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STRUCTURALIST VS. POST-KEYNESIAN THEORY: INDUSTRIAL PRICING IN INDIA

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Abstract

How is industrial price determined in India? Using 40 years data spanning from 1970-71 through 2009-10 we provide fresh evidence to this question. We ask whether industrial pricing responds more to wage cost that rises with exogenous factors such as food prices (Structuralist theory) or to the endogenous need to finance new investment (i.e., Post-Keynesian theory). Though both the theories argue that industrial price is cost-determined, yet they differ in their methodology and thus, policy implication differs. We use Engel-Granger cointegration test and ARDL bounds test to answer the question. Since data support both the theories, a non-nested test is conducted where we find that the Structuralist theory outperforms its rival. This points out to the important role of agricultural goods in general, and food prices in particular in industrial price. The policy implication of this finding is that since agricultural prices play an important role in industrial price inflation, then monetary policy cannot control core inflation. Rather, the solution may lie in improving agricultural productivity through raising greater public investment.

1. INTRODUCTION

The behavior of industrial price in India is governed by many factors like domestic agricultural production shortfall, exogenous shocks (raw materials and fuel prices), and overheating of the economy. But the performance of agriculture has always remained a key determinant of industrial price in India. Monetary policy, however, cannot control food inflation and fuel inflation. Thus, it should try to control sticky prices. Core inflation gives better information of the price pressures in the economy. If monetary policy targets headline inflation, it will become more volatile which does not augur well for the economy. Bryan and Cecchetti (1994) argued that since price changes due to bad monsoon do not constitute underlying monetary inflation, the monetary authorities should avoid basing their decisions on them. Similarly, Motley (1997) argued that since changes in food and energy prices, though have large effects on aggregate price level, revert quickly, they do not require a monetary policy response.

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Big central banks around the world have shifted their goals from headline to core inflation targeting. Since manufacturing inflation is taken as a proxy for core inflation, it calls for choosing an appropriate model for industrial price. Hence, this paper seeks to explain industrial price behavior and whether central bank has any role in controlling it. Thus, if it is determined by market forces (i.e., demand and supply) like that of developed countries, monetary policy can be helpful in controlling inflation. But if supply forces govern the price behavior of industrial products then hands of monetary policy are tied off.

Majority of the existing literature in India suggests that industrial prices are cost-determined (Chatterji, 1989, Balakrishnan, 1991, Sen & Vaidya, 1995).[1] It has been established that the cost-push factors have greater influence on industrial prices than demand pull factors (Bhattacharya & Lodh, 1990). Indian market structure is more or less oligopolistic in nature which implies that it has excess capacity and thus, can adjust to changing demand[2]. A typical feature of the oligopolistic market is that costs determine prices and demand determines output. The presence of excess capacity implies that if there is any short-run fluctuation in the demand, firms will respond by changing output.

In this paper we investigate the pricing behavior of industrial sector in India. In the literature two prominent theories - the Structuralist approach and Post-Keynesian approach - have been studied. Though these theories essentially believe that industrial prices are cost-determined, they differ in methodology and thus the policy prescription also differs. Balakrishnan (1991) showed industrial price inflation is linked to food inflation in general and relative price of food grains in particular.

The rest of the paper is organized as follows. Section 2 explains the two theories briefly. In section 3, discusses both the models. Methodology and data are discussed in section 4. Section 5 reports and interprets estimation results. As a robustness check, we did ARDL bounds test. Methodology of and results of ARDL bounds test are discussed in section 6. A non-nested test is conducted in section 7 to ascertain which theory fits to the data generating process better. Final section concludes the paper.

2. THEORY

2.1. The Structuralist theory

The Structuralist theory argues that the roots of inflation lie in the bottlenecks of agricultural sector. It is assumed that agricultural sector suffers from low productivity and thus, its supply is inelastic in the short run. The distinguishing feature of the Structuralist approach is the argument that this can lead to inflation. The structure of the economy is divided according to the rules of price formation and output determination. Thus, agricultural price is demand-determined and output is supply-determined while industry is characterized by cost-determined price and demand-determined output. This disaggregation of the macro-economy combined with a weak agricultural sector that is afflicted by low productivity implies that rising economic growth led by industrialization or expansion of non-agricultural sector puts upward pressure on demand for food stuffs and raw materials. Since agricultural output is supply-determined and cannot keep pace with rising demand, rising demand would only result in higher agricultural prices. As a result, relative price of agricultural goods rises. Relative prices of agricultural goods play a crucial role in ensuring inflationary process in the developing economies. This implies that every change in the structure of the economy requires a change in the relative prices (Canavese, 1982). This linking of the changes in the relative prices to the changes in the general prices is the most important feature of the theory of “structural inflation”. Structuralist impose another assumption that money prices of industrial products exhibit downward rigidity. The implication of this assumption is that when workers in the firms bargain for a rise in

[1] Chatterji (1989) did not find evidence of demand. But Madhur and Roy (1986) showed role of demand in the industrial price formation.

[2] Mani (1993) found the four firm concentration ratios for various industries in India between 1960 and 1988 have been high (averaging between 75% and 80%) and reasonably stable.

money wage in order to maintain the real wage, firms would allow a rise in money wage. Since cutting industrial prices is not ruled out, firms will pass these costs in terms higher money prices of industrial goods. This endogeneity of money wage is the core of the Structuralist theory. This type of propagation mechanism is a crucial aspect of the Structuralist explanation of the inflationary process. Although it cannot generate inflation on its own, this is sufficient enough to cause an economy wide inflation (Sunkel, 1958). Hence, given that non-food prices are sticky, rise in relative prices of food brings about rise in the general price level. Higher cost of industrial products would be fed into higher industrial prices. And this process is repeated to ensure inflationary process in the economy. This sparks off a wage-price inflation spiral (Kalecki, 1955).

Balakrishnan (1991) modeled the Structuralist theory in the Indian context. Though he finds theory fits to data well, the drawback of the theory is that for industrial sector to experience inflation there must exist supply bottlenecks or structural infirmities in the agricultural sector. One implication of the theory is that the necessary impulse for rising industrial price must come from agricultural sector. Stated otherwise, any autonomous development within the industrial sector cannot generate inflation. This implicit assumption has been criticized by Sen and Vaidya (1995) who argued that the Structuralist theory of industrial prices implies once structural bottlenecks from agriculture are removed industrial price cannot rise on its own.

2.2. The Post-Keynesian theory

Post-Keynesian theory, on the other hand, argues that industrial prices are determined by a wage cost plus mark-up rule (Weintraub, 1959, Eichner, 1976, Sen & Vaidya, 1995). Industrial prices are taken to be positively related to the profit mark-up and money wages and negatively to labor productivity. Post-Keynesians argue that firm's investment expenditure and the cost of external funds influence the mark-up. It implies if the firm wants to make new investments it can do so by raising the profit mark-up, that is, by raising the industrial price.

Sen and Vaidya (1995) tested both theories for the period 1960-88[3]. They found both the theories explain the data generating process. To find the theory that provides a better explanation of industrial price behavior, they applied cointegration techniques. Since they did not find evidence of cointegration in the Structuralist theory, they concluded Post-Keynesian theory is superior to the Structuralist theory.

However, one minor comment on Sen and Vaidya's paper is in order. The authors take prices of food articles in the Structuralist equation. Since they did not find cointegration among the variables, they argued that Post-Keynesian theory is better than its rival. They could have considered prices of food grains or primary articles in the estimation. Further, the authors did not mention the source of raw material prices or how they constructed it.

3. THE MODEL

3.1. The post-Keynesian model

Since the market structure of industrial products is often oligopolistic, the Post-Keynesian theory recognizes that price of industrial goods is cost determined. Post-Keynesian theory starts with the Wage-Cost Markup (WCM) which is stated below as[4].

$$P_t = \frac{K_t W_t}{Z_t} \qquad \text{………………….... (1)}$$

where *P*, *K*, *W*, and *Z* denote price index, profit markup, money wage per worker, and labor productivity in the industrial sector respectively.

[3] They have not mentioned time line of the study. The plots in their paper suggest time line: 1960-88.
[4] This model is reproduced from Sen and Vaidya (1995).

The markup is assumed to be an increasing function of investment. Since it is only an identity, Eichner (1976) provided a model that converts the above identity into a theory of industrial prices. Eichner argues that firms in the oligopolistic industry not only try profit maximization in the short run but also seek to maximize growth rates in the long run (see Sen & Vaidya, 1995). Hence, a firm would try to venture into new business and withdraw it from old industries. To do this the firm needs to raise the profit markup, which is termed as 'corporate levy' by Eichner. Thus, the theory postulates that the need for generating internal funds for new investment would lead to increase in profit mark-up, which would eventually lead to a rise in industrial prices. Further, a rise in money wage more than rise in productivity would result a rise in industrial prices. He further says that "the pricing decision in an oligopolistic industry is intimately bound up with the capital accumulation process" (see Eichner, 1976). Thus, Eichner provided the link between industrial price rise with industry's additional investment.

The demand for and supply cost of additional funds would determine industrial price. Planned investment expenditures constitute firm's demand for funds. To finance new investment the firm can generate internal funds by increasing profit markup, i.e., the corporate levy and borrowing from external sources. Though Eq(1) postulates that the firm has the power to increase industrial price to finance investment, Eichner (1976) however, argues that 'real cost' constrains the firms to increase the industry price level. The 'real cost' of the firm is the substitution factor, the entry factor, and the threat of government intervention. Thus, a part of the additional fund will come from external sources. The cost of external borrowing is interest rate. Thus, letting *R* as the interest rate and *I* as investment we can re-write Eq(1) as follows

$$P_t = \frac{f(R_t, I_t)\ W_t}{Z_t} \qquad \text{.......................... (2)}$$

where K = f (R, I), $f_R > 0, f_I > 0$

Eq(2) posits that mark-up is an increasing function of investment and interest rate.

We can specify the following functional form for K:

$$K = e^{a_0} R^{a_1} I^{a_2} \qquad \text{.......................... (3)}$$

where $a_0, a_1, a_2 > 0$.

Substituting Eq(3) into K in Eq(2) and taking log of both sides give us

$$P_t = a_0 + a_1 r_t + a_2 i_t + w_t - z_t \qquad \text{.......................... (4)}$$

where lower-case letters denote logs of the respective variables.

Though Eq(4) implies that changes in wages and productivity lead to equi-proportionate changes in industrial price, in reality firms absorb a part of rise in wage by reducing mark-up; and further, the firm also appropriates a part of productivity gains without reducing price. Taking account of the above facts the price equation is given as follows:

$$P_t = a_0 + a_1 r_t + a_2 i_t + (1 - a_3) w_t - (1 - a_4) z_t \qquad \text{.......................... (5)}$$

Eq(5) is the equation to be estimated by OLS. The equation represents the long-run relationship between industrial price, interest rate, investment, money wage and labor productivity.

3.2 The Structuralist model

This study tests Structuralist approach in two different ways.

3.2.1 Balakrishnan specification

We discussed earlier that the Structuralist theory believes that industrial prices are essentially cost determined. Hence, costs are decomposed into wage cost and raw material cost.
The level equation is given by

$$ip_t = \beta_1 + \beta_2 mw_t + \beta_3 rmp_t - \beta_4 z_t \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (6)$$

where *ip*, *mw*, *rmp* and *z* denote industrial price, money wage, raw material price and labor productivity respectively.

Does demand have any role to play in determination of industrial price? How does the price-cost strategy of the firm change in response to the cycle? How does the profit mark-up of the firms affect the industrial price? Though the Structuralist theory does not have a theory of mark-up, Balakrishnan (1991) modeled and showed the counter-cyclical nature of the mark-up. This implies when economic activity declines due to either agricultural shock or a recession, in order to maintain the profit, firms would raise the mark-up. Following the work of Balakrishnan (1991) we added the mark-up in our error correction model which is given below:

$$\Delta ip_t = \beta_1 + \beta_2 \Delta mw_t + \beta_3 \Delta rmp_t - \beta_4 \Delta z_t - \beta_5 ECM_{t-1} - \beta_6 D_t \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (7)$$

where *D* is the activity index, *ECM* is the error correction term that measures the speed at which past deviations from equilibrium value are corrected in the short-run.

The activity term captures the mark-up. A significant and negative *D* implies that mark-up is counter-cyclical and the interpretation is that the state of business cycle (or demand factors) has an important role in firm's pricing decisions.

3.2.2. Sen and Vaidya specification

Balakrishnan's specification (1991) of industrial price is not a true reduced-form 'Structuralist' equation, since it does not take into account of food articles *explicitly* which is key to Structuralist theory (Sen & Vaidya, 1995). They derive 'Structuralist' equation as follows.

$$ip_t = \beta_1 + \beta_2 mw_t + \beta_3 rmp_t - \beta_4 z_t - \beta_5 D_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (8)$$

Next, we specify the wage equation. Money wages are taken to be a function of the cost of living, given by the general price level, and productivity:

$$mw_t = \alpha_1 + \alpha_2 gp_t + \alpha_3 z_t \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (9)$$

where *gp* is the general price level.

Further, the general price level is the weighted average of three sectoral prices, namely, food price, industrial price, and raw material price. Letting w_i denote respective weights.

$$gp_t = w_1 fp_t + w_2 rmp_t + w_3 ip_t \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (10)$$

where $\sum_{i=1}^{3} w_i = 1$ and *fp* is the food price.

Plugging Eq(10) in Eq(9), we get

$$mw_t = \alpha_1 + \alpha_2 w_1 fp_t + \alpha_2 w_2 rmp_t + \alpha_2 w_3 ip_t + \alpha_3 z_t \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (11)$$

Then substituting Eq(11) in Eq(8) gives us

$$ip_t = \gamma_1 + \gamma_2 fp_t + \gamma_3 rmp_t + \gamma_4 z_t - \gamma_5 D_{t-1} \quad \text{.......................... (12)}$$

where γ_i are reduced-form coefficients with expected signs as given in the equation.

$$\gamma_1 = (\beta_0 + \alpha_1\beta_0)/(1-\beta_2\alpha_2 w_3), \quad \gamma_2 = (\beta_2\alpha_2 w_1)/(1-\beta_2\alpha_2 w_3), \gamma_3 = (\beta_2\alpha_2 w_2)/(1-\beta_2\alpha_2 w_3)$$
$$\gamma_4 = (\beta_2\alpha_3 - \beta_4)/(1-\beta_2\alpha_2 w_3), \quad \gamma_5 = (\beta_5)/(1-\beta_2\alpha_2 w_3)$$

4. METHODOLOGY AND DATA

Engel and Granger (1987) cointegration technique is used to test both theories. It requires all the variables should be *I*(1) i.e. integrated of order one. In the first step, this requires estimating the equation on the levels of the variables and if unit root test performed on residuals saved from level equation is *I*(0), i.e., stationary, we say the variables are cointegrated. In the second step, a dynamic equation should be estimated. And if the error-correction term is significant, the interpretation is that though the variables are cointegrated in long run, in the short run they deviate from their equilibrium values.

For our empirical analysis annual data spanning 1970-71 through 2009-10 is used. We take SBI advanced lending rate as a proxy for interest rate. We take SBI advanced lending rate, Wholesale Price Index (WPI), Consumer Price Index-Industrial Workers data from Handbook of Statistics on the Indian Economy, Reserve Bank of India. Data on wage, output and employment are taken from the Annual Survey of Industries (Central Statistical Organization (CSO)). Data on private corporate sector gross investment and private fixed investment are obtained from the National Accounts Statistics (CSO).

Industrial price series, *ip*, is constructed with base year 1981-82 = 100 by merging manufacturing price index with electricity price index[5, 6]. Both the price series are taken from WPI series of the EPW research foundation (EPWRF) time series data base. Price index of raw material is taken from Dash (2012)[7].

Money wage rate, *mw*, is defined as the total emoluments divided by the total number of employees in the manufacturing sector. Labor productivity, *z*, is defined as real (both gross and net) value added divided by the total number of employees in the manufacturing sector. To capture role of demand we use proxies like *IIP gap* (defined as deviation of actual output from its potential), Capacity Utilization Ratio (*CUR*). Following Chatterji (1989), we define CUR the ratio of actual output to potential output in the manufacturing sector. Potential output is defined as 5 year moving average. We use two definitions for private investment namely, private gross capital formation (*pgcf*), and private fixed capital formation (*pfcf*).

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[5] The formula used to merge two indices is: $IP = (W_M/TW) * P_M + (W_E/TW) * P_E$
where W_M and W_E refer to weights of manufacturing and electricity price respectively; P_M and P_E represent respective prices. *TW* stands for the sum of two weights.

[6] Price of manufacture products in the WPI excludes electricity price. The manufacturing sector data provided by the Annual Survey of Industries includes some sectors that the former excludes. These sectors are Electricity, Gas and Steam, Water Works & Supply, Storage & Warehousing, and Repair Services. The price indices of the last four of these sectors are not available in the WPI. Further, the definition of manufacturing sector keeps on changing in various revisions. Hence both the series are not directly comparable. So we neglect those sectors whose contribution to the gross manufacturing output is less than 1 percent. Since share of electricity in gross output of the manufacturing sector is around 10%, we merge the electricity price with manufacturing price to obtain Industrial price series, *ip*.

[7] See the Appendix II in Dash (2012) for a detailed discussion of the methodology.

5. RESULTS

5.1. Unit root test

We test the order of integration of logarithm of variables. We applied both ADF test and KPSS test to test the stationarity of variables. The null hypothesis of ADF test is non-stationarity; whereas the null hypothesis is stationarity for the KPSS test. ADF tests show (see Appendix I) all but demand proxy variables are $I(1)$ at 5% level of significance. Demand proxy variables are $I(0)$. But KPSS tests show labor productivity, and private investment variables like pfcf, pgcf are $I(0)$. However, we treat all but demand variables as $I(1)$[8].

5.2. The Post-Keynesian approach

Columns I and II of Table 1 report results of level equation of the Engel-Granger two-step regression. Applying ADF test on residuals saved from the level equation, we reject the hypothesis of non-cointegration at 1% level of significance[9]. Thus, we conclude that the variables are cointegrated. Since the level equation is a static regression, its coefficients can be interpreted as long-run coefficients. The signs are in accordance with the theory. The results show that interest rate, money wage and private investment have a positive impact on industrial price inflation. Though, sign of the labor productivity is negative, as expected, yet it is not significant.

Table 1: Post-Keynesian estimation of industrial pricing

Dependent Variable: ip Level Equations			Dependent Variable: Δip Error Correction Equations		
Regressors	**I**	**II**	**Regressors**	**III**	**IV**
Constant	1.12***	1.30***	Constant	0.04***	0.04***
R	0.14***	0.13***	Δr	0.15***	0.12***
Pgcf	0.05		Δpgcf	0.04**	
Pfcf		0.08***	Δpfcf		0.07***
Mw	0.68***	0.63***	Δmw	0.31***	0.31***
Z	-0.12	-0.15	Δz	-0.17*	-0.17***
			ECM (-1)	-0.25*	-0.26***
R^2	0.99	0.99	R^2	0.40	0.41
Resid#	No***	No***			
D-W			D-W	1.54	1.75
F statistic			F statistic	4.44***	4.63***

Notes: (1) All variables are in logarithm form. (2) # refers to ADF test of unit roots in the residuals saved from the level equation. We estimated only "none" equation of ADF test. (3) 'No' implies there is no unit root, implying existence of cointegration. (4) ***, **, and * denote significance levels at 1%, 5%, and 10% respectively

The next step is to estimate the dynamic equation; that is the error correction model which is estimated by regressing the first difference of each variable in the cointegration equation and addition of the lagged value of the error correction term (ECM) saved from the level equation[10].

Results of the error correction model are presented in Columns III and IV of Table 1. All variables are significant and have signs, as the theory suggests. The labor productivity, though insignificant in level equation, is highly significant in dynamic regression. The significance of the error correction

[8] Since, KPSS test suggests some variables as $I(0)$, ARDL model is used to estimate models.

[9] Since the residuals of the level equation will be free from serial correlation, ADF test is not relevant here. Because DF test is not in the EViews package, we apply ADF test. As a robustness check, we did KPSS test which gives us the same result.

[10] We added lag variables in our dynamic regression but none of the variables are found to be significant. Whenever the lagged variables are significant they severely worsen the explanatory power of the other variables in the equation. The same case arises when we estimate the Structuralist equation.

term implies there exists a cointegration among the variables. It shows that one-fourth of the deviation actual price from the equilibrium price in the last year is corrected in this year. Since the ECM term is negative, this implies that the in the short-run actual price is greater than the long-run relationship suggests. Post-Keynesians refer to it as the "rising market" phenomenon which implies existence of excess demand for manufacturing goods. As a consequence, Post-Keynesians argue that money wages would rise and productivity would fall in a "rising market".

Since private investment is so important for the mark-up in the Post-Keynesian theory, we replace *pgcf* by private fixed capital formation, *pfcf*. Both the level and error correction model suggest that there is cointegration (see Column II and IV respectively). Further, *pfcf* is significant both in level and dynamic equation. Importantly, the magnitude of *pfcf* is marginally higher than *pgcf*.

Residual diagnostic tests do not find evidence of heteroscedasticity, autocorrelation, non-normality of residuals (though not reported here). Finally, CUSUM of squares test and CUSUM test of the recursive estimation are conducted to test the stability of the coefficients. The test suggests parameter instability if the cumulative sum of recursive residuals goes outside the area between the two critical lines. Plots (not reported here) suggest parameters are stable over time.

5.3. The Structuralist approach

Column I & II of Table 2 report results of estimation of Sen-Vaidya specification of the Structuralist theory. Column III presents the best fitted model of Balakrishnan specification of the Structuralist theory. Labor productivity, irrespective of definition, is not significant[11]. Residuals saved from these regressions are put to unit root test to see if the residual series is stationary. The ADF test results show that the residuals don not contain unit root[12]. Hence, we conclude that the variables in the Structuralist equation are cointegrated in the long run.

Table 2: Results of Structuralist (Level) Equation

	Sen-Vaidya Specification		**Balakrishnan Specification**
Regressors	I	II	III
Intercept	0.35*	0.15	1.32***
Mw			0.52***
Fa	0.59***		
Fpi		0.46***	
Rmp	0.32***	0.43***	0.33***
Z	0.01	0.06	-0.15
R^2	0.99	0.99	0.99
Resid#	No**	No*	No*

Dependent Variable: ip

Notes: (1) All variables are in logarithm form. (2) fa and fpi denote price indices of food articles, foodgrains respectively. z is the labor productivity. (3) # refers to ADF test of unit roots in the residuals saved from the level equation. We estimated only "none" equation of ADF test. (4) 'No' implies there is no unit root, implying existence of cointegration. (5) ***, **, and * denote significance levels at 1%, 5%, and 10% respectively.

The results, as predicted by Structuralist theory, suggest that industrial prices are positively related to wage and raw material cost. The specification developed by Sen and Vaidya also confirms to the prediction of Structuralist theory. It is useful to mention here that the magnitudes of both

[11] We use three alternative definitions of labor productivity. First, following Banga and Goldar (2005) we also define *z* as gross value added per employee in the manufacturing sector divided by manufacturing price index. Second, we define *z* as real net value added divided by total number of employees in the manufacturing sector. Third, *z* is defined as real net valued added per employee in the manufacturing sector. But all turn out to be insignificant and sometimes wrong signs also.

[12] The KPPS test shows the same result; evidence of no unit root in the residuals.

specifications are almost similar. Labor productivity, however, turns out to be insignificant in both specifications.

Further, as we argue in the Section 2.2 that Sen and Vaidya could have tried with prices of food grains in their estimation, we also consider prices of food grains. As Column II of Table 2 shows, food grains price is also significant.

More importantly, we find evidence of cointegration in both the specifications. We choose to recall that Sen and Vaidya did not find cointegration and thus concluded that the Post-Keynesian specification was superior to the alternative competing Structuralist specification.

Table 3: Results of Structuralist (Dynamic) Equation

	Sen-Vaidya Specification			Balakrishnan Specification
Regressors	**I**	**II**	**III**	**IV**
Intercept	0.02**	-0.17	-0.06	-0.06
Δmw				0.23*
Δfa	0.23*	0.27**		
Δfpi			0.23***	
Δrmp	0.33***	0.33***	0.33***	0.38***
Δz	0.01	-0.04	-0.03	-0.16*
ECM (-1)	-0.20	-0.26*	-0.18	-0.27**
D		0.04	0.02	0.02
R^2	0.51	0.57	0.60	0.59
D-W	1.37	1.43	1.51	1.48
F statistic	8.74***	7.94***	9.00***	8.57***

Dependent Variable: Δip

Notes: (1) All variables except *D* are in logarithm form. (2) Estimates of Column IV are heteroscedasticity-corrected by White test. (3) ***, **, and * denote significance levels at 1%, 5%, and 10% respectively.

After establishing presence of cointegration in the first step, error correction model is estimated in the second step. Columns in Table 3 represent regressions. Columns I through III are estimated using Sen-Vaidya specification. In all these columns both raw material cost and wage cost are significant and positive. Magnitudes in both the specifications are similar. The ECM term is negative and significant in Column II. The result of Balakrishnan specification is presented in Column IV. ECM term is significant and negative. It suggests that there exists a long-run relationship and further, any disequilibrium in price and costs are corrected. Labor productivity is negative and significant. The fit of the model increased considerably compared to Post-Keynesian specification. It shows that the model provides a nice explanation of industrial price. The activity term, *D* is consistently insignificant[13]. Balakrishnan (1991), however, found the activity term to be highly significant and negative implying a counter-cyclical mark-up.

It is important to note here that the Sen-Vaidya derived the true reduced-form Structuralist model which replaces money wage with price of food articles. However, if we compare both the models (See Table 3), coefficients of *fa* and *mw* are strikingly similar. Thus, it suggests Balakrishnan's specification is robust.

Residual diagnostics of Column IV suggests the model suffers from heteroscedasticity at 5% level of significance. Hence, it is corrected by the White test and thus, White-corrected consistent estimated are reported. Further, CUSUM test and CUSUM of squares test are conducted on recursive residual

[13] *D* is measured by capacity utilization ratio (CUR).We tried with IIP gap, CUR3 (defined as ratio of actual output to potential. Potential output is a 3 year moving average). Similarly, we also created CUR5. But each turns out to be insignificant, perhaps suggesting a Wharton Index of capacity utilization captures activity better than the methodology adopted here.

to find out whether coefficients are constant over time. CUSUM test (charts not reported here) suggests instability of the parameters around 1992-95. However, CUSUM of squares test shows absence of coefficient instability in the estimated period. It is to be noted that stability test of Structuralist model model suggests the constancy of the parameters. As a robustness check, we subject our models to Bai-Perron multiple breakpoint tests. Though not reported here, the tests suggest no parameter instability in the estimated tine period.

6. ROBUSTNESS CHECK

Though the Engel-Granger test suggests cointegration exist in both the frameworks, as robustness check we apply Autoregressive Distributed Lag (ARDL) bounds testing approach to test cointegration. It has been shown that Engel-Granger cointegrating test is best suited for two variables, not for testing cointegration among multiple variables. ARDL results are superior to the finding of Engel-Granger cointegrating test in that it can be employed when variables are mixture of $I(0)$ and $I(1)$. Further, there is a conflict between the ADF test and KPSS test with regard to order of integration of variables like labor productivity, private investment – both *pgcf*, *pfcf*. Thus, since variables in the model are mixture of $I(0)$ and $I(1)$, ARDL is best suited to model variables. Next, we discuss the methodology of the ARDL in brief.

6.1. The methodology of ARDL bounds test

The ARDL modeling procedure is executed in three steps. In the first step, we estimate the ARDL model. Appropriate lag of the model is chosen on the basis of information criteria. Once, the model having the lowest AIC is chosen, the residual of this model should be serially independent. Accordingly, we apply the LM test. In the second step, we apply the “bounds test” to test the existence of cointegration among variables. The null hypothesis is that there is no long-run relationship among the variables. Pesaran *et al*. (2001) provided two sets of critical values of F statistic. The lower [upper] bound critical values are calculated on the assumption that all variables are $I(0)$ [$I(1)$]. If the computed F-Statistic is lower than lower bound of the critical value at chosen level of significance, the null hypothesis of no-cointegration cannot be rejected. If the computed F-Statistic lies in between the lower and upper bound of the critical value, the result is inconclusive. Lastly, if it lies above the upper bound of the critical value, the null is rejected and the conclusion is that cointegration exists. Once the presence of cointegration is established, the final step of ARDL modeling is to estimate an error-correction model. With this brief methodology we will present the results of bounds test.

6.2. Results and interpretation

The first step of ARDL model is to ensure that none of the variables are $I(2)$. The unit root test results, presented in Appendix I, shows it satisfies this criteria. We then apply ARDL approach to log of variables.

First, we present the bounds test results of Post-Keynesian model. Results are reported in Table 4. The first step of the model is to choose appropriate lag structure. The AIC suggested ARDL (1, 3, 1, 2, 3). The order of the variable is as given in Table 4. Then we checked serial correlation, heteroscedasticity, and normality test. The chosen model is free from all of these residual tests. Next step is to conduct a bounds test. Since the computed F-statistic is greater than at 1% level of significance, we reject the null hypothesis of no long-run relationship. Thus, we conclude that there is presence of cointegration among variables in the Post-Keynesian theory. The long-run cointegrating coefficients are presented in Table 4. The error correction term in the cointegrating equation is negative as expected and significant at 5% level of significance (result is not reported here). The significance of this error correction term also confirms to the conclusion of the bounds test which suggests existence of long-run cointegration. However, in the long-run cointegrating model, all variables except *mw* are insignificant.

Table 4: The Results of ARDL Bounds Test for Cointegration - Post-Keynesian Model

Post-Keynesian Model (ip, mw, lp, r, pfcf) Dynamic Regressors: ip, mw, lp, r, pfcf Fixed regressors: C, @Trend Selected Model: ARDL (1, 3, 1, 2, 3)		
F-statistic	5.90	$K^{\$}=4$
	Critical Value Bounds	
Significance level	*I*(0)	*I*(1)
10%	3.03	4.06
5%	3.47	4.57
1%	4.4	5.72
Long Run Coefficients		
Regressors	Coefficients	
Mw	1.65***	
Lp	0.45	
R	0.09	
Pfcf	-0.43	
Intercept	-1.20	
Trend	-0.04	

Note: (1) *** implies significant at 1% level of significance; $ implies K is the number of regressors

Next, we test the Balakrishnan specification of the Structuralist theory. Test results are presented in Table 5. The best model chosen by AIC is ARDL (1, 3, 3, 1, 3). The order of the variable is as given in Table 5. We then conducted a battery of residual tests. Residual tests suggest that the estimated residuals are not serially correlated, homoscedasticity and normally distributed. The Ramsey RESET test suggests the chosen model is free from specification error problem.

Table 5: The results of ARDL bounds test for cointegration – Structuralist model

Structuralist Model – Balakrishnan Specification (ip, lp, mw, rmp, D) Dynamic Regressors: ip, lp, mw, rmp, D Fixed regressors: rmp, C, @Trend Selected Model: ARDL (2, 2, 3)		
F-statistic	5.44	$K^{\$}=4$
	Critical Value Bounds	
Significance level	*I*(0) Lower Bounds	*I*(1) Upper Bounds
10%	3.03	4.06
5%	3.47	4.57
1%	4.4	5.72
Long Run Coefficients		
Regressors	Coefficients	
Mw	1.10***	
Lp	0.90	
Rmp	0.28	
D	-5.00	
Intercept	18.31	
Trend	-0.10**	

Note: (1) **** and ** imply significant at 1% and 5% level of significance. (2) $ implies K is the number of regressors

Then next step was to apply bounds test. Since the computed F-statistic is greater than the critical value at 2.5% level of significance, we reject the null of no cointegration and conclude that variables industrial price, labor productivity, money wage, raw material prices are cointegrated. However, our finding of cointegration is not robust when we remove the activity index; that is the capacity utilization ratio. Table 5 also reports the long-run coefficients and the cointegrating equation.

Further, though not reported here, we found the error correction term is negative and significant at 10% level of significance, thus confirming the presence of cointegration among the variables. It is to be noted that in the long-run cointegrating equation, only *mw* and *trend* terms are significant.

To summarize, the findings of ARDL bounds tests and long-run cointegrating model suggest that there is a cointegration among variables in both the theories. And this suggests our findings about cointegration are robust.

7. NON-NESTED TEST

Since there are two competing theories of cost-determined industrial pricing, it is pertinent to ask which model better fits to data. To answer this question, first we compare the properties of the models. The explanatory power of the Structuralist model being 0.60 (in both specifications; see Table 3) higher than Post-Keynesian model, 0.41. Note that time period is 1971-2010. In case of two competing models trying to explain industrial inflation it is better to perform a non-nested test
The specification of the non-nested F test is written below

$$H_0: \text{Model } 1 = \theta_0 + \theta_1 \text{fa} + \theta_2 \text{rmp} + \theta_3 \text{z} + \varepsilon_1$$
$$H_1: \text{Model } 2 = \delta_0 + \delta_1 \text{mw} + \delta_2 \text{pgcf} + \delta_3 \text{r} + \delta_4 \text{z} + \varepsilon_2$$

where 'Model 1' and 'Model 2' refer to the 'Structuralist Model' and 'Post-Keynesian Model' respectively and the non-nested model, Model 3, is given by

$$\text{Model 3}: \theta_0 + \theta_1 \text{fa} + \theta_2 \text{rmp} + \theta_3 \text{lp} + \delta_0 + \delta_1 \text{mw} + \delta_2 \text{pgcf} + \delta_3 \text{r} + \delta_4 \text{z} + \varepsilon_1 + \varepsilon_2$$

We say that H_0 encompasses H_1 if (i) 'Model 1' fits the data better than Model 2' and (ii) 'Model 1' can explain the way in which 'Model 2' fails to fit the data (Gilbert, 1989). In the non-nested model (i.e., Model 3), if coefficients of variables *mw*, *pgcf*, and *r*, are zero, then H_0 encompasses H_1. Similarly, if coefficients of variables *fa* and *rmp* are zero, then H_1 encompasses H_0. In the wake of large number of alternative ways of comparing competing hypotheses, it has been argued that the use of the Classical *F* test provides the most general encompassing test (See Gilbert, 1989). The results are reported in Table 6.

Table 6: Results of non-nested test

Test	Sen-Vaidya Specification F-statistic	Balakrishnan Specification F-statistic
'Model 1' Vs. 'Model 2': F(3, 32)	3.08	4.53
'Model 2' Vs. 'Model 1': F(2, 32)	10.76	20.14

Note: (1) Time period: 1971-2009. (2) For Sen-Vaidya Specification, F Critical-values at 10% are F (3, 32) =4.51, F (2, 32) = 5.39 respectively. For Balakrishnan Specification, F Critical-values at 10% are F (2, 32) = 3.32 and F (1, 32) = 4.17

The test hypothesis 'Model 1' Vs. 'Model 2' is to be read as follows: Model 1 (Structuralist Model) outperforms Model 2 (Post-Keynesian Model). If the calculated F-statistic is greater than critical F-statistic, then we reject the null and conclude that Model 1 does not outperform Model 2. Similarly interpretation follows for 'Model 2' Vs. 'Model 1'. We pit the Post-Keynesian model against both the specifications of Structuralist model. On the basis of Sen-Vaidya specification, we find clear evidence from the classical *F* Test that the Structuralist model outperforms Post-Keynesian model in explaining industrial inflation. But, when it comes to Balakrishnan specification of the Structuralist model, *F* Test suggests that none of the models are superior. Hence, we conclude that the Structuralist model explains data better than its rival, the Post-Keynesian model.

8. CONCLUSION

This study investigated pricing behavior in the industrial sector against the backdrop of Sen and Vaidya's (1995) finding that the Post-Keynesian is model is superior to the Structuralist model. Results of Engel-Granger cointregartion and ARDL suggest that variables in each theory are cointegrated and also existence of error correction mechanism which implies any deviation of industrial price from the long-run price is corrected in the short-run. Thus, the econometric results support both the theories. Thus, a classical *F* test or the non-nested test is conducted to find out which model accounts for industrial price better. *F* test suggests that the Structuralist model is superior to the Post-Keynesian explanation of industrial inflation in India. It is important to note that though both the models essentially believe that industrial prices are cost determined, they differ in their approach. Accordingly, the policy implications of models also differ. But because the Structuralist model provides a better explanation of the data, it points out to the important role of agricultural goods in general, and food prices in particular in industrial price. Since the Structuralist theory argues propagation mechanism will lead to sustaining inflation, removing bottlenecks from the agricultural sector would help stabilize industrial inflation, unless and until the firms raise the mark-up, i.e., the corporate levy, and money wage rises due to rise in productivity as the Post-Keynesian theory argues. However, Post-Keynesian theory rightly argues that agriculture is not necessary, rather sufficient condition for rise in industrial prices.

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Appendix I

Table A.1: Results of unit root tests

	ADF test			KPSS Test		
	At Level		First Difference	At Level		First Difference
	C/T	C	C	C/T	C	C
mp	-0.92 (0.94)	-1.75 (0.39)	-3.98 (0.00)	0.19	0.77	0.55
pfcf	-3.25 (0.09)	-0.20 (0.93)	-6.57 (0.00)	0.04	0.77	0.06
pgcf	-2.88 (0.18)	-0.32 (0.91)	-5.86 (0.00)	0.07	0.77	0.07
sbial	-2.41 (0.37)	-2.40 (0.15)	-5.28 (0.00)	0.18	0.18	NR
cmr	-2.98 (0.15)	-2.92 (0.05)	-6.40 (0.00)	0.17	0.20	NR
z	-3.18 (0.10)	-0.18 (0.93)	-6.66 (0.00)	0.08	0.76	0.07
Rmp	-1.94 (0.61)	-0.99 (0.74)	-5.97 (0.00)	0.15	0.78	0.18
Mw	-1.63 (0.76)	-0.72 (0.89)	-6.80 (0.00)	0.16	0.78	0.16
Cur	NR	-6.12 (0.00)	NR	NR	0.14	NR

Notes: (1) All variables are in logarithmic form. (2) (C) denotes test is performed on intercept only and (C/T) implies a trend term is included in the test equation. (3) The critical values at level and first difference for ADF (KPSS) test equation at 5% level of significance are -2.94 (0.46) when the trend is not included and -3.53 (0.146) when the trend term is included. (5) p-values are given in parenthesis. (6) NR implies the test is not done