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MARKUPS, REAL WAGES, AND BUSINESS CYCLES

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Markups and real wages have recently become central concepts in explaining the relationship between market structure and macroeconomic fluctuations.

In this paper, we focus on the empirical testing about the patterns of markups and procyclicality of real wages in Korea using quarterly data during the period of (1970-1995). For that purpose, we construct a simple markup determination model derived from firm's cost minimization principle assuming constant returns to scale technology. With this basic setup, we analyze the relationship between real wages, markups, and business cycles at industry level.

We find several pieces of empirical evidence in this paper. First, the markup ratio is much greater than 1 in most of industries as in Hall (1988). Second, industries with high average markups tend to be largely fluctuating in the level of markups, which gives a certain insight that markups are affected by demand shocks. Third, markups have weak countercyclicality over GNP fluctuations. Fourth, real wages are shown to be procyclical. In addition to those evidence, it is noted that institutional factors such as labor movement could influence on markups, real wages, and economic growth to some extent in Korea.

I. INTRODUCTION

The realtionship between market structure and macroeconomic fluctuations has recently been the focus of attention to many scholars from both theoretical and empirical perspectives. Markups and real wages have gradually become central concepts in explaining the above relationship.

One of the issues of debate along these lines is the cyclicality of real wages. Theoretically, Lucas and Rapping (1969) and Fisher (1981) show countercyclicality of real wages. By contrast, the Real Business Cycle (RBC hereafter) approach

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(Kydland and Prescott (1982), Long and Plosser (1983)) and some of New Keynesian models (Hall (1988), Rotemberg and Summers (1990), and Rotemberg and Woodford (1991, 1992)) support for procyclical real wages. In empirical contexts, while Sargent (1978) and Kim (1988) find countercyclical real wages, others such as Bodkin (1969), Garman and Richard (1992), and Bils (1985) support for procyclical behavior of real wages.

It is generally recognized that, under the assumption of decreasing marginal product of labor and competitive input markets, increases in labor input result in, ceteris paribus, decreases in real wages (coutercyclical real wages). However the real business cycle theories assert that under the assumptions of perfectly competitive markets and constant returns to scale technology increases in labor input can lead to procyclical real wages because production function shifts up due to technological progress. On the other hand, the New Keynesians[1] insist that, in imperfect markets, variations in markup (the ratio of price to marginal cost) can also shift labor demand curve just as technology shocks do. Positive demand shocks can raise output and employment if firms lower markups, thus resulting in countercyclical markups and procyclical real wages.

In this paper, we focus on the empirical testing about the patterns of markups and procyclicality of real wages in Korea using quarterly data during the period of (1970-1995). For that purpose, we construct a simple markup determination model derived from firm's cost minimization principle assuming constant returns to scale technology. With this basic setup, we estimate 24 industrial markups focusing on the manufacturing 2-digit industries and analyze the relationship between real wages, markups, and business cycles at industry level.

Our paper is organized as follows: Section Ⅱ presents empirical model to estimate markups. Section Ⅲ presents our empirical evidences. Section Ⅳ concludes.

Ⅱ. MODEL

We start with constant returns Cobb-Douglas technology to estimate time series for markups. The specification is as follows.

$$y_t = z_t k_t^{\alpha} l_t^{1-\alpha}, \; 0 < \alpha < 1, \tag{1}$$

where y_t, k_t, and l_t denote, respectively, real output, real value of capital stock, and labor hour at time t. z_t represents Hicks-neutral technical progress coefficient at time t and α denotes the elasticity of output with respect to capital stock. If input markets are perfectly competitive, α and $1-\alpha$ are equal to capital and la-

[1] See Rotemberg and Saloner (1986), Stiglitz (1991), and Rotemberg and Woodford (1991, 1992) for theoretical models.

bor share of output respectively. In our model, α and $1-\alpha$ may not be equal to capital and labor share of output since we do not assume apriori perfectly competitive input markets.

Firm's cost minimization with the above production function yields the following cost function.

$$C_t = z_t^{-1}\alpha^{-\alpha}(1-\alpha)^{\alpha-1}R_t^{\alpha}W_t^{1-\alpha}y_t, \tag{2}$$

where C_t, R_t, and W_t denote cost, nominal interest rate, and nominal hourly wage respectively. From equation (2), maginal cost is derived as follows.

$$MC_t = z_t^{-1}\alpha^{-\alpha}(1-\alpha)^{\alpha-1}R_t^{\alpha}W_t^{1-\alpha} \tag{3}$$

Following Hall (1988), markup is defined as price over marginal cost.

$$\mu_t = P_t/MC_t = P_t z_t \alpha^{\alpha}(1-\alpha)^{1-\alpha}R_t^{-\alpha}W_t^{-(1-\alpha)}, \tag{4}$$

where μ_t and P_t represent markup and price respectively.
Taking log both sides of equation (4) yields;

$$\begin{aligned}\ln(\mu_t) = {} & \ln(P_t) + \ln(z_t) + \alpha\ln(\alpha) + (1-\alpha)\ln(1-\alpha) \\ & - \alpha\ln(R_t) - (1-\alpha)\ln(W_t)\end{aligned} \tag{5}$$

Equation (5) is the basic representation for time series of markups. We can thus measure markup series from observed time series for prices, nominal interest rates, nominal wages, and unobserved series for z_t and α. The technology shocks (z_t) and output elasticity (α) are not directly observed, thus be estimated from production function.[2]

In order to estimate z_t and α, we assume that log form of technical progress follows AR (1);

$$\ln(z_t) = \gamma\ln(z_{t-1}) + \nu_t,\ 0 < \gamma \leq 1,\ \nu_t\text{: i.i.d.}, \tag{6}$$

Using equation (1) and equation (6), the production function to be estimated be-

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[2] Our estimation method of Solow residual (measure of technical progress rate) is distinct from those of Solow (1957), Hall (1988), and Rotemberg and Woodford (1991) in that we directly estimate α and z_t. All used output elasticities as observed shares of inputs in deriving markup series which are different from output elasticities (α and $1-\alpha$) if input markets are not competitive. Also Hall (1988) estimated marginal costs abstracting output increase from technical progress rate. Therefore, compared with ours, Hall (1988)'s measure of markups are likely to be underestimated.

comes;

$$\ln(y_t/l_t) = \gamma \ln(y_{t-1}/l_{t-1}) + \alpha \ln(k_t/l_t) - \gamma \alpha \ln(k_{t-1}/l_{t-1}) + \nu_t. \quad (7)$$

From equation (1),

$$\ln(z_t) = \ln(y_t/l_t) - \alpha \ln(k_{t-1}/l_{t-1}) \quad (8)$$

We finally construct markups series by substituting estimates of α and $\ln(z_t)$ (from equation (7) and equation (8) respectively) into equation (5).

Ⅲ. EMPIRICAL RESULTS

The results in table 1 show a basic and comprehensive results: an estimate of production function (α) and average markups measured from equation (5) and equation (7). Estimates of equation (7) proved to be robust and stable even though using quarterly data as it appears in high t-ratio and no autocorrelation. Value added output elasticity to capital stock (α), in general, reflects relatively well industry specificity as capital intensive industries such as electricity, metal mining, petroleum show high values of α. Average markups proved to be greater than one except electricity.[3] This means most of industries have market power. These results are similiar to those of Hall (1988) even though the magnitude of markups are greater than those reported by Hall.[4]

In the sample period we find markups to be much fluctuating. One thing to be noted is that industries with high average markups show large fluctuations in markups. This phenomenon provides an insight that markups are affected by demand shocks. Tables 2-4 summarize empirical evidences on the behavior of markups and industrial real wages over business cycle. The results needs to be considered in three subsections.

1. Countercyclicality of Markups

As shown in table 2, we find procyclical patterns of real wage movements and weak countercyclicality of markups, while showing strongly negative correlation of real wages and markups at industry level. In the correlation of GNP and real wages, all sample industries except wholesale and retail have positive sig-

[3] Low markup of electricity may reflect regulated industry where price is determined by regulatory commission.

[4] We did not consider tax, some overhead cost, energy cost, transportation cost, and R&D cost etc. in estimating marginal cost (markups). Thus we may underestimate marginal cost (overestimate markups).

[Table 1] Estimates of Output Elasticity with Respect to Capital and Measured Average Markups

Industry	α (S.E.)[a]	D. W.[b]	Average[d] Markups(S.D)[c]
○ Electricity	0.9484 (0.0733)	2.44	0.75 (0.0510)
○ Construction	0.3814 (0.3253)	2.14	5.45 (0.2619)
○ Wholesale, Retail	1.0185 (0.0714)	2.11	–
○ Transport,Communication	0.7678 (0.0906)	2.26	1.01 (0.0581)
○ Coal Mining	0.2562 (0.2172)	1.92	3.16 (0.1120)
○ Metal Ore Mining	0.7078 (0.0872)	2.36	4.62 (0.1867)
○ Food	0.1474 (0.0660)	2.26	4.60 (0.1582)
○ Textiles	0.0736 (0.0248)	2.12	2.77 (0.0856)
○ Apparel	0.8943 (0.1133)	2.11	5.50 (0.2808)
○ Leather	0.9341 (0.0674)	1.88	4.38 (0.2191)
○ Wood	0.1622 (0.0528)	2.35	2.44 (0.0628)
○ Paper	0.4928 (0.0794)	2.61	2.06 (0.0549)
○ Printing	0.6251 (0.1298)	1.99	3.74 (0.1032)
○ Petroleum Products	0.8478 (0.0745)	2.08	1.57 (0.0732)
○ Chemicals	0.2601 (0.1356)	2.16	3.20 (0.0725)
○ Rubber and Plastics	0.5732 (0.0752)	2.35	2.34 (0.0739)
○ Non-Metalic Products	−0.2726 (0.1647)	2.44	–
○ Basic Metalic Products	0.6776 (0.0742)	2.01	1.33 (0.0666)
○ Fabricated Metalics	0.9760 (0.0787)	2.66	3.16 (0.1654)
○ Machinery	0.2455 (0.1848)	2.51	3.08 (0.1489)
○ Electrical Machinery	0.6659 (0.0870)	1.96	0.46 (0.0129)
○ Precision Instruments	0.7725 (0.1120)	2.13	4.53 (0.1329)
○ Transport Equipments	−0.1544 (0.2128)	2.06	–
○ Other Manufacturing	0.5210 (0.1229)	2.33	3.73 (0.1518)

a) S. E. denotes standard error
b) Durbin-Watson statistics
c) S. D. denotes standard deviation.
d) Average markups means averages of varying markups in the sample period.

(Data Sources for Estimation)

Industrial Value Added Output (1990 constant price): 「Mining and Manufacturing Statistics」(1970-1995), The Economic Planning Board and 「National Accounts」(1994), The Bank of Korea.

Industrial Capital Stock (1990 constant price): Kim and Koo(1992) and 「National Wealth Statistics」(1987), The Economic Planning Board.

Industrial Nominal Hourly Wage and Industrial Labor Hour: 「Monthly Labor Statistics」(1970-1995), The Labor Ministry.

Coporate Bond Yields(Interest Rate) and Industrial Wholesale Price Index (1990 = 100): 「Annual Statistics」(1970-1995), The Bank of Korea.

ns, which implies procyclical tendency of real wages. And most of industries have negative correlation between markup and real wage. However, the correlation between GNP and markup tends to be industry specific. Industries with high value of markup and also durable goods industries are more likely to have a positive correlation between GNP and markup, thus showing weakly countercyclical tendency of markups. This result seems to be consistent with the results reported by Rotemberg & Woodford (1991). As the correlation of real wage and markup and industrial total hours instead of GNP shows analogous results as shown in column 4 and 5 in Table 2. In most of manufacturing industries, industry hours and real wages have positive correlations and correlation between markup and industry total hours proved in most to be negative.

Table 3 summarizes weak countercyclicality of markup, classifying 14 industries with negative correlation and 8 industries with positive correlation. It is significant for us to classify the countercyclicality of markup into the possible three cases as follows.

$$\Delta \text{GNP} > 0,\ \Delta\mu < 0,\ (\Delta\mu = \Delta P - \Delta MC) : \text{(Countercyclicality)}$$

$$\Delta\mu < 0 \rightarrow \begin{array}{l} \text{Case I } \Delta P < 0,\ \Delta MC > 0 \\ \text{Case II } \Delta P < 0,\ \Delta MC \leq 0,\ |\Delta P| > |\Delta MC| \\ \text{Case III } \Delta P > 0,\ \Delta MC \geq 0,\ |\Delta P| < |\Delta MC| \\ (\Delta \text{ denotes the rate of growth of a variable}) \end{array}$$

This classification would be helpful to verify the endogeneity of markup by decomposing markup and by investigating correlations of each component with GNP variation. Analysis of each case with the Korean data may provide basic evidence for testing RBC theories and New Keynesian perspectives.

2. Technological Effect on Business Cycle

As mentioned in section II, Equation (5) is the basic representation for time series of markups. In a log deviation form, equation (5) is expressed by;

$$d\ln(\mu_t) = d\ln(P_t) + d\ln(z_t) - \alpha d\ln(R_t) - (1-\alpha)d\ln(W_t). \tag{9}$$

Equation (9) implies that both price change and productivity shock change (Solow residual) are positively related to markup variation, while nominal interest rate and nominal wage rate changes are negatively related to markup variation. That is, markup variations can be decomposed into three factors; growth rates of product price, technical progress, and input prices. We compare variations of several variables and we will interpret empirical results mainly based on this equation.

[Table 2] The Behavior of Measured Markups and Real Wages

Correlations / Industry	GNP and Markup	Markup and Real Wage	GNP and Real Wage	Indus. Total Hours and Real Wage	Indus. Total Hours and Markup
○ Electricity	−0.1221	−0.5962	0.2410	−0.3868	−0.0189
○ Constuction	0.2198	−0.1869	0.1062	−0.0498	−0.2726
○ Wholesale, Retail	−	−	−0.1668	−0.0109	−
○ Transport, Communication	−0.0888	−0.2856	0.1370	−0.0643	−0.2450
○ Coal Mining	−0.2643	−0.5997	0.2913	−0.4976	0.2533
○ Metal Ore Mining	−0.2189	−0.3059	0.1747	−0.1843	0.0974
○ Food	−0.1348	−0.9304	0.1867	0.0013	−0.2369
○ Textiles	−0.2318	−0.7696	0.3364	0.0051	−0.0764
○ Apparel	0.1123	−0.3053	0.3055	−0.0754	0.2269
○ Leather	0.0931	−0.1831	0.0199	0.0625	0.0298
○ Wood	−0.1469	−0.4575	0.2747	0.2688	−0.6706
○ Paper	−0.1216	−0.6400	0.2797	0.2168	−0.3877
○ Printing	−0.0878	−0.7289	0.1153	0.0620	−0.1614
○ Petroleum Products	−0.3944	−0.6503	0.5283	0.1033	−0.0873
○ Chemicals	−0.1419	−0.7029	0.2876	0.2612	−0.5215
○ Rubber and Plastics	−0.2792	−0.3945	0.4556	0.0169	0.1623
○ Non-Metallic Products	−	−	0.3887	−0.0099	−
○ Basic Metallic Products	−0.0185	−0.5040	0.3013	0.1652	−0.2426
○ Fabricated Metallics	0.0374	−0.1550	0.2791	−0.0409	−0.3127
○ Machinery	0.2871	−0.4151	0.0477	0.2693	−0.3622
○ Electrical Machinery	0.3047	−0.4418	0.0287	−0.0046	0.0098
○ Precision Instrument	0.1152	−0.3821	0.2705	0.1562	−0.0655
○ Transport Equipment	−	−0.1247	0.0315	−	
○ Other Manufacturing	−0.2195	−0.7188	0.2289	0.1757	−0.1361

[Table 3] Correlation Coefficients Between Measured Markups Variations and GNP Fluctuations

Positive Correlation Coefficients			Nagative Correlation Coefficients		
0.20 ~	0.10~0.199	0.01~0.09	−0.20 ~	−0.10~−0.199	−0.01~−0.09
○ Construction ○ Machinery ○ Electrical Machinery	○ Apparel ○ Precision Instrument	○ Leather ○ Fabricated Metallic Products	○ Coal Mining ○ Metal Mining ○ Textiles ○ Petroleum Products, ○ Rubber, Plastics ○ Other Manufacturing	○ Electricity ○ Food ○ Wood ○ Paper ○ Chemicals	○ Transport and Communication ○ Printing, ○ Basic Metallic

As shown in previous part, markups have weakly countercyclical tendency with GNP and industry total hours. In this part, to elucidate weak countercyclicality we need to decompose markup into four components as shown in equation (9) and investigate correlations of each component with GNP variation. As shown in equation (9), the rate of growth of markup is composed of production price index (ΔP), interest rate (ΔR), real wages (ΔW), technology (ΔZ). Table 4 shows the correlations of each component with ΔGNP. While interest rate and real wages have positive correlations, production price index shows negative correlations except leather industry. This result provides a significant insight on the technological effect on GNP fluctuations. All the remaining terms except technology term (ΔZ) on the equation have a strong nagative correlations with GNP variations. Here we can expect markups to have a strong countercyclicality without technology term or with nagative correlation of ΔZ with ΔGNP. However, in the results shown in table 4, technology term almost appears in postive correlations except four industries. Thus the existence of technology term must have led to weak countercyclicality of markups.

Analyzing the three cases suggested in the previous subsection, we need to assume that marginal cost is composed of capital cost, real wage, and technological changes. That is, variation in marginal cost can be defined as follows.

$$\Delta MC = -d\ln(Z_t) + \alpha d\ln(R_t) + (1-\alpha)d\ln(W) \qquad (10)$$

From the positive correlations of ΔZ, ΔR, and ΔW with ΔGNP as shown in the above, ΔMC may have positive or negative correlation with ΔGNP depending on the magnitude of variation of each component. If ΔMC has positive correlation, markup must be expected to be negative correlation with ΔGNP. However, weak countercyclicality of markup in our results implies that ΔMC has negative correlation with GNP variation. From this interpretation, we may infer that technological advances have more influences on markup variation than real wage and capital costs. Therefore this fact provides an evidence to support the RBC theories that emphasize the role of technological changes in macroeconomic fluctuations.

3. Institutional Changes

Another remarkable results are the rapid downward tendency of markups and fast increases in industrial real wages during the period of 1987-1995 (see the graphs in the appendix). In general, these tendencies support the new Keynesian perspectives which are similar to those of Hall (1988) and Rotemberg and Woodford (1991, 1992). At the same time they reflect the structural and institutional changes beginning in the late of 1980s. Positive competition policy and active open economy policy which aimed at the structural and institutional changes

[Table 4] Correlations of Markup Components Variations With GNP Variations

Industry	Production Price Index	Technological Coefficient	Real Wages
○ Electricity	−0.2527	0.2289	0.2410
○ Constuction	−0.1028	0.3347	0.1062
○ Wholesale, Retail	−0.3169	0.5978	−0.1688
○ Transport, Communication	−0.3630	0.4113	0.1370
○ Coal Mining	−0.3510	−0.0315	0.2913
○ Metal Ore Mining	−0.2895	−0.0013	0.1747
○ Food	−0.6061	0.2624	0.1867
○ Textiles	−0.4497	−0.0108	0.3364
○ Apparel	−0.3624	0.4291	0.3055
○ Leather	0.1709	0.1097	0.0199
○ Wood	−0.3414	0.0716	0.2747
○ Paper	−0.2841	0.1998	0.2797
○ Printing	−0.0591	0.0664	0.1153
○ Petroleum Products	−0.4834	0.3159	0.5283
○ Chemicals	−0.3105	0.2336	0.2876
○ Rubber and Plastics	−0.4821	0.0040	0.4556
○ Non-Metallic Products	−0.4789	0.2021	0.3887
○ Basic Metallic Products	−0.2243	0.1969	0.3013
○ Fabricated Metallics	−0.3280	0.3069	0.2791
○ Machinery	−0.2187	0.3837	0.0477
○ Electrical Machinery	−0.3957	0.3492	0.0287
○ Precision Instrument	−0.4017	0.3592	0.2705
○ Transport Equipment	−0.3964	0.0152	0.1247
○ Other Manufacturing	−0.4601	−0.0298	0.2289

have contributed to decreasing markups. The labor dispute and enormous labor demand caused by government's housing construction project resulted in steep rise of real wages. We may safely conclude that our empirical analysis implies that institutional changes affecting markups and real wages may be one of determinants in macroeconomic fluctuations.

Ⅳ. CONCLUSIONS

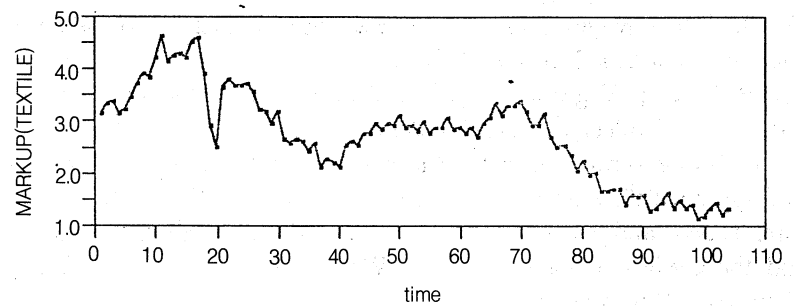
We find several pieces of empirical evidence in this paper. First, a large gap between price and marginal cost is found in most of industries, i. e, the markup ratio is much greater than 1 as in Hall (1988). Seond, industries with high average markups tend to be largely fluctuating in the level of markups, which gives a

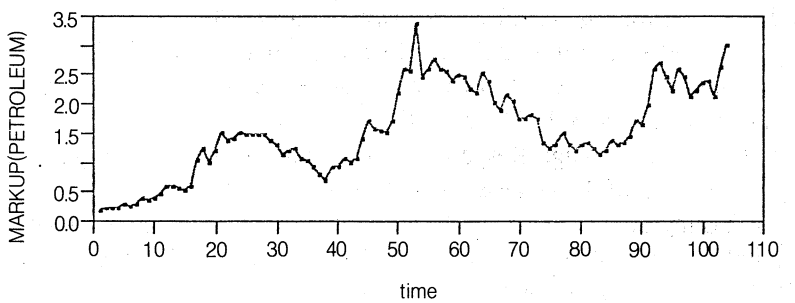
certain insight that markups are affected by demand shocks. Third, markups have weak countercyclicality over GNP fluctuations. Fourth, real wages are shown to be procyclical. In addition to those evidences, it is noted that institutional factors such as labor movement could influence on markups, real wages, and economic growth to some extent in Korea.

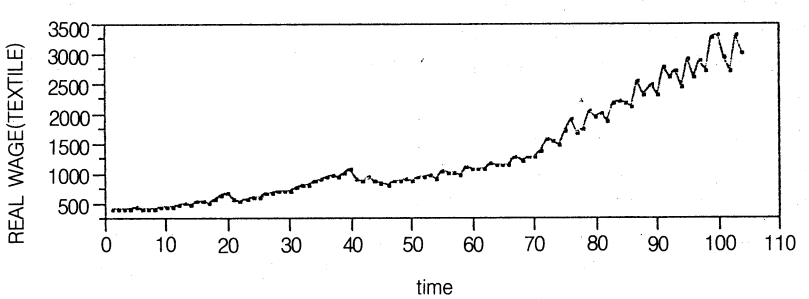
In theoretical perspectives, as shown in the previous empirical section, both the Real Business Cycle approch and the New Keynesian one are helpful in analyzing the business cycle of Korean economy.

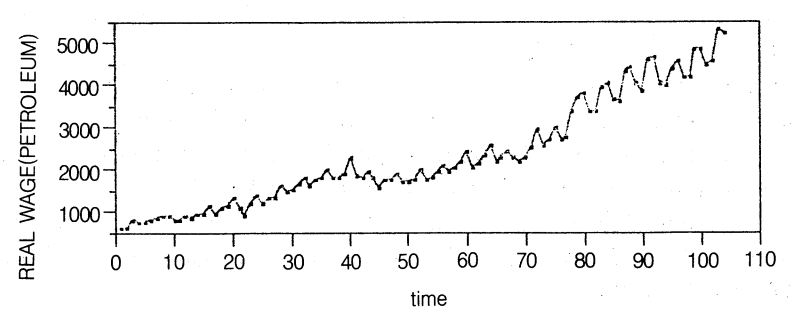
In this paper, we assumed constant returns to scale production function. For more realistic specification of technology, we need to extend our model with alternative form of production function, for example, such as including fixed cost, and technological progress. A particularly promising line of research is to develop theories which could explain the relationship between markups, technology, labor market, capital market, and business cycles based on rigorous microfoundation.

APPENDIX: Trend of Markup and Real wage (Textile, Petroleum)









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