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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.

Key words: public sector wages, private sector wages, minimum wages, causality

JEL Classification: C32, E62, J3, J4

Section 1: Introduction and Motivation

A major concern for economics is to understand how labor markets work because roughly two-thirds of total income is classified as labor income. One such aggregate aspect of labor markets is the relationship between real public and private sector wages and the causal links running between them. Therefore, in this paper we focus on the dynamic inter-relationships, sectoral spillovers and transmission mechanisms of wage-setting across sectors. Furthermore, the issue of wage leadership is relevant for both policy makers and central banks from analytical and monetary policy perspective. So far the literature has mostly neglected the dynamic correlation between the two wages and to the best of our knowledge, 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 the Bulgarian economy for the period of 2000-2016. We chose this period both for the relative stability of the Bulgarian lev (BGN) and 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 the existing literature. Most studies of EU counties, 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 public sector wages. In line with the 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 for 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 over the private and public sector ones. This suggests that minimum wage plays no role in improving welfare as raising it does not in turn

raise the average public and private sector wages. The finding is in line with the framework in Economides and Moutos's (2016) minimum wage study[1].

In our empirical analysis we use de-trended quarterly data to obtain a Vector-Auto-Regression (VAR) model in a time-series context. Further, we derive all empirical results in both nominal and real terms with CPI preferred as a main deflating tool. Results show that real 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 the 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, inspecting 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, public wage increase follows until long-run equilibrium is reached. We further discuss some possible sources of the shocks which establish private wage as the leader. Lastly, we delve into public and private wage determinants by considering several labor market models, such as perfect competition, monopsony and unions, search and matching frictions, efficiency wags and minimum wages.

The rest of the paper is organized as follows: section 2 reviews the literature, followed by section 3, which presents description of the data, some stylized facts on Bulgarian wages and the process of wage determination. Section 4 explains the methodology employed in analyzing the data. We also include some limitations to our study, policy recommendation in line of 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, spillovers and leadership proves to be quite scarce. Furthermore, its focus falls on the relationship between

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

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 (2000) generally assume static relationship between the public and private wages, where the public one influences private wage through the labor 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 in Jacobson *et al* (1994) which finds that the sector more open to international competition is the established wage leader. In the case for Sweden, the leader is the private sector, as it is found to have higher productivity growth. The competitive market theory, in which wage increases run from the competitive to the protected sector, has further been collaborated 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 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.

Apart from the theoretical models, empirical results for most countries also differ, so we focus primarily on literature connected to the Eastern European region and the 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 analyzing the available data. We chose to follow an ECB study of the 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 main reference. It is part of 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. Further, Lamo *et al* (2008) find that causal links between the two nominal wages suggest that feedback occurs in direct manner, i.e. through prices. Despite the institutional differences across countries, strong correlation and long-term co-integration is reported for the majority of the cases.

In another study done as part of the WDN, Afonso and Gomes (2010) analyze the interactions between public and private sector wages for the 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. Further, 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 urbanization rate, growth rate of the average hours worked per employee and fiscal conditions. However, there is no minimum wage present in the model.

Christou (2007) obtains a bi-variate VAR estimation on dynamic public and private wage behavior 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 analogous 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 of 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 patronized 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 to higher unemployment. The empirical results point 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 absolute.

In a very recent study, Vasilev (2015) uses data for Germany for the period 1970–2007 to study the importance of public sector unions within a 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 the public and private wages in Germany is less than perfect (0.5) but positive, providing some support for the moderate leadership of the private sector wage over the public one. In a following paper on German data (1970-2007) in the context for EU-12 countries Vasilev (2016) models the government sector as unproductive, or wasteful, with public and private wages again jointly determined as endogenous variables. Further, public wage determination is only slightly affected by the process of rent-seeking, but is still mainly determined from the government's balanced budget and the households' supply of labor 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 by D'Adamo (2011) who uses a VAR specification to analyze spillover 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 in 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 the private wage exhibits even stronger causal leadership over the public one.

As on the literature of minimum wage, there is plenty of discussion on its efficiency as an income policy tool, but no systematic approach[2]. The exception is a very recent study of 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 in minimum wage determination. Their study considers the case of perfect competition among firms, with the public wages 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 because an artificially imposed wage ceiling reduces the firm's profits. The cost of this inefficiency cannot be transferred to anyone else but the capitalists, which would result in decreasing returns to scale. Moreover, these analyses are in line with economic theory, which dictates that employers would choose to have less workers when a binding minimum wage is imposed in 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 Bulgarian wages, suggesting that growth of labor cost is not fully in line with productivity growth. Further, Loukanova (2011) finds that the minimum wage is not a push-up for the average one and that it in fact affects only wage values that are close to it. Lozev *et al* (2011) and Paskaleva (2016) report that wage changes occur only once in a year as compared to an eight-month price duration. The latest survey on Bulgarian wages, discussed in detail in the next section under stylized facts, finds that firms with minimum wage prevalence claim that economic uncertainty, high payroll taxes and changes in labor laws lead to lesser employment of workers.

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

Section 3: Data description and Stylized Facts

3.1 Data Description

We use data from the NSI (October 2016) database on Bulgarian CPI and wages. As data on nominal wages is reported on monthly basis, we converted it in quarterly one for easier modelling. We used NSI data on average earnings for government, private and minimum wages approximated as compensation per employee. Compensation of 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 the section provides a detailed explanation on how the wage determination mechanisms in Bulgaria work.

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 minimize 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. In this period the gap between private and public wages was 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 artifact of inflation, real wages in Figure 2 below are shown to have similar co-movement and trend over the period[3].

[3] Seasonally adjusted graphs of wages in nominal and real terms are reported in Appendix A.

Figure 1 Nominal Wages Movement

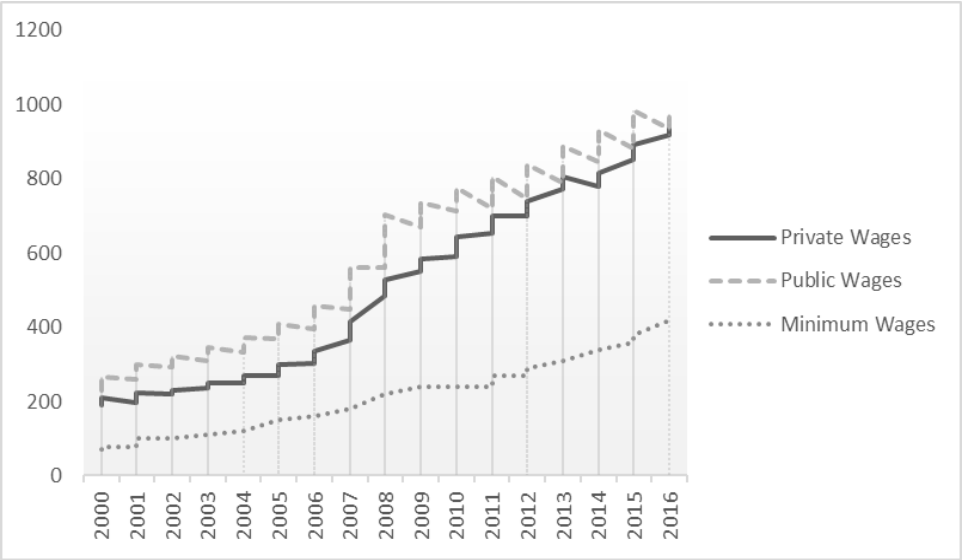
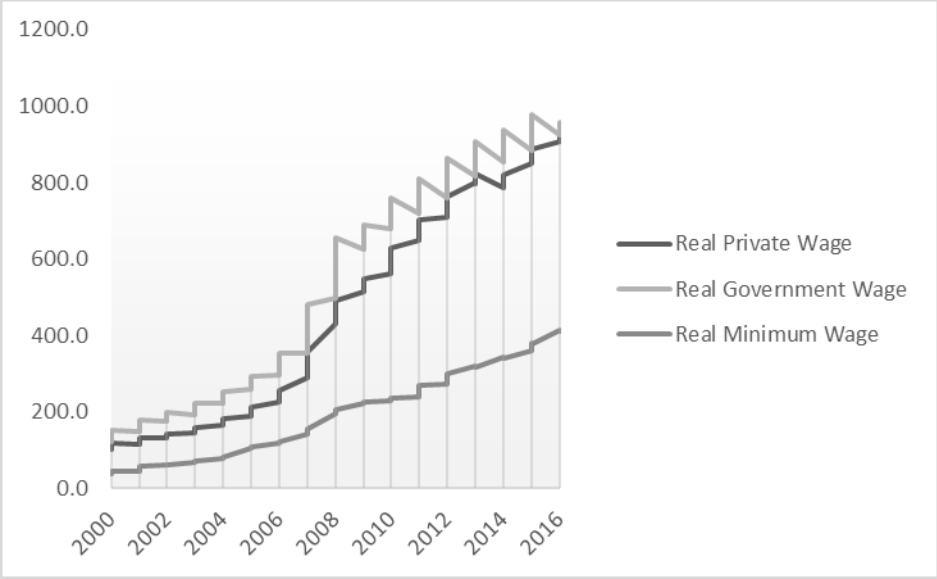


Figure 2 Real Wages Movement



The increase in government sector wages during the crisis suggests a poor adaptability of wages to economic performance, as also pointed out in Loukanova (2011). Moreover, as employment decreased, manly low-skilled workers were laid off (approximately 20% according to Loukankova (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. Further, 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 observed (2000-2016). This is especially important in the context of EU government spending on labor since the latter has been increasing in many European countries over the past years, as pointed in Afonso (2008). Moreover, as documented in 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 has 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 the budget constraint. Wage setting is determined through the so-called Tripartite Cooperation bargaining, comprised of government representatives, business employers and unions, as documented in Nenovsky and Koleva (2001). Further, collective wage bargaining can be differentiated into two levels: sector and company. Companies set their wages according to profit constraints which in turn limit the rigidity of the labor 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 eventually close down. The other possible reason for lower private sector wages may lie in the existence of monopsonies in certain sectors. Many firms in Bulgaria were privatized and as a result they can now be viewed as a single regional employer which would allow for setting lower wages and creating envelope wage practice.

Moreover, collective bargaining in Bulgaria is mostly characteristic for firm rather than for industry level, with most companies following their own price settings. This makes the exact determination of private wages more difficult, collaborating to the weak price-wage link. Firms that faced worsened economic conditions applied reduced flexible wage components and wage cuts in the private sector. The period 2009-2013 was marked by deterioration in both 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 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 are dependent upon the private sector ones 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 both is not comparable as it cannot be measured in monetary terms. Next, productivity cannot be fully captured as some public goods are more labor-intensive than others and the working time of employees in the public sector differs from that in the private one. Further, according to Rose (1985), having higher public wages can be viewed as somewhat counterintuitive because there should be a tradeoff between higher level of job security, the benefits provided by the government and the level of wages. However, this is not the case as public employees are better compensated 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 labor union protections 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 the public sector one could be viewed as a solution to a bargaining process between unions and the government. This means that when there are government funds available, labor 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 the government administration, together with the fact that the government may start running budget deficits as compared to the profit-maximizing firms in the private sector. As a result of this, 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 size 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 the trade unions, which argued in favor of protection of low-income workers and establishing 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 observed slow rise in labor 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 in Loukanova (2011). Therefore, it can be argued that minimum wage can actually hurt low-skilled workers despite its initial purpose of providing 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 labor 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 of 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, discussed in section 4.3.

In our case, the de-trending process applied takes out the deterministic trend component and filters the 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 Hodrick-Prescott (1997) filter, complemented by removal of the seasonal component to de-trend the variables. The underlying assumption is that the data is integrated of order one (I_1) i.e. the variables contain a unit root as well as 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 is 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.

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

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 Hodrick-Prescott filter to smooth the 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 it 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 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 display similar outcomes[4]. The same procedure of accounting for the unit root is applied. The difference here is that the minimum wage displays a significant trend, which is smoothed by the Hodrick-Prescott filter, as standard procedure suggests.

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-

[4] For unit root tests in logs, refer to Appendix B.

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 applied in the Granger-causality series of Wald tests, correlation relationships and impulse-response functions where the data is 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 the 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 summarizes the results obtained from a Johansen co-integration test. There is a single co-integration equation between the 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 existing 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 among the three wages. Table 4 summarizes the results in both level and log forms. Each row displays the correlation coefficients among the three variables, obtained by using a model of differenced and seasonally adjusted wages at time t and t-k (k stands for 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 one as deflated by the CPI.

Table 4 Nominal Compensation Correlation

Correlations of nominal 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	-0.1359	0.0248	0.0516	-0.0234	0.1157	-0.032	**0.5445***	0.2662	0.060
Log Forms	-0.2596	0.0582	0.1615	0.0758	0.2434	-0.061	**0.4492***	0.2874	-0.018

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 estimated coefficient is positive. Further, 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 for 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	-0.3102	-0.0416	0.2244	0.0395	**0.4302***	0.1039	**0.3262***	0.1979	-0.141
Log Forms	**-0.3319***	0.0441	0.1885	0.1371	**0.5409***	0.1788	0.4138	0.2314	-0.152

In both cases, the variables are filtered using Hodrick-Prescott filter (1997) to account for the seasonal and cyclical components. Table 4 gives 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 log (0.4492) terms. We take these values as an indicator of a strong correlation between public and private wages in nominal terms.

Table 5 presents data for the nominal deflated by CPI wages where we derive similar outcomes. The strongest correlation occurs at zero lags, 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 as its value is more inclined towards the weak to moderate wage relation and it further occurs only at one value. Therefore, we take the stronger and more persistent positive correlation as a sign of co-movement and causal relationship among the 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 the one proposed by Granger (1969). It states that a variable X is said to Granger-cause another variable (Y) if it provides statistically significant information about Y. We take a statistically significant result to be one at the 5% level of significance for all tests. In this section we use Granger's (1969) definition of causality for establishing causal links among the public, private and minimum wages. Next, we use impulse-response functions to compare the results and further evaluate the 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 the 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 the possible influences outside of the model.

$$\begin{bmatrix} W_t^g \\ W_t^p \\ W_t^{min} \end{bmatrix} = C + \sum_{j=1}^{p} A_j \begin{bmatrix} W_{t-j}^g \\ W_{t-j}^p \\ W_{t-j}^{min} \end{bmatrix} + \varepsilon_t$$

Table 6 on the next page displays the statistical outcomes of the simple probability tests on nominal wages[5]. The table should be read as follows: the excluded variable is the estimator which causes the equation variable at 5% level of significance. Only real private wage causing public one has a significant p-value coefficient; all other Wald test probabilities are found to be insignificant. Further, 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 the 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 in the level forms of real private wages causing public ones. Given that we take 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 in logs, the causality running from private to public compensation is again highly significant (0.002), as shown in Table 6 below.

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	0.562

[5] Correlation data and coefficients on real wages can be found in Appendix B

	Wage	
Minimum Wage	Public Wage	0.760

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 such) on the "response" variable. In general, IRF functions are used for determining whether one variable is able to forecast another over a specified time horizon. Further, 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[6]. We also take prices explicitly to obtain the impulse of CPI to nominal wages and the feedback that occurs.

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 the 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.

The last panel on 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 previously obtained results from the Wald tests, namely that public wages respond to changes in private wages with a lag of approximately two quarters (to two and a half). 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 the minimum wage, it can be disregarded as having no statistically significant effect. The last panel focuses on the impact that 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

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

initial change before the response dies out. This means that public wages are affected by changes in the private one with a delay of half a year.

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 the labor literature[7], 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 labor 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).

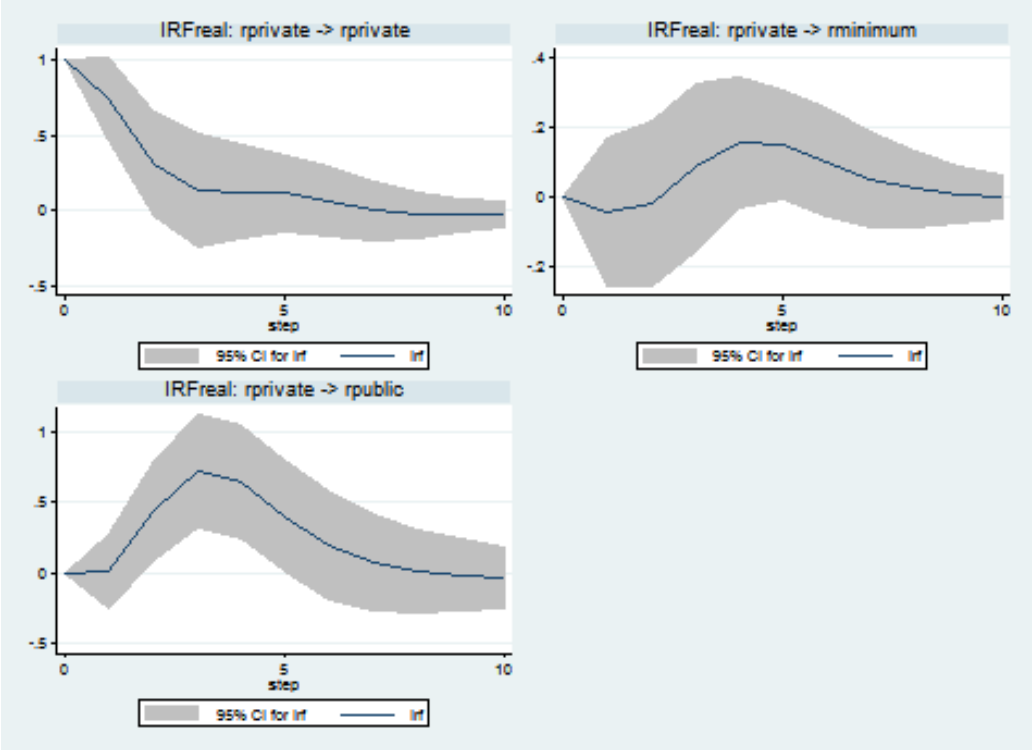


Figure 3 Private Real Wages

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

Similar reasoning for the case of real pubic wage on Figure 4 below shows that, as expected, at step zero public wage increases by one unit and then slowly decreases to zero. In addition, public wage shock has no statistically significant effect on minimum wages. Further, the last plot in the figure shows that the response of the private wage has a higher coefficient but it is still negligible. This shock can be attributed to policies such as an unexpectedly high tax revenue or drop in other costs, such as 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 the public sector wages is consistent with setups where wages are decided based on availability of government funds.

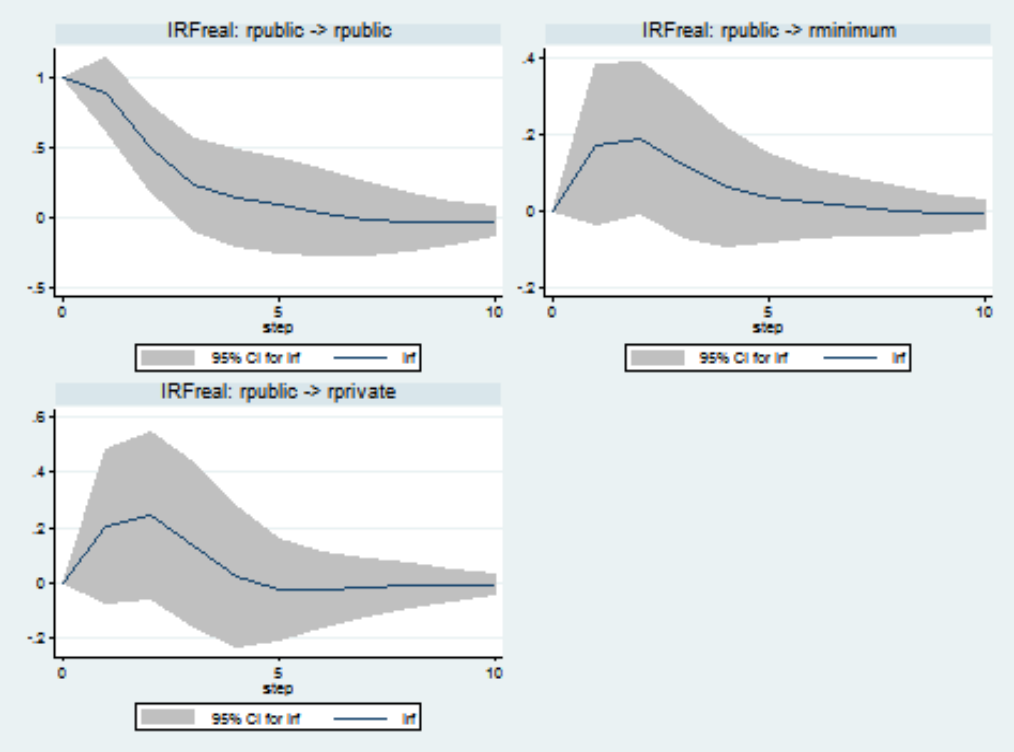


Figure 4 Real Public Wage

Next, we study the effect of minimum wages on the other two. As seen from Figure 5 below, real minimum wage shocks have no long term effects on either of the three variables. This result shows that real minimum wage is still behind productivity growth. Nominal minimum wages also display similar results to changes. Therefore, it can be concluded that recent government policy of increasing the minimum wage in order to decrease the gap between the 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. Further, epsilon minimum, or the source of the shock, captures the effect of innovation of minimum wage to minimum wage, i.e. the government policies aimed at its increases. It may be used as an instrument to lower the percentage of the grey economy, but the results show that it is not effective as an income policy tool. A possible explanation is the prevalence of "envelope wages" (people declare minimum wage as an official income, but at the same time receive cash under the table) which could diminish the possible effect of the minimum wage.

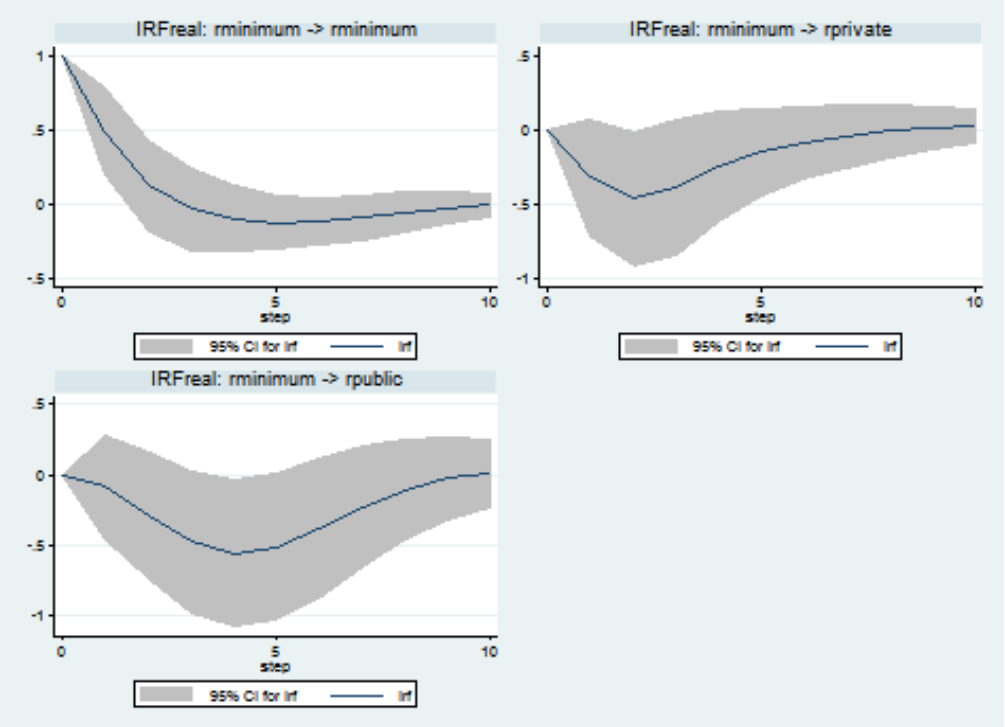


Figure 5 Real Minimum Wage

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 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 as compared to other EU countries and wage changes in response to inflation are not as quick to occur, as documented in Lozev *et al* (2011).

Wage stickiness may play important role in price adjustment, which implies that wages in Bulgaria are changed mainly because of reasons not linked to inflation (e.g. length of service). Further, Vladova (2012) finds evidence from surveys which shows 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 for Bulgaria.

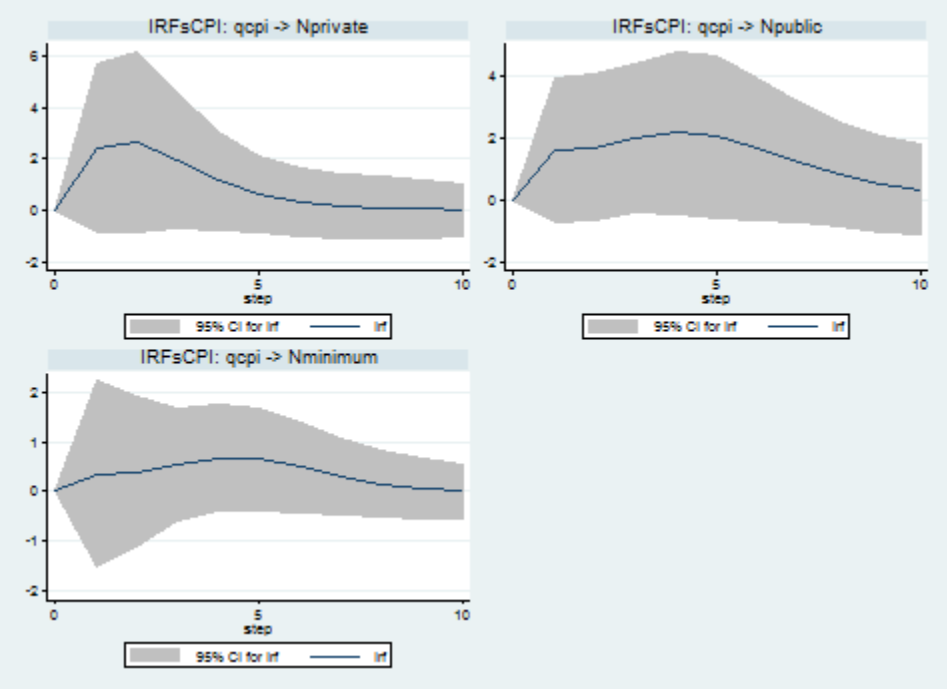


Figure 6 CPI on Nominal Wages

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 de facto an increase in monetary base, or 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 labor costs as well (Reuters). Foreign inflows in Euro could also increase money supply (M2) when converted in BGN in line with the 1.955 fixed exchange rate. Another example of foreign inflows are time deposits of foreigners, such as foreigners deposing their money or receiving their pensions through Bulgarian banks, etc. A beneficial to wages factor might be the lowering of the main interest rate, which was lastly recorded as 0% and has been close to it 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 labor will be affected through the demand channel. The increased demand for cheaper oil would lead to lower labor costs and positively affect wages. A decrease in oil prices may in addition influence public wages by affecting wages in public utilities companies. Another positive private wage shock is a possible trade shock, based on the export-led growth resulting of 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 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 labor and profit income.

Minimum wage shocks could be the result of a positive shock to laziness, or the decreased preference to work (technically, a shock to the relative weight attached to the utility of leisure). 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, labor is more productive, so wages also increase. Next, a shock to capacity of input utilization, i.e. capital and labor or elasticity of substitution between labor and consumption can also have an effect on wages. Alternative sources of income or consumption, such as home production, can increase consumption or lead to a 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 wage and further finds evidence of co-movement and long-term co-integration. It next 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 labor models as possible explanations of the findings. What is new is the inclusion of minimum wage in the model as a contribution to the existing literature. We report no causal relationship from minimum wages to public and private ones. This finding is important in policy perspective since it poses the question whether minimum wage is relevant as policy making tool. We conduct series of Granger-causality Wald test on quarterly data and construct impulse-response functions to find the relationship and causal links among the wages. In order to avoid spurious results, we use seasonally and cyclically adjusted variables after de-trending them. We take 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 value added is the inclusion of the minimum wage as an income policy tool in the private and public sector wage dynamics. We have discussed 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 falls on 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 the wage determination mechanisms.

This limitation opens venues for future research as it would be extremely interesting to delve into the disciplined theoretical approach of the 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 venue to follow would be to specify a dynamic stochastic general equilibrium (DSGE) model, based on optimization and rational behavior.

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

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Appendix A

Section 2: Seasonally adjusted wages in nominal and real terms

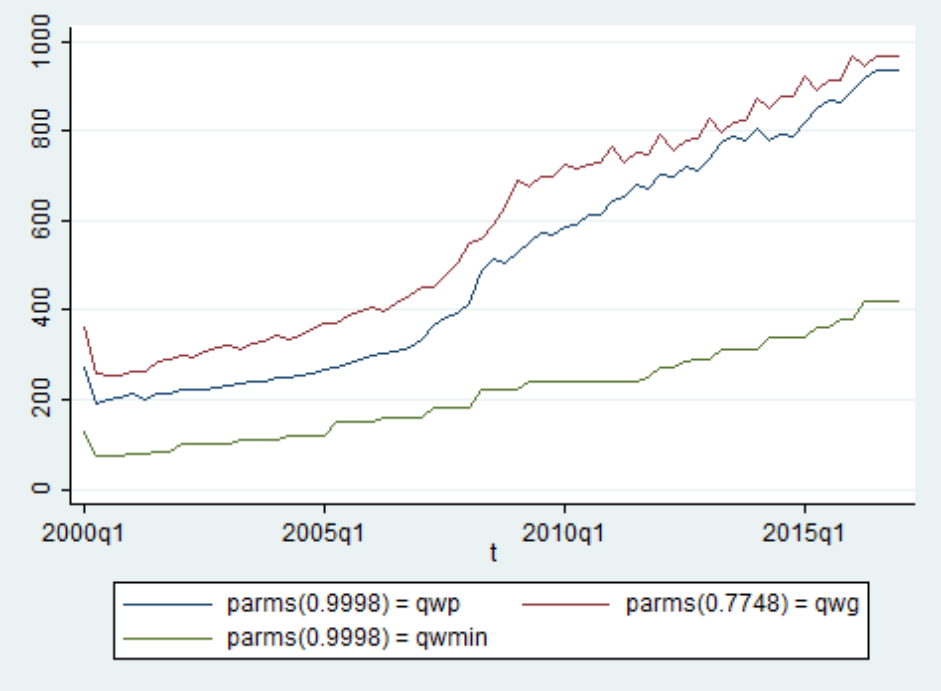

Figure 7 Seasonally adjusted nominal wage movement

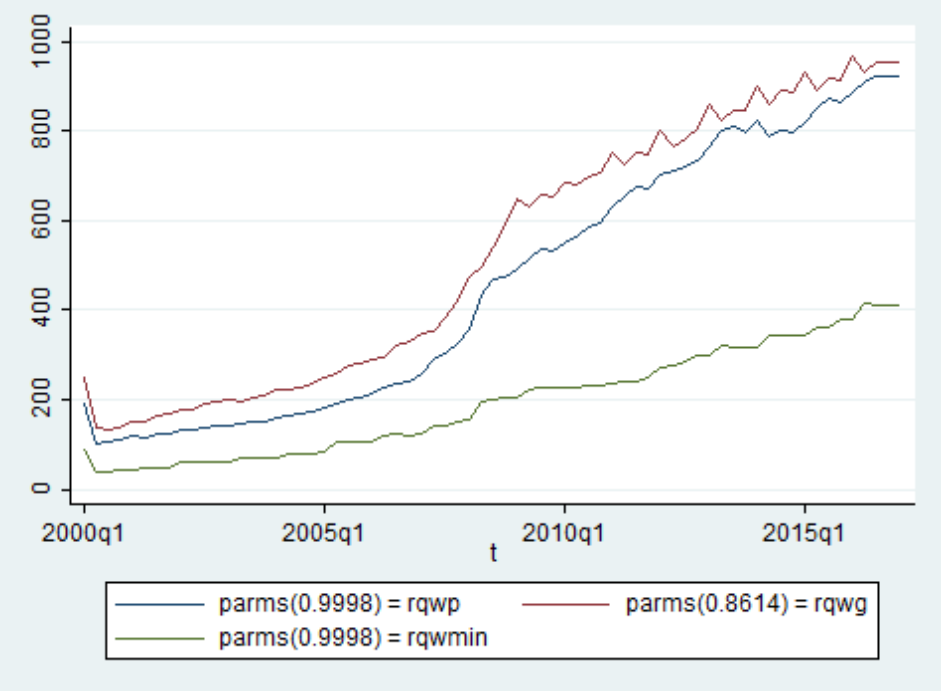

Figure 8 Seasonally adjusted real wage movement

Appendix B

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 the 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:

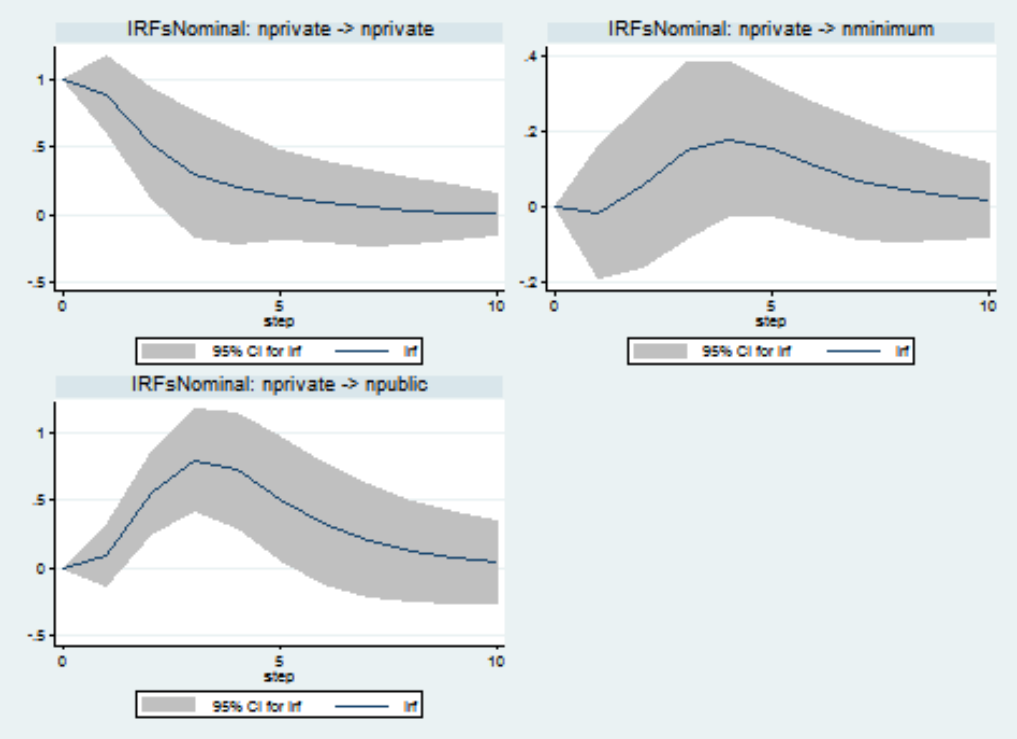

Figure 9 Nominal Private Wages

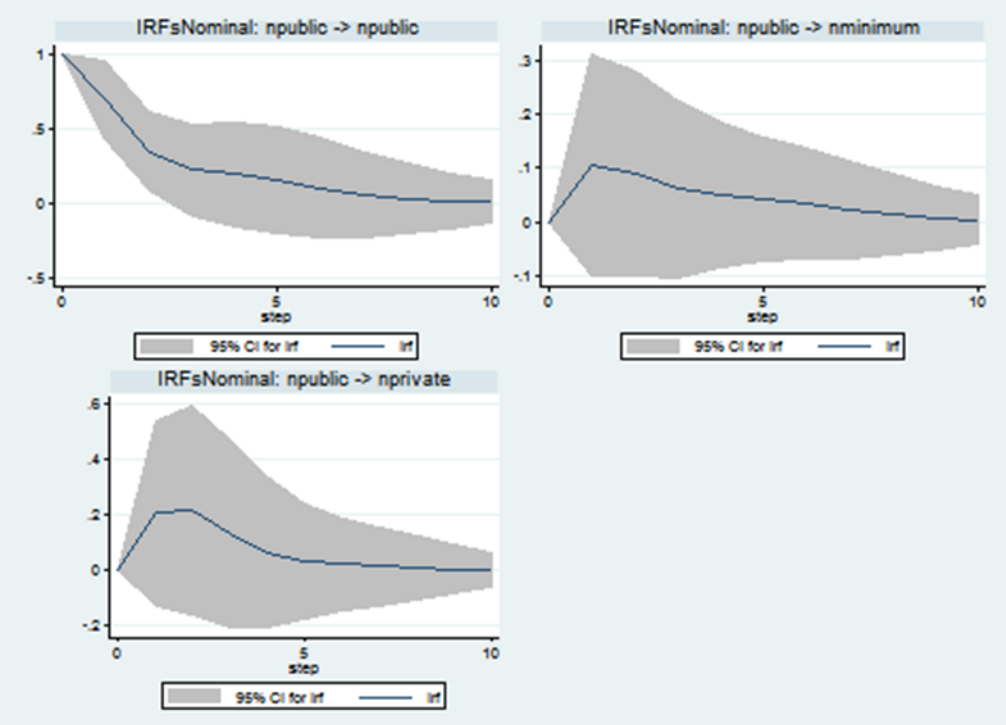

Figure 10 Nominal Public Wages

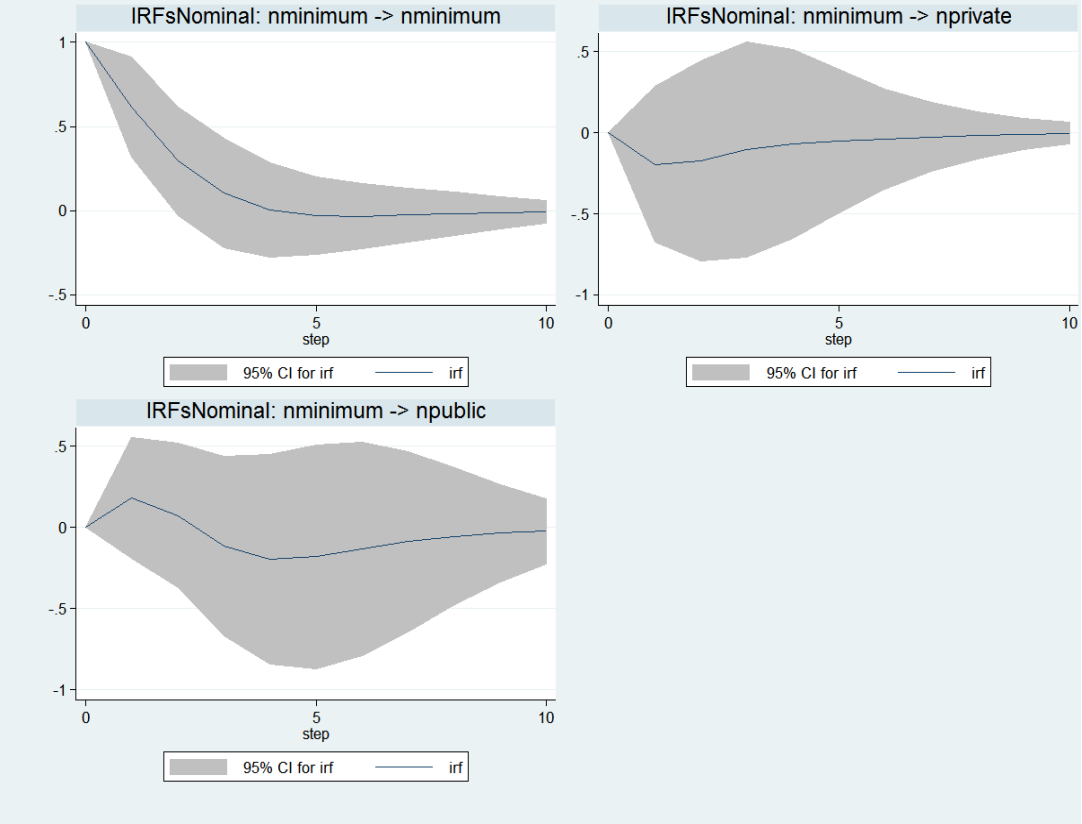

Figure 11 Nominal Minimum Wage

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

Table113FEVD 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 analyze several labor market models in the context of our findings. These models can rationalize the observed wage dynamics and their response to shocks as documented with the impulse-response functions. We analyze separately labor market models for the private and public sector.

Private Sector

Perfect Competition

Perfect competition models assume that in equilibrium wages equal the marginal product of labor (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 labor. 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 ability to measure output and effort, something that is not as easily captured in the cases below. Despite being unrealistic, this restrictive model is a useful starting point to study labor markets.

Monopsonies

In the general model, monopsonies, or single buyers of labor, have the purpose of maximizing profits. In order to do that, employers would offer wages below the competitive equilibrium as compared to the one in perfect competition. Paying a lower wage also means that the wage is below MPL, because the monopsonists hires according to the marginal cost MC and not the labor supply curve. If a monopsonist hires a marginal worker at a higher wage, he/she needs to increase the wages of all the previously hired. In equilibrium, a monopolist employs fewer people and pays lower wages. This, combined with the limited power of labor unions in the private sector (as pointed out in section 3), is a plausible explanation of the lower private sector wages in Bulgaria. Further, data on Bulgaria shows little mobility between regions (NSI 2016). Therefore, this model is credible if we assume that little labor 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 privatized in the 1990s, which resulted in forming regional monopsonies able to keep the wage artificially lower.

Unions

In general, labor unions bargain for higher wages or better working conditions for the workers. As discussed previously in Section 3, private sector labor unions can be viewed as having limited power since their demands are constrained in bargaining for wages higher than the marginal product in a profit-maximizing firm. They can achieve wage greater than MPL, for instance at

the expense of decreasing the share of capital income, however it will still be along 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). This means that unions would not allow monopsonies to pay workers below the minimum or a set wage. However, unions have a limited potential to explain labor market dynamics in Bulgaria.

Search and Matching

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

Efficiency Wages

Efficiency wages in labor 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. They can also be viewed an incentive for the semi-skilled and skilled labor. 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 answer to changes in other prices or wages. Further, 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 the increases in the public wage. Another explanation for the disparity may be the practice of envelope wages by some employers who prefer to complement the officially documented wage with cash under the table. Further, real rigidities and efficiency wages imply that a worker's effort depends on the real wage and to maximize profit, firms choose the real wage that would result in the most effort from 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 also have potential to 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. Minimum wage can in this sense be viewed as an efficiency wage that aims to deter people from going to the grey sector by offering an incentive to seek job in the private sector. Another possible explanation is that minimum wage is used to increase the labor productivity. However, as productivity is difficult and often costly to measure and monitor, it is not always clear whether minimum wage is an effective tool of increasing it. Moreover, the higher the minimum wage, the higher the company's' incentive to either fire workers or practice envelope wages, resulting in the contrary outcome to the one described above. According to the National Revenue Agency (NRI), one-third of the Bulgarian working population declared working for the minimum wage in 2016. Further, the 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:

$$W_t^p = \gamma * MPL_t + (1-\gamma) * MU_{Lt}$$

Where γ is the bargaining weight of the firm multiplied the marginal product of labor MPL. Marginal utility MU could be viewed as a function of stochastic taste shift parameter (as sources of epsilon private). MU can also be attributed to taste shocks, such as 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 γ equals one, the model denotes perfect competition and when it equals zero, wage equals marginal disutility of labor or an outside option, such as unemployment benefits or MPL generated in the grey economy. In search and matching frictions model, gamma would equal 0.5.

In a perfect competition model, wage, marginal product of labor and marginal utility of labor would be equal. In union and search models, however, wage would differ from either MPL or MU. Further, the models of monopsonies and unions could account for the lower wages in the private sector if the reverse causality was true, i.e. 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. Further, wages in Bulgaria change frequently as compared to the rigid model of efficiency wages. Therefore, the models of both efficiency wages and the minimum wage as efficiency one cannot fully explain the findings due to the weak price-wage link. However, the efficiency wage and search and matching frictions models still capture the 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, overrepresentation of women due to the opposite in the private sector, etc. The public sector's objective can be to maximize employment due to social considerations or gain more votes through public employment. As there aren't as many theories which could help to explain our findings for the public sector, we took the private sector models and will now look at them through the prism of the public sector. However, there is no best model to be selected in the public sector case.

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

Unions and a single buyer of labor, or the government

The government is a single employer of labor that determines public sector wages according to the government budget constraint. Further, as some jobs exist exclusively in the public sector, the government is a single employer, or monopsonist that exclusively sets wages, 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 and generally have more power than in the private sector since they are not restricted by profit-maximization. However, as union power is not as strong as it used to be, this model can be disregarded as less explanatory than the rest.

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, for example due to favoritism, political considerations or information asymmetries. The model could explain the wage premium in the public sector wage. However, public sector employees can also be viewed as risk averse since government positions are relatively secure compared to private sector positions. 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 often or to quit their jobs, so that the process of search and matching occurs less often, if not once as compared with the frequency of job changes in the private sector. We conclude that search and matching frictions do not explain the labor market as well as in the private sector.

Efficiency Wages

The efficiency wage model is a possible explanation the wage premium of the public sector wage. Further, the government pays rent in wages to establish not only loyalty from its employees, but also a reputation for a good employer. Moreover, the public sector tends to

attract people with higher education or once with advanced degree which can account for the higher wages. Further, 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 motive in the private sector. The excess rent that government employees receive is de facto an efficiency wage shared among 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 attempt to fight the increasing percentage of the grey economy. Friedrich Shneider finds that the percentage of grey economy for 2015 is 30,6%, a figure that has increased for 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 out findings point, the minimum wage is not an effective tool and 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 patronized by it. Public wages and in this case as well as minimum ones can be increased prior to an election to encourage people to vote for a particular party. This would also explain discrimination among workers with similar abilities and characteristics as well as the higher public wage. There also exists a theory that bureaucracy self-breeds and creates more and more complicated bureaucratic system in order to hire more people (subordinates), known as Parkinson's law (Parkinson, 1955). 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 forms of taxes. This also means that public employment is a function of what happens in the private sector and is thereby logically the follower to private wage changes.

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