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Farm Wage and Rice Price Dynamics in Bangladesh

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Abstract:

Concepts regarding wage-price nexus in Bangladesh are diverse and conflicting. A proper understanding of the relationship between food prices and rural wages is essential for policy planning relating to the rural poor. In exploring the link between food prices and rising rural wages, this study critically examines previous studies and updates the dynamic relations by using the monthly data from 1994 to 2106. Vector error correction mechanism (VECM) is implemented to determine the long and short run relationships between wages and food prices. Findings from this study show that in the long run food prices are not a single major factor to explain the variation of rural wages in the national level, and the influence of urban wages become stronger in some places. Additionally, this study discloses the major drivers such as foreign remittances, rainfalls that have a significant impact on farm wages. However, divisions, where changes in wages are not related to food prices, may require different policies regarding poverty and price stability contrast to the divisions where both wages and prices are well cointegrated.

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JEL Codes: J23, J21

#152



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1. Introduction:

There is no doubt that the economy of Bangladesh which is close to 50 years old, has now started to face the structural transformation regarding increasing wages, rising food prices with stable production, and poverty reduction. Structural transformation of less developed agrarian economies is both a cause and consequence of the steady amelioration of food and labor market imperfections (Timmer, 2007). The relationship between agricultural wages and staple food prices is an important empirical issue under the blink of such transformation in the economy. The importance of linking farm wages with food prices also arises from different statistics. In Bangladesh still, the bottom 5% income group of the rural households expends 71.4% of their total consumption expenditure on food (Statistical Year Book, 2016) and it is believed that any large spikes in food prices are a serious threat to this group. Among the different food grains, rice alone consumed by more than 90% of the population, and it covers 75% of the total cropped land (HIES, 2010). Rice farming as a largest agricultural sector employs 45% of the rural labor force. Thus, it is very likely that changes in rice prices will have a significant impact on agricultural wages. Additionally, both the factors (price and wage) affect the poverty situation of a country. Responsiveness of wages to prices determines how the standard of living of the poor evolves (Boyce & Ravallion 1991). In the same way, any quick or sluggish adjustment of wages to rice prices has positive or detrimental effects on the poor as they have only their labor to sell to earn income (Ivanic, 2008). In response to any volatile situation of food prices and labor wages, usually, the governments take some policies to stabilize the markets and for saving the poor. In Bangladesh, the government sometimes launched countrywide open market sales (OMS) of

rice at the subsidized rate, control import duties, etc. Therefore, this study tries to determine the inter-linkages between food prices and wages which have significant importance to the policymakers and development practitioners in the context of developing country like Bangladesh.

In the recent decades, both the food and labor markets in Bangladesh experience the global crisis in 2007-2008. World food prices rose suddenly and sharply in late 2007 through to early 2008, fell in the aftermath of the global financial and economic crisis of 2008, and rose again in 2010 (Jayasuriya, Mudbhary, & Broca, 2012). Since 2007 there have been two major price shocks (2008 & 2011) in the food markets of Bangladesh (M. Hossain, 2012). However, recent international food prices declined by 14% between 2013 and 2015, sliding into a five-year low, which consequently declines food prices in Bangladesh because of increasing availability of cheaper imports (World Bank Group, 2015). In the meantime, rural wages in Bangladesh are rising apparently faster in the second half of the 2000s than before, i.e., the average (male) rural wage rose in real terms by 45% between 2005 and 2010. Furthermore, the booming manufacturing sector also increases the wages of the urban labors and admittedly attracts the surplus labor from the rural sectors. This research is motivated to explore the present trend of food price and wage relationships under such changing scenario of prices and real wages, where both the neo-classical and efficiency wage theories appear to be inconsistent to explain the wage-price nexus.

1.2. Main research questions:

This study tries to answer the following two research questions in the perspective of rural Bangladesh:

1. Does the agricultural wage rate respond to changes in rice prices?
2. Are agricultural labor markets independent of urban labor markets?

1.3. Major Key implications:

- What do price changes imply for rural welfare such as poverty reduction?
- Should the government continue to control the price to reduce rural poverty, or should they foster off-farm employment?

Rest of the paper describes the previous empirical studies on wages determination and wage response in section 2, theories and the implemented methodologies in section 3. The results are discussed in section 4 and policy and conclusions are drawn in section 5.

2. Literature review:

Wage determination and its interaction with other economic variables in developing countries like Bangladesh, both theoretically and empirically have intrigued the economist for decades. The neo-classical theories are not able to explain the stable wages under unlimited supply and involuntary unemployment in the emerging economies (Zhang, Rashid, Ahmad, & Ahmed, 2014). The efficiency wage theory also cannot explain properly about the logic behind emerging trend of wages in South Asia. Food prices influence agricultural wages, but the extent of adjustment in between these two is varied over time. Several studies have done on food wage relationships. Most of them used rice price as a proxy of food price and agricultural wage as a rural wage. Besides using rice price as an exogenous variable in the model, they also used manufacturing wage rate, agricultural productivity, and population, etc. to explain agricultural wages. Some of the authors conclude that in past rice, the price was the only single factor that can explain the trend of agricultural wage by developing a long-run cointegrating relationship but now the trend has been changed. But others are arguing, urban wage rate of major cities is the most important factor that describes the long run dynamics of agricultural wage rate. The recent increase in rural wages also proved by the economist who is arguing this is the reason for increasing job opportunities in nonfarm sectors. Beside that rural wages as a form of income and production cost has immense importance on smallholder farmers' food security and poverty reduction. In this regard, there is a paucity of economic research that could explain the probable explanation of such patterns.

2.1. Wage response to rice price:

Boyce and Ravallion (1991) assumed a long-run equilibrium relationship between the nominal agricultural wage and the nominal prices of rice, jute and corn, the manufacturing wage, and a productivity index. They found that wages responded significantly to rice price in the short run with an elasticity of 0.22. They argued the long-run effects of higher rice prices may be more advantageous to agricultural laborers, but they do not suggest that gains in agricultural productivity have had a positive effect on real wage rates in Bangladesh. Later Palmer-Jones (1993) criticize their findings on the issue of stability test. Another study by (Rashid, 2002) found that the trend in the relative price of labor and food documented in the earlier studies had changed in the 1990s and agricultural wages and rice prices have no long-run relationship. He argued that rice prices and wages were no longer co-integrated. Empirical analysis from India by (Jacoby, 2016) showed that nominal wages for manual labor across rural India respond elastically to higher (instrumented) agricultural prices. In particular, wages rose faster in the districts growing relatively more of the crops that experienced comparatively

large run-ups in price over the 2004-5 to 2009-10 periods. Similar kind of study conducted in the Philippines confirms the general hypothesis that rice prices are an important influence on agricultural wages (Lasco, Myers, & Bernstein, 2008). Surprisingly, in the Philippines, Dawe (2003) reports a negative relation of rice price with agricultural wages as his result shows a decrease in rice prices would not decrease demand for labor in the agricultural sector because farmers will diversify to other crops which are labor-intensive than rice. The famous work of Ivanic (2008) use GTAP model to explain wage price elasticity but, unfortunately, the use of coefficient from the previous study for validity test lower the acceptance of results of this model.

2.2. Wage response to productivity:

Khan (1984) for the first time introduced some results in favor of the trickle-down effects (positive effects of production per acre) on real wages. However, Boyce and Ravallion (1991) denied and noticed the specification error in the model of Khan (1984). At the beginning of 2000, Rashid (2002) tests on the variables used in the previous studies were nonstationary and reported that price and productivity is no longer a significant determinant of the agricultural wage rate. But Hossian (2008) mentioned that findings of Rashid (2002) failed to examine the responses of nominal wages to a set of commodity prices. The latest study by Rahman (2009) showed the evidence in favor of the trickle-down hypothesis that agricultural production indeed affects rural wages positively in the long run

2.3. Wage response to urban income opportunities:

The econometric works of Rashid (2002) indicates that the urban wage rate of unskilled workers in major cities is the single most important variable to explain the long-run dynamics of agricultural wage rates while he opposed to using productivity (per acre) variable to explain this dynamic. While Ahmed (2014) also claim that real wages can only be explained by the Lewis (1954) theory of economic development with an unlimited supply of labor. According to Guha and Tipathi (2014), due to public works programmes, the bargaining power of labor increases which also lead the raise in wages and consequently, food price inflation induces laborers to bargain for higher wages.

2.4. Research gap and contribution:

The systematic review of the past studies strongly shows the existence of diversity, conflicts, and limitations to explain wages and food price dynamics. Most of the past studies estimate the model's parameter by using annual data, which are not based on large observation. Moreover, those studies failed to properly define the variables that represent food price, such as in the case of using rice prices none of the study explained which varieties of rice (Aus, Aman or Boro) were considered for analysis. Importantly, there are no studies except Rashid in 2002 and, Martin and Ivanic in 2015, which followed

proper econometric methods to explain the wage-price nexus. Though, these two studies as said before have some theoretical and conceptual limitations too, including the use of trend without considering a structural break and use of general equilibrium framework by assuming the elasticity of wages to price as 1 to estimate the other coefficients. Rather than that, it is unknown about the wage-price responsiveness at the subnational levels that are essential for the proper policy implication at the bottom level of the country. There is also no recent study to address the structural transformation (if any) in the rural and urban labor market with the proper statistical approach and reliable data. This study tries to extract the wage and price relation at the sub-national (division) level by using reliable data from multiple sources with the meaningful econometric approach.

3. Theory and Methodology:

3.1 Basic theories of wages:

Farm wage determination is always a debatable concept in developing countries (Ak. A. Hossain, 2008). Several theories explain wages, i.e., agricultural wages and each different theory have strong advocacy in favor of their arguments under certain conditions. In the body of the economic literature, some group of economist believes that prosperity brought by the green revolution in the 1990s have a trickle-down effect that, rural wages are positively affected by agricultural productivity. The hypothesis here argues that higher productivity means lower agricultural prices as well as higher employment, which in turn means higher wage (M. Rahman, 2009). The basic wage models of Rahman (1993) and Ravallion (1994) were able to prove trickle-down effect in the short run, but not in the long run. Another group of thought believes that when real wages keep low for a longer cycle of time, then the economy has surplus labor and wages and employment under such condition explained by the nutrition-based efficiency wage theories. (Ak. A. Hossain, 2008). This theory of wage-efficiency describes the dependence of production on consumption and argues for paying a wage that covers the calorie requirement of the labor. However, studies from Rosenzweig (1978, 1980) for India and Ahmed (1981) for Bangladesh suggest that in labor-abundant countries agricultural wages started to exhibit long-term upward trends with fluctuations. Such trends and fluctuations in farm wages disfavor the nutrition-based wage arguments. Recently, a majority of the literature supports the Arthur Lewis dual economy model with unlimited labor supply to explain the higher agricultural wages in the developing countries like Bangladesh. Thus, in short, different theories has separate views, and the debate is all about the shape of the labor supply schedule under specific environment. Figure 1, briefly describe the major three concepts of labor supply and demand.

Classical/neoclassical: In classical point of view the labor supply schedule is vertical, which is determined by demographic, sociological and institutional factors. Wage changes for a shift in demand or supply curve or both. In Figure 1, real wages fluctuate between W_2 and W_1 in response to a shift in demand for labor.

Keynesian: At the subsistence wage level (W_s) the curve is horizontal. A shift in the demand for labor changes the level of employment say between E_2 and E_1 . Fluctuation in employment occurs for the shift in the demand curve, and real wages remain stable at the subsistence level.

Lewis: In this theory wages remain horizontal up to certain tipping point (E_s). Real wages remain stable until the surplus labor is exhausted. After that point, an increase in the demand for labour raises real the wages.

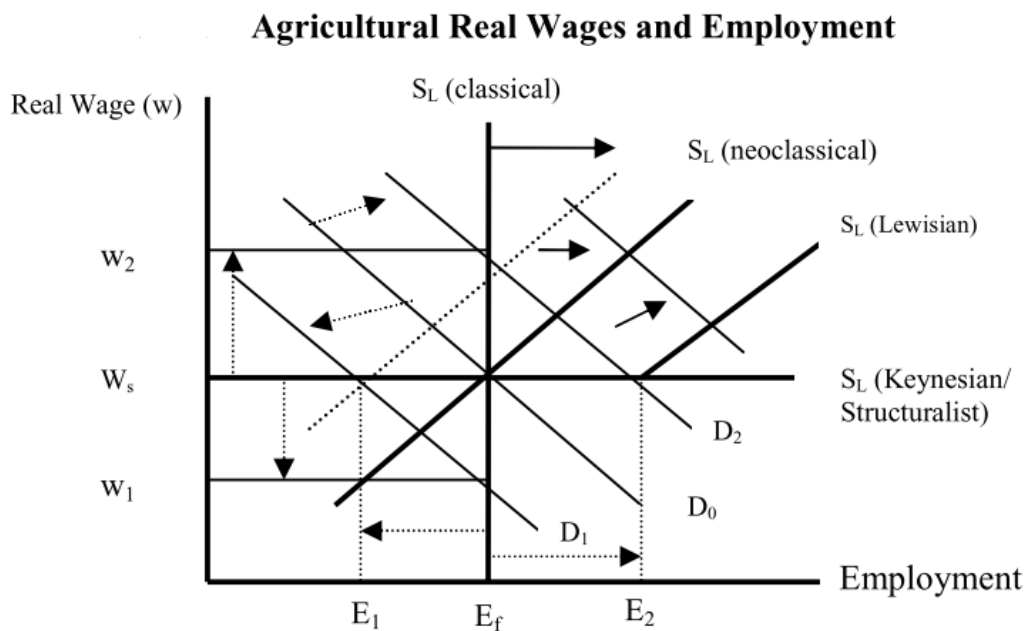


Figure 1: wage and employment under different theories (Source: Adopted from Hossain, 2008)

3.2 Empirical specification:

Both theories have different views, but neoclassical theory of elastic supply (not perfect) curve will be more flexible to explain the changes in wages due to the shift of labor demand. The empirical model can be derived based on the neoclassical utility maximizing framework. Agricultural wages depend obviously on the demand and the supply of labor. In developing settings, like Bangladesh, the demand for labor may influence by the total agricultural production and the supply of labor by the total population. However, the criticism of using a production (also productivity per capita) term in the

previous studies as well as for non monthly nature of the variable limits us to consider it in the current study. As rice is the country's main crop, therefore, the responsiveness of agricultural wage to rice price is obvious and will be a good indicator of variation in wages. The prices of non-agricultural goods, which are also important in the consumption bundle of the labor may affect any estimation of food-wage, i.e., Cloth price or Cloth price index. Other natural factors like realized rainfall over the course of the agricultural production period may have an impact on wages because fluctuations in rainfalls influence production uncertainty. Thus, in our study, we can use monthly rainfall as a good proxy indicator of production. In the literature, we also find that real wage rises due to more ample job opportunities in the nonfarm sector, especially in the manufacturing sector for women in Bangladesh (Zhang et al., 2014). Skilled and unskilled labor demand from the urban labor market may also influence the farm wages. The progress of the manufacturing sectors especially in the readymade garments and the textile sector are quite flourishing in the last decades and create employment for millions of people. Similar to the garments sectors, the construction business is also booming up in the semi-urban areas which attract both skilled and unskilled workers and provides relatively higher payment in contrast to manual workers in the farm sectors. Hence, both manufacturing and constructional worker wages as a proxy for an urban wage can influence the rural wages. The national level policy of the government has a potential impact on the labor supply market, for example, policies regarding social safety nets. There is much evidence where the rise in wages is because of an increase in bargaining power due to public works programs (Bhattarai, Kumar, Sandhya, & Bantilan, 2014).

In exploring the relationship between agricultural wages and food prices, it is important to control for other determinants of wages. Thus, our model of agricultural wages includes variables reflecting conditions on both the labor demand and the supply side. Besides the price variables, the vector of explanatory variables consists of the following:

Agricultural Wage (W_a) is a function of food (rice) price (F_p), unskilled manufacturing wage (W_m), construction worker wage (W_c), rainfall, and remittances.

$$W = f (W_m, W_c, F_p, G_p)$$

3.3. Time series framework:

The character of the time series data will tell us about the right sort of model necessary to check the relationship between food and labor market. Then cointegration of the food and labor market will be checked by the Johansen cointegration method. Cointegration states that if there exists a long run relationship among a set of non- stationary variables, then the deviation from the long run equilibrium path should be bounded. Two non- stationary series say W_1 and W_2 are said to be cointegrated if both

series are integrated of the same order. If the selected time series variables are all stationary, then we can simply use the ordinary least square method to estimate the parameters. However, most of the time series are nonstationary, that's why the very first step in the time series analysis requires the checking of stationarity of the series. Normal regression (OLS) cannot be applied in case we find any unit root or structural breaks in the series. If the unit root tests suggest the presence of unit root in the series, then we need to check the number of integration needed to make the series stationary, which is the very important step to choose an exact model. Majority of the macroeconomic variable become stationary after first differences $I(1)$. If all the variables under the considered function are integrated of order 1, i.e., $I(1)$ then we can check for co-integration rank. If the con-integration rank test confirms the existence of at least one rank, then we can implement the vector error correction framework (vecm). Otherwise, the alternative option is to use simple vector autoregressive model. The vector autoregression (VAR) model is a natural extension of the univariate autoregressive model to dynamic multivariate time series where all the variables are assumed to be endogenous (Adak S. 1998). The test relies on the relationship between the rank of a matrix and its eigenvalues (or characteristic roots). Therefore, the first step in co-integration analyses is to examine the order of integration of relevant variables and then check whether or not the non-stationary variables form a co-integrating or long-run relationship among them. The simple form of Vector Autoregression (VAR) is given below:

$$\mathbf{y}_t = \mathbf{u}_t + \Pi_1 \mathbf{z}_{t-1} + \Pi_2 \mathbf{z}_{t-2} + \dots \Pi_\rho \mathbf{z}_{t-\rho} + \varepsilon_t$$

ρ representing the order of each of *all, for example, m* endogenous variables as a function of lagged values of all *m* endogenous and say, *n* exogenous variables. \mathbf{y}_t is a vector of length *m*, and the \mathbf{z}_{t-i} are vectors of length *m+n* (Patterson, 2000). \mathbf{u}_t is a vector of constants and ε_t is a vector of residuals. The corresponding Vector Error Correction Model (VECM) is (Pesaran & Pesaran, 1997; Patterson, 2000):

$$\Delta \mathbf{y}_t = \mathbf{a}_0 + \mathbf{a}_1 t + \Pi \mathbf{w}_{t-1} + \Gamma_1 \Delta \mathbf{w}_{t-1} + \Gamma_2 \Delta \mathbf{w}_{t-2} + \dots \Gamma_{\rho-1} \Delta \mathbf{w}_{t-(\rho-1)} + \Psi \mathbf{D}_t + \varepsilon_t$$

$\Delta \mathbf{y}_t$ is a vector length *m* of changes in each of the endogenous variables in the underlying VAR. Vectors \mathbf{w} and $\Delta \mathbf{w}$ have the *m* endogenous variables as well as *q* $I(1)$ exogenous variables. $\Pi = \alpha \beta'$ is a square matrix of dimension *m+q*. β' is the matrix of coefficients generating long-run equilibrium? Each row of length *(m+q)* corresponds to one of *r* cointegrating vectors. α is a matrix containing the coefficients that show the speed of adjustment to long-run equilibrium (Patterson, 2000).

On the other hand, if some of the series are $I(1)$ and some are $I(0)$ then it is suggested to use autoregressive distributed lag model (ARDL). However, ARDL cannot be used if any of the series in the model has integration of order $I(2)$.

3.4 Data sources:

The econometric models of this study rely on a comprehensive and elaborate database covering the monthly data from the period of 1994- 2016. The time series model utilizes national and subnational-level data to estimate the interlinkages between rural wages and food price. Data on agricultural and urban wages, consumer price index (CPI) were obtained from different issues of monthly statistical bulletins of Bangladesh Bureau of statistics; rice prices as a proxy of major food price are obtained from Food Planning and Monitoring Unit (FPMU) and Department of Agricultural Marketing. However, rice prices of a selected varieties exist only for the market arrival seasons. Therefore, to develop a general series of wholesale rice prices we considered the monthly price of those varieties that are available in the market. In doing so, we observed that coarse rice varieties during “Boro” and “Aman” seasons covered maximum months of a year. Furthermore, the significant amount of missing values for some specific months of few years made it very difficult to construct a general nominal price series. However, following the methods of Goletti and Naser (2000) and using the nationally representative secondary panel survey from the BRAC (non-government organization) we successfully estimate the missing values. The final rice price series provides the data for major 23 districts (subdivisions), which are used to get the average estimate of seven subnational (division) level series. Here, the rural wages represented by daily agricultural wages (male and female without meal). Urban labor wages in the construction and manufacturing sectors are available from major seven districts. Depending on the distance from the other selected districts, a proper proxy of non-farm wages used to create time series. Skilled non-agricultural (constructional) workers wage was obtained by taking the daily averages of carpenters, masons, and the brick breakers observed over a month. Manufacturing wage rates in cotton textile and jute industry collected from the major four division of Bangladesh and available in monthly statistical bulletins. Some others national level data such as remittances and rainfalls (district levels) are collected from Bangladesh bank and Bangladesh Meteorological Department respectively.

4. Result and discussion:

Before going to jump to the analysis of co-integration, we follow a structural way to define the trends and nature of price, wage, and poverty.

4.1 Wages, Food Prices, and Poverty:

A primary asset for the poor is their physical labor. Therefore, it is expected that positive wage growth in the labor market can translate into enhancement in the poor’s livelihood and lead to a reduction in poverty. There is strong advocacy in favor of the statement that sudden shock in food prices may worsen

the net food buyer poverty situation in the developing countries. Indeed, rising wages are seen as the major driver of rural poverty reduction in recent decades (Datt and Ravallion, 1998). Farm wages influence the welfare of the poorest groups who rely heavily on these wages for income (Lasco et al., 2008). Analyzing dynamics of poverty is important both for uncovering the nature of the problem and for formulating effective poverty alleviation strategy (Lanjouw and Stern, 1993; Baulch and Hoddinot, 2000; Krishna a, 2004). It is also inevitable that falling food prices relative to incomes has been a feature of a developed economies (Dorward, 2013).

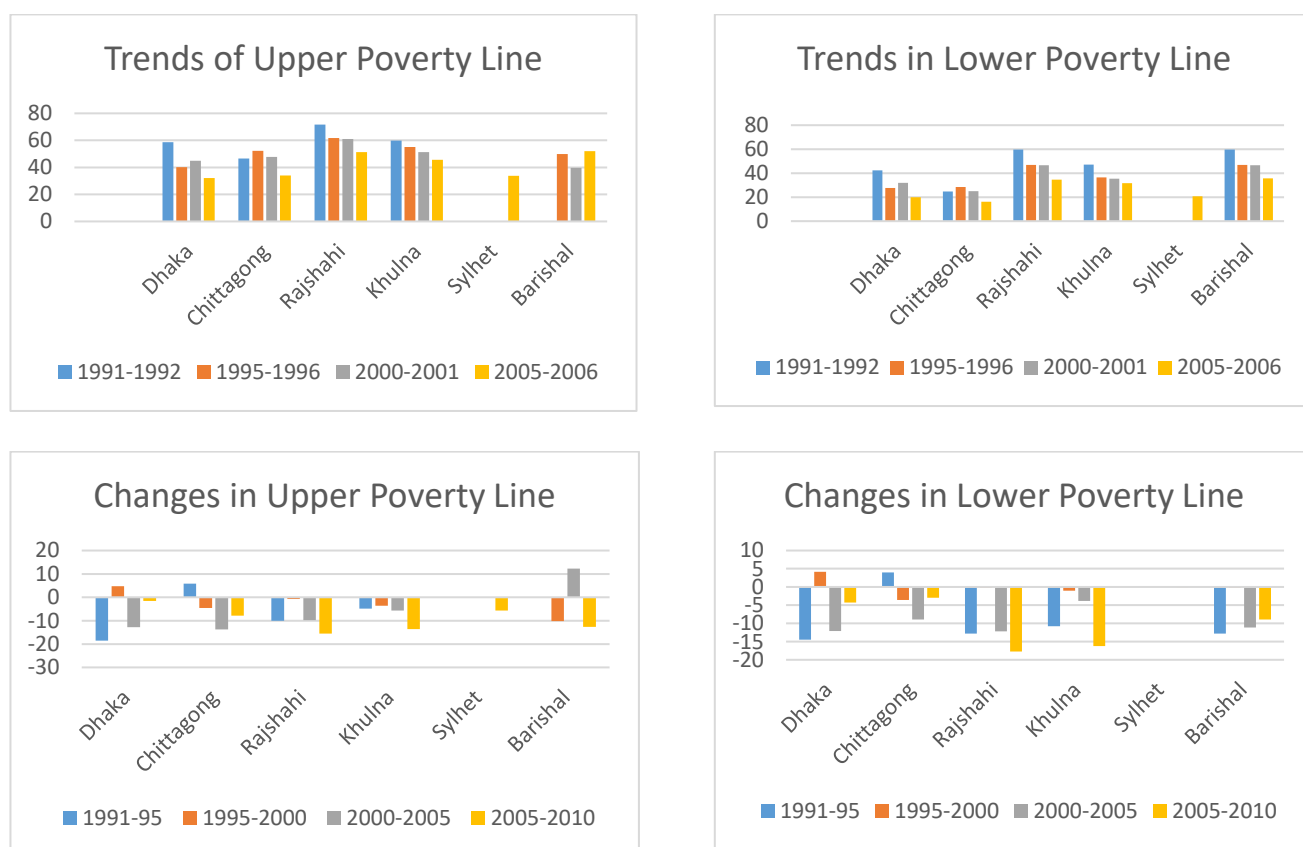


Figure 2: Trends in poverty from 1991 to 2010

Household income and expenditure survey data over 20 years are utilized to get the inside knowledge of poverty situation at the sub-national level of Bangladesh. Sylhet and Rangpur both are the relatively new divisions so complete data of the past poverty rates are not available here for a couple of the survey round of HIES. From the Figure 2, it is clear that both upper and lower poverty line is higher for the Rajshahi the northern part of the country. But over the time lower poverty rate changes drastically for this northern region. However, the impact of changing price and wages on poverty is evident from the Figure 3.

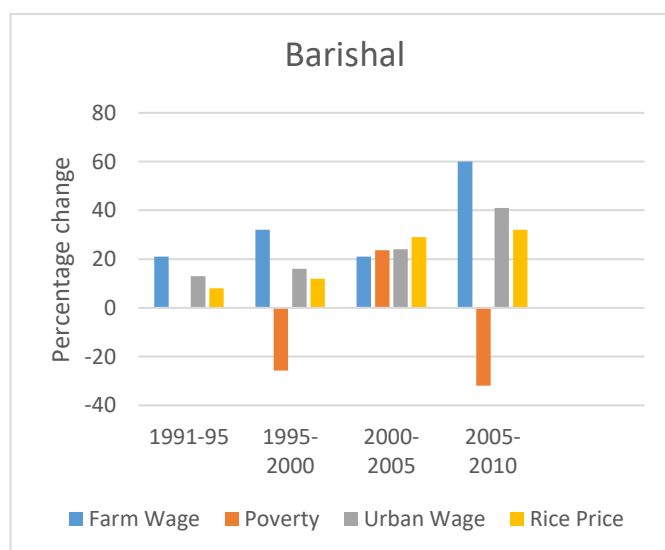
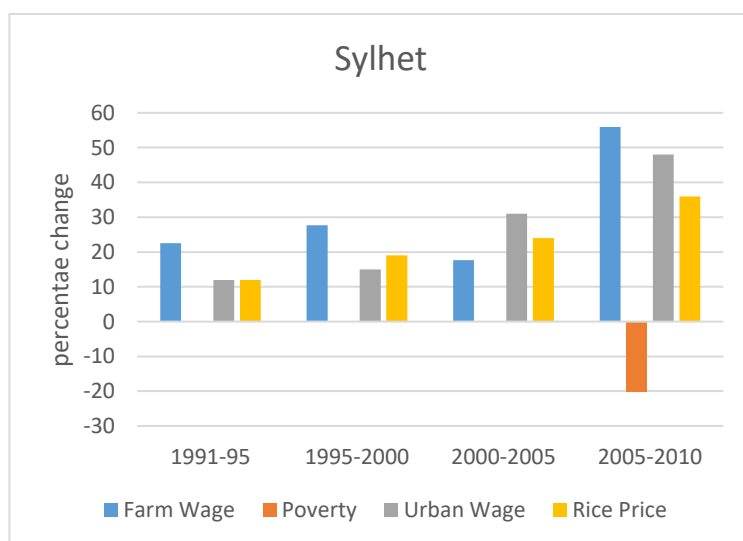
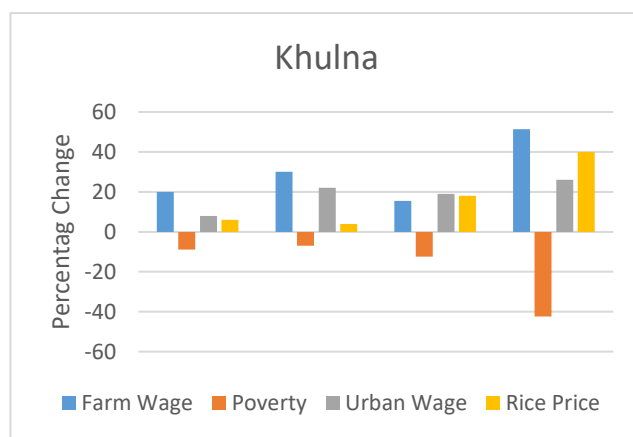
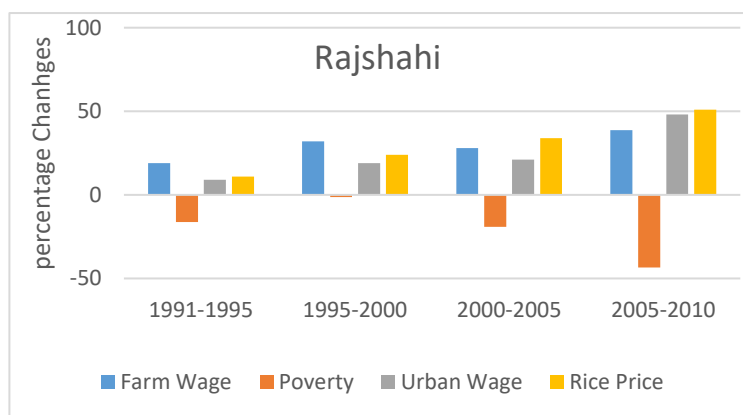
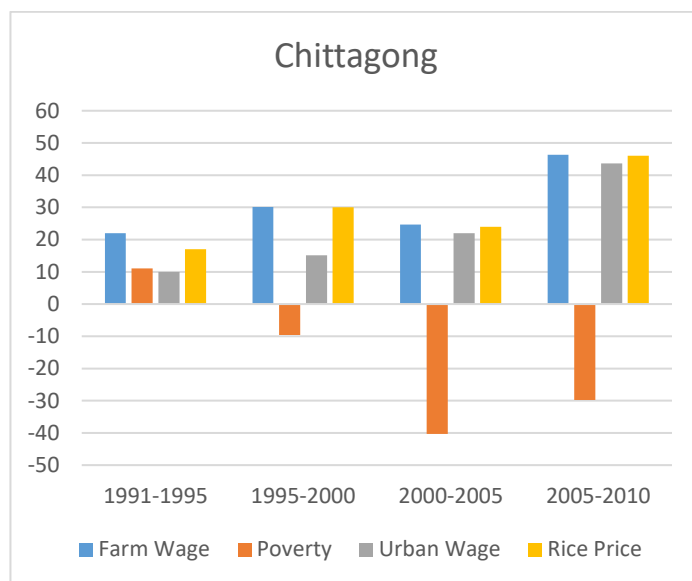
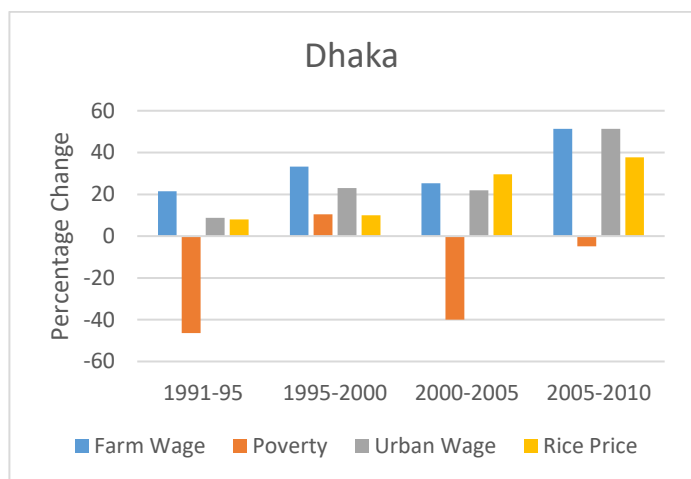


Figure 3: Changes in wages, price and upper poverty lines

In Dhaka division, poverty rates are decreased sharply with the increase of farm and urban wage. Here urban wages reflect the average daily wages of construction and manufacture laborer. It is noticeable that positive changes in farm wage rates are higher compare to the urban wage in all the divisions except Rajshahi. In the meantime, rice price growth in Rajshahi after 2005 is highly correlated with the reduction of poverty. Changes in farm wages are higher in Barisal where the rate of poverty reduction is slow in Khulna. Thus it is clear that increasing farm wages may have a higher share to reduce poverty. Now the question is how these different wages and food prices interact with each other over the time?

4.2. Interlinkage of food price and wages at the national level:

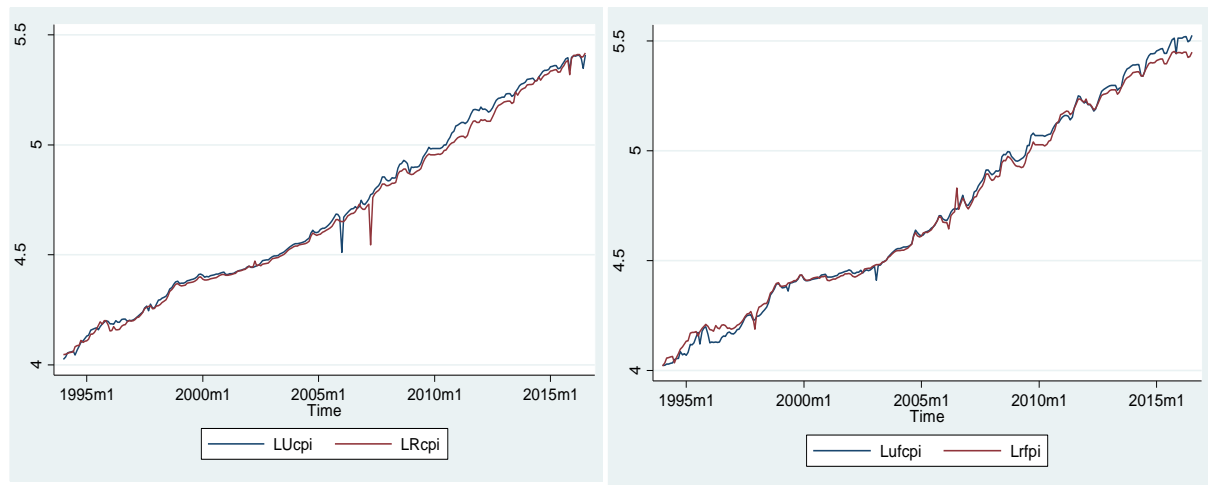
From the cross-sectional data (HIES), it is evident that both farm-labor wages and food prices have been rising in the last four survey round. Is the observed wage increase response to the rising food inflation or is the food inflation caused by rising costs of production that are induced by the secular increase in farm labor wages? However, we try to answer this question at the country level by using the monthly time series data, where we also consider some other factors like remittances and rainfall that might have influenced the interlinkage of wage-price.

We hypothesize that higher food prices will increase the value of marginal product of the farm laborer which pulling up their wages and high wage of this laborer should increase the costs of production of crops thereby pushing up the food prices

Since wage response is the focus of this study, we consider the following function as stated earlier in the empirical sections: $W_a = f (W_m, W_c, F_p, Z_p)$

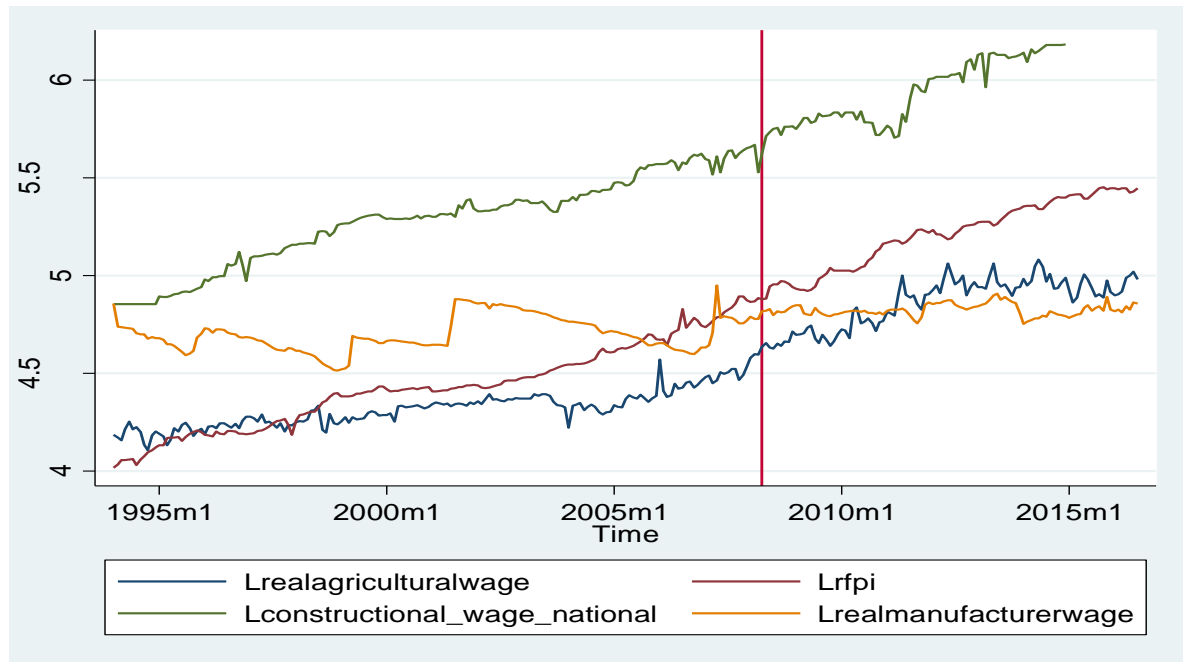
Here at the national level analysis, we consider W_a , as the real rural wage obtained by diving nominal farm wages with the rural consumer price index. W_m , W_c is the real manufacturing and constructional worker wage obtained by dividing their nominals with the urban consumer price index. Z_p is the vector of exogenous variables. Food prices at the national level are represented by the rural consumer food price index as our major concern is the response of farm wages. Besides, these variables we also consider the monthly remittances and rainfall at the national level. All the variables are transformed to their natural logarithm to reduce any extremes as well as minor outliers.

For any time series, it is essential to determine whether the data is stationary or have any other patterns like trend, seasons and cycles. All the time series are checked for stationarity and structural break. As we already get informed from the earlier studies that our economy experiences the global crisis in the first quarter of 2008. So we first check for a known structural break by using Wald test and Bai and Peron (2003), which confirms the break in April 2008 (vertical line in Figure 4c).



a. Log of urban and rural CPI

b. Log of urban and rural food CPI



c. Trends in real wages and food price at the National level.

Figure 4: National Trends of real wages, urban and rural CPI and food prices

From the first part of the Figure 4a and 4b, it is clear that there are no such significant differences between urban and rural general as well as food CPI. But in the Figure 4c, it is observable that real constructional wage remains well above than the other factors, and the deviation between real rural food price index and real farm wage are getting larger after the structural break. However, one interesting feature observed from Figure 5c that after the second half of 2010, real farm wages are gradually increasing than the real manufacturing workers wage which supports the notions of Lewis turning point.

Both the Augmented Dickey Fuller and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test confirms the presence of unit root and all the variables become stationary after the first difference (Appendix 2).

Period 1: January 2000 to March 2008

Long Run

Variable	Constant	Rural FCPI	Real Manufacturing wages	Real Constructional worker wage
Real Rural Wages	0.1.08	0.87	0.35	0.16

Short Run

Variable	Constant	Δ Rural FCPI _{t-1}	Δ Real Manufacturing wages _{t-1}	Δ Real Construction worker wage	Δ Real Rural Wage _{t-1}	ECT _{t-1}	Remittances (exogenous)	Rainfall (exogenous)
Δ Real Rural Wages	0.010***	-0.118*	-0.0668**	-0.109*	-0.331	-0.321**	0.018	0.12

**Significant at 5 percent

***Significant at 1 percent

Period 2: April 2008 to August 2016

Long Run

Variable	Constant	Rural FCPI	Real Manufacturing wages	Real Constructional worker wage
Real Rural Wages	0.956	0.45	0.87	0.15

Short Run

Variable	Constant	Δ Rural FCPI _{t-1}	Δ Real Manufacturing wages _{t-1}	Δ Real Construction worker wage	Δ Real Rural Wage _{t-1}	ECT _{t-1}	Remittances (exogenous)	Rainfall (exogenous)
Δ Real Rural Wages	0.025***	-0.682*	-0.368*	0.053	-0.682	-0.46***	0.109*	0.098

**Significant at 5 percent

***Significant at 1 percent

4.3. Lag selection and the decision about co-integrating equations:

We divide the period of analysis into two based on the structural break. Then we select the appropriate lag based on the previous unit root test result and also by the model information criterion (Appendix 1). There are two test statistics in the Johansen procedure, namely, the trace test and the maximum eigenvalue test. Each of these test statistics can be used to determine the

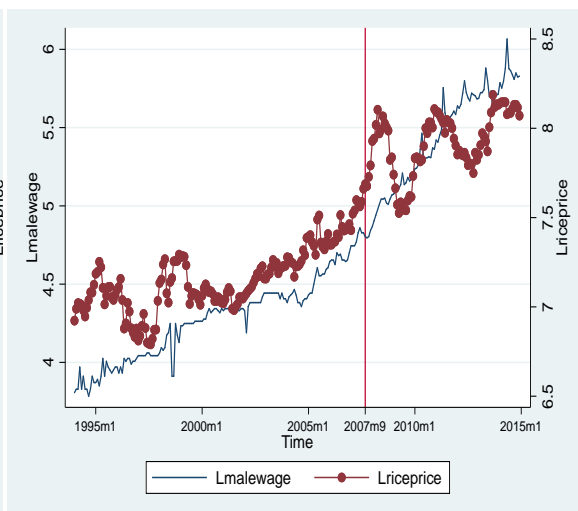
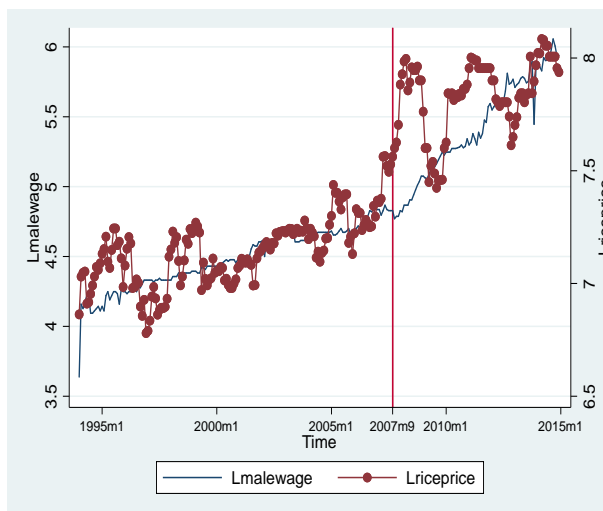
number of integrating vectors present. Trace statistics suggest for one co-integrating equation in each period (Appendix 2). From the results of the above table, it shows that in the period one the rural food price index has a strong influence on real rural wages than the period 2. But the impact of real manufacturing wages on real farm wages are getting double in the second term. In the first period, if there is any deviation from the long run equilibrium then it takes 37 months to adjust, where in the second half it takes 26 months to adjust. Both the error correction terms are significant and negative. Besides the influence of food prices, we also observe the positive and significant effect of remittances in the second period, while rainfall has positive but insignificant influence. Therefore, at the national level, we can conclude that food prices are influencing rural wages, but the strength of such influence become low in the recent past while manufacturing wages started to influence rural wages. Such findings support the urban-rural co-integration of wages where after a certain point rural wages rise faster than urban wages. Stability of the estimated models is checked by Lagrange multiplier test of 5 lags, where we found no autocorrelation among the lags (Appendix 3).

4.4. Interlinkage of food price and wages at the subnational level:

Now we are interested to see whether we can conclude the type of results of wage-price nexus for the bottom level of the country. Government strategy is to reach, provide and execute their plans to the lower strata of the society so that any vulnerable group belonging to those strata can fight back and lead as normal as before. Similarly, it is obviously interesting to the policymaker whether national-level findings are appropriate for all domestic regions (markets and economies).

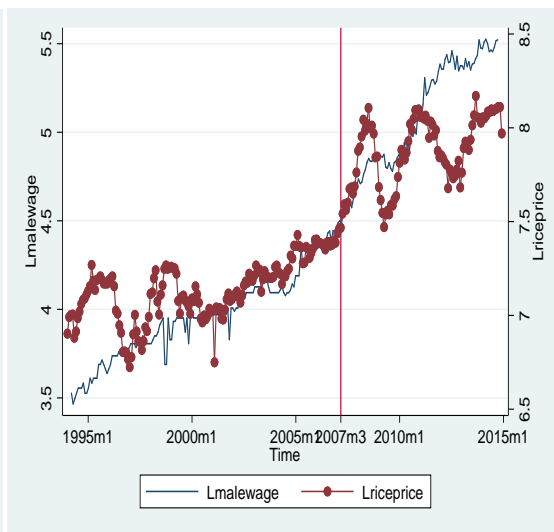
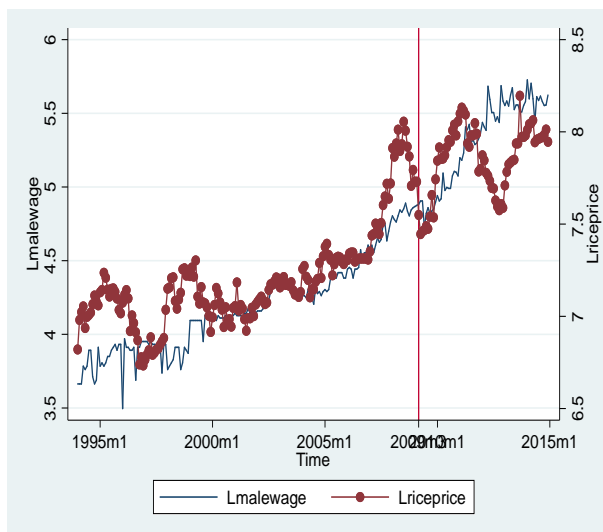
4.5. Seasonality and Structural break in the respected series:

For any time series, it is essential to determine whether the data is stationary or have any other patterns like trend, season and cycle. Here we have four monthly data series of 21 years. Firstly, for all series of the six divisions, we checked the possibility of having a structural break by Bai and Perron (2003) test. Figure 5 represents the structural breaks of the log values of the series.



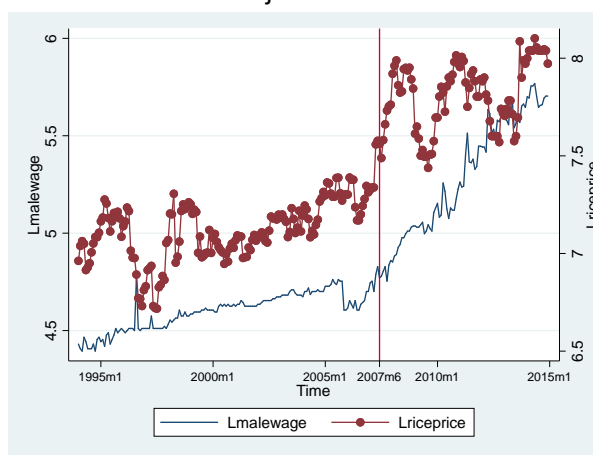
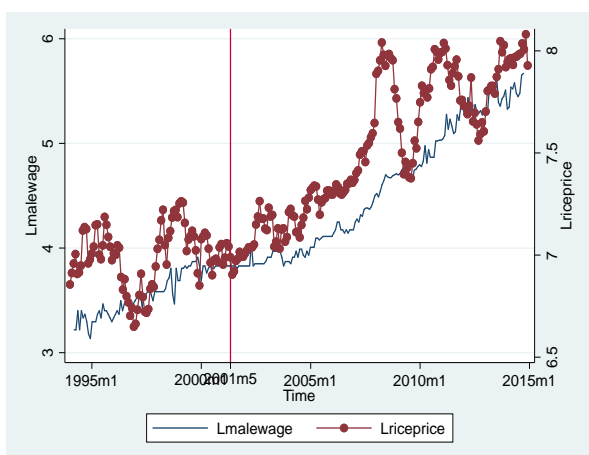
Chittagong

Dhaka



Khulna

Rajshahi



Rangpur

Sylhet

Figure 5: Structural break of the major series (Farm wage and rice price)

Sometimes both seasonal unit roots and seasonal heterogeneity are common in time series data. HEGY (Hylleberg, Engle, Granger, and Yoo, 1990) test is the common tool for detecting the seasonal unit roots. Secondly, for all the series, considering the structural break, we check the possibility of having regular unit root along with the seasonal unit root test.

Table 1: Structural break between the different series

Division	Farm wage (unknown)	Rice price (Unknown)	Unskilled wage of manufacturer worker (known)	Constructional worker (Known)
Dhaka	2007M9	2007M9	2007M9	2007M9
Khulna	2009M3	2009M3	2009M3	2009M3
Sylhet	2007M6	2007M6	2007M6	2007M6
Rajshahi	2007M3	2007M3	2007M3	2007M3
Rangpur	2001M5	2001M5	2001M5	2001M5
Chittagong	2007M9	2007M9	2007M9	2007M9

Table 2: HEGY test of regular and seasonal unit root

Division	Stages of unit root	Wa	Fp	Wm	Wc
Dhaka	Non-seasonal unit root (Zero frequency)	yes	yes	yes	yes
Khulna	Seasonal unit root (4 months per cycle)	No	No	No	No
Sylhet	Seasonal unit root (2.4 months per cycle)	No	No	No	No
Rajshahi	Seasonal unit root (12 months per cycle)	No	No	No	No
Rangpur	Seasonal unit root (3 months per cycle)	No	No	No	No
Chittagong	Seasonal unit root (6 months per cycle)	No	No	No	No

From Table 1 that there is a single break for each series. We are more highlighted on the agricultural wage and rice price that's why we check the unknown structural break for this two then check the known break accordingly for the manufacturing and constructional wage. From the Table 2, it is evident that all the log series have the unit root at zero frequency with one percent significance level, ensures the probability of having regular unit root in the series. However, seasonal unit root for two months per cycle is accepted at one percent but rejected in both five and ten percent levels. Now to ensure the level of integration of the series, we again test the regular unit root statistics. Most popular tests like Augmented Dickey-Fuller (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) and modified Dickey-Fuller t-test (ADF–GLS) have been utilized to test the presence of *regular unit root*. The null-hypothesis for an Augmented Dicky Fuller (ADF) and generalized least square ADF test is that the data

are non-stationary. Another popular unit root test is the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) *test* that reverses the hypotheses, so the null hypothesis is that the data are stationary. All types of test, presented in Table 3 accept the presence of unit root with the trend.

Table 3: Regular Unit root test

Division	Stages of unit root	Ln Wa	Ln Fp	Ln Wm	Ln Wc	After 1 st Difference
		Level				
Dhaka	ADF	yes	yes	yes	yes	All series became stationary
	GLS ADF	yes	yes	yes	yes	
	KPSS	no	no	no	no	
Khulna	ADF	yes	yes	yes	yes	
	GLS ADF	yes	yes	yes	yes	
	KPSS	no	no	no	no	
Sylhet	ADF	yes	yes	yes	yes	
	GLS ADF	yes	yes	yes	yes	
	KPSS	no	no	no	no	
Rajshahi	ADF	yes	yes	yes	yes	
	GLS ADF	yes	yes	yes	yes	
	KPSS	no	no	no	no	
	ADF	yes	yes	yes	yes	
Rangpur	GLS ADF	yes	yes	yes	yes	
	KPSS	no	no	no	no	
	ADF	yes	yes	yes	yes	
	GLS ADF	yes	yes	yes	yes	
Chittagong	KPSS	no	no	no	no	
	ADF	yes	yes	yes	yes	
	GLS ADF	yes	yes	yes	yes	
	KPSS	no	no	no	no	

4.6. Optimal lag length selection: Using both the Schwarz criterion (SBIC) and Hannan–Quinn information criterion (HQIC) we estimate the optimal lag length. Most of the model before the structural break has two months period of lag, and after the break, they have one period break. In case of different lag suggest by the selection criteria, we go for the maximum lag.

Table 4: Lag selection

Division	SBIC	HQIC	SBIC	HQIC
	Before structural break		After structural break	
Dhaka	2	2	1	1
Khulna	2	1	2	2
Sylhet	1	2	1	1
Rajshahi	2	2	2	1
Rangpur	2	2	1	1
Chittagong	2	1	1	1

4.7. *Test for co-integration:* We test the series for the existence of co-integrating equations by following the Johansen's Co-integration method and using trace statistics (Eigenvalues). Presence of co-integration indicates a long-run relationship between the tested series. Our results from Johansen's test (after applying appropriate lag lengths) show evidence of nominal farm wage rates, urban wage rate, and food price to be co-integrated, that means there is evidence that in the long run, both variables may move together.

Table 5: Long Run relation between farm wages, rice price, and manufacturing and constructional worker wages before structural break

Division	Farm wage	Rice price	Unskilled wage of manufacturer worker	Constructional worker
Dhaka	-	0.349	0.473	0.356
Khulna	-	0.464	0.413	0.336
Sylhet	-	0.567	0.466	0.421
Rajshahi	-	0.371	0.138	1.286
Rangpur	-	0.456	1.197	0.743
Chittagong	-	0.10	0.372	0.546

Table 6: Long Run relation between farm wages, rice price, and manufacturing and constructional worker wages after structural break

Division	Farm wage	Rice price	Unskilled wage of manufacturer worker	Constructional worker
Dhaka	-	0.103	1.47	0.60
Khulna	-	0.694	0.498	0.336
Sylhet	-	0.427	0.393	0.401
Rajshahi	-	-1.01	1.429	4.59
Rangpur	-	-0.44	0.452	1.78
Chittagong	-	0.11	0.17	2.06

Table 7: Error correction term before the structural break:

Division	Farm wage (Speed of adjustment)	Rice price	Unskilled wage of manufacturer worker	Constructional worker	Adjustment period
Dhaka	-.2638***	0.128	.0428	.0953	46
Khulna	-0.364***	0.195	0.042	0.094	32
Sylhet	-0.320***	0.045	0.086	0.018	37
Rajshahi	-0.143***	0.061	0.016	0.046	83
Rangpur	-0.304***	0.14	0.042	0.094	31
Chittagong	-0.236***	0.02	0.0948	0.018	51

Table 8: Error correction term after the structural break:

Division	Farm wage (Speed of adjustment)	Rice price	Unskilled wage of manufacturer worker	Constructional worker	adjustment period (months)
Dhaka	-.2638173***	.12897	.0428331	.0953439	46
Khulna	-0.153***	0.0257	0.08567	0.19069	78
Sylhet	-0.110***	0.0559	0.01713	0.0814	109
Rajshahi	-0.121***	0.135	0.064	0.119	99
Rangpur	-0.093***	0.051	0.034	0.134	129
Chittagong	-0.49***	0.174	0.069	0.106	25

4.8. Long run relations among the series and speed of adjustment:

By referring Table 5 and 6, it is not surprising that both before and after the break, in the long run, farm wages in Dhaka more influenced by the urban wages, specifically by the wages in manufacturing sectors. These results are similar to the findings of Rashid (2002), who supported that the urban wage rate is the most influential factor of the farm wages. However, for the Dhaka division, it is obvious that the number of garments and textile workers is more than any of the division of the country. But for Khulna and Sylhet the farm wages still, considered to be influenced by the local rice prices. Constructional worker wage seems to be more vital for explaining the farm wages in Chittagong division. However, surprisingly both in Rajshahi and Rangpur rice price seems to be less important than construction and manufacturing wages.

Table 6 & 7 represent the speed of adjustment for any deviation from the long run equilibrium. It is quite clear from the table that in both periods all the error correction terms have a negative sign and significant at 1 percent level of significance. That also represents the good fit of the models. Before the break lowest adjusted period is found for Rangpur (25 months) and the highest adjustment period is for Rajshahi (83 months). After the break, the lowest adjusted period is found for Chittagong (25 months) and surprisingly highest adjustment period is found for Rangpur (126 months).

4.9. Stability test:

All the model is tested and diagnosed for the stable coefficient of the estimated parameters. Wald test and Lagrange multiplier test of the selected lag of the residuals of the fitted model have been tested for autocorrelation. Normality of the residuals is also examined. However, one minor limitation of the few models is that they pass the examination of the autocorrelation but marginally failed to form a normal distribution of the residuals.

5. Conclusion and scope of the further research:

Labor and food market integrations are not same in all the divisions of the country. Especially, if we focus on the latest years (after the break), we can easily identify that urban wages become stronger to explain rural wages. However, any increase in the rice price of Khulna and Sylhet division may increase the farm wages, which ultimately affect the production cost of agricultural commodities. So, the safety net program in these areas related to rice price stabilization can intervene quickly to maintain the balance in the labor market. For example, price control projects, such as selling rice at Taka 10/Kg for low-income families in 2017 and the fair price card from 2011 still need to be operated in different phases for those regions. On the other side, farm wages in Rajshahi region is highly sensitive (positively) to construction worker wage and moderately (negatively) to rice price. Such type of results in Rajshahi may have two implications, one is still, the people who are a net consumer of rice face trouble to compete in the labor market in the edge of rising rice prices, so they make themselves available in the market by negotiating daily farm wages at a reduced rate. Secondly, the increased wage in the booming constructional workers in this area naturally attract more people to work in this sector and migrate nearby places, thus ultimately increase the demand for the remaining causal agricultural laborers. The same explanation applies to Rangpur region. Wage-price nexus in Rajshahi and Rangpur division urge government to create proper employment generation program to maintain the farm wages in the face of a sudden surge in rice prices. The rice price slightly influences farm wages in Chittagong region; however urban wages share the bigger weight to maintain the rural wage. Thus the national level study may help the government to decide macroeconomic policies like imposing a tariff to import rice price or liberalize trade restriction. However, our findings support that rice prices will not affect the rural wages in the long run. But the divisional level findings show exactly the places where immediate actions are required to control price and reduce poverty. Finally, more concrete conclusion and policies can be drawn for the sub-national level if the proper panel data at the household levels are available. This research in the future will add the dynamics of wage- prices from the panel data and can validate the present results with that.

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Appendix 1

Unit root at level

dfuller realagriculturalwage

Dickey-Fuller test for unit root				Number of obs	=	270
Interpolated Dickey-Fuller	-----					
Test	1% Critical	5% Critical	10% Critical			
Statistic	Value	Value	Value			
Z(t)	-0.867	-3.458	-2.879	-2.570		
MacKinnon approximate p-value for Z(t) = 0.7986						

. dfuller Lrfpi

Dickey-Fuller test for unit root				Number of obs	=	270
Interpolated Dickey-Fuller	-----					
Test	1% Critical	5% Critical	10% Critical			
Statistic	Value	Value	Value			
Z(t)	-0.152	-3.458	-2.879	-2.570		
MacKinnon approximate p-value for Z(t) = 0.9440						

. dfuller Lconstructional_wage_national

Dickey-Fuller test for unit root				Number of obs	=	251
Interpolated Dickey-Fuller	-----					
Test	1% Critical	5% Critical	10% Critical			
Statistic	Value	Value	Value			
Z(t)	-0.532	-3.460	-2.880	-2.570		
MacKinnon approximate p-value for Z(t) = 0.8855						

dfuller Lrealmanufacturerwage

Dickey-Fuller test for unit root				Number of obs	=	270
Interpolated Dickey-Fuller	-----					
Test	1% Critical	5% Critical	10% Critical			
Statistic	Value	Value	Value			
Z(t)	-2.521	-3.458	-2.879	-2.570		
MacKinnon approximate p-value for Z(t) = 0.1103						

.

Unit root after first difference

fuller D1.realagriculturalwage

Dickey-Fuller test for unit root				Number of obs	=	269
Interpolated Dickey-Fuller	-----					
Test	1% Critical	5% Critical	10% Critical			
Statistic	Value	Value	Value			
Z(t)	-18.146	-3.458	-2.879	-2.570		
MacKinnon approximate p-value for Z(t) = 0.0000						

. dfuller D1.Lrfpi

Dickey-Fuller test for unit root				Number of obs	=	269
Interpolated Dickey-Fuller	-----					
Test	1% Critical	5% Critical	10% Critical			
Statistic	Value	Value	Value			
Z(t)	-17.041	-3.458	-2.879	-2.570		
MacKinnon approximate p-value for Z(t) = 0.0000						

```
. dfuller D1.realmanufacturerwage

Dickey-Fuller test for unit root                                Number of obs   =      269

Interpolated Dickey-Fuller      -----
Test          1% Critical      5% Critical      10% Critical
Statistic          Value          Value      Value
Z(t)          -18.290          -3.458          -2.879 -2.570

MacKinnon approximate p-value for Z(t) = 0.0000

. dfuller D1.Lconstructional_wage_national

Dickey-Fuller test for unit root                                Number of obs   =      250

Interpolated Dickey-Fuller      -----
Test          1% Critical      5% Critical      10% Critical
Statistic          Value          Value      Value
Z(t)          -21.439          -3.460          -2.880 -2.570

MacKinnon approximate p-value for Z(t) = 0.0000
```

Appendix 2

Lagrange Multiplier test before break			
lag	chi2	df	Prob > chi2
1	45.6325	16	0.05245
2	29.2436	16	0.01693
3	23.5483	16	0.28977
4	58.3215	16	0.08221
5	39.2834	16	0.37457
H0: no autocorrelation at lag order			

Lagrange Multiplier test after break			
lag	chi2	df	Prob > chi2
1	36.5184	16	0.05245
2	30.2124	16	0.01693
3	18.6034	16	0.28977
4	24.3463	16	0.08221
5	17.1717	16	0.37457
H0: no autocorrelation at lag order			

Appendix 3

Johansen tests for cointegration
Trend: constant Number of obs = 171
Sample: 1994m2 - 2008m4 Lags = 1

				5%	
maximum				trace	critical
rank	parms	LL	eigenvalue	statistic	value
0	4	1508.378	.	57.5560	47.21
1	11	1526.1005	0.18721	22.1111*	29.68
2	16	1532.9184	0.07665	8.4752	15.41
3	19	1537.1416	0.04819	0.0288	3.76
4	20	1537.156	0.00017		

maximum						
rank	parms	LL	eigenvalue	SBIC	HQIC	AIC
0	4	1508.378		-17.52157*	-17.56525	-17.59506
1	11	1526.1005	0.18721	-17.51838	-17.63847*	-17.72047
2	16	1532.9184	0.07665	-17.44778	-17.62246	-17.74174
3	19	1537.1416	0.04819	-17.40697	-17.6144	-17.75604
4	20	1537.156	0.00017	-17.37707	-17.59542	-17.74451

Johansen tests for cointegration
Trend: constant Number of obs = 81
Sample: 2008m4 - 2014m12 Lags = 2

				5%	
maximum				trace	critical
rank	parms	LL	eigenvalue	statistic	value
0	20	742.95291	.	52.1363	47.21
1	27	756.86687	0.29076	24.3084*	29.68
2	32	763.66396	0.15450	10.7142	15.41
3	35	768.60508	0.11485	0.8320	3.76
4	36	769.02106	0.01022		

maximum						
rank	parms	LL	eigenvalue	SBIC	HQIC	AIC
0	20	742.95291		-17.25947*	-17.61348	-17.85069
1	27	756.86687	0.29076	-17.22325	-17.70118*	-18.0214
2	32	763.66396	0.15450	-17.11982	-17.68625	-18.06578
3	35	768.60508	0.11485	-17.07907	-17.6986	-18.11371
4	36	769.02106	0.01022	-17.03509	-17.67231	-18.09929