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WAGE DYNAMICS AND BULGARIA CO-MOVEMENT AND CAUSALITY

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Abstract
Motivated by recent debates on the possible role of wages as an income policy tool, in this study we examine the dynamic inter-relationship between wages in Bulgaria, mainly in the context of its EU accession. Relative to the WDN studies on the other EU member states, the novelty in this paper is the inclusion of the minimum wage as a possible conditional determinant of the other two wages. We demonstrate that minimum wage increases do not cause changes in average wages in either the government or the private sector. Using variety of econometric tests, we also demonstrate the leadership of private sector wage over public compensation and recommend the implementation of policy measures aimed at labor productivity growth.

JEL Classification: C32, E62, J3, J4
Keywords: Public Sector Wages, Private Sector Wages, Minimum Wages, Causality

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Section 1: Introduction and Motivation

A major concern for economics is to understand how labour markets work because roughly two-thirds of total income is classified as labour income. One such aggregate aspect is the relationship between real public and private sector wages and the causal links running between them. We focus on dynamic inter-relationships, sectoral spill-overs and transmission mechanisms. The issue of wage leadership is further relevant for both policy makers and central banks from analytical and monetary policy perspectives. So far, the literature has mostly neglected the dynamic correlation between the two wages and no studies have included minimum wage together with the analysis of public and private wage dynamics. This is where the contribution of this paper lies.

This paper analyses the co-movement and causality of public and private sector wages as well as the role of the minimum wage in Bulgarian economy for the period of 2000-2016. We chose this period, on the one hand, for the relative stability of the Bulgarian lev and, on the other, because of the 2007 Bulgarian accession to the EU. The first part of the study examines the causal effects between public and private sector wages in the context of existing literature. Most studies of EU countries, such as Lamo *et al.* (2008) point to a strong bi-directional causality and co-integration of both wages with the private sector, established as a leader in wage determination. Our study adds to the existing knowledge by reporting one-directional causal effects running from private over to public sector wages. In line with EU findings, we conclude that the private sector is an established leader in wage determination and that its leadership is stronger than in some EU countries. Despite the presence of a large public sector as a major employer, both in Bulgaria and in the EU, it is the private sector that establishes itself as a leader in wage determination in the case of Bulgaria. We further derive the co-movement over the business cycle and establish that there is a tendency for long-term co-integration. The second part of the study focuses on the role of the minimum wage as a tool for income policy. We find no long-term causal effects of the minimum wage on private and public sector wages. This suggests that minimum wage plays no role in improving welfare, as raising it does not, in turn, raise average public and private sector wages. This finding is in line with the framework in the minimum wage study by Economides and Moutos (2016)[1].

In our empirical analysis we use de-trended quarterly data to obtain a VAR model in a time-series context. Furthermore, we derive all empirical results, in both nominal and real terms, with CPI preferred as a main deflating tool. Results show that real

1. Economides and Moutos (2016), discussed in Section 2, find that it is impossible for any level of minimum wage to increase incomes of employed workers and, this way, the authors prove the inefficiency of minimum wage as an income policy tool.

public wages react to increases in private sector wages with a lag of half a year (two quarters). In addition, nominal public and private sector wages exhibit a common trend and tendency for long-term co-integration. We use Granger-causality Wald tests to show that the private sector is the leading one in wage determination and that minimum wage plays no role in the latter. Furthermore, applying impulse response functions leads to the same conclusion as do the correlation coefficients between the wages and the Wald tests. The effect of real private wages on public and minimum ones is graphically presented to show that economic adjustments to shocks tend to follow two periods (quarters) of time. Half a year after a wage increase in the private (leading) sector, a public wage increase follows until long-run equilibrium is reached. We further discuss some possible sources of the shocks that establish private wage as the leader. Next, we delve into public and private wage determinants by considering several labour market models, such as perfect competition, monopsony and unions, search and matching frictions, efficiency wages and minimum wages.

The rest of the paper is organised as follows: section 2 reviews the literature, followed by section 3, which presents description of the data, some stylised facts on Bulgarian wages and the process of wage determination. Section 4 explains the methodology employed in analysing the data. We also include some limitations to our study, a policy recommendation in line with our findings, a venue for possible future research and conclusions under section 5.

Section 2: Literature Review

As pointed out in Lamo, *et al.* (2008), the literature on wage dynamics, spill-overs and leadership proves to be quite scarce. Furthermore, its focus falls on the relationship between public and private sector wages with the effect of the minimum wage, if such, studied separately. The few existing models, such as in Demekas' and Kontolemis' one (2000), generally assume a static relationship between public and private wages, where the public influences the private wage through the labour supply principle, i.e. increases in the public wage leave no choice for private businesses but to increase wages in the respective sector, as well.

This direction of causality is reversed in the so-called Scandinavian model, as discussed in Jacobson *et al.* (1994), which finds that the sector more open to international competition is the established wage leader. In the case of Sweden, the leader is the private sector, as it is found to have higher productivity growth. The competitive market theory, according to which wage increases run from the competitive to the protected sector, has been further elaborated by Lindquist *et al.* (2004), who find that the Swedish private sector Granger-causes the public one. Therefore, it can be concluded that, in the case for Sweden, Norway and Finland, it is the market forces that drive wage mechanisms in establishing causal links. However, apart from the two models above, there is no unified theoretical model, since findings tend to be heterogeneous across individual countries.

Not only theoretical models but also empirical results for most countries differ, so we primarily focus on literature concerning the Eastern European region and EU member states. It should be noted that one of the reasons for this difference in wage dynamics may be attributed to the different institutional and wage bargaining processes in place, as well as to the variety of approaches used in analysing the data available. We chose to follow an ECB study of wage interactions over the period 1960-2006 for the Euro area, Euro area countries and a number of other OECD countries (Lamo *et al.*, 2008), as our main references. This ECB study is was undertaken by the Wage Dynamics Network (WDN), consisting of economists from the European Central Bank (ECB) and the National Central Banks (NCBs) of the EU Member States. The study uses a VAR model to find a strong contemporaneous correlation between private and public wages over the business cycle, as well as a tendency towards long-run co-movement. Furthermore, Lamo *et al.* (2008) find that causal links between the two nominal wages suggest that feedback occurs in a direct manner, i.e. through prices. Despite institutional differences across countries, strong correlation and long-term co-integration are reported for the majority of the cases.

In another study undertaken as part of the WDN, Afonso and Gomes (2010) analyse the interactions between public and private sector wages of OECD countries for the period 1973-2000. Their study presents a two-sector system, public and private, where the two wages are estimated by two different wage functions. The study further tests the validity of variables as instruments affecting wage determination. The econometric method used is a three-stage least-squares, an estimation of the two wages and their determinants via a two-equation system. The study reports that public sector wage growth is mainly driven by private sector wage increases and the government fiscal condition. Besides, public wage growth is found to positively affect private wage increases. These results are driven by the validity of instruments used, such as total factor productivity, unemployment and urbanisation rates, growth rates of the average hours worked per employee and fiscal conditions. However, there is no minimum wage present in the model.

Christou (2007) obtains bi-variate VAR estimation on dynamic public and private wage behaviour for the period 1993-2007. The study finds bi-directional causality running between public and private wages. Moreover, the Romanian economy can be regarded as similar to the Bulgarian one, since both countries gained EU accession in 2008 and both share comparable institutional and economic settings. Despite the fact that in Romania government wages are higher, on average, and their sector share is growing faster (in line with most EU countries), private wages are found to equally influence public ones. Christou (2007) ignores minimum wages from the estimated VAR system.

Another important paper in the wage dynamics literature relevant to our study is the study by Demekas and Kontolemis (1999), who find evidence of public wage leadership in VAR analysis for Greece (1971-1993). Demekas and Kontolemis (1999) also use a two-sector theoretical model to find that employment and wage decisions in the public sector are fundamentally different from those in the private one due to the presence of political economy factors (employees are also voters and can be patronised by the government) in the government sector. Moreover, the study reports that increases in government wages lead to both increases in private-sector wages and higher unemployment. Empirical results indicate that the government sector's decisions as an employer are important for understanding aggregate market settings and conclude that this effect of the public sector should not be taken as an absolute fact.

In a very recent study, Vasilev (2015) uses data about Germany for the period 1970–2007 to study the importance of public sector unions within an RBC model, relevant for a number of EU member states. This is relevant to our research, as Vasilev (2015) studies wage dynamics using a micro-founded general equilibrium model. The study also finds that both government wages and public employment share increase at the expense of the private sector. Furthermore, the correlation found between public and private wages in Germany is less than perfect (0.5) but positive, providing some support for the moderate leadership of private sector wage over the public one. In a following paper on German data (1970-2007) in the context of EU-12 countries, Vasilev (2016) models the government sector as unproductive, or wasteful, with public and private wages jointly determined as endogenous variables, once again. Furthermore, public wage determination is only slightly affected by the process of rent-seeking, but still mainly determined by the government's balanced budget and households' supply of labour in the public sector. Overall, Vasilev (2015, 2016) studies public and private wage dynamics in a bi-directional relationship, but does not include minimum wage as a possible income policy tool. This is where we try to contribute with this study.

Another relevant study is that by D'Adamo (2011), who uses a VAR specification to analyze spill-over effects in wage determination for ten Eastern European countries over the last decade. Since results are largely heterogeneous, across different countries, we focus on his VAR models for the two Bulgarian wages. The study adopts the theoretical framework of the Scandinavian model, where the internationally traded sector is the leader for wage determination. D'Adamo (2011) finds that, for Bulgaria, the Industry (Traded) and Services (Non-Traded) sectors are wage leaders and that a weak version of the Scandinavian model applies for the country with the traded (private) sector established as a leader. D'Adamo's (2011) results are also in line with our findings, where private wage exhibits even stronger causal leadership over the public one.

Similar to findings in the literature on minimum wage, there is plenty of discussion on its efficiency as an income policy tool, but there is no systematic approach[2]. The exception is a very recent study by Economides and Moutos (2016), who incorporate minimum wage in a dynamic general model applicable to any country. In their model, workers and capitalists are the two main agents for minimum wage determination. Their study considers the case of perfect competition among firms, while public wages are missing from the model. The government is taken as an agent that imposes the minimum wage in addition to levying taxes. Economides and Moutos (2016) find that it is impossible for any level of the minimum wage to increase incomes of employed workers and that minimum wage is, therefore, inefficient as an income policy tool. The reason behind this finding is the fact that minimum wage introduces inefficiency, since an artificially imposed wage ceiling reduces a firm's profits. The cost of this inefficiency cannot be transferred to anyone else but capitalists and this would result in decreasing returns to scale. Moreover, these analyses are in line with economic theory, which dictates that employers would choose to have fewer workers when a binding minimum wage is imposed on the economy.

Lastly, we explore the literature on Bulgarian wages. There are several surveys conducted as part of the WDN (Wage Dynamics Network), which examine wage rigidity and the main features of the wage-setting process for firms in Bulgaria. Vladova (2012), Lozev *et al.* (2011), Loukanova (2011) and Paskaleva (2016) report a relatively weak wage-price link in the case of Bulgarian wages, suggesting that labour cost growth is not fully in line with productivity growth. Besides, Loukanova (2011) finds that the minimum wage is not a push-up for the average one and that, in fact, it affects only wage values close to it. Lozev *et al.* (2011) and Paskaleva (2016) report that wage changes occur only once a year as compared to the eight-month price duration. The latest survey of Bulgarian wages, discussed in detail in the next section under stylised facts, finds that firms with minimum wage prevalence claim that economic uncertainty, high payroll taxes and changes in labour laws lead to lower employment of workers.

Section 3: Data description and Stylised Facts

3.1 Data Description

We use data from the NSI (October 2016) database on Bulgarian CPI and wages. As data on nominal wages are reported on a monthly basis, we converted them into quarterly ones for easier modelling. We used NSI data on average earnings

2. For example, see: Burkhauser R. and J. Sabia (2007), Economides G. and T. Moutos (2014, Neumark D. and W. L. Wascher (2008).

for government, private and minimum wages approximated as compensation per employee. Compensation for all private sector employees is defined as compensation of all employees minus compensation of government employees in the Bulgarian economy. Compensation per private sector employee is then computed by taking the private compensation of employees, divided by private sector employees minus government employment minus self-employment, as in Lamo *et al.* (2008). The rest of this section provides a detailed explanation on how wage determination mechanisms work in Bulgaria.

Regarding wage measurement, we have taken compensation per employee both in real and nominal terms for the period 2000-2016. We use CPI as a main price deflator to obtain real wages, with all specifications conducted in a time-series context. The driving force behind deflating wages is to exclude possible shocks and minimise the possibility for spurious outcomes when modelling wage relations. Figure 1, below, shows that wages seem to share a linear trend, which may also indicate the presence of non-stationarity, co-movement and possible long-term co-integration.

As evidenced from Figure 1 on the next page, the 2008 economic crisis led to private wage decreases and higher unemployment rates. During this period the gap between private and public wages was the highest and lasted until the end of 2010, when the economy experienced some positive growth. At the beginning of 2011, the private wage was again closely co-moving with the public one. After a few years of adjustment, the two wages have nearly converged (2016). To show that our results are not an artefact of inflation, real wages in Figure 2 below are shown to have similar co-movement and trend over the period studied.

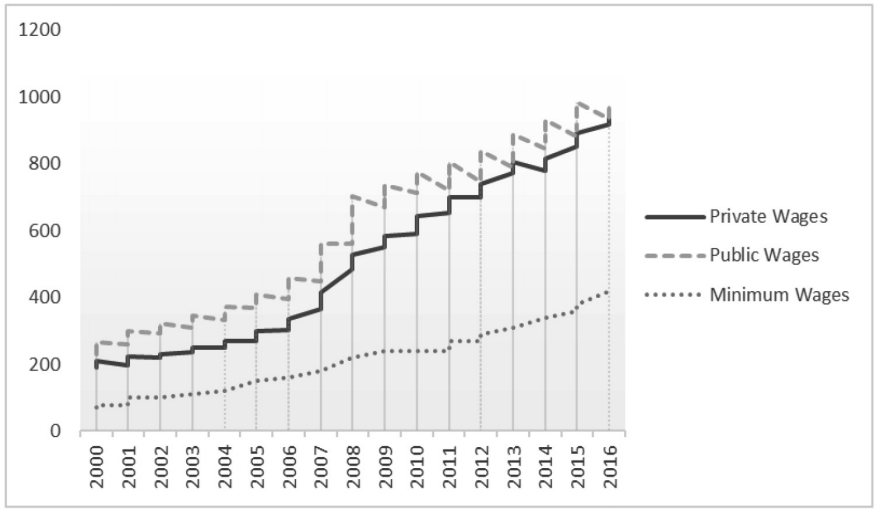

Figure 1. Nominal Wages Movement

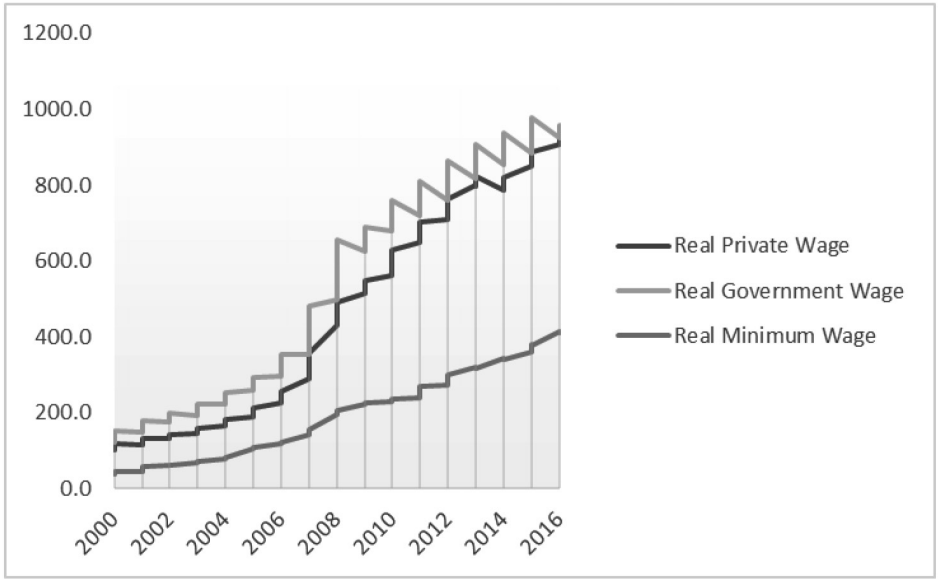

Figure 2. Real Wages Movement

The increase in government sector wages during the crisis suggests poor adaptability of wages to economic performance, as also pointed out by Loukanova (2011). Moreover, as employment decreased, many low-skilled workers were laid off (approximately 20% according to Loukanova (2011)) which lead to increases in average wage. The latter hints that the government budget deficit was not handled very well during that period, as it indicates lower economic efficiency and productivity. Furthermore, productivity increased in the period after the crisis (2011), but wage growth was slower and real wages actually decreased.

3.2 Public and Private Wage Determination

First, as shown in Figure 1 above, public sector wages are consistently higher than private ones for the period studied (2000-2016). This is particularly important in the context of EU government spending on labour, since the latter has been increasing in many European countries over the past years, as pointed out by Afonso (2008). Moreover, as documented by Vasilev (2015), the increase in the public wage bill, as evidenced in the post-World War II period together with the increase in public sector employment have led to a higher share captured by the public output for selected EU member states.

As for Bulgaria, there are several forces behind wage determination. The main factors for public and private wage formation are the legislation system and collective bargaining forces acting in accordance with budget constraints. Wage setting is

determined through the so-called Tripartite Cooperation bargaining, comprising government representatives, business employers and unions, as documented by Nenovsky and Koleva (2001). Further, collective wage bargaining can be differentiated at two levels: sector and company. Companies set their wages according to profit constraints, which, in turn, limit the rigidity of labour unions in the private sector. Since firms are profit-oriented, unions cannot ask for excessively high wages, or else the firm would not be able to afford such costs and would eventually close down. The other possible reason for lower private sector wages may lie in monopsonies existing in certain sectors. Many firms in Bulgaria were privatised and, as a result, they can now be viewed as a single regional employer, which would allow for setting lower wages and creating an envelope wage practice.

Moreover, collective bargaining in Bulgaria is mostly characteristic at the firm rather than the industry level, with most companies following their own price setting. This makes the exact determination of private wages more difficult, contributing to the weak price-wage link. Firms that faced worsened economic conditions implemented reduced flexible wage components and wage cuts in the private sector. The 2009-2013 period was marked by deterioration in demand and worsened customer ability to pay (Lozev *et al.*, 2011), which are factors connected to wage rigidity. Survey results show that wage changes occur in approximately 27 months for the above period, a figure relatively low for the EU (Paskaleva, 2016). The main reason behind it is that firms reported a preference for wage freezes rather than wage changes, which can be taken as yet another explanation for the weak wage-price link in Bulgaria. All of these reasons can be viewed as influences on real wages, as well as on their slower growth and change frequency, for the last couple of years (Paskaleva, 2016).

Rose (1985) notes that public employees depend on private sector employees, since taxes generated in private sector activities account for the revenues paying the salaries of most public employees. Direct comparison between the two sectors is not possible, for various reasons. First, the output of the two is not comparable, since it cannot be measured in monetary terms. Next, productivity cannot be fully captured, as some public goods are more labour-intensive than others and the working time of employees in the public sector differs from that in the private sector. Furthermore, according to Rose (1985), having higher public wages can be viewed as somewhat counterintuitive because there should be a trade-off between higher level of job security, the benefits provided by the government and the level of wages. However, this is not the case, since public employees receive better compensation than private ones, despite the fact that private wage earners face higher taxes and lower job security. Having higher public wages than economic principles dictate can be an indicator of the presence of political economy. It should be noted that government employees are also voters and enjoy higher labour union protection than their private sector counterparts.

One way to look at wage settings, as pointed by Vasilev (2015), is that private sector wage is determined within a competitive market framework, while public sector wages could be viewed as a solution to a bargaining process between unions and the government. This means that, when there are government funds available, labour unions in the public sector would ask for higher wages, as they have greater bargaining power than their private sector counterparts. This is due to the lack of profit motive in government administration, together with the fact that the government may start running budget deficits, as opposed to profit-maximising firms in the private sector. As a result, the government wage tends to be higher than the public sector wage.

3.3 Minimum Wage Determination

There has been a mandatory minimum wage in Bulgaria since 1990. Its scale is determined as a nominal value per month and hour and has been further calibrated according to the poverty line level introduced in 2007. As documented by Loukanova (2011), the minimum wage was introduced due to the strong bargaining power of trade unions, which argued in favour of protection of low-income workers and of establishing a basic standard of living.

In practice, however, there are no long-term effects of minimum wage as its increases are not in line with the slow rise observed in labour productivity. Every subsequent minimum wage increase can be shown to raise the bar for marginal worker productivity, which, in turn, forces firms to seek more productive workers, as pointed out by Loukanova (2011). Therefore, it can be argued that the minimum wage practice may actually hurt low-skilled workers despite its initial purpose to provide protection for them. Currently, the minimum wage is 420 Bulgarian leva (EUR 214.74) and is expected to reach approximately EUR 230 in 2017. The government has been steadily increasing the minimum wage over the past few years (see Figure 1 above) which, however, has not been effective in narrowing the gap between minimum and average wage. Therefore, if wages are driven by labour productivity in a competitive setting, minimum wage increases would have no effect in raising the overall standard of living.

Section 4: Methodology

4.1 Unit Root Tests

In this section we focus on the co-movement and causality effects of the public, private and minimum nominal and real wages. We use a vector autoregressive (VAR) model of the three wages, suited for analysis of short-, medium- and long-run correlations at different forecast horizons. The VAR model is a tool to study dynamic inter-relationships between variables. As in Lamo, *et al.* (2008), we use den Haan's

methodology (2000), which can be applied to both stationary and non-stationary variables. We use the non-stationary method in obtaining long-term co-movement specifications and the stationary (de-trended) series for the Granger causality tests and impulse-response functions. Moreover, Dickey-Fuller (1979) and Phillips-Perron (1988) unit root tests confirm the need for de-trending and the existence of a single unit root. We, also, further use Breusch-Godfrey (1978) and Durbin-Watson (1951) tests for serial correlation, as discussed in section 4.3.

In our case, the de-trending process applied takes out the deterministic trend component and filters data for seasonal disturbances and cyclical adjustments. The empirical literature on the issue, such as Lamo *et al.*, (2008) applies different types of de-trending methods and filters for the sake of obtaining a non-spurious econometric specification. We, however, focus primarily on using the Hodrick-Prescott (1997) filter, complemented by removal of the seasonal component to de-trend variables. The underlying assumption is that data are integrated at order one (I_1), i.e. the variables contain a unit root as well as a seasonal component which fluctuates around a deterministic trend, both of which become inert when the series are de-trended. As for the forecast horizon, we use a period of ten quarters to obtain impulse-response functions in the short-run.

We test for unit root at 5% significance using the Augmented Dickey-Fuller test with four lags. As evidenced from Table 1 below, nominal private wages display a unit root – the high Mackinnon value of 0.4423 indicates the series are not stationary. There are also a trend and a drift present. Therefore, as Figure 1 in the previous section suggests, we need to seasonally adjust the series in order to account for the difference in private sector salaries during different seasons. To smooth the series, we seasonally adjust them and apply a Hodrick-Prescott filter for the cyclical component, resulting in stationary variables. This procedure is equivalent to first-differencing, which we apply as an alternative method to account for non-stationarity. The results show that the series are first-difference stationary, or I_1.

After removing the seasonal component from the nominal public wage, the results point at the presence of a unit root and a drift (initially, as shown in Table 1, there is no unit root prior to seasonal adjustment of the data); therefore, we also apply the Hodrick-Prescott filter to smoothen data. Regarding the minimum wage, its significant unit root is accounted for in the same manner of de-trending and, as expected, there is no trend present. The reason for this is that changes in the minimum wage occur more rarely and thus are not subject to seasonal disturbances as often as the private and public sector wages are. In order to account for possible spurious results, we also apply the Phillips-Perron unit root test and obtain the same or similar results. After removing the unit root component, the variables display a Mackinnon p-value close to zero, no trend and a constant factor. We also apply first-differencing and obtain a Mackinnon value of 0.000 and, therefore, account for the presence of

the single unit root in each variable. The second part of the table displays wages in real terms, which bring about similar outcomes[3]. The same procedure of accounting for the unit root is implemented. The difference here is that the minimum wage displays a significant trend, which is smoothened by the Hodrick-Prescott filter, as standard procedure suggests.

Table 1. Unit Root Tests in Levels

Variable	Mackinnon p-value	Trend p-value	Const. p-value	Order of Integration (I)
Nom. Private Wage	0.4423	0.017	0.041	1
Nom. Public Wage	0.0297	0.001	0.001	1
Nom. Min. Wage	0.9776	0.389	0.382	1
Real Private Wage	0.3903	0.017	0.856	1
Real Public Wage	0.1377	0.006	0.409	1
Real Min. Wage	0.5947	0.029	0.789	1

4.2 Co-integration

Following standard practice, as in Lamo *et al.* (2008), we measure long-term co-movement using the cross-correlation functions for the three non-stationary wages. We use de-trended (stationary) series for obtaining the correlation coefficients and the short-run co-movement and causality results. In short, the only tests for which we do not use de-trended variables are the co-movement and co-integration tests, since establishing long-run links requires the variables to be non-stationary, as documented in den Haan (2000). The reverse methodology is

3. For unit root tests in logs, refer to Appendix A.

applied in the Granger-causality series of Wald tests, correlation relationships and impulse-response functions, where data are required to be stationary and, therefore, de-trended. Our findings in Table 1 on the previous page and Table 2 below are in line with stationarity tests performed by D'Adamo (2011) for Bulgaria and several East European countries (particularly Romania), which also confirm the presence of a unit root and exactly one long-term co-integrating equation for public and private wages. Test estimations show that the number of optimal lags to be used is four, as expected by the quarterly nature of the data. We used Akaike, Schwarz and Hannan-Quinn (1979) information criteria in determining the number of optimal lags.

Table 2. Selection Criteria for Optimal Lag Number

Selection-order criteria			
Lag	**AIQ**	**HQIC**	**SBIC**
0	31.9995	32.04	32.1025
1	24.6771	24.8388	25.0888
2	24.3033	24.5862	25.0238
3	23.7173	24.1214	24.7466
4	**23.21***	**23.7353***	**24.548***

Table 3 below summarises the results obtained from a Johansen co-integration test. There is a single co-integration equation between public and private sector wages, as confirmed by D'Adamo (2011). We also run co-integration tests on minimum wages with the other two and obtain no co-integrating relationship in either case.

Table 3. Johansen test for Co-integration

Johansen tests for cointegration		
Maximum Rank	**Trace Statistic**	**5% Critical Value**
0	17.8539	15.41
1	**1.0984***	3.76
2	-	-

4.3 Correlation

In this subsection, we focus on the correlation of the three wages. Table 4 summarises the results at both level and log forms. Each row displays the correlation coefficients between the three variables, obtained by using a model of differenced and seasonally adjusted wages at time t and t-k (k stands for the number of lags). Since our model is derived by using quarterly data and because rank tests show that the number of optimal lags is four, we trace the correlation relations for four periods. The first output table reports nominal compensation per employee and the second displays real compensation as deflated by the CPI.

Table 4. Nominal Compensation Correlation

Correlations of nominal detrended public and private wages per employ ee in levels and logs									
k(lags)	-4	-3	-2	-1	0	1	2	3	4
Level Forms	-0.14	0.02	0.05	-0.02	0.12	-0.03	**0.54***	0.26	0.06
Log Forms	-0.26	0.06	0.16	0.08	0.24	-0.06	**0.45***	0.29	-0.02

Following common practice on wage dynamics, as in Lamo *et al.* (2008), we base our analysis on the evidence that two variables are said to co-move in the same direction if the absolute maximum value of the coefficient estimated is positive. Furthermore, the variables move in opposite directions if the coefficient of the same de-trended series is negative and they do not co-move if the coefficient is close to zero. Again in line with Lamo *et al.* (2008), we take values between 0.30-0.39 as an evidence of weak to moderate correlation and values above 0.40 as evidence of strong correlation in absolute terms.

Table 5. Real Compensation Correlation

Correlations of real de-trended public and private wages per employee in levels and logs									
k(lags)	-4	-3	-2	-1	0	1	2	3	4
Level Forms	-0.31	-0.04	0.22	0.04	**0.43***	0.10	**0.33***	0.20	-0.14
Log Forms	**-0.33***	0.04	0.18	0.14	**0.54***	0.17	0.41	0.23	-0.15

In both cases, the variables are filtered using Hodrick-Prescott filter (1997) to account for seasonal and cyclical components. Table 4 presents the coefficients in nominal terms; an asterisk (*) marks the highest correlation coefficient, which is observed to be at a lag of 2 periods both in level (0.5445) and in log (0.4492) terms. We regard these values as an indicator of a strong correlation between public and private wages in nominal terms.

Table 5 presents data for nominal wages deflated by CPI, where we derive similar outcomes. The strongest correlation occurs at zero lag, whereas a moderate one can be observed at lag 2 for level forms and at lag -4 for logs. The negative correlation

implied by the latter is, however, insufficient evidence against the general positive co-movement of wages, since its value is inclined more towards the weak toward a moderate wage relation and, furthermore, it occurs at only one value. Therefore, we regard the stronger and more persistent positive correlation as a sign of co-movement and causal relationship between wages. We explain these causality links in the following sub-section.

4.4 Empirical Results: VAR Model. Causality

One of the most preferred methods for establishing causal relationship in empirical analysis and literature is that proposed by Granger (1969), which states that a variable X is said to Granger-cause another variable (Y) if it provides statistically significant information about Y. We consider a result to be statistically significant at the 5% level of significance for all tests. In this section we use Granger's (1969) definition of causality for establishing causal links between public, private and minimum wages. Next, we use impulse-response functions to compare results and further evaluate causality links. Following the ECB study on wage dynamics by Lamo *et al.* (2008), we use VAR or vector autoregressive systems and Wald tests for public and private wage causality and extend the study to additionally incorporate minimum wages. The wage variables included in the VAR model are de-trended and filtered for cyclical and seasonal components to account for the existing trend and for possible spurious results.

The following equation captures public, private and minimum wages of the VAR model. C is a vector of constant factors and A is a 3x3 matrix which contains all VAR coefficients of variables of lag from 1 to p. W^{p}, $W^{g.}$, W^{min} denote nominal private, government and minimum wages and ε_t are all possible influences outside the model.

Table 6 on the next page displays statistical outcomes of simple probability tests on nominal wages[4]. The table should be read as follows: the excluded variable is the estimator which causes the equation variable at 5% level of significance. Only the real private wage causing the public one has a significant p-value coefficient; all other Wald test probabilities are found to be insignificant. Additionally, the real minimum wage is shown to have no effect on either real public or private wages. Its highly insignificant coefficient values raise the issue of possible policy recommendations discussed in the next section.

As evidenced from the Wald tests, the dominant pattern for all possible testing adjustments is for private wages to lead public sector developments over the business cycle. Nominal wages show similar results to those displayed for both log and level forms. When prices are accounted for, there is a 0.07 probability for the level

4. Correlation data and coefficients on real wages can be found in Appendix B.

forms of real private wages causing public ones. Given that we take a 5% level of significance, the case of real wages in levels is the only one where we can reject the hypothesis that private wages cause public ones. As for the tests at logs, the causality running from private to public compensation is, again, highly significant (0.002), as shown in Table 6 below.

4.5 Impulse-Response Functions

In this section we analyse the Impulse-Response Functions obtained after running a VAR model. An IRF indicates the impact of an unanticipated one-unit change in the 'impulse' variable and the effect it has (if any) on the 'response' variable. In general, IRF functions are used for determining whether one variable is capable of forecasting another over a specified time horizon. Furthermore, IRFs capture the reaction of a dynamic system in response to some external change; in our context they capture how adjustments in one wage affect the other wages. In line with the ECB study on wage dynamics by Lamo *et al.* (2008), we took the results of the differenced, i.e. stationary, level series as the ones most suitable for analysing. We also include real-wage IRFs, where variables are de-trended by CPI to determine the long-run effect of actual price influence[5]. We also take prices explicitly to obtain the impulse of CPI to nominal wages and the feedback that occurs.

Table 6. Real Wage Granger Causality in Logs

Granger Causality Wald Tests		
Equation	Excluded	Probability
Private Wage	Public Wage	0.546
Public Wage	Private Wage	0.002
Private Wage	Minimum Wage	0.562
Minimum Wage	Private Wage	0.599
Public Wage	Minimum Wage	0.562
Minimum Wage	Public Wage	0.760

Next, after fitting a VAR model, we estimate the Forecast Error Variance Decomposition (FEVD). FEVDs are used to determine how much of the forecast error variance of each variable is explained by exogenous shocks to other variables in the VAR. In short, FEVDs measure the relative importance of each shock or innovation that influences the respective wage. After trying different time horizons, we chose 12 forecast periods as sufficient to explain the shocks affecting wages.

5. Results on nominal wage IRFs and real and nominal FEVD tables can be found in Appendix C.

The last panel of Figure 3 on the next page shows the IRF of real private over public wages. This is the most significant graph in our study, since it confirms the results previously obtained from the Wald tests, namely that public wages respond to changes in private wages with a lag of approximately two (to two and a half) quarters. The first plot shows that a shock of real private wage to itself raises it, but quickly dies out and over time reaches zero. As for the shock of private on minimum wage, it can be disregarded as having no statistically significant effect. The last panel focuses on the impact the private wage shock has on the public wage; the shock starts from zero and reaches its peak in the second period, i.e. two quarters after the initial change. This means that public wages are affected by changes in the private wage with a delay of half a year.

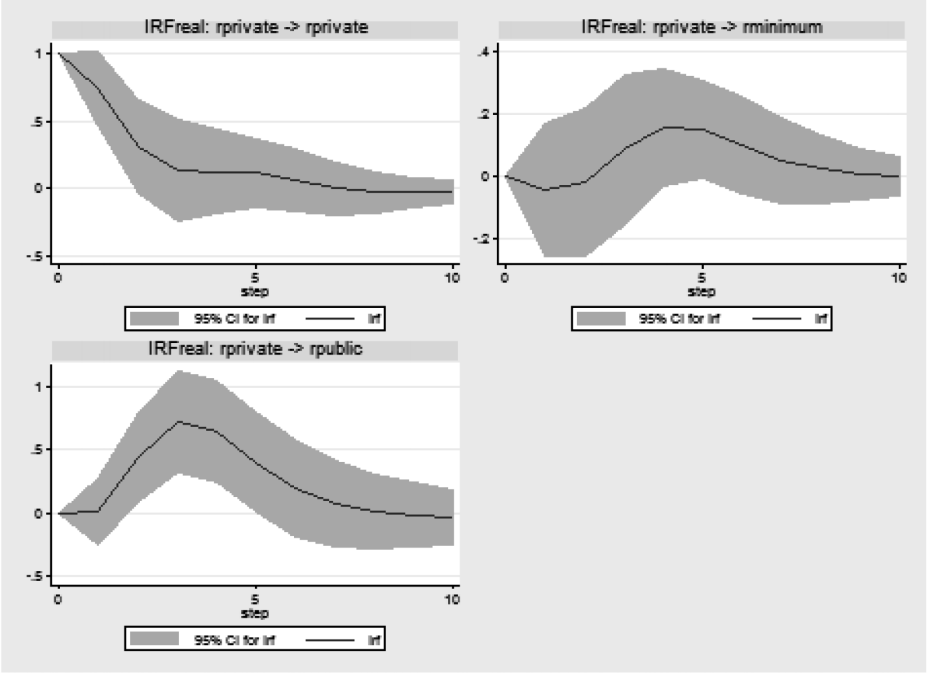

Figure 3. Private Real Wages

The source of this shock, epsilon private, can be attributed to the increase in innovations and productivity (TFP) associated with the private sector. This explanation is consistent with the main theoretical models in labour literature[6], where the wage rate is determined as an outcome of the bargaining process between workers and the firm. In this case, wage is considered to be proportionate not only to labour productivity, but also to the marginal rate of substitution and, more specifically, the shock

could be driven by factors other than technological innovation, such as change in taste or leisure preferences or shocks to alternative income (changes in productivity in the non-market sector).

Similar reasoning for the case of real public wage in Figure 4 below shows that, as expected, at step zero, public wage increases by one unit and then slowly decreases to zero. In addition, a public wage shock has no statistically significant effect on minimum wages. Furthermore, the last plot in the figure shows that the response of the private wage has a higher coefficient but remains negligible. This shock can be attributed to policies such as an unexpectedly high tax revenue or drop in other costs, e.g., lower demand for public services, etc. Lastly, government policies of changing public wages do not have any noticeable effect on increases in private wages. The response in public sector wages is consistent with setups where wages are decided based on availability of government funds.

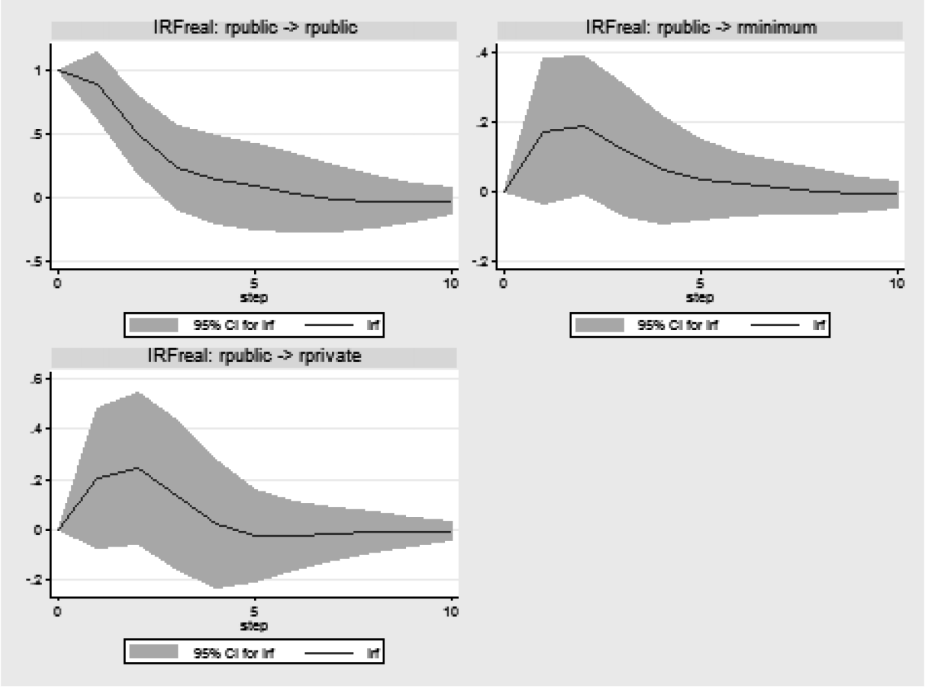

Figure 4. Real Public Wage

6. Discussions on possible models as explanations to epsilon public, private and minimum can be found in Appendix D.

Next, we study the effect of minimum wages on the other two wages. As shown in Figure 5 below, real minimum wage shocks have no long term effects on any of the three variables. This result shows that real minimum wage is still lagging behind productivity growth. Nominal minimum wages also display similar results to changes. Therefore, it can be concluded that the recent government policy of increasing the minimum wage in order to narrow the gap between minimum and average Bulgarian wages is of no substantial effect; the weak or overall lacking response elicited from the two sector wages is negligible over the one-year period shown. Furthermore, epsilon minimum, or the source of the shock, captures the effect of innovation of minimum wage to minimum wage, i.e., government policies aimed at wage increases. This may be used as an instrument to lower the percentage of grey economy, but results show that it is not effective as an income policy tool. A possible explanation is the prevalence of 'envelope' money (people declare minimum wage as an official income, but at the same time do not declare all income), which diminishes the possible effect of the minimum wage.

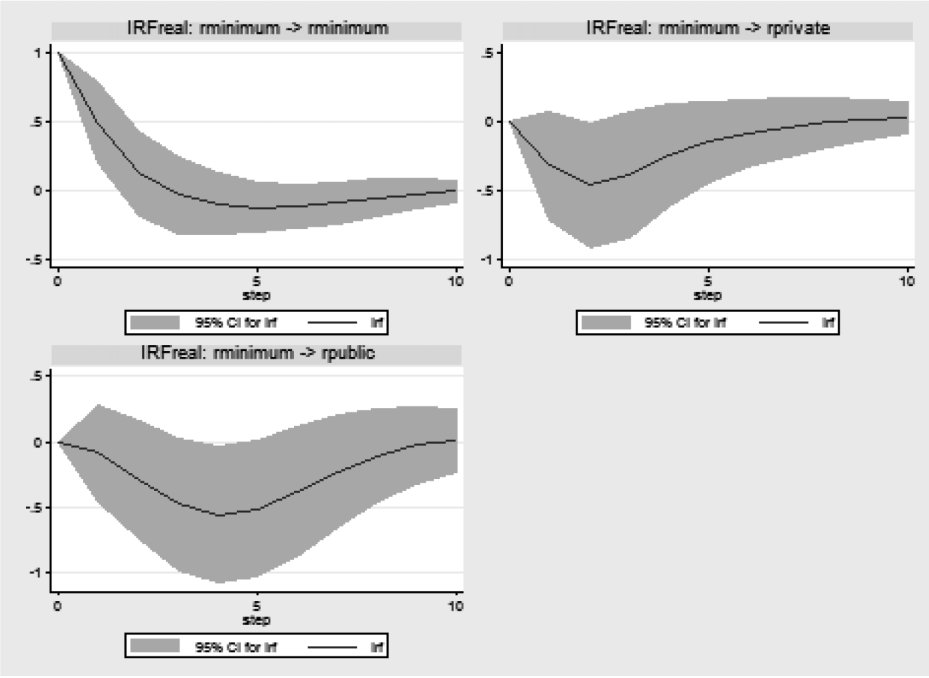

Figure 5. Real Minimum Wage

When we take the shock of CPI to nominal private, public and minimum wages, there is little feedback from them over a one-year period, as evidenced from Figure 6 below. The price shock to nominal private wages gets a statistically insignificant response for the first quarter and eventually dies out in the next period. The feedback from public and minimum wage is even more negligible, which indicates that CPI has no effect in the short run (4 quarters). Price-wage link in Bulgaria is, therefore, weaker when compared to other EU countries and wage changes in response to inflation are not as quick to occur, as documented by Lozev *et al.* (2011).

Wage stickiness may play an important role in price adjustment, which implies that wages in Bulgaria are changed mainly for reasons not linked to inflation (e.g., length of service). Furthermore, Vladova (2012) finds evidence from surveys indicating that only 27% of the firms in Bulgaria take into consideration the connection between prices and wages, as compared to 40% in the EU. Therefore, it can be concluded that price-driven wage changes are not common in the case of Bulgaria.

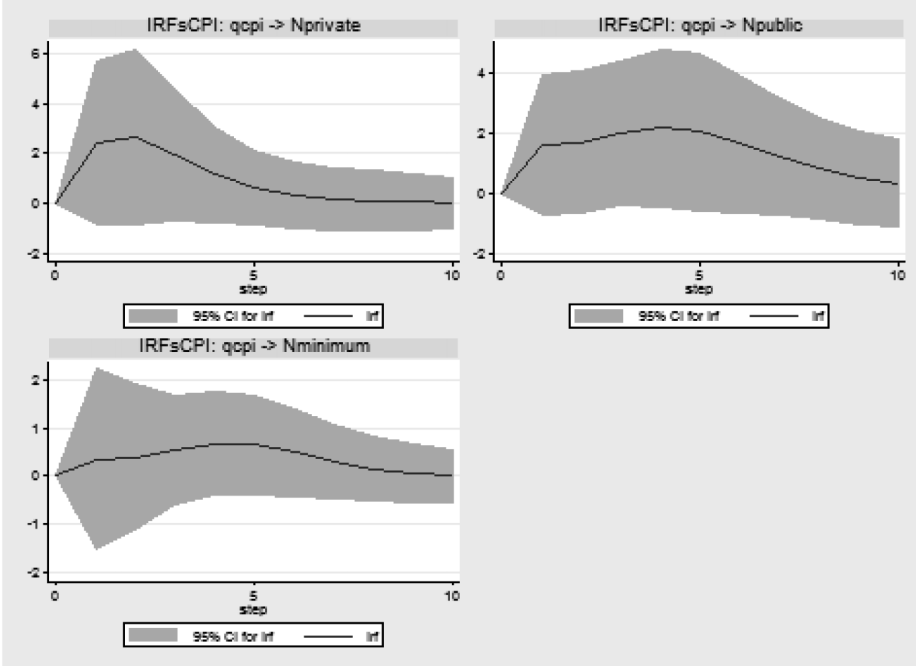

Figure 6. CPI on Nominal Wages

A possible explanation behind the shocks for the private, public and minimum wages is that they could be driven by monetary policy shocks. These shocks are a *de facto* increase in monetary base, or an increase in the circulation and reserve money,

which can beneficially affect wages. An example of a one-time monetary shock that might lead to public wage increase is the 2016 budget surplus of 1.6 billion (Reuters). Moreover, Bulgaria is targeting a 1.4% deficit of GDP in 2017, which is expected to induce higher spending, possibly positively affecting labour costs as well (Reuters). Foreign inflows in Euro could also increase money supply (M2) when converted to BGN, in line with the 1.955 fixed exchange rate. Another example of foreign inflows are foreigners' time deposits, such as foreigners depositing their money or receiving their pensions through Bulgarian banks, etc. A factor beneficial to wages might be lowering the main interest rate, which was lastly recorded as 0% and has been close to zero since 2010 (BNB). The lower interest rate also attracts international companies and higher investment, which could be taken as a positive shock to nominal wages.

An oil price shock could be one factor affecting changes in private wages. The Bulgarian industry is energy-intensive and lower oil prices, as in 2016, can result in a positive shock to private wages. Since total costs would fall, capital and labour would be affected through the demand channel. Increased demand for cheaper oil would lead to lower labour costs and positively affect wages. A decrease in oil prices may, in addition, influence public wages by affecting wages in public utility companies. Another positive private wage shock is a possible trade shock, based on the export-led growth resulting from Bulgaria's accession to the EU in 2007. Many private businesses took advantage of the open EU borders and expanded their production beyond country-level, which generally results in a positive impact on private sector wages. In addition, the lower corporate tax rate (10% as of 2008) could also induce a positive wage shock, increasing the value of after-tax "surplus", divided between labour and profit income.

Minimum wage shocks could be the result of a positive shock to laziness, or the decreased preference to work. A shock to laziness, or relative preference for leisure, would trigger a substitution away from official work and towards either collecting benefits or transfers, or working in the grey economy. Further, receiving minimum wage also comes with children benefits, which can be a factor attractive to mothers. Other types of transfers that can induce this substitution effect are food vouchers, unemployment benefits, housing subsidies, transfers in kind (heating vouchers, electricity or other types of vouchers), etc. Another factor could be a shock to investment technology, such as higher inventory or lower installation costs. With more capital used, labour is more productive, so wages also increase. Next, a shock to capacity of input utilisation, i.e. capital and labour or elasticity of substitution between labour and consumption can also have an effect on wages. Alternative sources of income or consumption, such as home production, may increase consumption or lead to higher income. These shocks are all some possible explanations for our IRF results documented above.

Section 5: Conclusion, Limitations of the Study and Future Research

This paper studies the relationship between public, private and minimum wages in Bulgaria. It reports a strong correlation between public and private wages and finds further evidence of co-movement and long-term co-integration. Next, it demonstrates that causality runs from private to public wages and presents the implications from this finding. The study also focuses on policy recommendations based on these empirical results and reviews several labour models as possible explanations of the findings. What is new is the inclusion of minimum wage in the model and this is a contribution to existing literature. We report no causal relationship from minimum wages to public and private ones. This finding is important from a policy perspective since it poses the question whether minimum wage is relevant as a policy making tool. We conduct series of Granger-causality Wald tests on quarterly data and construct impulse-response functions to find the relationship and causal links between wages. In order to avoid spurious results, we use seasonally and cyclically adjusted variables after de-trending them. We consider both level and log forms to conduct our study and further use CPI as a main deflator in obtaining real wages. Following Lamo *et al.* (2008), we include CPI in the VAR with nominal wages to study possible price-wage linkages.

Next, we will consider some limitations of our study. This paper's added value is the inclusion of a minimum wage as an income policy tool in the private and public sector wage dynamics. We discuss some possible explanations for our findings in the Appendix, but it is outside the scope of our study to consider a fully specified model. Our focus is wage leadership and causality in terms of one variable forecasting another. Therefore, what we do not include is a theoretical model that would provide a deeper understanding of wage determination mechanisms.

This limitation opens venues for future research, as it would be extremely interesting to delve into the disciplined theoretical approach of Bulgarian wage dynamics. The current study can be extended to a micro-founded model to explore how wages change over time, rather than taking them in a Walrasian static equilibrium context. An interesting path to follow would be to specify a dynamic stochastic general equilibrium (DSGE) model based on optimisation and rational behaviour.

Finally, in the light of these results, we recommend implementing policies aimed at total factor productivity increases in the private sector to stimulate its growth and, consequently, growth in the public sector. Furthermore, this would strengthen the otherwise weak link between wages and labour productivity. Lastly, in the light of our findings, we recommend less reliance on minimum wage as an income policy tool.

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Appendix A

Section 4: Unit Root data on Log Forms

Table 1.2 Unit Root Tests on Wages in Logs

Variable	Mackinnon p-value	Trend p-value	Const p-value	Order of Integration (I)
Nom. Private Wage	0.6704	0.093	0.055	1
Nom. Public Wage	0.2581	0.016	0.009	1
Nom. Min Wage	0.3291	0.023	0.011	1
Real Private Wage	0.7681	0.166	0.074	1
Real Public Wage	0.7388	0.147	0.071	1
Real Min. Wage	0.8262	0.239	0.077	1

Section 4: VAR statistics

The tables on the next two pages should be read as follows:
PW – Private Wage
PU – Public Wage
MIN W. – Minimum Wage
L1 – First Lag L2 – Second Lag
Coeff. – Coefficient (alpha)
SE – Standard Error

The VAR tables display the regression outcome of each dependent variable on lags of itself and lags of all other dependent variables (wages).

Table 7. VAR for Nominal Wages in Levels

	Coeff.	SE	P-value
Private Wage			
PW L1	0.862	0.130	**0.000**
L2	-0.246	0.136	0.072
PU W L1	0.156	0.178	0.382
L2	-0.053	0.166	0.749
MIN W L1	-0.083	0.236	0.725
L2	-0.027	0.243	0.814
Public Wage			
PW L1	0.047	0.092	0.604
L2	0.263	0.096	**0.007**
PU W L1	0.780	0.126	**0.000**
L2	-0.137	0.117	0.244
MIN W L1	0.153	0.167	0.358
L2	-0.121	0.172	0.481
Min. Wage			
PW L1	-0.008	0.072	0.903
L2	0.133	0.076	0.083
PU W L1	0.091	0.100	0.358
L2	-0.067	0.093	0.466
MIN W L1	0.595	0.132	**0.000**
L2	-0.102	0.136	0.452

Table 8. VAR for Nominal Wages in Logs

	Coeff.	SE	P-value
Private Wage			
PW L1	0.810	0.135	**0.000**
L2	-0.149	0.143	0.299
PU W L1	0.252	0.193	0.192
L2	-0.048	0.183	0.793
MIN W L1	-0.037	0.083	0.657
L2	-0.106	0.083	0.198
Public Wage			
PW L1	0.010	0.083	0.899
L2	0.331	0.088	**0.000**
PU W L1	0.837	0.119	**0.000**
L2	-0.246	0.112	**0.029**
MIN W L1	0.0243	0.051	0.635
L2	-0.091	0.051	0.073
Min. Wage			
PW L1	-0.089	0.224	0.690
L2	0.248	0.236	0.294
PU W L1	0.257	0.319	0.420
L2	0.108	0.302	0.719
MIN W L1	0.540	0.137	**0.000**
L2	-0.181	0.137	0.186

Table 9. VAR for Real Wages in Levels

	Coeff.	SE	P-value
Private Wage			
PW L1	0.920	0.142	**0.000**
L2	-0.307	0.145	**0.035**
PU W L1	0.090	0.184	0.626
L2	-0.009	0.170	0.957
MIN W L1	0.166	0.300	0.580
L2	-0.144	0.315	0.646
Public Wage			
PW L1	0.082	0.115	0.475
L2	0.107	0.118	**0.044**
PU W L1	0.779	0.150	**0.000**
L2	-0.171	0.138	0.218
MIN W L1	0.474	0.243	0.352
L2	-0.311	0.256	0.230
Min. Wage			
PW L1	0.011	0.066	0.865
L2	0.098	0.067	0.148
PU W L1	0.061	0.086	0.478
L2	-0.071	0.079	0.367
MIN W L1	0.691	0.140	**0.000**
L2	-0.121	0.147	0.408

Table 10. VAR for Real Wages in Logs

	Coeff.	SE	P-value
Private Wage			
PW L1	0.937	0.155	**0.000**
L2	-0.240	0.164	0.143
PU W L1	0.218	0.200	0.276
L2	-0.105	0.183	0.564
MIN W L1	-0.016	0.098	0.868
L2	-0.079	0.096	0.411
Public Wage			
PW L1	0.154	0.113	0.173
L2	0.211	0.120	**0.015**
PU W L1	0.844	0.146	**0.000**
L2	-0.395	0.134	**0.003**
MIN W L1	0.050	0.072	0.489
L2	-0.041	0.070	0.560
Min. Wage			
PW L1	-0.135	0.207	0.514
L2	0.222	0.219	0.312
PU W L1	0.117	0.267	0.662
L2	0.147	0.245	0.548
MIN W L1	0.569	0.132	**0.000**
L2	-0.192	0.128	0.135

Section 4: Granger-causality tests

Table 6.1 Nominal wages in level forms

Granger Causality Wald Tests		
Equation	Excluded	Probability
Private Wage	Public Wage	0.598
Public Wage	Private Wage	0.00
Private Wage	Min. Wage	0.835
Min. Wage	Private Wage	0.104
Public Wage	Min. Wage	0.632
Min. Wage	Public Wage	0.655

Table 6.2 Nominal wages in log forms

Granger Causality Wald Tests		
Equation	Excluded	Probability
Private Wage	Public Wage	0.257
Public Wage	Private Wage	0.00
Private Wage	Minimum Wage	0.188
Minimum Wage	Private Wage	0.547
Public Wage	Minimum Wage	0.174
Minimum Wage	Public Wage	0.547

Table 6.3 Real-term wages in level forms

Granger Causality Wald Tests		
Equation	Excluded	Probability
Private Wage	Public Wage	0.834
Public Wage	Private Wage	0.07
Private Wage	Minimum Wage	0.842
Minimum Wage	Private Wage	0.137
Public Wage	Minimum Wage	0.149
Minimum Wage	Public Wage	0.137

Appendix C

Nominal Impulse-Response Functions:

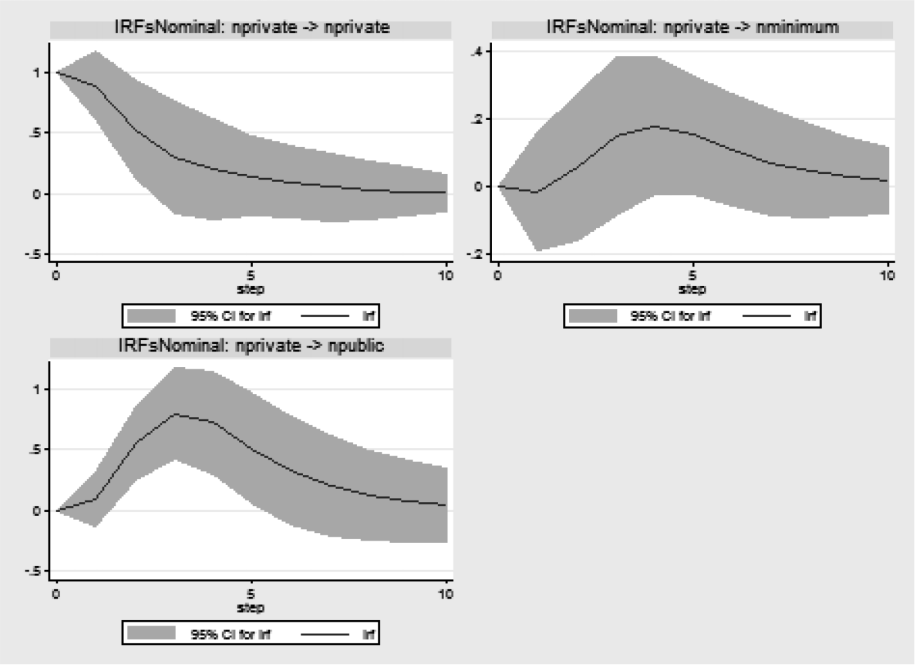

Figure 9. Nominal Private Wages

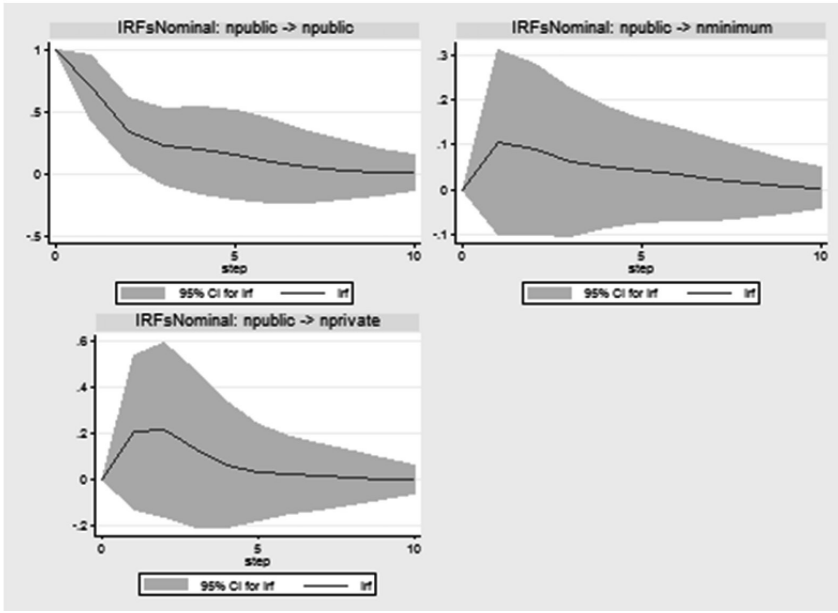

Figure 10. Nominal Public Wages

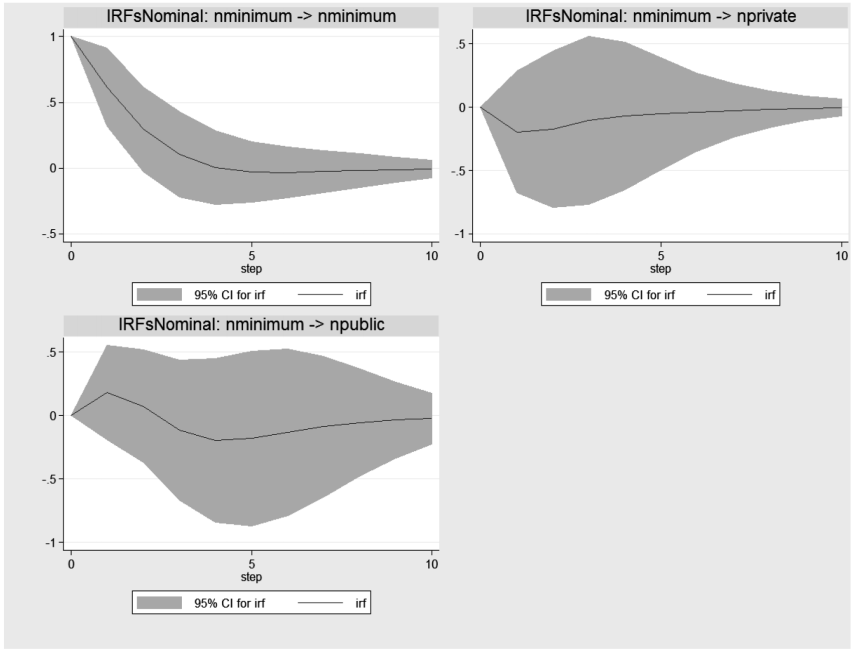

Figure 11. Nominal Minimum Wage

FEVD (Forecast Error Variance Decomposition)

Table 111. FEVD Nominal Private and Real Private Wage

Step	FEVD Private-Private	FEVD Private-Public	FEVD Private-Minimum	Step	FEVD Public-Public	FEVD Public-Private	FEVD Public-Minimum
0	0	0	0	0	0	0	0
1	1	0.095399	0.072028	1	0.904601	0	0.021455
2	0.993514	0.124059	0.074906	2	0.868071	0.005388	0.043451
3	0.984384	0.269065	0.13016	3	0.723478	0.011418	0.045992
4	0.977676	0.426127	0.216028	4	0.568288	0.014796	0.042944
5	0.974103	0.516344	0.275185	5	0.477878	0.016213	0.040661
6	0.972494	0.55642	0.300895	6	0.43619	0.016787	0.039968
7	0.97182	0.572006	0.309109	7	0.418737	0.017041	0.039985
8	0.971544	0.577502	0.311156	8	0.411797	0.01716	0.04012
9	0.97143	0.579305	0.311634	9	0.409112	0.017217	0.040255
10	0.971383	0.579876	0.311645	10	0.408084	0.017244	0.040276
∞	0.971362	0.580063	0.311645	∞	0.407686	0.017256	0.040285

Table112. FEVD Nominal Public and Real Public Wage

Step	FEVD Minimum-Minimum	FEVD Minimum-Private	FEVD Minimum-Public	Step	FEVD Private-Private	FEVD Private-Public	FEVD Private-Minimum
0	0	0	0	0	0	0	0
1	0.906517	0	0	1	1	0.272742	0.148299
2	0.881643	0.001099	0.00787	2	0.994426	0.331508	0.171599
3	0.823848	0.004198	0.007457	3	0.98718	0.407196	0.239792
4	0.741029	0.007527	0.005585	4	0.982506	0.478459	0.314881
5	0.684154	0.009684	0.005778	5	0.98069	0.524724	0.362743
6	0.659137	0.010719	0.00739	6	0.9802	0.547103	0.383199
7	0.650905	0.011139	0.009257	7	0.980076	0.555381	0.389196
8	0.648724	0.011295	0.010701	8	0.980033	0.557674	0.390306
9	0.648224	0.011352	0.011583	9	0.971383	0.579305	0.311566
10	0.648111	0.011373	0.01204	10	0.971362	0.579876	0.311634
∞	0.648079	0.011381	0.012251	∞	0.971353	0.580063	0.311645

Table113. FEVD Nominal Minimum and Real Minimum Wage

Step	FEVD Public-Public	FEVD Public-Private	FEVD Public-Minimum	Step	FEVD Minimum-Minimum	FEVD Minimum-Private	FEVD Minimum-Public
0	0	0	0	0	0	0	0
1	0.727258	0	0.045876	1	0.805825	0	0
2	0.638017	0.003138	0.065901	2	0.7625	0.002435	0.030475
3	0.553634	0.008839	0.061426	3	0.698782	0.003981	0.03917
4	0.483889	0.013067	0.054503	4	0.630615	0.004428	0.037652
5	0.440385	0.014869	0.050479	5	0.586778	0.004441	0.034891
6	0.41963	0.015372	0.048834	6	0.567967	0.004428	0.033267
7	0.412007	0.015477	0.048409	7	0.562394	0.004447	0.032612
8	0.409903	0.015499	0.048378	8	0.561316	0.004468	0.032423
9	0.409112	0.017217	0.04021	9	0.561207	0.00448	0.032395
10	0.408084	0.017244	0.040255	10	0.561207	0.004486	0.032403
∞	0.407686	0.017256	0.040276	∞	0.561205	0.004488	0.032414

Appendix D

In this part of the Appendix we analyse several labour market models in the context of our findings. These models can rationalise the wage dynamics observed and their response to shocks as documented with impulse-response functions. We analyse labour market models for the private and public sector separately.

Private Sector

Perfect Competition

Perfect competition models assume that, in equilibrium, wages equal the marginal product of labour (MPL) on the firm side. Some of the aspects of the model suppose that everyone has perfect information on prices and that firms have limited market power in influencing prices and wages, i.e. firms are small and non-influential. Perfect observability is another assumption of the model. On the consumer side, wage equals the marginal utility MU of labour. Another aspect is the idea of free entry and exit of firms, as well as their ability to adopt technology without any cost incursions. The perfect competition model is particularly useful in its capacity to measure output and effort, something not as easily captured in the cases below. Despite being unrealistic, this restrictive model is a useful starting point when studying labour markets.

Monopsonies

In the general model, monopsonies, or single buyers of labour, have the purpose of maximising profits. In order to do that, employers would offer wages below the competitive equilibrium as compared to that of perfect competition. Paying a lower wage also means that the wage is below MPL, because monopsonists hire according to the marginal cost MC and not the labour supply curve. If a monopsonist hires a marginal worker at a higher wage, s/he needs to increase the wages of all those hired previously. In equilibrium, a monopolist employs fewer people and pays lower wages. This, combined with the limited power of labour unions in the private sector (as pointed out in section 3), is a plausible explanation of the lower private sector wages in Bulgaria. Furthermore, data on Bulgaria show little mobility between regions (NSI 2016). Therefore, this model is credible if we assume that little labour mobility holds; if a monopsony pays less than the market-clearing wage, it is natural that workers would change jobs. Additionally, state-owned monopsonies were privatised in the 1990s, which resulted in forming regional monopsonies capable of keeping wages artificially lower.

Unions

In general, labour unions bargain for higher wages or better working conditions for workers. As discussed previously, in Section 3, private sector labour unions can be viewed as having limited power, since their demands are constrained when bargaining for wages higher than the marginal product in a profit-maximising firm. Unions can achieve wages greater than MPL, for instance, at the expense of decreasing the share of capital income; however, this will still be within the profit constraint in order to avoid bankruptcy. In the presence of monopsony, unions playing the same role as minimum wage mitigate the excessive monpsonistic power, as documented by Boeri and Ours (2008), which means that unions would not allow monopsonies to pay workers below a minimum or a set wage. However, unions have limited potential to explain labour market dynamics in Bulgaria.

Search and Matching

In this model, we consider a labour market with search and matching frictions. Such frictions are primarily the result of having imperfect information or information asymmetry in the labour market. Search and matching frictions generate externalities, since it takes time for jobseekers to be matched to a position. In this non-Walrasian model, equilibrium is determined by the demand side, while the number of people hired is determined by the labour quantity demanded. This model could, in addition, account for the presence of an involuntary level of unemployment. Furthermore, individuals might not always take the prevailing wage, while finding the best match is often a long and costly process, in terms of both time and resources. Another possibility that accounts for the persisting level of unemployment might be that individual workers differ in terms of skills/competences and it may often be difficult to find a perfect match. Therefore, search and matching frictions seem to be quantitatively important in explaining labour market dynamics in Bulgaria.

Efficiency Wages

Efficiency wages in labour economics denote the tendency of some employers to pay more than the market-clearing wage in order to encourage higher productivity. Efficiency wages are often used as a 'gift exchange', where the employer pays higher than the equilibrium wage in order to induce more effort from the worker. Such wages can also be viewed an incentive for semi-skilled and skilled labour. This model could also explain the disparity between public and private wages in the context of real rigidities. Rigidities are prices or wages that do not adjust to the expected equilibrium level in response to changes in other prices or wages. Additionally, if private sector wages are seen as rigid, they may change only in response to technological shocks and account for the percentage of existing involuntary unemployment.

Therefore, this would explain the lower private sector wage, which fails to adjust to wage increases in the public sector. Another explanation for the disparity may be the practice of 'envelope' wages by some employers who prefer to complement the officially documented wage with undeclared cash compensation. Furthermore, real rigidities and efficiency wages imply that a worker's effort depends on the real wage and to maximise profit, firms choose the real wage that would induce the highest effort on the part of workers. However, we also discussed the weak price-wage link, pointed out by Vladova (2016), which means that real wages do not adjust as often as prices change. Finally, efficiency wages can also potentially explain wage dynamics in Bulgaria.

Minimum Wages

The minimum wage model may be applied to attract people from the grey economy, especially when the percentage of the latter is too high in the overall economic activity. A minimum wage can, in this sense, be viewed as an efficiency wage that aims to deter people from shifting to the grey sector by offering an incentive to seek a job in the private sector. Another possible explanation is that a minimum wage is used to increase labour productivity. However, as productivity is difficult and, often, costly to measure and monitor, it is not always clear whether a minimum wage is an effective tool for increasing productivity. Moreover, the higher the minimum wage, the stronger a company's incentive to either fire workers or use 'envelope' wages, which is counter-productive. According to the National Revenue Agency (NRI), one-third of the Bulgarian working population declared working for the minimum wage in 2016. Besides, recent increases in minimum wage are not in line with productivity increases, again according to IME (2015) information.
We can also express the models of private wage with a Nash bargaining equation:
.....,
where .... is the bargaining weight of the firm multiplied by the marginal product of labour MPL. Marginal utility MU could be viewed as a function of the stochastic taste shift parameter (as a source of epsilon private). MU can also be attributed to taste shocks, such as a change in preferences for higher home production or leisure preferences. It can also work as an outside option, such as people choosing to work in the grey economy or to receive unemployment benefits. When ..... equals one, the model denotes perfect competition and when it equals zero, wage equals marginal disutility of labour or an outside option, such as unemployment benefits or MPL generated in the grey economy. In the search and matching frictions model, gamma would equal 0.5.

In a perfect competition model, wage, marginal product of labour and marginal utility of labour would be equal. In union and search models, however, wage would differ from either MPL or MU. Furthermore, the models of monopsonies and

unions could account for the lower wages in the private sector if the reverse causality were true, i.e. if the public sector was the wage leader. However, since private wage changes lead to public wage changes, the model becomes less plausible. Next, going back of the IRFs, we concluded that shocks in CPI do not affect either wage in nominal terms. Additionally, wages in Bulgaria change frequently as compared to the rigid model of efficiency wages. Therefore, the models of both efficiency wages and a minimum wage as an efficiency one cannot fully explain the findings because of the weak price-wage link. However, the efficiency wage and search and matching frictions models still capture business cycles better than the other models, as documented by Vasilev (2016) and Vasilev (2017).

Public Sector

What follows are some possible theories that explain the consistently higher wages in the public sector. The discussion in section 3 pointed at some privileges when working in the public sector, such as having state-financed employee social contributions, higher after-tax income, due to government payment towards pension, over-representation of women because of the contrary happening in the private sector, etc. The public sector's objective can be to maximise employment, due to social considerations, or gain more votes through public employment. As there are not as many theories that could help explain our findings about the public sector, we took the private sector models and will now look at them from the public sector aspect. However, there is no best model to be selected in the case of the public sector.

In the government sector there is no profit motive, so perfect competition is not a good approximation to the problem of pricing labour in the public sector.

Unions and a single buyer of labour, i.e. the government

The government is a single employer of labour that determines public sector wages according to the government budget constraint. Furthermore, since some jobs exist exclusively in the public sector, the government is a single employer, or monopsonist that exclusively sets wages, as, for example, in the case of the railway (BDZ), the police, etc. As documented by Borjas (2013), unions in the public bargain for higher wages and better working conditions generally have more power than in the private sector, since they are not restricted by profit-maximisation. However, as union power is not as strong as it used to be, this model can be disregarded as less explanatory than others.

Search and Matching

Search theory suggests that people with the same abilities may often end up at differently paid jobs in the process of matching, due to, for example, favouritism,

political considerations or information asymmetries. The model could explain the wage premium in the public sector. However, public sector employees can also be viewed as risk averse, since government positions are relatively secure compared to those in the private sector. Working in the government sector can also be an occupational choice if people find it more rewarding to work for the public good or for their country. Government employees are also less likely to change positions frequently or to quit their jobs, so the process of search and matching occurs less often, if not only once, as opposed to the frequency of job changes in the private sector. We conclude that search and matching frictions do not explain the labour market as well as in the private sector.

Efficiency Wages

The efficiency wage model is a possible explanation for the wage premium of the public sector. Furthermore, the government includes a rent allowance in wages to establish not only loyalty from its employees, but also a reputation as a good employer. Moreover, the public sector tends to attract people with higher education or those with advanced qualifications, which may account for their higher wages. Besides, employees tend to have more experience than their counterparts in the private sector and, in general, have higher long-term benefits compared to the quick money incentive in the private sector. The additional rent allowance that government employees receive is *de facto* an efficiency wage shared between employees and the government.

Minimum Wages

The official Bulgarian minimum wage will reach BGN460 in 2017; one reason for its continuous increase for the past several years is the government's attempt to fight the increasing percentage of the grey economy. Friedrich Schneider finds that the percentage of grey economy for 2015 is 30.6%, a figure that has increased in the last year. The Institute for Market Economics (IME) reports in 2015 that, for every 100 BGN the minimum wage grows, 1.4% decline of employment follows. However, as our findings indicate, the minimum wage is not an effective tool or a sufficient model, not only because it introduces unemployment, but also because it fails to reduce the percentage of the grey economy.

Political Economy Factors

As noted in Section 3, Rose (1985) points out that public sector workers are also voters and are often affiliated with a particular party in order to be patronised by it. Public wages and, in this case, minimum wages can be increased prior to an election to encourage people to vote for a particular party. This would also explain

discrimination between workers with similar abilities and characteristics, as well as the higher public wage. There is also a theory, known as Parkinson's law (Parkinson, 1955), that bureaucracy self-breeds and creates an increasingly complicated bureaucratic system in order to hire more people (subordinates). This theory might explain the ever-growing and larger public employment, as well as the wage premium in the presence of political economy in Bulgaria. However, the cycle hierarchy described is mitigated by having finite finances for wages coming from the private sector in the form of taxation. This also means that public employment is a function of what happens in the private sector and is, thereby, logically following private wage changes.

Overall, these theories are in line with the observed IRFs, which show that private wage is the driver and that public wages respond to changes in private wages.