with the findings of a large literature that considers the impact of trade shocks and structural changes such as globalisation and technological change on the wage distribution. Our results support the argument that such changes may have an asymmetric impact on the wage distribution. From a policy perspective, these results imply that international economic developments should be taken into account when designing policies to combat wage inequality. From a theoretical perspective, they highlight the importance of incorporating transmission of international shocks when modelling the distribution of wages.

The paper is organised as follows. Section 2 presents the empirical model and describes the data set. The main results are presented in section 3 while section 4 concludes.

2 Empirical model and data

2.1 Empirical model

As explained below, our data set comprises a pseudo panel of average real wage growth in the deciles of the distribution covering the US, UK and Germany. Collecting the data set into a $T \times M$ matrix X_{it}, we postulate the following model:

$$X_{it} = B_i^C F_t^C + B_i^W F_t^W + v_{it} \tag{1}$$

where $i = 1, 2, .., M$ and $t = 1, 2, .., T$. Equation 1 states that average wage growth is affected by a set of K^C country-specific unobserved factors F_t^C and a set of K^W unobserved factors F_t^W common across countries, while the error term v_{it} captures the unobserved idiosyncratic components. The factor loadings on the country and common factors are denoted by B_i^C and B_i^W.

Each of these unobserved factors are assumed to follow $AR(P)$ processes. For ease of notation we collect these factors in the $T \times \left(3 \times K^C + K^W\right)$ matrix F_t. The kth column of this matrix is described by the process:

$$F_{kt} = c_k + \sum_{j=1}^{P} b_{kj} F_{kt-j} + \sigma_k^{1/2} e_{kt}, e_{kt} \tilde{} N(0,1) \tag{2}$$

Similarly, the M idiosyncratic components are described by $AR\left(q\right)$ process:

$$v_{it} = \sum_{j=1}^{q} d_{ij} v_{it-j} + h_i^{1/2} e_{it}, e_{it} \tilde{} N(0,1) \tag{3}$$

Equation 1 implies that:

$$var\left(X_{it}\right) = \left(B_i^C\right)^2 var\left(F_t^C\right) + \left(B_i^W\right)^2 var\left(F_t^W\right) + var\left(v_{it}\right)$$

This equation can be used to estimate the contribution of the world and country factors to the

variance of each series. The contribution of the world and country factors are:

$$S^W = \frac{\left(B_i^W\right)^2 var\left(F_t^W\right)}{\left(B_i^C\right)^2 var\left(F_t^C\right) + \left(B_i^W\right)^2 var\left(F_t^W\right) + var\left(v_{it}\right)} \tag{4}$$

$$S^C = \frac{\left(B_i^C\right)^2 var\left(F_t^C\right)}{\left(B_i^C\right)^2 var\left(F_t^C\right) + \left(B_i^W\right)^2 var\left(F_t^W\right) + var\left(v_{it}\right)} \tag{5}$$

Estimates of S^W and S^C can be used to infer if the variance of wage growth has been driven by country specific factors or events that are common across countries. Similarly, a comparison of the ith data series X_{it} with the 'fitted values' $\hat{X}_{it}^W = B_i^W F_t^W$ and $\hat{X}_{it}^{W+C} = B_i^C F_t^C + B_i^W F_t^W$ can be used to assess how the factors contribute to the changes in wage growth over time.

This dynamic factor model is estimated using a Gibbs sampling algorithm which is fairly standard and described in detail in the technical appendix. In short, the algorithm is based on successively sampling from the conditional posterior distribution of F_t and the remaining parameters. It exploits the fact that given a draw for F_t, the model collapses to a series of linear regressions with standard conditional posterior distributions. One novel aspect of the procedure is the fact that we have to deal with a number of missing values in X_{it} (present in the panel for the UK). We treat these missing values as unknown parameters and extend the basic algorithm to sample from their conditional posterior distribution. The model is subject to the usual scale and sign identification problems affecting factor models. First the scale of the factors is unidentified. We fix the scale of the factors by assuming that $\sigma_k^2 = 1$. Second, the sign of the factors and factor loadings is not identified separately. However, this is not an issue for our applications below as that do not require an estimate of the factors and their loadings individually, but use either the square of the loadings or the product of the factors and their loadings.

As our data is sampled at an annual frequency, we fix the lag lengths P and q to 1. The choice of the number of common and country-specific factors is a key specification issue. We consider values of K^W and K^C up to 3 and compute the deviance information criterion (DIC) for each specification.[1] As discussed in Spiegelhalter *et al.* (2002), the DIC rewards fit while penalising model complexity with smaller values of DIC preferred. In our case the DIC is minimised for $K^W = K^C = 3$.

2.2 Data

For each country, we collect wages using household surveys. For the US, the data is obtained from the Consumer Expenditure Survey (CEX). Wages are defined as the amount of salary income received by all the members of the household over the past twelve months before deductions (code: FSALARYM). For the UK, our data source is the Family Expenditure Survey (FES). The variable of interest is defined as gross wage (code: P008). This refers to take home pay including deductions such income tax and national insurance contributions. This variable is summed over all members of each household in the sample. For Germany, the data is obtained from the German Socio-Economic Panel (GSEP) and produced by the Deutsches Institut Für Wirtschaftsforschung (DIW) where the variable is coded as I11103$$. The variable we use is defined as the sum of total family income from labor earnings. Labor earnings include wages and salary from all employment including training, self-employment income, bonuses, overtime, and profit sharing.

[1] The maximum number of factors is fixed to 3 to limit the number of unobserved state variables to a manageable number.

	US		UK		DE	
	World	Country	World	Country	World	Country
P_1	42.5	22.7	36.6	26.9	34.6	38.3
	(27.1, 58.4)	(11.5, 37.1)	(20.6, 53.1)	(13.5, 42.9)	(19.1, 52.5)	(22.9, 52.6)
P_2	55.2	25.1	62.4	29.9	46.8	49.7
	(41.8, 67.5)	(14.8, 37.2)	(48.2, 75.9)	(17, 43.4)	(30.6, 63.9)	(32.7, 65.7)
P_3	57.1	26.4	56.3	40.1	59.9	39.1
	(44.5, 67.9)	(16.5, 37.0)	(40.5, 73.5)	(23.1, 55.6)	(43.8, 75.3)	(23.7, 55.2)
P_4	54.5	36.5	57.4	39.5	71	27.9
	(40.8, 66.7)	(25.1, 49.7)	(37.5, 78.3)	(18.5, 59.4)	(56.2, 83.1)	(15.8, 42.7)
P_5	40.7	48.2	56.8	38.9	66.8	31.8
	(28, 53.3)	(34.4, 62.2)	(37.8, 78.4)	(17.7, 58)	(52, 81.2)	(17.4, 46.4)
P_6	31.6	59.6	58.0	38.7	66.5	32.8
	(19.6, 44)	(47.1, 71.4)	(40.8, 78.6)	(17.9, 56.3)	(52, 80.5)	(18.7, 47.3)
P_7	25.9	71.8	64.3	33.4	63.7	35.1
	(14.8, 39.4)	(58.2, 82.7)	(47.8, 83.3)	(14.3, 49.9)	(49.1, 78.1)	(20.8, 49.8)
P_8	19.6	75.5	57	36.2	59.5	38.5
	(9.4, 32.9)	(62.5, 86.2)	(41.1, 73.4)	(19.6, 52.8)	(44.6, 74.1)	(24.1, 53.3)
P_9	15.7	39.2	31.4	36.6	54.4	39.6
	(6.8, 27.2)	(20.7, 61.1)	(17.8, 46.5)	(21.3, 52.4)	(39.3, 69.7)	(24.9, 54.4)

Table 1: Contribution of World and Country factors to the variance of wage growth. 68 percent error bands in parenthesis

For each country, household level wages are deflated using the CPI and top and the bottom percentile are removed to ameliorate the influence of extreme values. Following Cloyne and Surico (2017), we construct a pseudo panel by assigning households to percentile groups and calculating average real wage growth in each group. We define nine percentile groups: $P_1 = [\leq 10th], P_2 = [> 10th \& \leq 20th], P_3 = [> 20th \& \leq 30th], ..., P_9 = [> 90th]$ that constitute the cross-sectional dimension of the pseudo panel for each country. The time series for average real wages in each group runs from 1984 to 2014.[2]

3 Results

The main results from the variance decomposition are summarised in Table 1. The table presents the contribution of the world and country factors to the variance of decile specific wage growth. It is interesting to note that for groups P_1 to P_4, the world factor plays an important role in determining the fluctuations in wage growth for all countries. The magnitude of this contribution is estimated to be large – i.e. close to 50 percent in almost all cases. Moreover, barring the results for groups P_1 and P_2 in Germany, the median contribution of the world factor exceeds that of the country factor. This suggests that world developments are particularly important for wage growth below the median.

Results are more heterogenous across countries for groups P_6 to P_9. Consider the results for the US. The contribution of the country factor to the variance of the wage growth is estimated to

[2]These groups can be defined in terms of other household characteristics such as age or education. We use percentile groups as our interest centers on wage inequality.

be substantially larger than the contribution of the world factor. This is in contrast to the left tail of the distribution where common or world economic developments matter more than the country factor. For the UK, a similar pattern is seen for the top group P_9 where the contribution of the country factor is somewhat larger than the contribution of the world factor. For groups P_6 to P_8, however, the contribution of the world factor is more important. Similarly, the variance of the right tail in the German wage growth distribution is largely explained by the world factor.

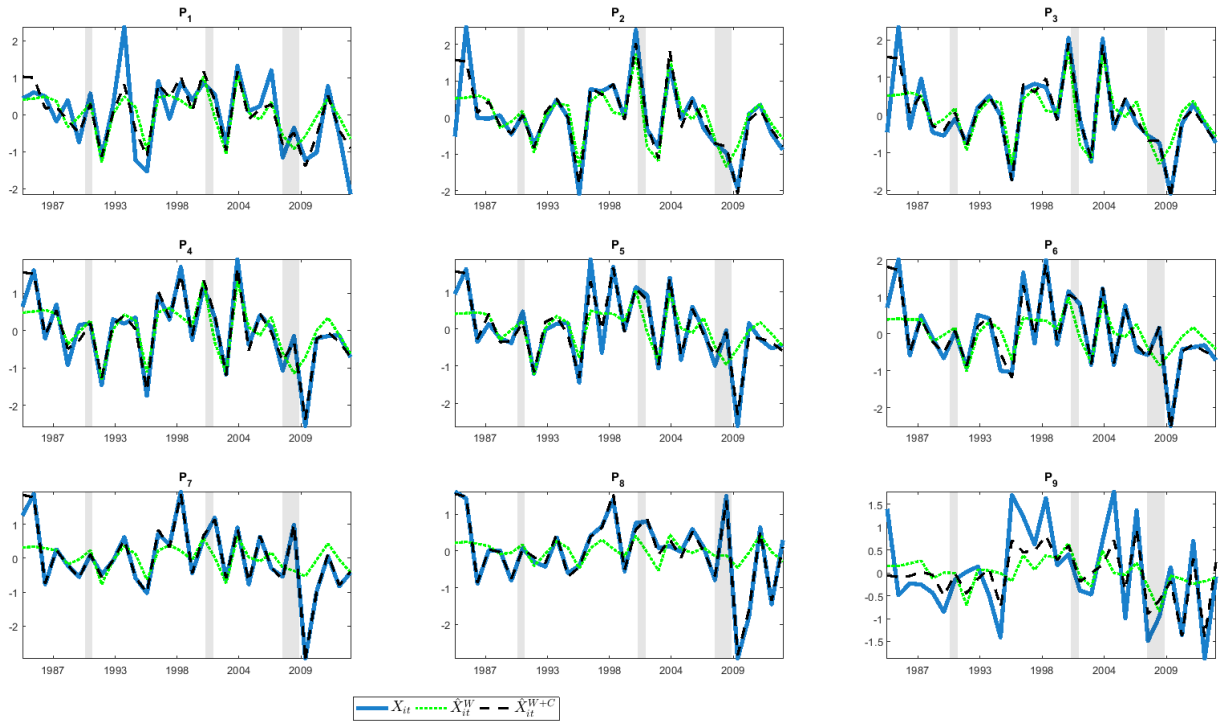

Figure 1: US real wage growth X_{it}, the contribution of the world factor X_{it}^{W} and the contribution of the world and country factors X_{it}^{W+C}. Shaded areas represent NBER recession dates.

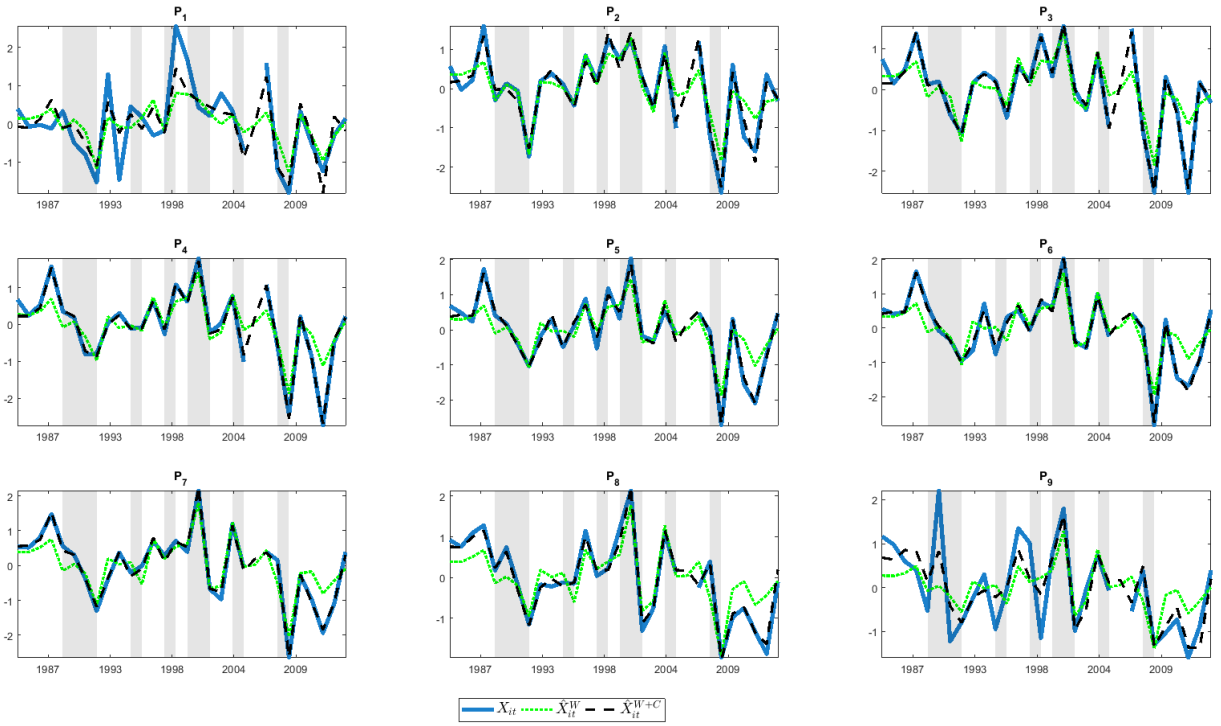

Figure 2: UK real wage growth X_{it}, the contribution of the world factor X_{it}^{W} and the contribution of the world and country factors X_{it}^{W+C}. Shaded areas represent OECD recession dates.

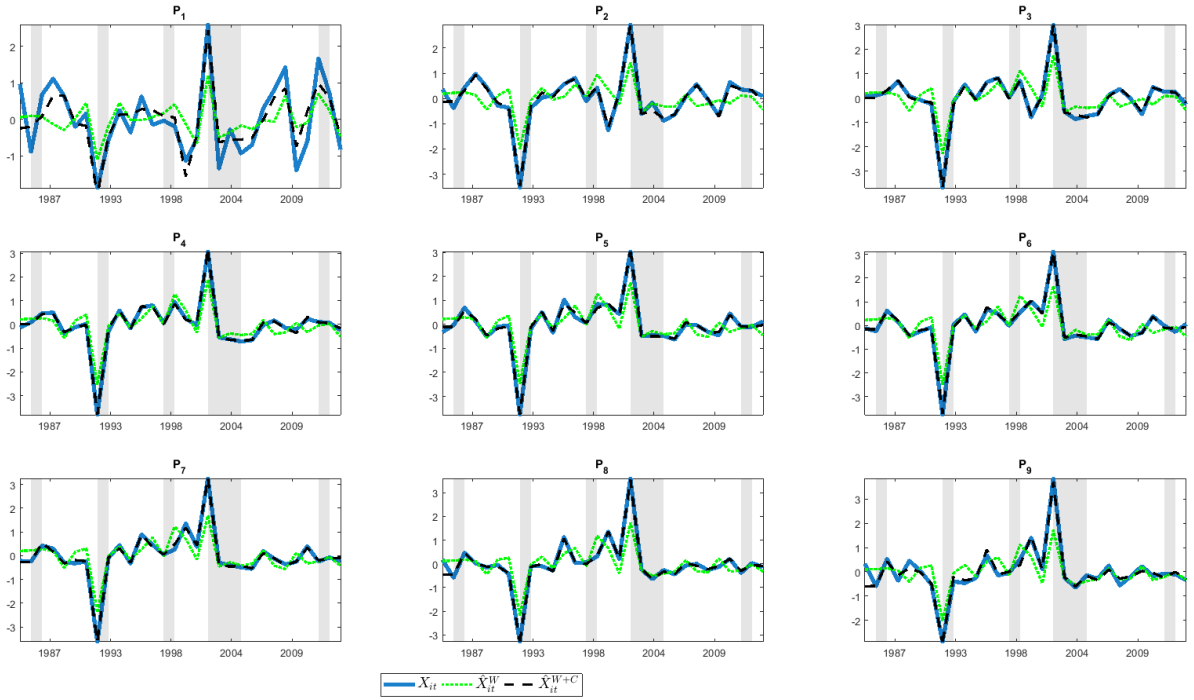

Figure 3: German real wage growth X_{it}, the contribution of the world factor X_{it}^{W} and the contribution of the world and country factors X_{it}^{W+C}. Shaded areas represent OECD recession dates.

Figure 1 shows the growth of real wages in the different groups for the US along with the fitted values $\hat{X}_{it}^{W} = B_i^W F_t^W$ and $\hat{X}_{it}^{W+C} = B_i^C F_t^C + B_i^W F_t^W$. For most groups, the mid 1980s were a period of high wage growth that declined as the 1990s approached. The difference between $\hat{X}_{it}^{W}$ and $\hat{X}_{it}^{W+C}$ over this period indicates that this change was driven to a large extent by country specific conditions. The mid 1990s saw large declines in wage growth. For the lower percentile groups, this was largely driven by the world factor with $\hat{X}_{it}^{W}$ and $\hat{X}_{it}^{W+C}$ overlapping. However, country specific conditions appear to be more important for the higher percentile groups over this period. Wage growth was also suppressed in the aftermath of the recessions in 2000 and 2007. In terms of contributions a similar pattern is apparent during these recessions. For lower percentile groups, the world factor makes an important contribution with country-specific conditions more important towards the right tail of the distribution.

For the UK (see Figure 2), country-specific conditions appear to be important in driving the increase in wage growth during the late 1990s and mid-2000's for group P_1. It is interesting to note that for the remaining groups, country-specific factors played an important role towards the end of the sample when wages displayed a sharp decline. In contrast, the the world factor made the largest contribution to the fall in wages after the 2008 recession.

Figure 3 shows that real wages in Germany display large movements in the aftermath of the ERM crisis and around the period when the Euro was adopted at the end of the 1990s. In both cases, the bulk of the movement is explained by the world factor. However, note that country-specific conditions also made a contribution to wage movements during the second episode with their impact largest towards the right tail of the distribution.

3.1 Discussion

Our empirical results suggest that global factors are important for the percentile groups below the median. This result is consistent with the recent literature on changing labour market dynamics and structure. Traditionally, the decline of wage growth for the lower percentile groups in the second half of the 1990s has been related to trade shocks, both the North American Free Trade Agreement (NAFTA) in 1994 and the increase of trade deficit with China which surged further in 2000 (see e.g. Machin and Reenen (2007)). More recently, the role of trade has been reassessed (see e.g. Epifani and Gancia (2008), Hakobyan and McLaren (2016), Autor *et al.* (2013)). Further evidence highlights how both skill-biased technological change and skill supply together with institutional changes (e.g. de-unionization) affected the distribution non-monotonically (e.g. Acemoglu *et al.* (2016)), but also the timing of how it impacted the wage structure in different national contexts (e.g. Autor *et al.* (2008)). Also, as argued by Slaughter and Swagel (1997), labour markets in the US and the UK, where the wages are flexible, are decentralised and therefore, a decline in the demand for unskilled or semi-skilled occupational groups results in lower wages for these groups (especially when the supply increases due to globalisation and immigration). This is also supported by Bivens (2013) who found that wages of semi/unskilled workers decreased due to the fact that globalisation enabled US labour-intensive industries to move to developing countries, and thus reducing the demand for labour in the US.

Accordingly, our results confirm that, far from being stable as traditionally believed, despite a technology similar to the UK and US, the German wage distribution has undergone a change similar to the one experienced in the US and in the UK albeit a decade later. However, the German low wage groups have been affected relatively more by domestic factors. The country's re-unification and non-market institutional factors might have played a role in bringing about this change (e.g. Dustmann *et al.* (2009)).

4 Conclusions

In this note we use a dynamic factor model to decompose movements in real wages at the household level into components specific to each country in our sample and those that capture common shocks. The estimates suggest that factors that are common across countries play an important role for real wages. This is particularly true for the wages of households that lie towards the left tail of the distribution. For the US, country-specific factors remain highly important for high wage households.

Our results are consistent with the argument that global factors such as trade and globalisation have affected the left tail of the wage distribution. From a policy perspective, this result highlights the importance of accounting for international developments when designing labour market policies. In future work it would be useful to examine if similar results hold for household level income and expenditure. It would also be of interest to expand the set of countries and investigate if regional factors also play an important role.

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