An Industry Analysis of Inflation and the Markup in the United States

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Markup and Inflation

1. Assuming inflation is stationary (i.e. constant mean)

Galí and Gertler (1999), Batini, Jackson and Nickell (2000, 2005), Galí, Gertler and López-Salido (2001, 2005), Rudd and Whelan (2005, 2007), and Kiley (2007)

Richards and Stevens (1987), Franz and Gordon (1993), Cockerell and Russell (1995), and de Brouwer and Ericsson (1998)

$\Rightarrow$ implies only one long-run rate of inflation

$\Rightarrow$ can only be an approximation

Markup and Inflation

2. Assuming inflation is integrated

Difference the data

Cogley and Sbordone (2005, 2006) and Ireland (2007)

Long run cointegrating relationships

Banerjee, Mizen and Russell (2007), Russell and Banerjee (2006), Banerjee and Russell(2005), Banerjee and Russell (2004), Banerjee, Cockerell and Russell (2001), Banerjee and Russell (2001), Banerjee and Russell (2001)

$\Rightarrow$ Inflation is bounded and so only an approximation

What is the ‘true’ statistical process of inflation?

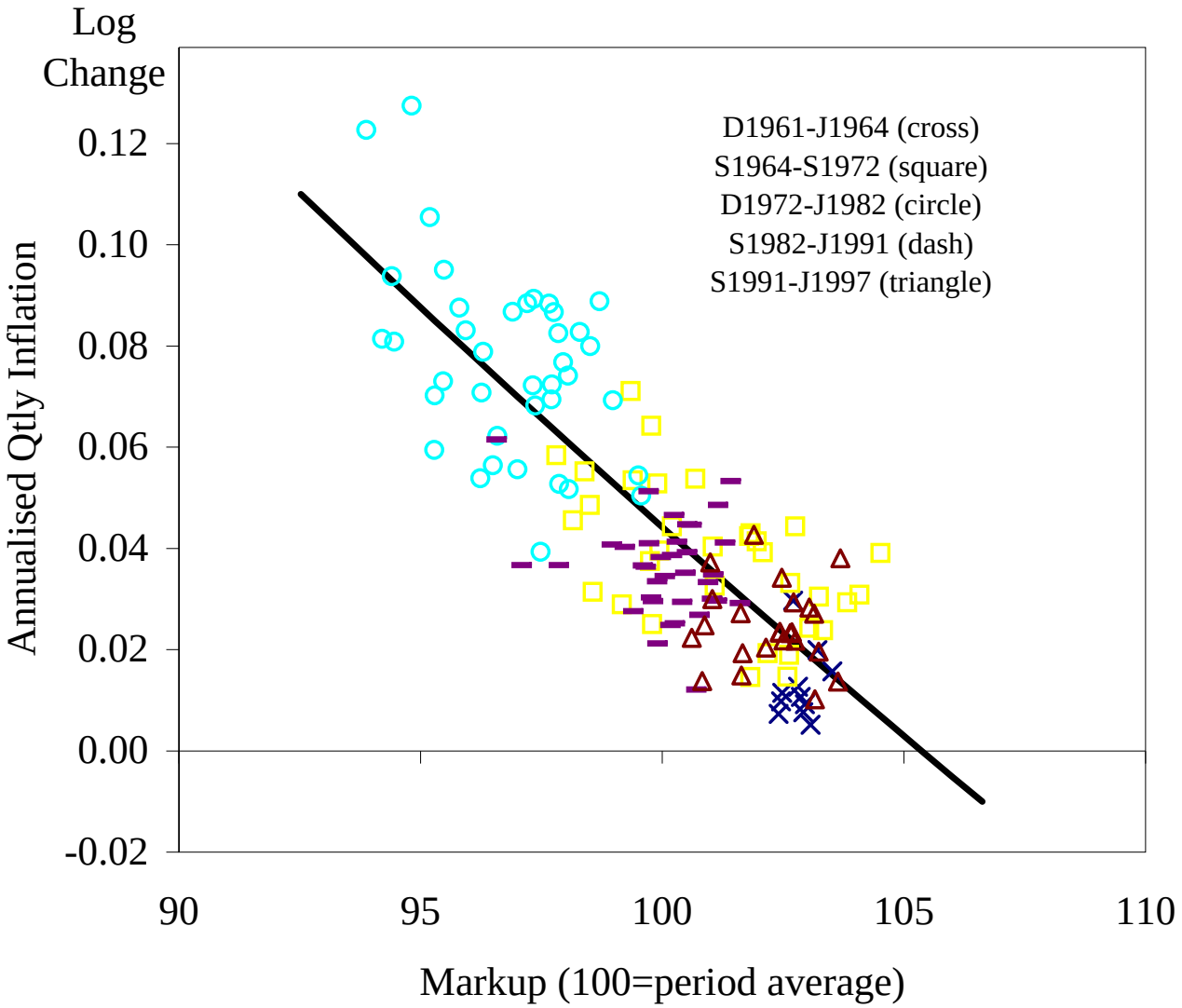
1. **Shocks mean zero and no change to MP then inflation varies around the long-run rate of inflation**

2. **An increase in long-run rate requires a loosening in MP $\Rightarrow$ inflation converges on new long-run rate**

$\Rightarrow$ **Implies inflation is stationary around shifting means**

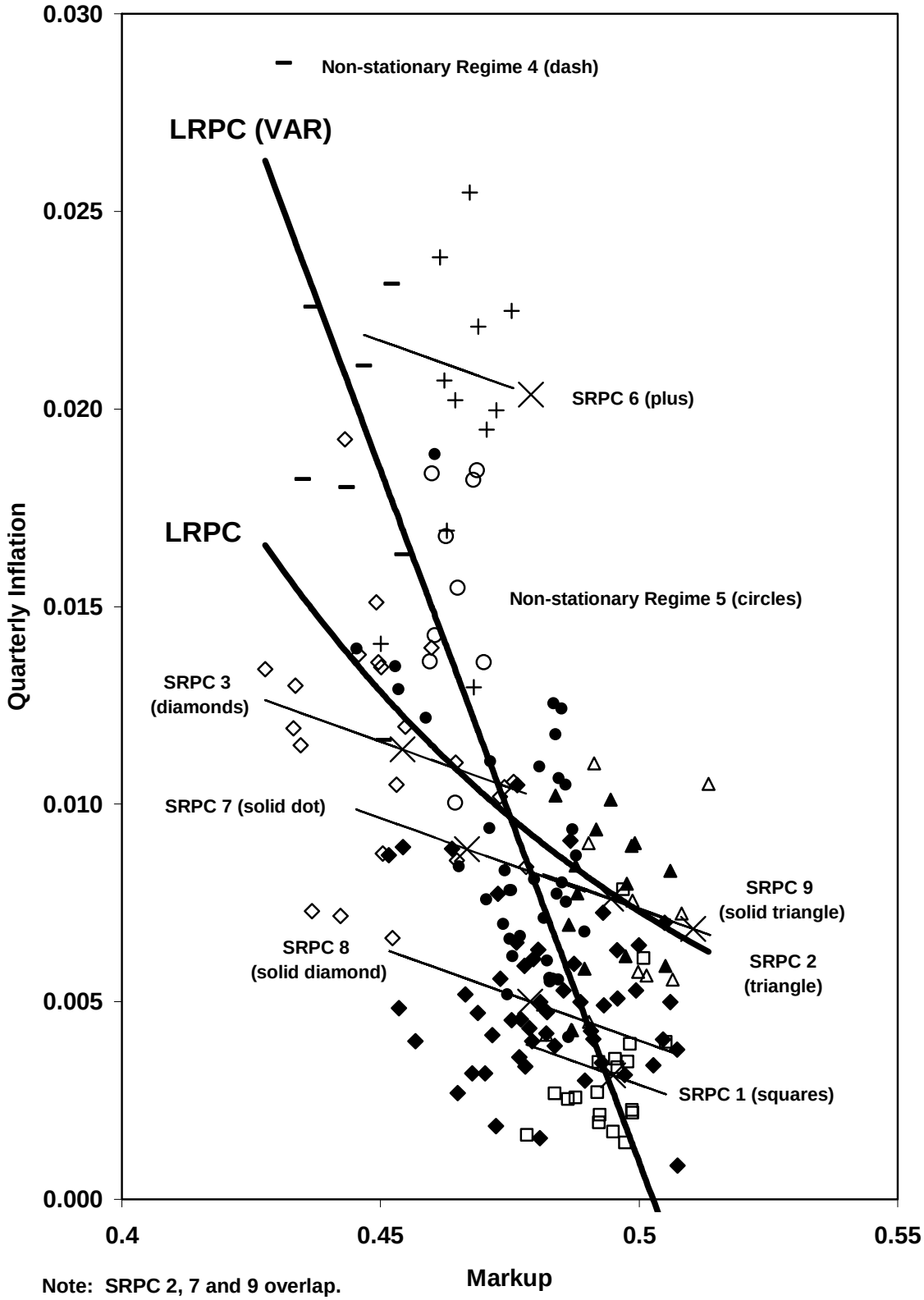
$\Rightarrow$ **Russell, Banerjee and Malki (2009) show approximating as an integrated process valid**

UNITED STATES
December 1961 - June 1997



Banerjee, A. and B. Russell (2001). 'Inflation and the Markup in the G7 Economies and Australia', *Review of Economics and Statistics*, vol. 83, no. 2, May, pp. 377-87.

United States Inflation and the Markup



Note: SRPC 2, 7 and 9 overlap.

Russell, Banerjee and Malki (2009)

2 Questions

1. **Is the negative long-run inflation-markup relationship due to aggregation?**

2. **Where does the relationship come from?**

   (i) In terms of theory

   (ii) Component sub-sectors

Remainder of Presentation

1. **Statistical processes of inflation, markup and business cycle**

2. **Theories of inflation and the markup**

3. **Empirical model**

4. **Results**

   Panel **DOLS and FMOLS**

   Individual Industries **VAR-ECM and DOLS**

5. **Aggregate across industries**

1. Statistical processes

1. **Data is annual United States 1955 – 2007 from GDP-by-Industry BEA**

2. **12 Industries and total private industries (i.e. no government)**

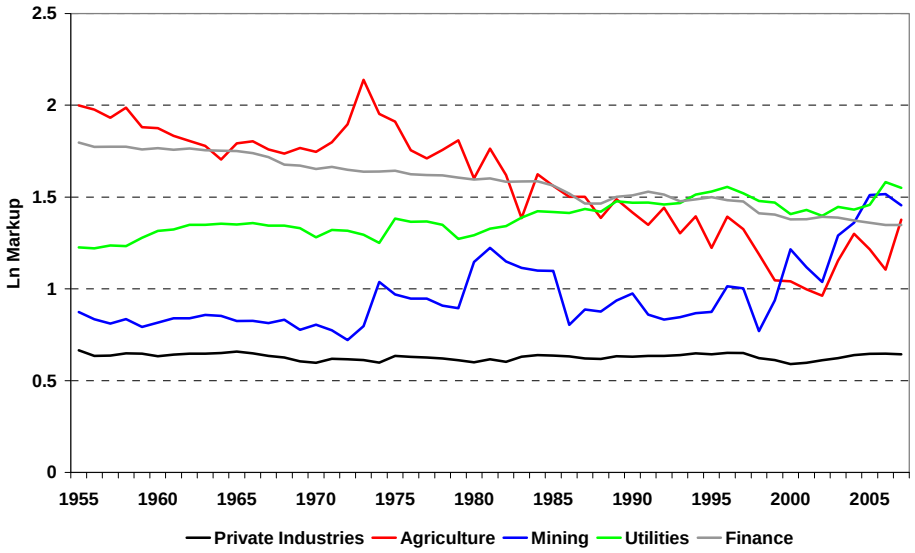
3. **Inflation is log change in GDP ipd**

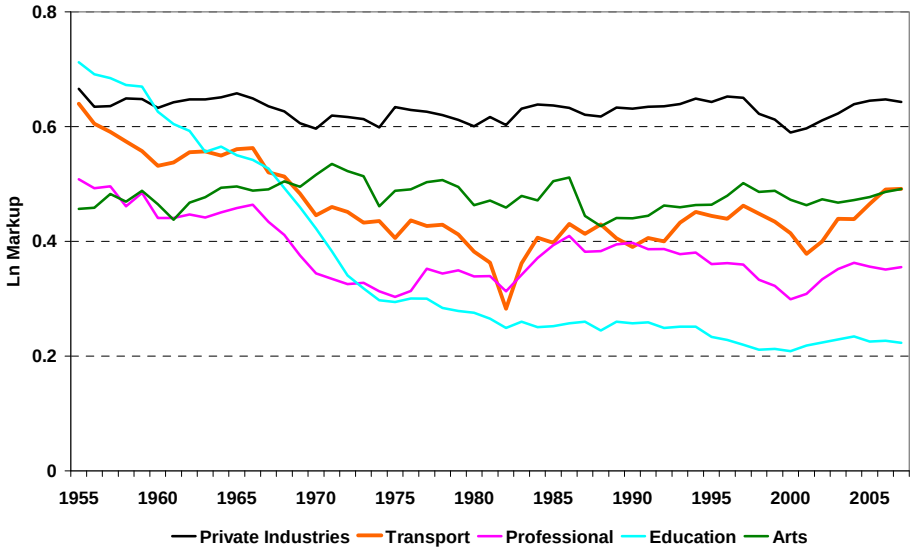
4. **Markup is log (IPD / ULC)**

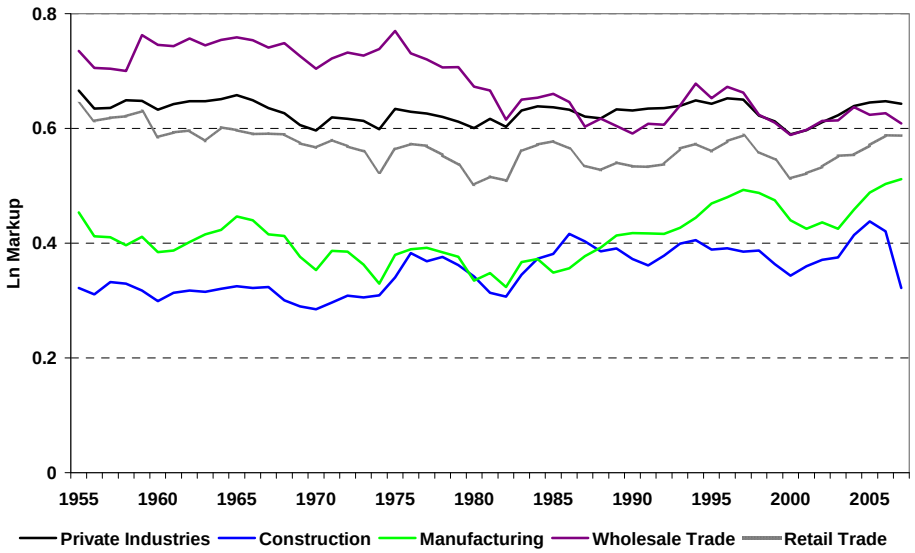
5. **Business cycle is de-trend log GDP by HP filter (lambda = 10)**

	INDUSTRY	WEIGHT
1.	Agriculture, forestry, fishing and hunting	0.012
2.	Mining	0.015
3.	Utilities	0.024
4.	Construction	0.055
5.	Manufacturing	0.180
6.	Wholesale trade	0.075
7.	Retail trade	0.084
8.	Transportation and warehousing	0.038
9.	Professional and business services	0.144
10.	Educational services, health care, and social assistance	0.086
11.	Arts, entertainment, recreation, accommodation, and food services	0.044

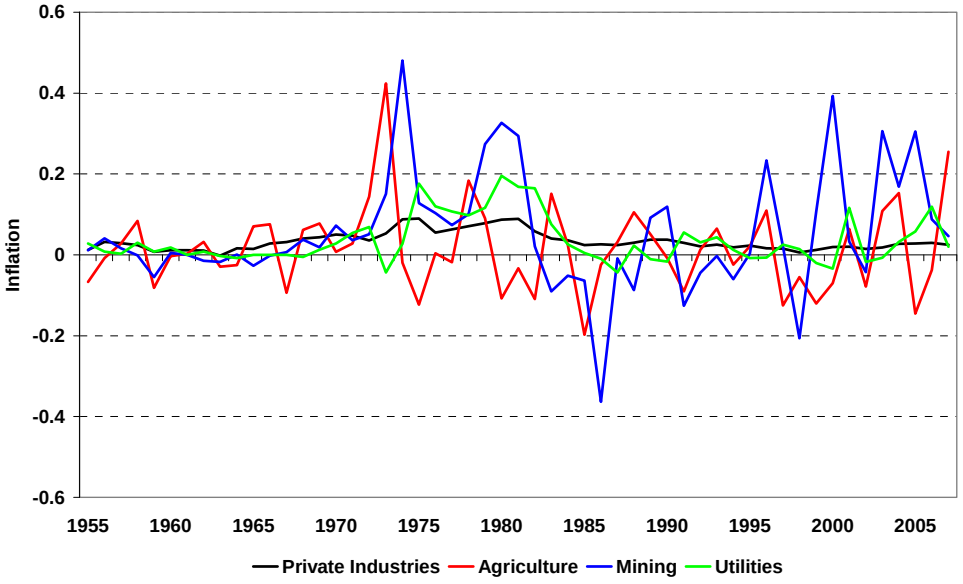
Graph 2: The Markup– Annual 1955 to 2007

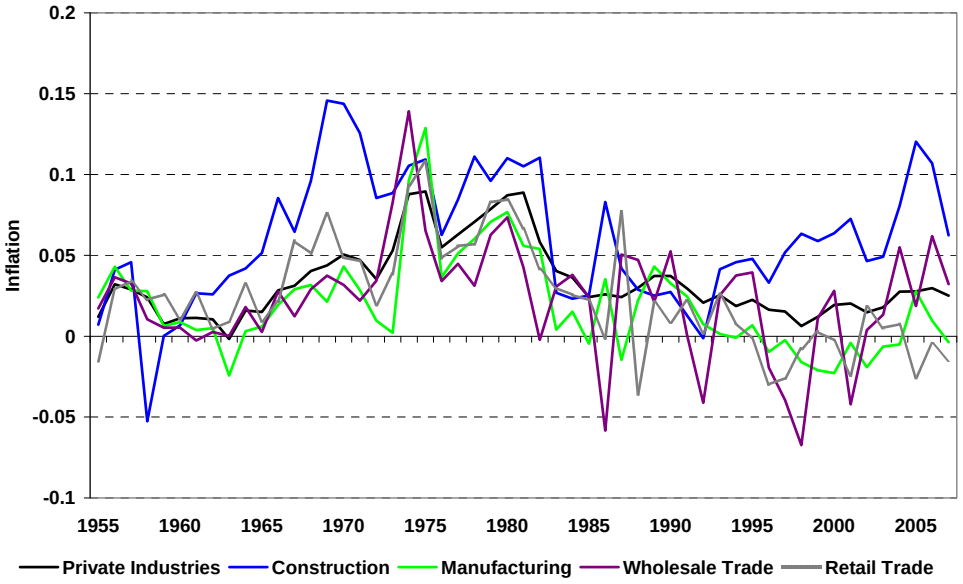


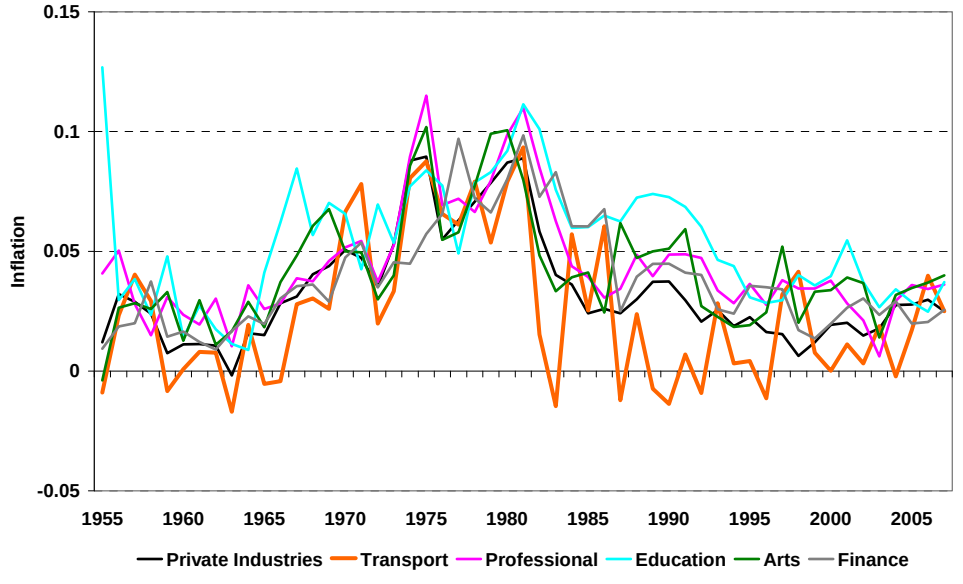




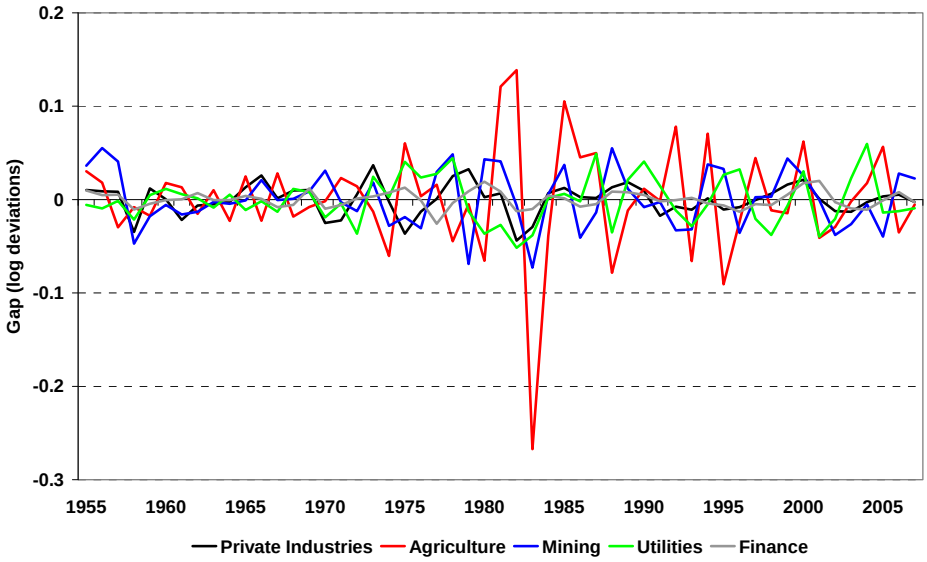
Graph 1: Inflation – Annual 1955 to 2007

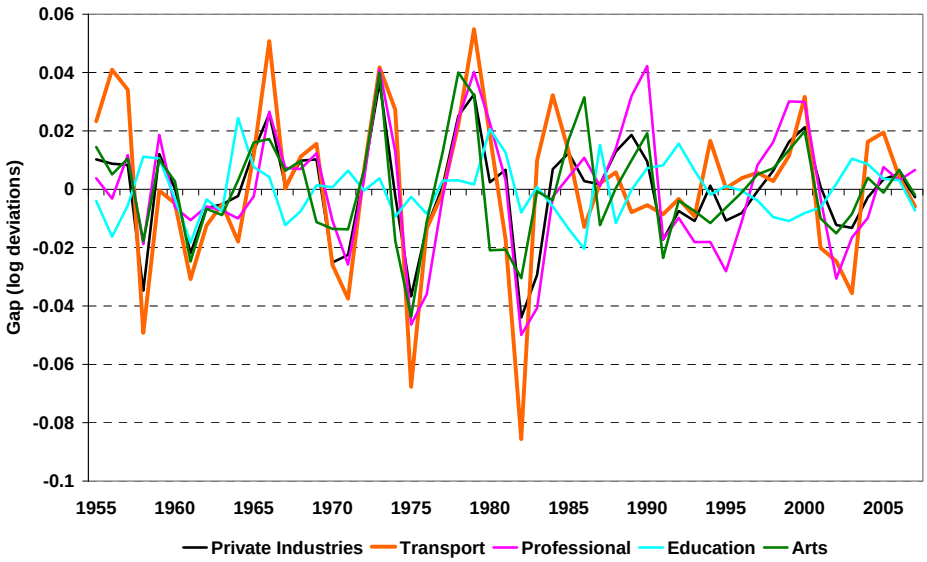


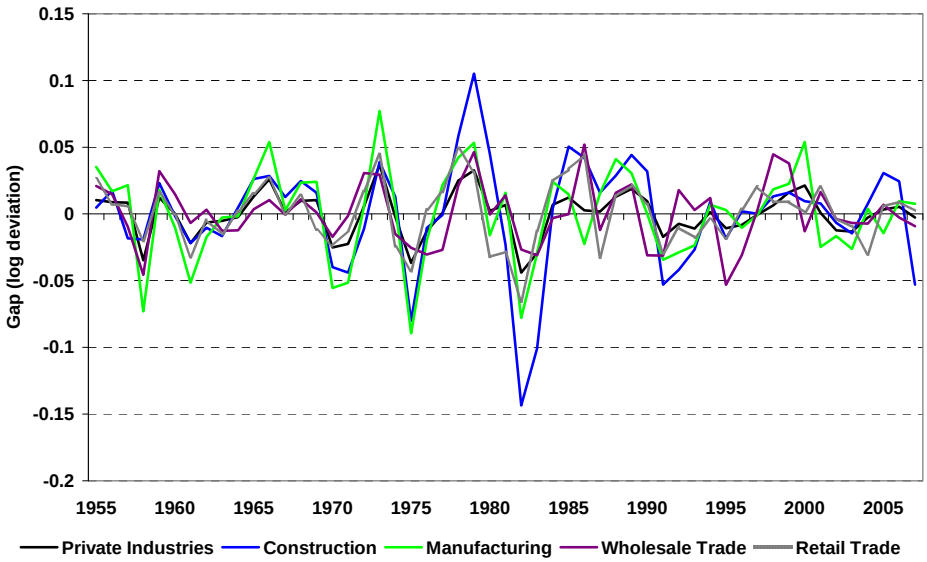




Graph 3: Business Cycle – Annual 1955 to 2007







2. Theories of inflation and the markup

Assume

(i) Constant returns to scale

(ii) Labour only input and output indexed so that one worker produces one unit of output

(iii) Therefore Y=N

(iv) If firms maximise profits then MC=UC=P

$$P = \mu UC \qquad \mu = 1 \qquad \mu > 1$$

2. Theories of inflation and the markup

(i) Standard story markup is constant

(ii) But literature has theories of systematic influences on the markup

$$\mu = f_{\mu}\left(e_{\Delta p},\ \hat{y},\ \Delta p,\ \sigma_{\Delta p},\ \overline{\Delta p}\right)$$

(iii) Stories fit some sectors better than others

4. Empirical Model

1. **Banerjee, Cockerell and Russell (2001) set out imperfect competition model where firms impose 'costs' on the firm**

$$mu_{it} = q_i + \lambda_i \Delta p_{it} + \delta_i \hat{y}_{it} + e_{it}$$

2. **Gross markup** q_i

3. **Long-run Inflation cost coefficient** λ_i

4. Empirical Model

Estimate model with:

(i) Panel DOLS - Pedroni (1996)

(ii) Panel FMOLS - Pedroni (2001)

(iii) VAR-ECM - Johansen (1988, 1995)

(iv) DOLS - Stock and Watson (1993)

ADF Unit Root Tests of Individual Industry and Aggregate Series							
	Markup		**Inflation**		**BC**		**Int**
	C & T	**C**	**C & T**	**C**	**C & T**	**C**	
1. Agriculture, forestry, fishing and hunting	- 3.23			- 6.69		- 6.71	1,0,0
2. Mining	- 2.32			- 4.81		- 4.77	1,0,0
3. Utilities	- 2.68			- 3.59		- 3.62	1,0,0
4. Construction	- 3.96			- 3.23		- 4.15	0,0,0
5. Manufacturing	- 2.14			- 3.36		- 4.79	1,0,0
6. Wholesale trade	- 2.40			- 4.57		- 4.14	1,0,0
7. Retail trade		- 3.05		- 3.61		- 4.32	0,0,0
8. Transportation and warehousing		- 2.59		- 4.11		- 4.41	1,0,0
9. Professional and business services		- 2.40		- 2.03		- 3.66	1,1,0
10. Educational services, health care, and social assistance		- 3.87		- 2.20		- 3.67	0,1,0
11. Arts, entertainment, recreation, accommodation, and food services		- 3.30		- 2.51		- 4.56	1,1,0
12. Finance, insurance, real estate, and leasing	- 2.94			- 1.46		- 3.98	1,1,0
Total Private Industries		- 3.25		- 2.03		- 6.30	1#,1,0

Panel Unit Root Tests							
	Markup		**Inflation**		**BC**		**I**
	LL	**IPS**	**LL**	**IPS**	**LL**	**IPS**	
Constant only	0.64	- 1.43	0.39	0.64	-16.10	-22.44	1,1,0
Constant and trend	- 1.09	- 2.67	- 0.56	0.23	- 13.3	-22.30	?,1,0

Table 2: Panel Cointegration Tests

Test	**Statistic**
Panel pp- statistic	2.6504
Panel adf-statistic	2.8453
Group pp- statistic	2.5098
Group adf-statistic	2.5729

Notes: Pedroni (1999, 2004) test statistics computed using 60 periods of data for all 12 industries and distributed N(0,1) under the null of no cointegration. Test of no cointegration of the panel model that includes inflation, markup and the business cycle.

Table 4: Individual Industry DOLS Estimates of the United States long-run Inflation-Markup relationship 1955 - 2007

INDUSTRY	W	Int	Dp	Trend	BC
1. Agriculture, forestry, fishing and hunting	0.012	1,0,0	1.9028 (2.37)	- 0.0170 (- 6.40)	2.2370 (2.63)
2. Mining	0.015	1,0,0	0.7298 (1.55)	0.0074 (2.18)	- 3.2639 (- 0.75)
3. Utilities	0.024	1,0,0	- 0.5051 (- 2.37)	0.0043 (6.00)	1.1199 (1.43)
4. Construction	0.055	0,0,0	- 0.2733 (- 1.89)	0.0022 (6.46)	0.3343 (1.42)
5. Manufacturing	0.180	1,0,0	- 1.1580$^{(nt)}$ (- 5.86)		0.3441 (0.95)
6. Wholesale trade	0.075	1,0,0	0.2362 (1.27)	- 0.0036 (- 4.95)	- 1.0174 (- 0.91)
7. Retail trade	0.084	0,0,0	- 0.4823 (- 2.71)	- 0.0014 (- 3.88)	- 0.1517 (- 0.40)
8. Transportation and warehousing	0.038	1,0,0	- 1.2957 (- 5.50)	- 0.0028 (- 3.28	0.7448 (1.38)
9. Professional and business services	0.144	1,1,0	- 1.3261 (- 2.71)	- 0.0020 (- 2.72)	0.1670 (0.17)
10. Educational services, health care, and social assistance	0.086	0,1,0	- 2.6402 (- 5.02)	- 0.0086 (- 10.45)	1.9424 (0.92)
11. Arts, entertainment, recreation, accommodation, and food services	0.044	1,1,0	0.30903 (1.69)		0.0395 (0.08)
12. Finance, insurance, real estate, and leasing	0.244	1,1,0	0.0751 (0.34)	- 0.0090 (- 25.73)	- 1.6648 (- 1.36)

Table 3: Panel Industry Estimates of the United States long-run relationship between Inflation and the Markup, 1955 - 2007

INDUSTRY		DOLS		FMOLS	
	W	**LR**	**Business Cycle**	**LR**	**Business Cycle**
1. Agriculture, forestry, fishing and hunting	0.012	2.2339 (0.96)	3.5077 (0.23)	0.2777 (0.34)	- 0.5433 (- 0.36)
2. Mining	0.015	0.8499 (2.12)	- 4.2320 (- 1.03)	0.7952 (2.62)	- 0.7968 (- 0.63)
3. Utilities	0.024	- 0.3196 (- 0.47)	1.1526 (0.31)	- 0.1162 (- 0.22)	- 0.0056 (- 0.00)
4. Construction	0.055	- 0.1470 (- 0.63)	0.1907 (0.25)	- 0.1610 (- 0.69)	0.0400 (0.16)
5. Manufacturing	0.180	- 1.3121 (- 4.94)	0.8965 (1.55)	- 1.1381 (- 3.50)	0.1402 (0.52)
6. Wholesale trade	0.075	0.8827 (1.27)	- 2.9964 (- 1.01)	0.5281 (1.20)	- 0.6951 (- 1.03)
7. Retail trade	0.084	- 0.2482 (- 0.66)	- 0.6385 (- 0.42)	- 0.3477 (- 1.04)	0.0527 (0.11)
8. Transportation and warehousing	0.038	- 1.3390 (- 1.29)	2.1480 (0.62)	- 0.6541 (- 0.75)	0.2754 (0.32)
9. Professional and business services	0.144	- 1.4167 (- 1.77)	0.1641 (0.07)	- 1.2829 (- 1.86)	0.2459 (0.33)
10. Educational services, health care, and social assistance	0.086	- 4.3147 (- 1.74)	6.7176 (0.48)	- 2.9413 (- 1.55)	1.6618 (0.30)
11. Arts, entertainment, recreation, accommodation, and food services	0.044	0.3382 (1.46)	- 1.1331 (- 1.15)	0.3240 (1.65)	- 0.2478 (- 0.86)
12. Finance, insurance, real estate, and leasing	0.244	- 0.8171 (- 0.3860)	- 4.8338 (- 0.26)	- 0.2877 (- 0.15)	- 0.7188 (- 0.15)
Panel Group Mean Estimate		- 0.4697 (- 1.75)	0.0786 (- 0.10)	- 0.4170 (- 1.13)	- 0.0493 (- 0.38)

Table 5: Individual Industry VAR-ECM Estimates of the United States long-run Inflation-Markup relationship 1955 - 2007

INDUSTRY - Int	Long-run			Short-run			
	C	**Dp**	**Trend**	α_{MU}	α_{Dp}	BC_{MU}	BC_{Dp}
1. Agriculture, forestry, fishing and hunting - 1,0,0	No	- 8.0846 (- 2.18)	- 0.0191 (- 2.28)	- 0.0987 (- 2.88)	- 0.0986 (- 2.38)	- 1.7887 (- 5.48)	0.5399 (1.37)
2. Mining - 1,0,0	Yes	- 8.2243 (- 5.24)		0.0127 (0.61)	- 0.0399 (- 1.45)	- 0.2065 (- 0.43)	0.6520 (1.01)
3. Utilities - 1,0,0	No	- 0.5198 (- 2.03)	0.0050 (6.64)	- 0.4127 (- 3.18)	- 0.3114 (- 2.7)	- 0.4892 (- 2.48)	1.1086 (5.8)
4. Construction - 0,0,0	No	- 1.5050 (- 3.05)		- 0.0818 (- 1.99)	- 0.1795 (- 3.2)	- 0.2656 (-3.66)	0.3505 (3.49)
5. Manufacturing - 1,0,0	No	- 1.4415 (- 3.89)	0.0013 (2.01)	- 0.2177 (- 3.89)	- 0.1937 (- 2.71)	- 0.3993 (- 6.67)	0.5001 (6.53)
6. Wholesale trade - 1,0,0	No	- 0.4307 (- 1.02)	- 0.0034 (- 5.07)	- 0.2452 (- 3.24)	- 0.1080 (- 0.91)	- 0.4789 (- 4.32)	0.9199 (5.28)
7. Retail trade - 0,0,0	Yes	- 1.1086 (- 6.13)	- 0.0023 (- 6.27)	- 0.1802 (- 2.65)	- 0.5161 (- 5.46)	- 0.5486 (- 6.64)	0.7013 (6.10)
8. Transportation and warehousing - 1,0,0	Yes	- 3.2201 (- 5.95)	- 0.0033 (- 3.01)	- 0.1184 (- 3.64)	- 0.1788 (- 5.39)	- 0.4192 (- 3.79)	0.5607 (4.97)
9. Professional and business services - 1,1,0	No	- 2.2166 (- 5.39)	- 0.0025 (- 3.88)	- 0.0674 (- 1.21)	- 0.1647 (- 3.97)	- 0.4294 (- 4.2)	0.3491 (4.58)
10. Educational services, health care, and social assistance - 0,1,0	Yes	- 3.3618 (- 14.28)	- 0.0097 (- 26.87)	- 0.1421 (- 3.26)	- 0.2946 (- 6.63)	- 0.3776 (- 2.24)	0.6057 (3.53)
11. Arts, entertainment, recreation, accommodation, and food services - 1,1,0	No	2.2215 (3.38)		0.0294 (0.59)	0.1173 (3.27)	- 0.6876 (- 4.83)	0.6081 (5.92)
12. Finance, insurance, real estate, and leasing - 1,1,0	No	0.1012 (0.44)	- 0.0087 (- 27.33)	- 0.4363 (- 3.74)	- 0.0086 (- 0.10)	0.0313 (0.12)	0.6703 (3.46)

Group Mean Long-run Coefficients and *t*-statistics

1. **Mean versus weighted average**

2. **Appropriate t-statistics**

Pedroni (2001)

$$t_P = \frac{1}{\sqrt{n}} \sum_{i=1}^{n} \left(\frac{\alpha_i t_i}{\sqrt{\sum_{i=1}^{n} \alpha_i^2}} \right)$$

Group Mean Long-run Coefficients and *t*-statistics

Alternative is treat the estimated coefficients as random variables

$$Var\left[\sum_{i=1}^{n}\alpha_i\,\beta_i\right] = \sum_{i=1}^{n}\alpha_i^2\;Var\left[\beta_i\right] + \sum_{j\neq k}\alpha_j\,\alpha_k\,Cov\left[\beta_j,\beta_k\right]$$

$$t_{HD} = \frac{\sum_{i=1}^{n}\alpha_i\,\beta_i}{\sqrt{\sum_{i=1}^{n}\alpha_i^2\;Var\left[\beta_i\right] + \sum_{j\neq k}\alpha_j\,\alpha_k\,Cov\left[\beta_j,\beta_k\right]}}$$

Table 6: Aggregate Estimates of the long-run Inflation Cost Coefficient λ

	Individual VAR-ECM	Individual DOLS	Panel DOLS	Panel FMOLS
Total Private Industry	- 0.3087	- 0.4499 [(t)]		
t-statistic	- 2.58	- 5.04		
Mean Estimates				
Group Mean λ	- 2.3159	- 0.3690	- 0.4697	- 0.4170
Pedroni *t*-statistic	- 13.09	- 5.44	- 1.75	- 1.13
Mean *t*-statistic	-3.78	-1.57	-0.51	-0.33
Heaton/Dewhurst *t*-statistic	- 6.57	-3.40	-1.28	-1.58
Weighted Mean Estimates				
Weighted Group Mean	- 1.3117	- 0.6576	- 0.9757	- 0.7075
Pedroni style *t*-statistic	- 9.58	- 5.79	-3.57	-2.73
Weighted mean *t*-statistic	- 3.58	-2.17	- 1.33	-1.02
Heaton/Dewhurst style *t*-statistic	-10.06	-6.03	-1.69	-1.39

Notes: Group mean is the mean value of the inflation cost coefficients across industries. Weighted group mean is the weighted mean where the weights are the industry share of total GDP in the year 2000.

Table 7: Aggregate Estimates of the Business Cycle Coefficient

	Individual VAR-ECM		Individual DOLS	Panel DOLS	Panel FMOLS
	MU	**Inflation**	**MU**	**MU**	**MU**
Total Private Industry	- 0.4312	0.2808	- 0.6485		
t-statistic	- 6.59	4.12	- 0.99		
Mean Estimates					
Group Mean λ	- 0.5049	0.6305	0.0693	0.0786	- 0.0493
Pedroni *t*-statistic	- 12.88	15.02	1.61	- 0.10	- 0.38
Mean *t*-statistic	-3.72	4.34	0.46	-0.03	-0.11
Heaton/Dewhurst *t*-statistic	-8.21	8.66	0.15	0.03	-0.076
Weighted Mean Estimates					
Weighted Group Mean	- 0.3378	0.5932	- 0.1891	- 0.6463	- 0.0371
Pedroni style *t*-statistic	- 9.46	12.57	0.08	0.37	0.08
Weighted mean *t*-statistic	- 3.53	4.70	0.03	0.18	- 0.09
Heaton/Dewhurst style *t*-statistic	-4.85	10.47	-0.46	-0.14	-0.03

Conclusions

- **Long-run inflation-markup not due to aggregation**
- **Industries that contribute depend on market structure and statistical process of data**
- **Relationship is between the markup and mean rates of inflation**
- **Potentially better estimates by modelling each industry and then aggregating**

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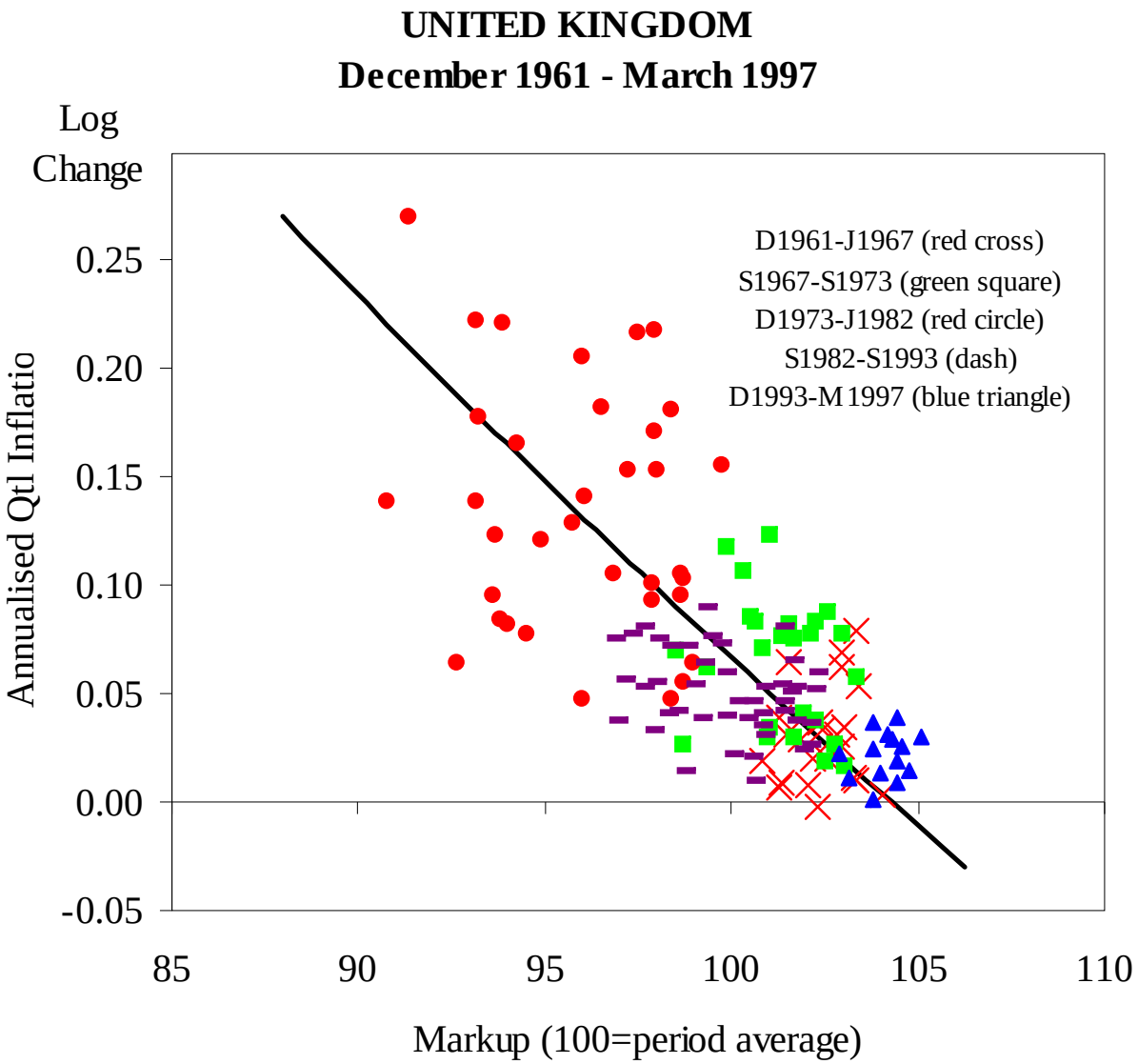

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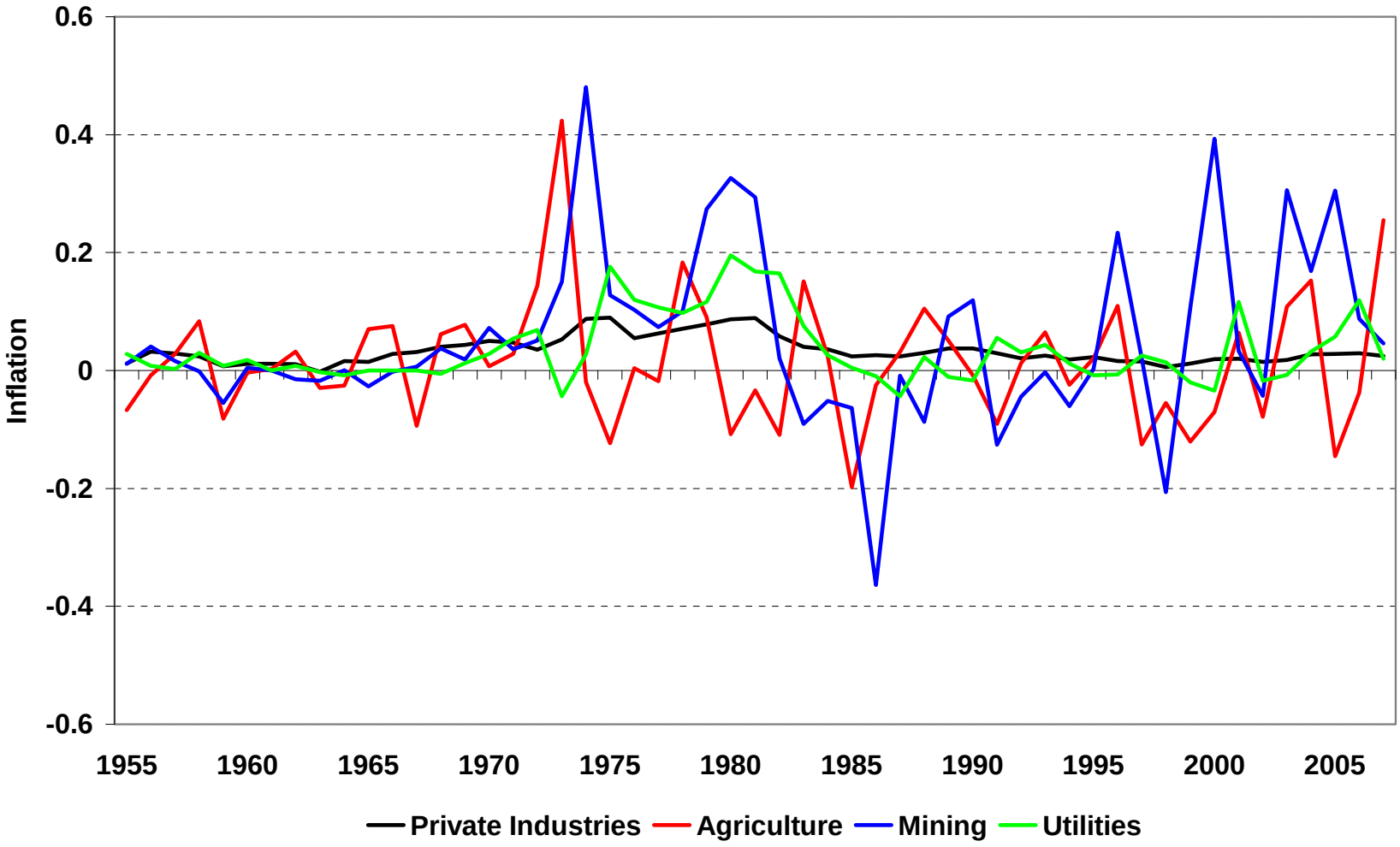
Graph 1: Industry Inflation – Annual 1955 to 2007



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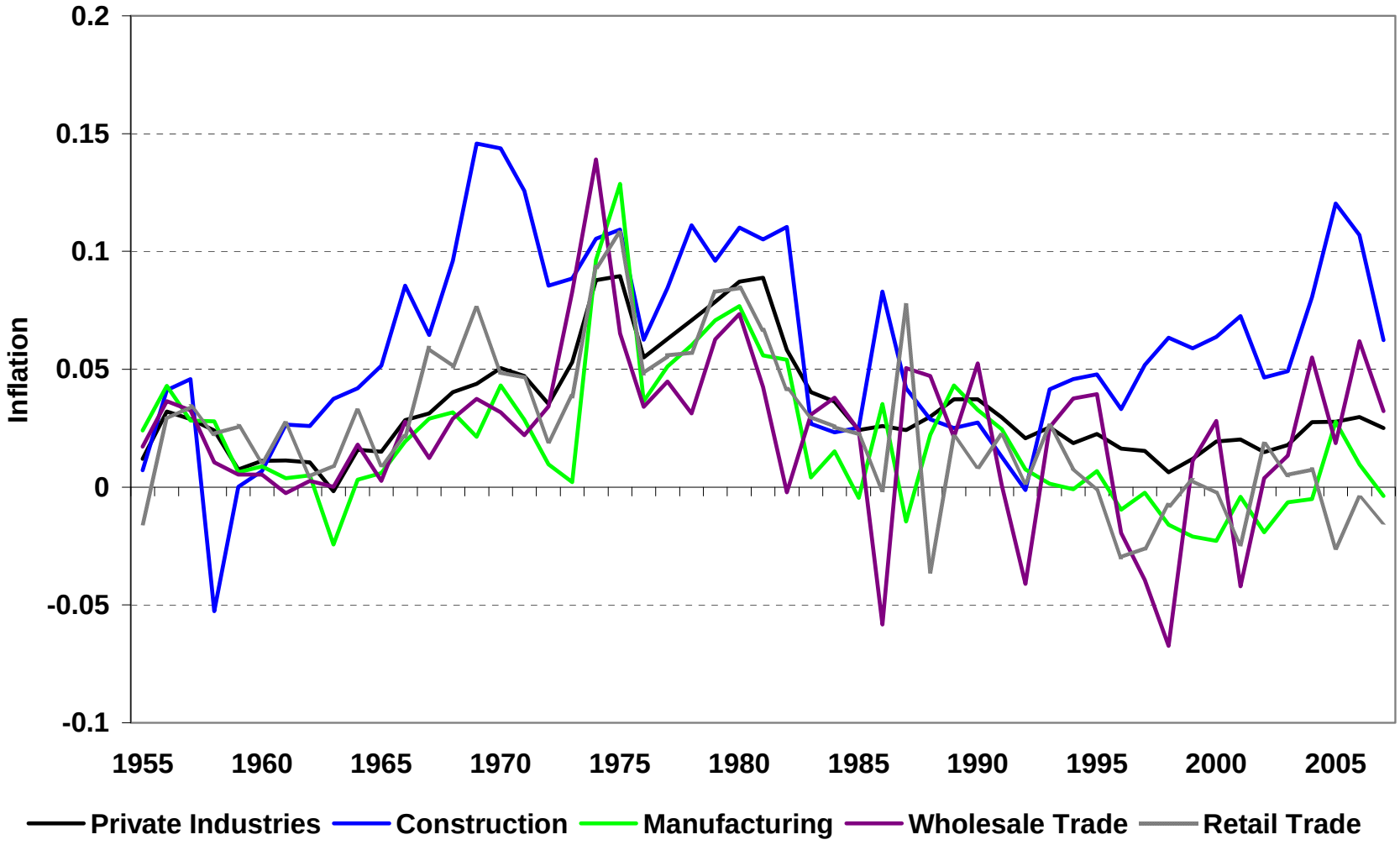

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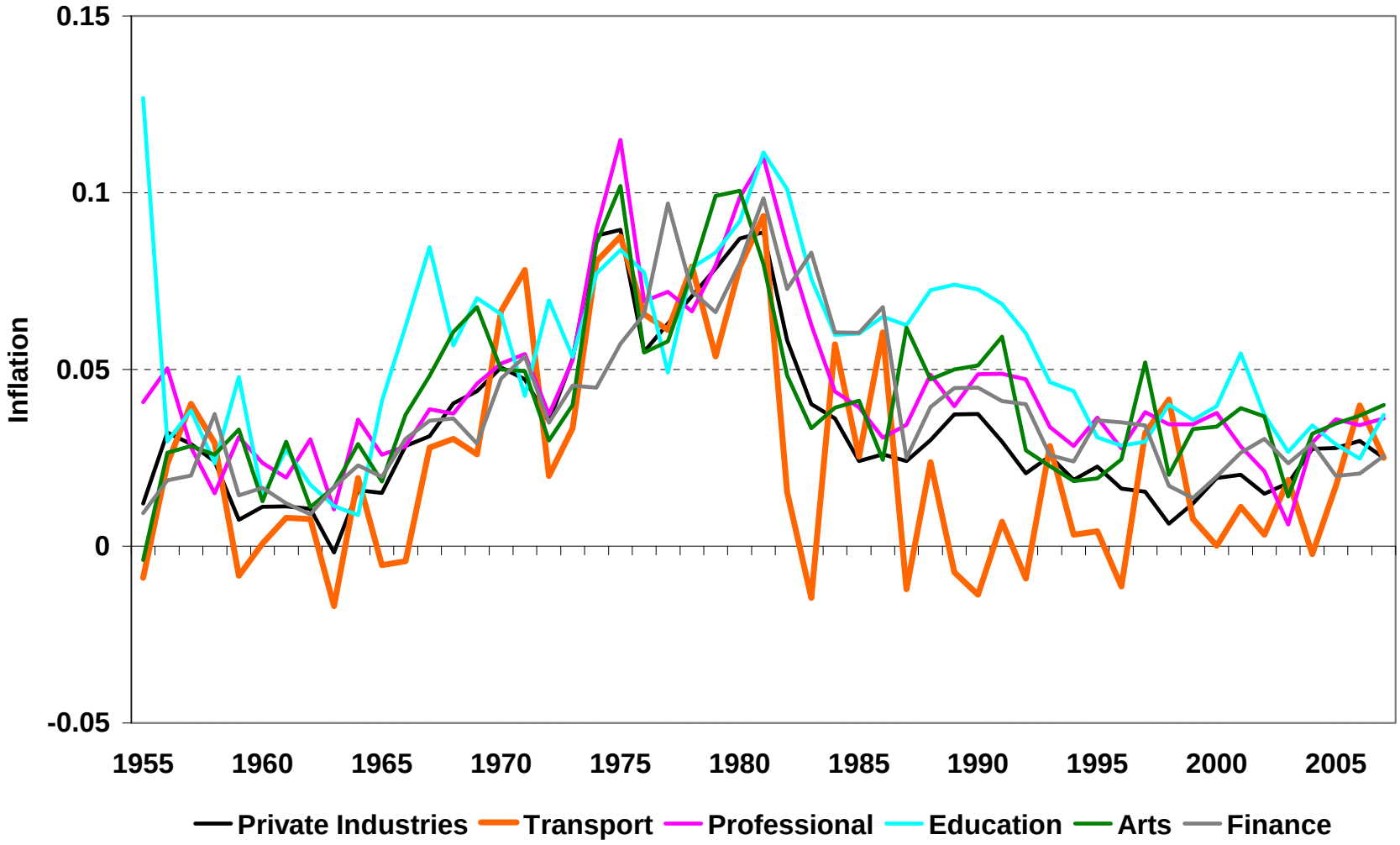
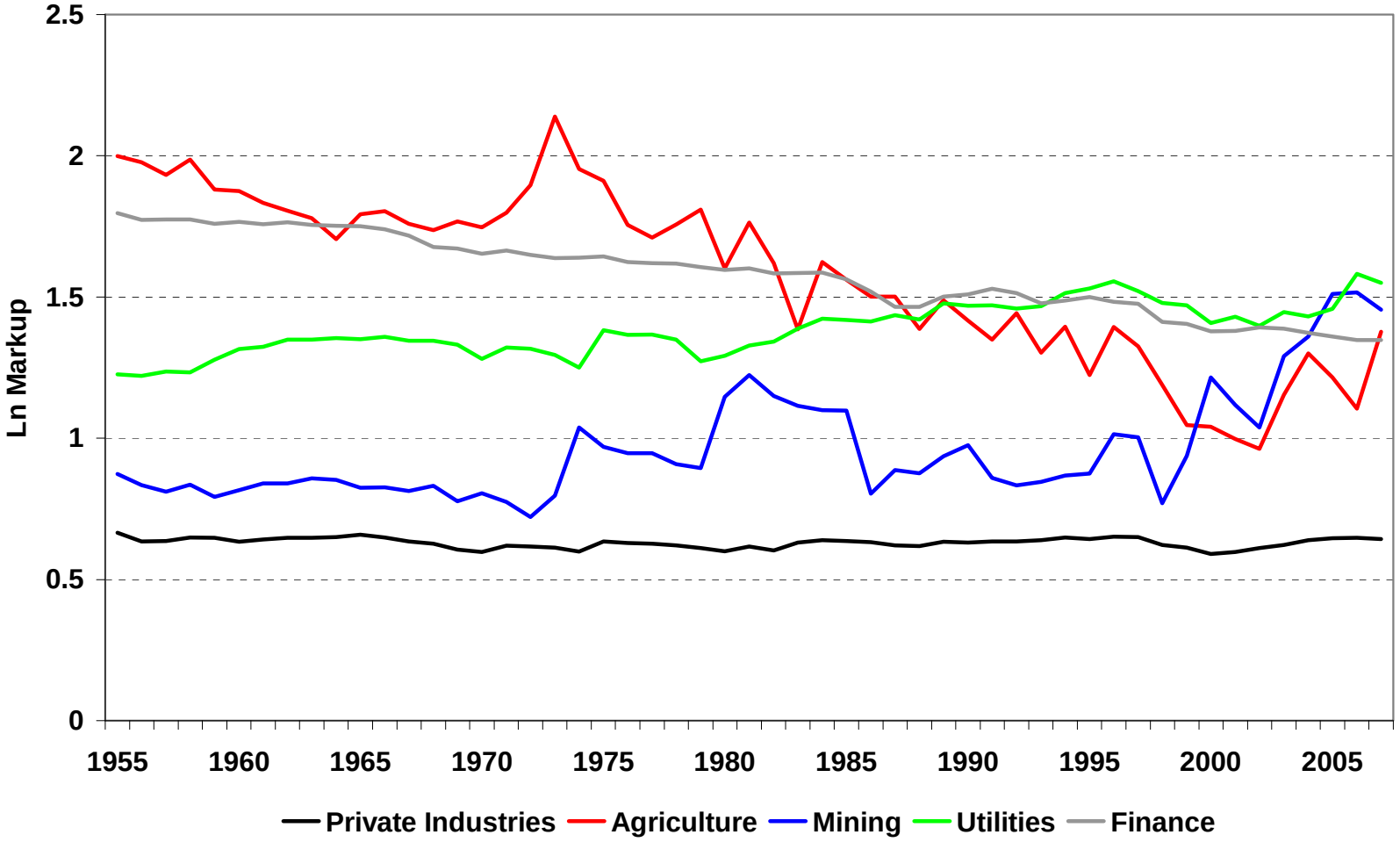


Graph 2: The Industry Markup– Annual 1955 to 2007



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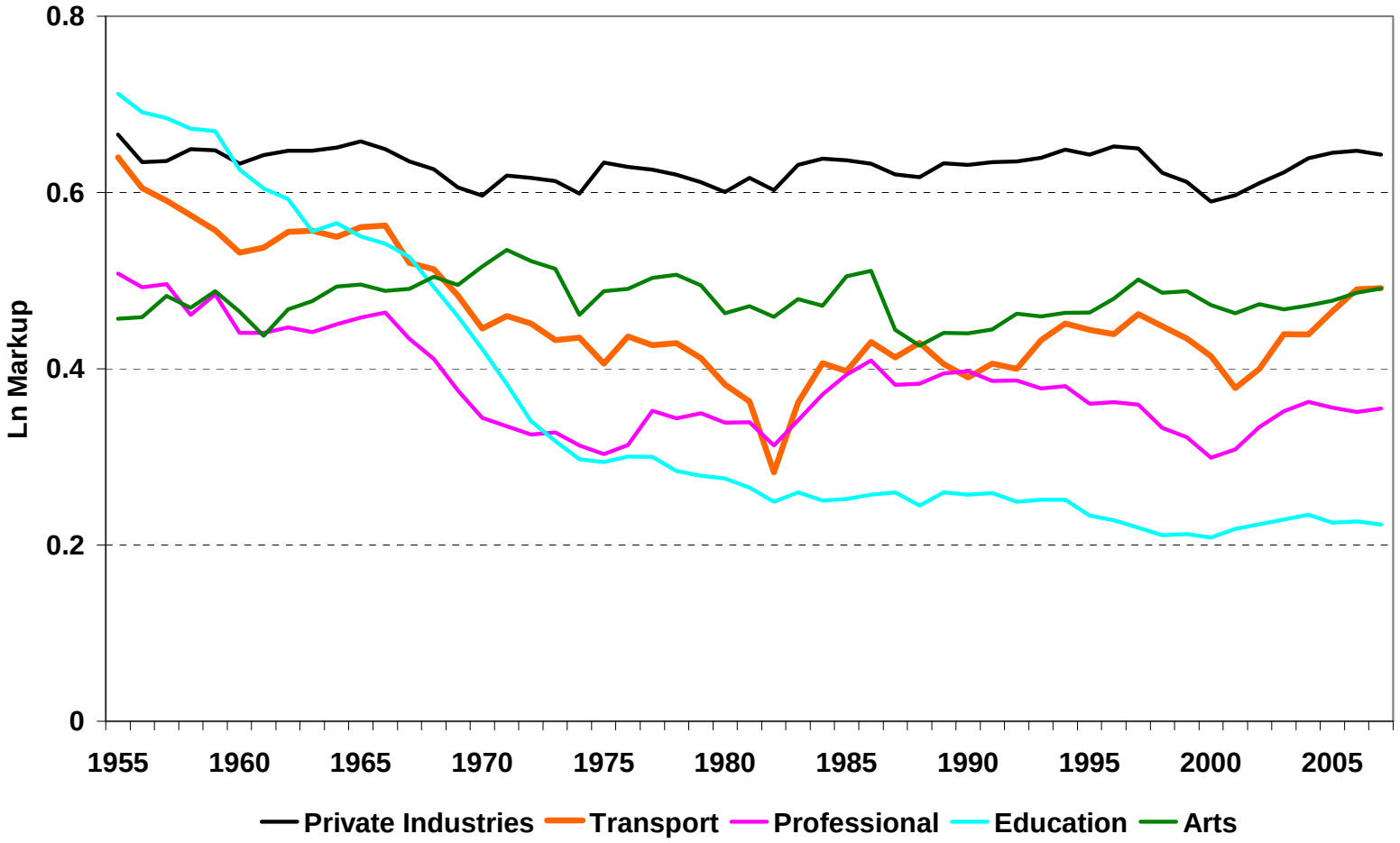

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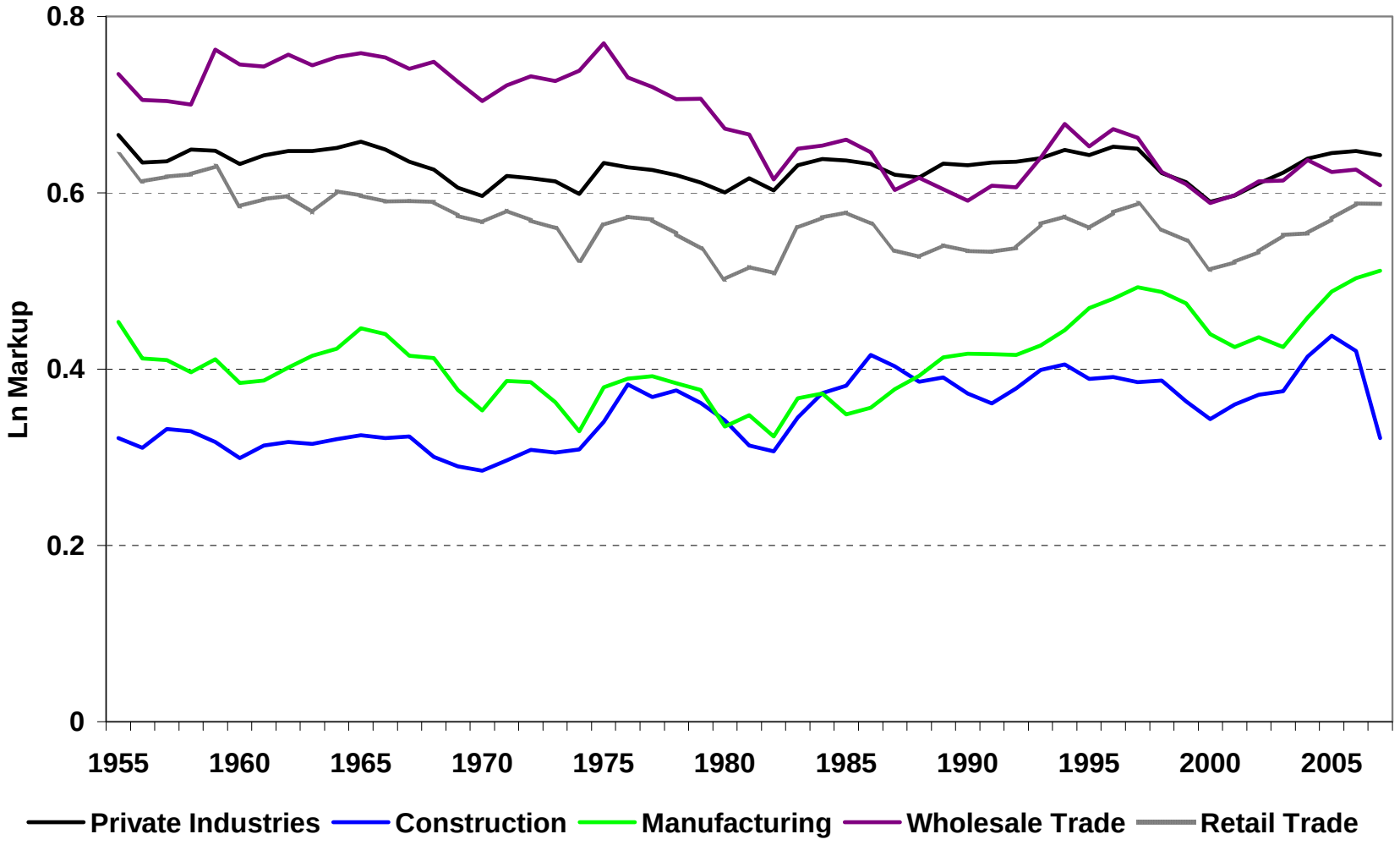
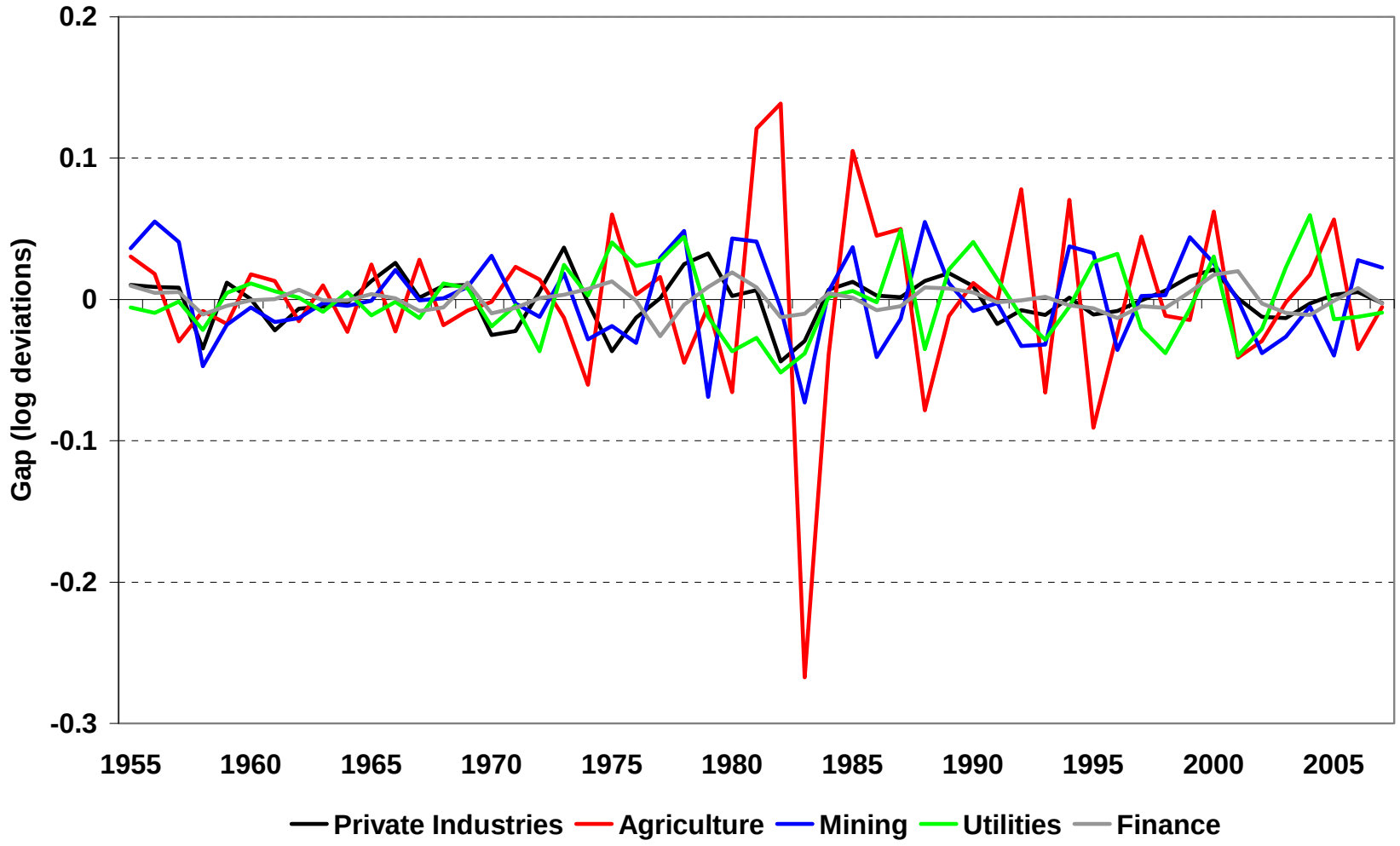
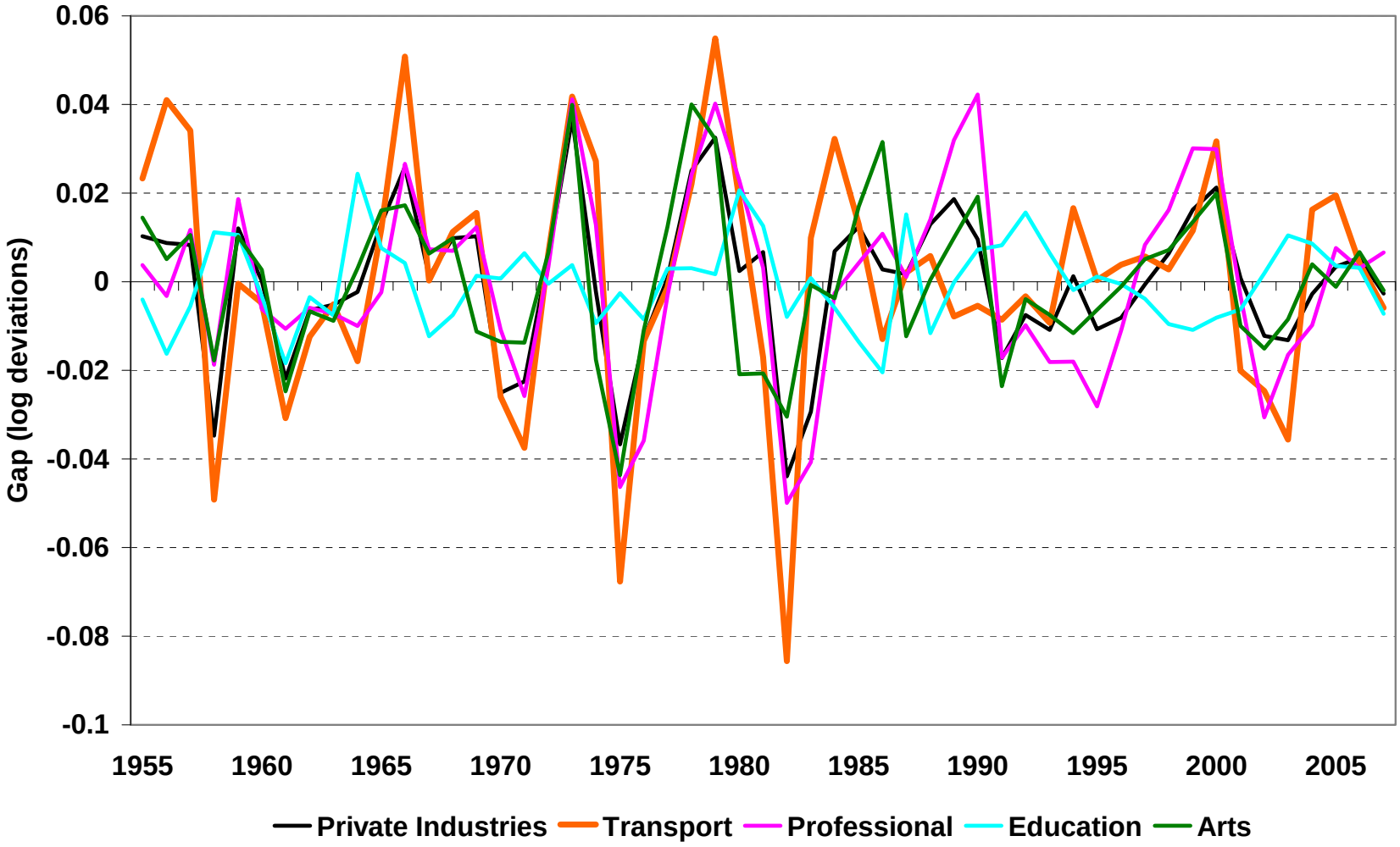


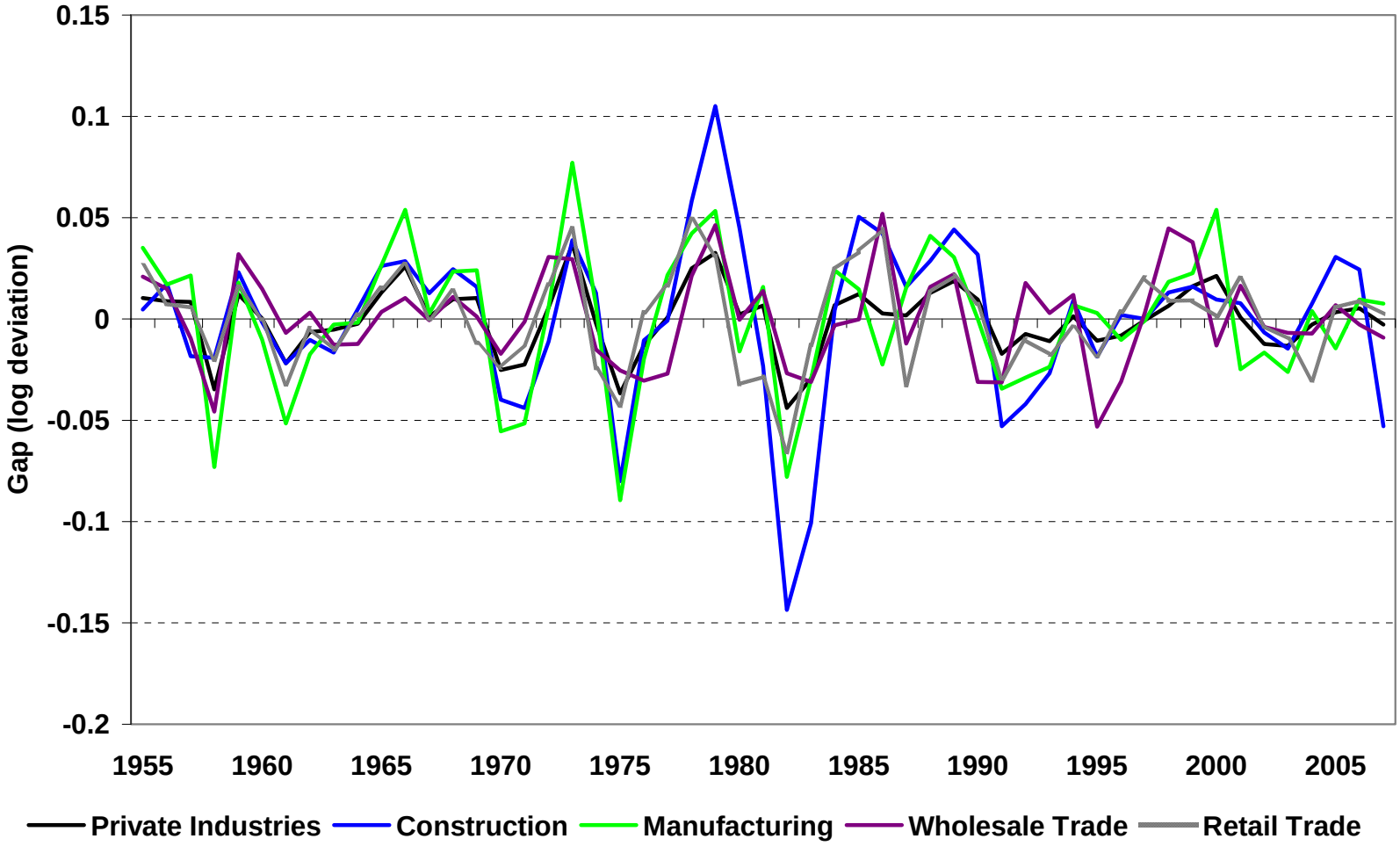
Graph 3: Industry Business Cycle – Annual 1955 to 2007



Graph 3: Industry Business Cycle – Annual 1955 to 2007



Graph 3: Industry Business Cycle – Annual 1955 to 2007



2. Theories of inflation and the markup

(a) 'Menu Cost' focus is adjustment - Rotemberg (1983), Kuran (1986), Naish (1986), Danziger (1988), Konieczny (1990) and Bénabou and Konieczny (1994)

(b) 'Menu cost' but focus is search - Bénabou (1988, 1992) and Diamond (1993)

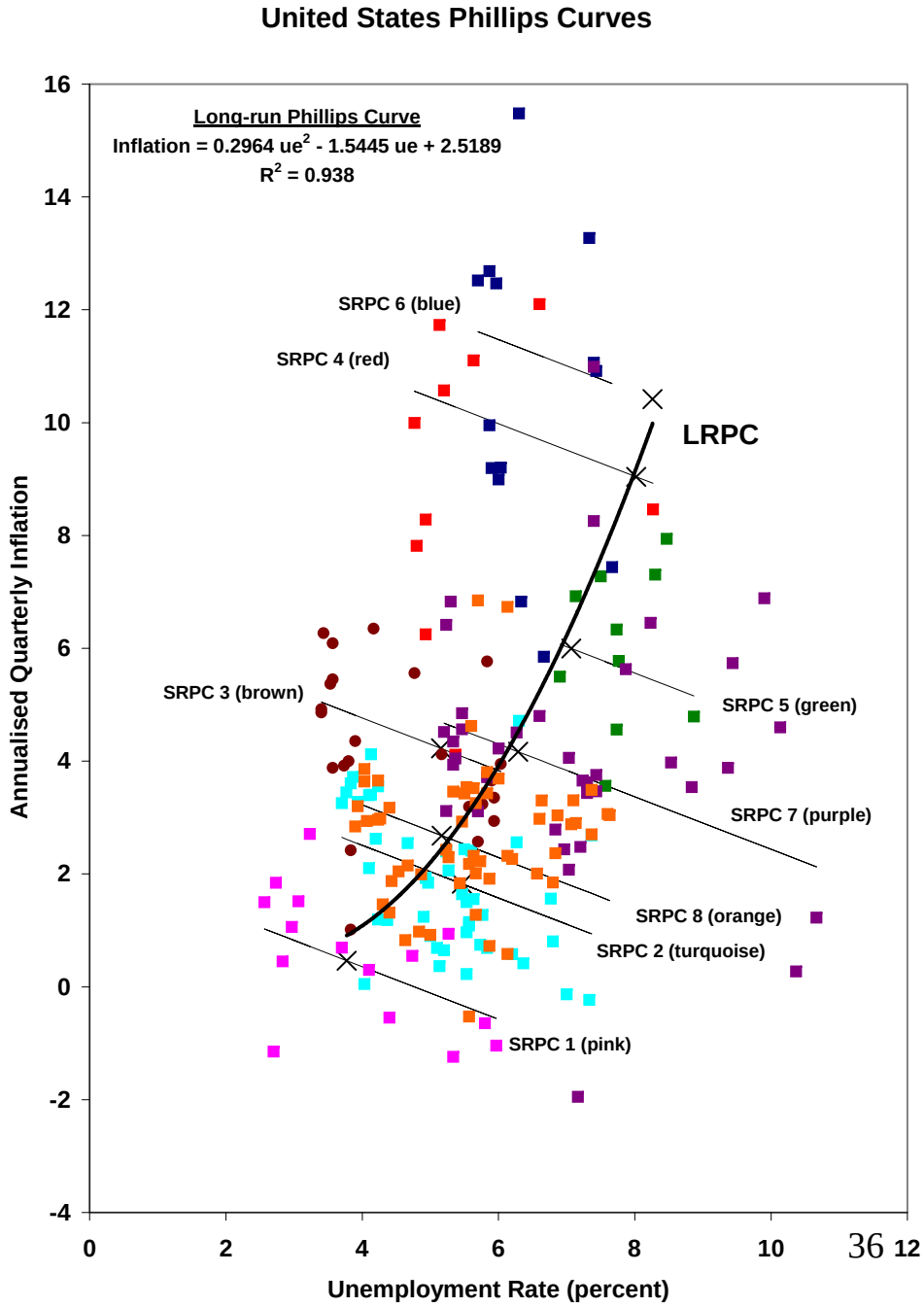
(c) Behavioural Equilibrium Models - Russell (1998), Russell, Evans and Preston (2001) and Chen and Russell (2001)

From Russell (2007). Non-stationary Inflation and Panel Estimates of United States Short and Long-run Phillips Curves.

Price index is all urban CPI.

Assumes inflation is stationary around shifting means.

Same data as Russell and Banerjee (2008).

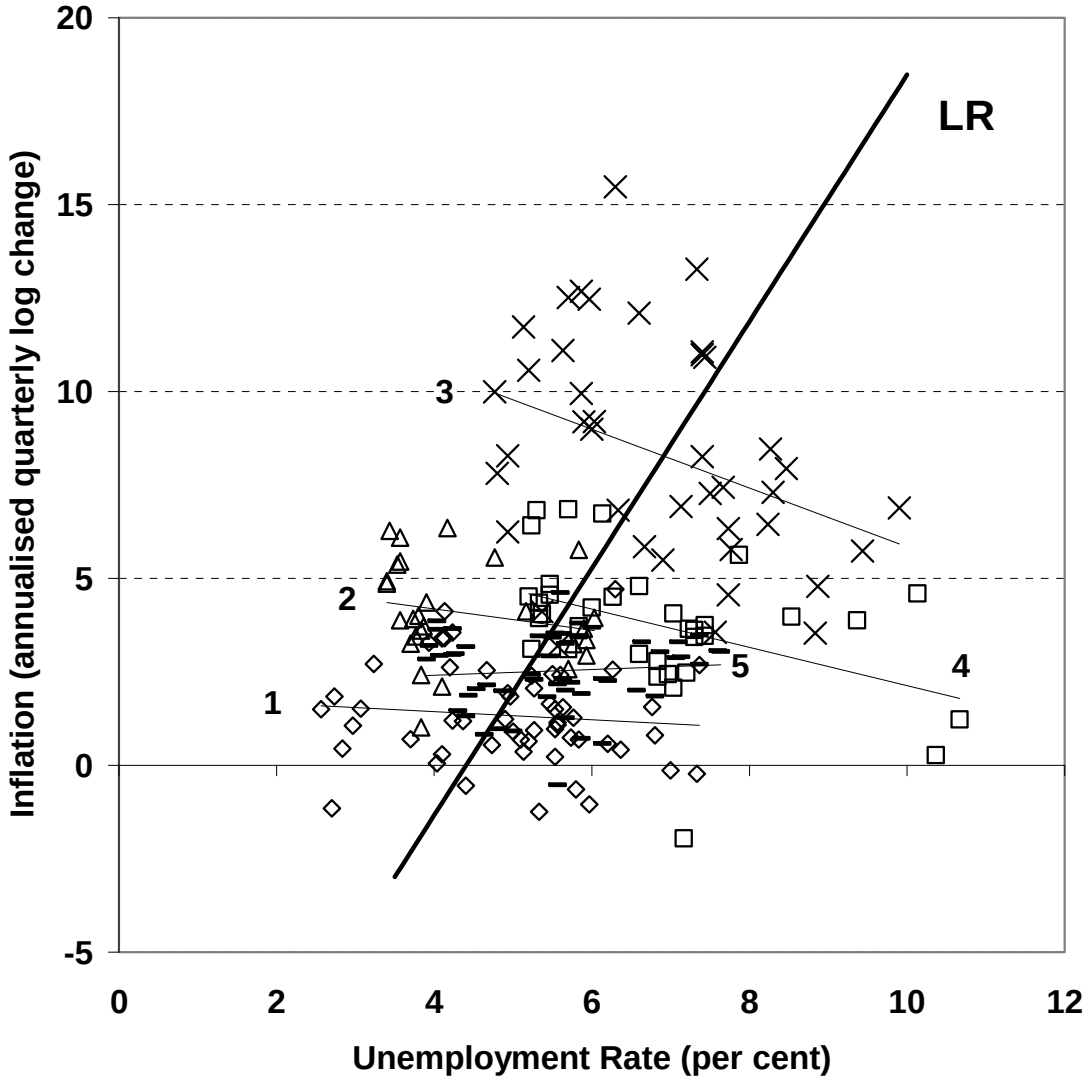


From Russell and Banerjee (2008). The Long-run Phillips curve and Non-stationary Inflation, Journal of Macroeconomics, vol. 29, pp. 355-67.

Price index is all urban CPI.

Assumes inflation and markup are integrated.

Graph 9: United States Long-run Phillips Curve



Issues: long-run Phillips curve has a positive slope

- **Ross and Wachter (1973)**
- **Friedman's (1977) Nobel Lecture**
- **Akerlof, Dickens and Perry (2000)**
- **Markup and inflation are negatively related in the long-run**

Graph 4: United States Phillips Curves