Inflation, Information Rigidity and the Sticky Information Phillips curve

César Carrera and Nelson Ramírez-Rondán

Central Reserve Bank of Peru

October 29, 2013

Motivation

The **Phillips curve** is one of the most important structural relationships.

On theoretical grounds, different views derives this relationship under a different set of assumptions:

- Price stickiness (New Keynesian Phillips curve)
- Information stickiness (Sticky Information Phillips curve)
- Price and information stickiness (Hybrid Phillips curve).

Lucas (1973), Ball, Mankiw, and Romer (1988) and Kiley (2007) discuss the exogeneity of the degree of price stickiness i.e. firms has the same probability of changing prices independent of the inflation regime.

Motivation

The **Phillips curve** is one of the most important structural relationships.

On theoretical grounds, different views derives this relationship under a different set of assumptions:

- Price stickiness (New Keynesian Phillips curve)
- Information stickiness (Sticky Information Phillips curve)
- Price and information stickiness (Hybrid Phillips curve).

Lucas (1973), Ball, Mankiw, and Romer (1988) and Kiley (2007) discuss the exogeneity of the degree of price stickiness i.e. firms has the same probability of changing prices independent of the inflation regime.

Contribution: This paper provides consistent estimations of the Sticky Information Phillips curve and presents consistent evidence that agents update information faster during high inflation regimes.

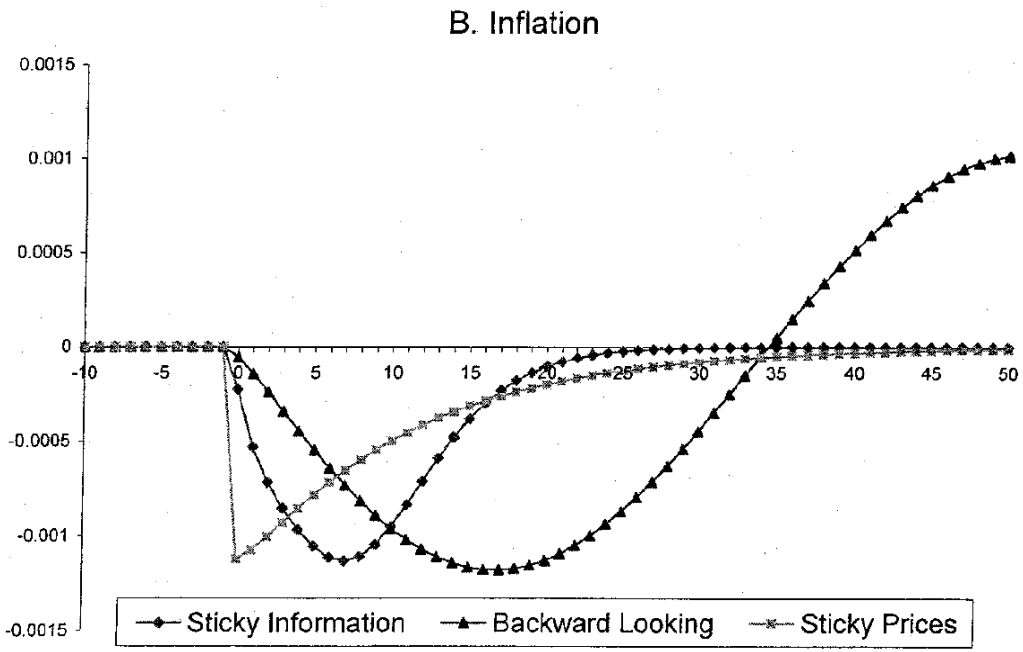
Some Literature

Recent papers on the Sticky Information Phillips curve (SIPC):

- Mankiw, G., Reis, R., 2002 (The Quarterly Journal of Economics). Sticky Information Versus Sticky Prices: A Proposal To Replace The New Keynesian Phillips Curve.
- Khan, H., Zhu, Z., 2006 (JMCB). Estimates of the Sticky-Information Phillips Curve for the United States.
- Coibion, O., 2010 (Review of Economics and Statistics). Testing the Sticky Information Phillips Curve.
- Korenok, O., 2007 (Journal of Macroeconomics). Empirical comparison of sticky price and sticky information models.
- Kiley, M., 2007 (JMCB). A quantitative comparison of sticky-price and sticky-information models of price setting.

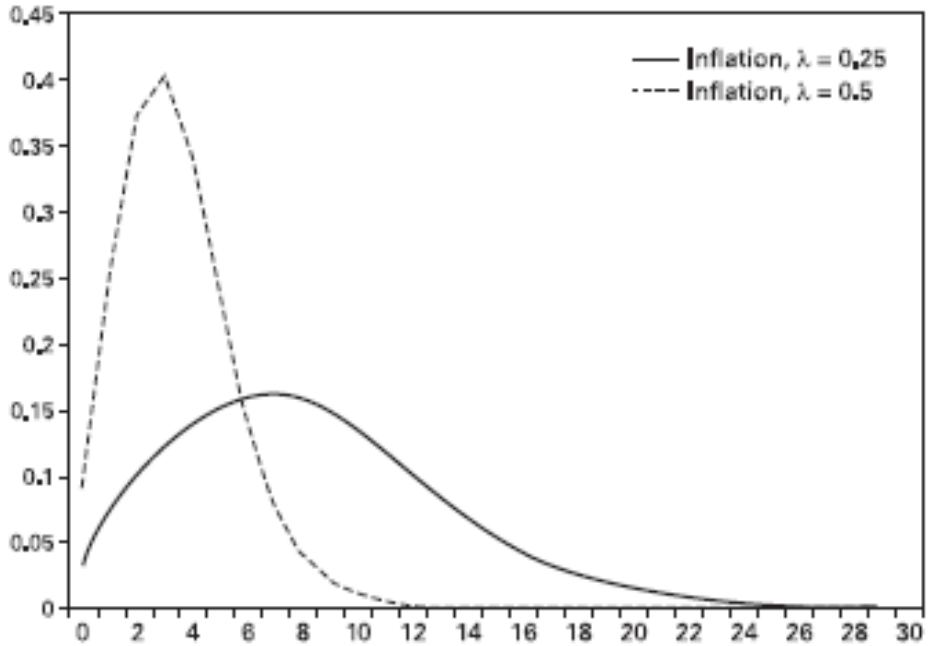
Mankiw and Reis, 2002

Figure : Response of inflation to a one-standard-deviation monetary policy shock



Walsh, 2010

Figure : Response of inflation to a one-standard-deviation monetary policy shock



The Sticky Information Phillips curve

Mankiw and Reis (2002):

- Each firm has the same probability of being one of the firms updating its information set, regardless of how long it has been since its last update.
- In this set-up, inflation depends on output, past expectations of current inflation, and past expectations of changes in current output growth.

The Sticky Information Phillips curve

$$\pi_t = \frac{\lambda\alpha}{1-\lambda} y_t + \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}(\pi_t + \alpha \Delta y_t) \tag{1}$$

where:

- λ is a fraction of firms obtain new information about macroeconomic conditions.
- α is the real rigidity (i.e. desired price $p_t^* = p_t + \alpha y_t$, where p_t is the overall price level and y_t is the output gap (or aggregate demand related variable).
- $\Delta y_t = y_t - y_{t-1}$ is the growth rate of output
- $\pi_t = p_t - p_{t-1}$ defines the growth rate of prices (inflation).

The Sticky Information Phillips curve

The Khan and Zhu (2006) strategy consists in the truncation of Equation (1).
Empirical counterpart of the SIPC suggested by Khan and Zhu (2006):

$$\pi_t = \frac{\lambda\alpha}{1-\lambda} y_t + \lambda \sum_{j=0}^{j^{max}} (1-\lambda)^j E_{t-1-j}[\pi_t + \alpha \Delta y_t] + u_t, \qquad (2)$$

where $u_t = \lambda \sum_{j=j^{max}+1}^{\infty} (1-\lambda)^j E_{t-1-j}[\pi_t + \alpha \Delta y_t]$.
For a given λ, the approximation error, u_t, gets theoretically smaller with an increase in the truncation level (j^{max}).

The Sticky Information Phillips curve

Joint estimation of α and λ:

Table : Estimation of information and real rigidities

		$y^{Quadratic\ Detrended}$		$y^{Hodrick-Prescott}$	
	$j^{max}+1$	$\widehat{\alpha}$	$\widehat{\lambda}$	$\widehat{\alpha}$	$\widehat{\lambda}$
$\pi^{CPI\ inflation}$	5 Quarters	0.02	0.75	0.01	0.86
		(0.015)	(0.110)	(0.013)	(0.121)
	8 Quarters	0.02	0.75	0.01	0.86
		(0.015)	(0.111)	(0.013)	(0.121)
	12 Quarters	0.02	0.75	0.01	0.86
		(0.015)	(0.111)	(0.013)	(0.121)
	20 Quarters	0.02	0.75	0.01	0.86
		(0.015)	(0.011)	(0.013)	(0.121)
$\pi^{Core\ inflation}$	5 Quarters	0.03	0.67	0.02	0.78
		(0.018)	(0.111)	(0.011)	(0.141)
	8 Quarters	0.02	0.74	0.01	0.87
		(0.016)	(0.129)	(0.015)	(0.154)
	12 Quarters	0.02	0.74	0.01	0.87
		(0.016)	(0.129)	(0.015)	(0.154)
	20 Quarters	0.02	0.74	0.01	0.87
		(0.016)	(0.129)	(0.015)	(0.154)
$\pi^{GDP\ deflator}$	5 Quarters	0.02	0.72	0.01	0.85
		(0.011)	(0.093)	(0.010)	(0.109)
	8 Quarters	0.02	0.72	0.01	0.85
		(0.011)	(0.094)	(0.010)	(0.109)
	12 Quarters	0.02	0.72	0.01	0.85
		(0.011)	(0.094)	(0.010)	(0.109)
	20 Quarters	0.02	0.72	0.01	0.85
		(0.011)	(0.094)	(0.010)	(0.109)
Average		0.02	0.73	0.01	0.85
		(0.014)	(0.106)	(0.012)	(0.128)
In quarters			1.4		1.2

The sample period is 1971Q1-2007Q4. Standard errors are in parenthesis.

The Sticky Information Phillips curve

Estimation of λ, for a given α:

Table : Estimation of information rigidity ($\alpha = 0.1$)

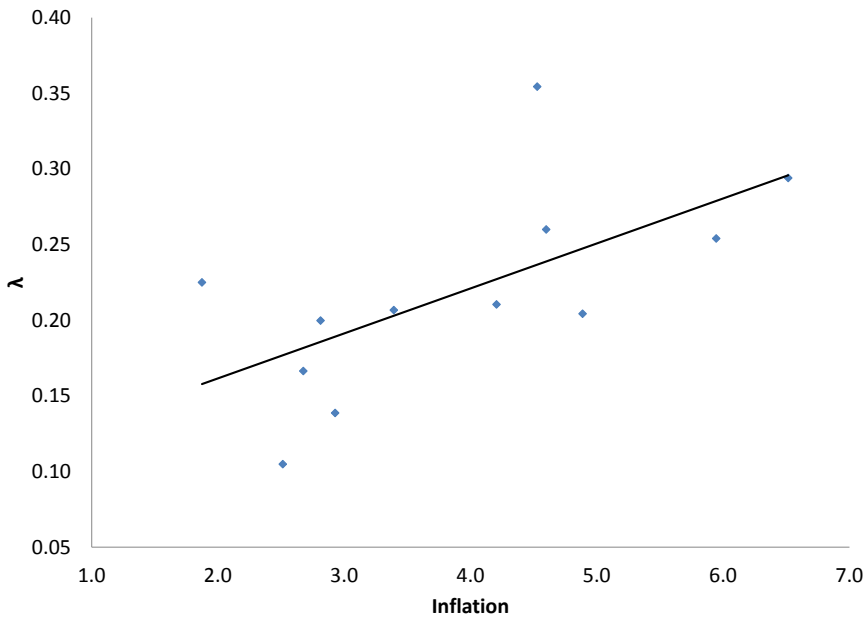
		$y^{Quadratic\ Detrended}$	$y^{Hodrick-Prescott}$
	$j^{max}+1$	$\widehat{\lambda}$	$\widehat{\lambda}$
$\pi^{CPI\ inflation}$	5 Quarters	0.48	0.54
		(0.030)	(0.040)
	8 Quarters	0.47	0.54
		(0.030)	(0.040)
	12 Quarters	0.47	0.54
		(0.030)	(0.040)
	20 Quarters	0.47	0.54
		(0.030)	(0.040)
$\pi^{Core\ inflation}$	5 Quarters	0.45	0.50
		(0.032)	(0.043)
	8 Quarters	0.45	0.52
		(0.034)	(0.046)
	12 Quarters	0.45	0.52
		(0.034)	(0.046)
	20 Quarters	0.45	0.52
		(0.034)	(0.056)
$\pi^{GDP\ deflator}$	5 Quarters	0.45	0.51
		(0.023)	(0.032)
	8 Quarters	0.43	0.50
		(0.024)	(0.035)
	12 Quarters	0.43	0.50
		(0.024)	(0.034)
	20 Quarters	0.43	0.50
		(0.024)	(0.034)
Average		0.45	0.52
		(0.029)	(0.041)
In quarters		2.2	1.9

The sample period is 1971Q1-2007Q4. Standard errors are in parenthesis.

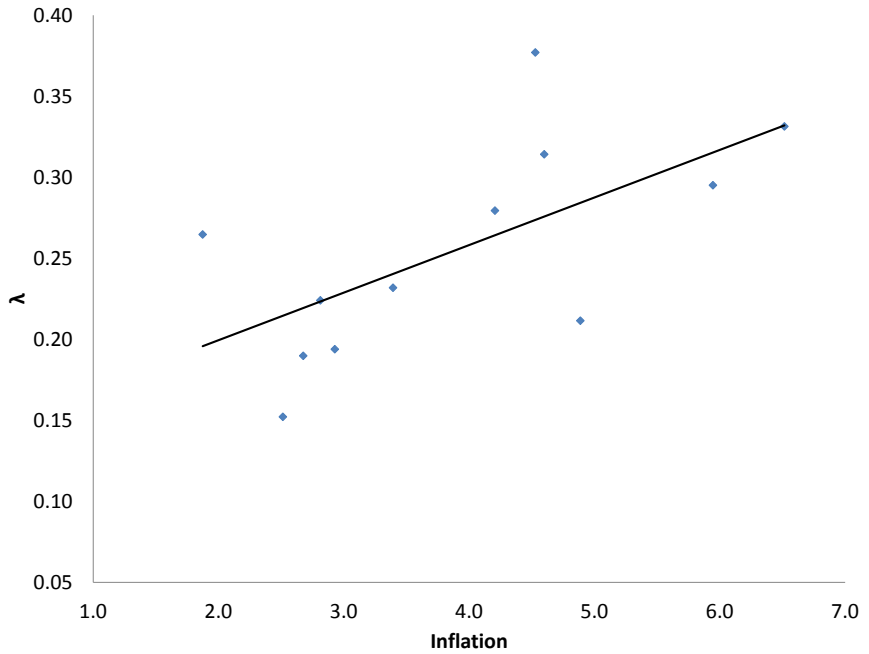
In OECD countries

Figure : Information rigidity and inflation for OECD countries

(a) CPI inflation and detrended output gap



(b) CPI inflation and Hodrick-Prescott output gap

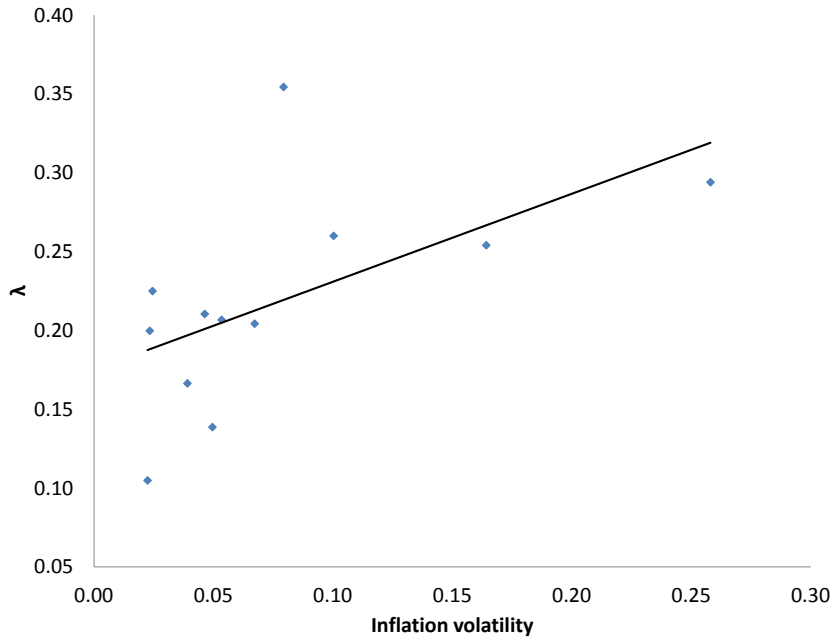


Note: The information rigidity estimate for each country is the average for different truncation levels

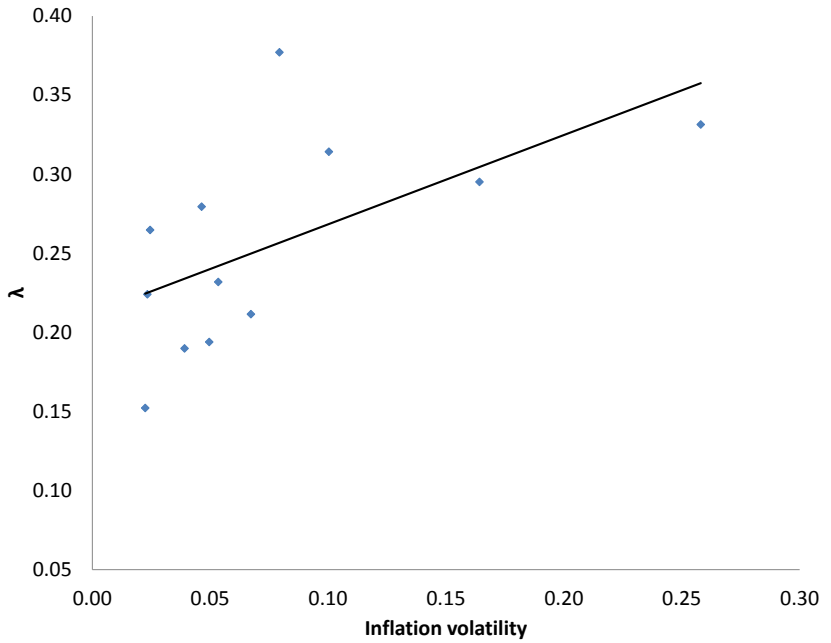
In OECD countries

Figure : Information rigidity and inflation volatility for OECD countries

(a) CPI inflation and detrended output gap



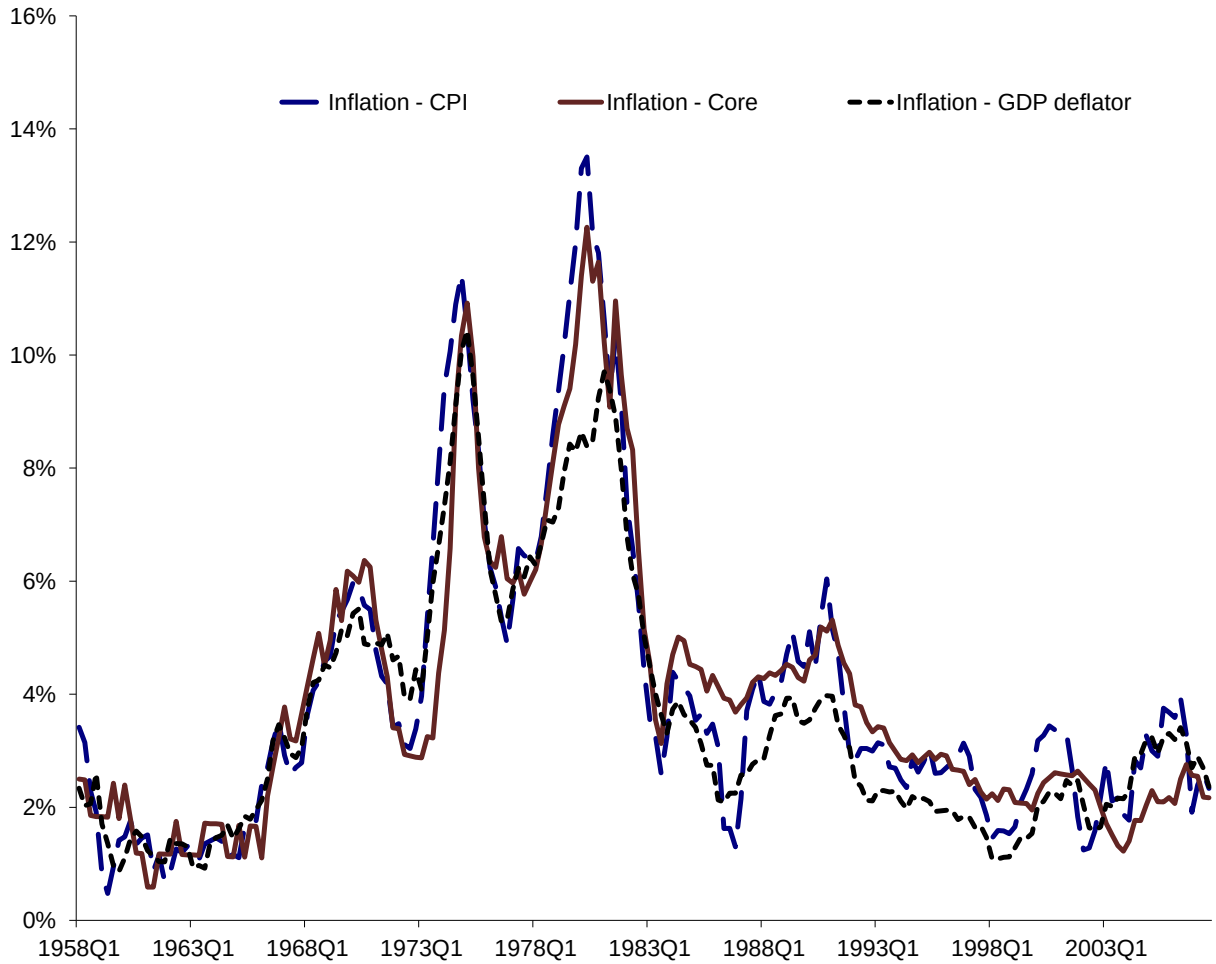
(b) CPI inflation and Hodrick-Prescott output gap



Note: The information rigidity estimate for each country is the average for different truncation

Two regimes?

Figure : U.S. Inflation



Two regimes?

Table : Information rigidity in high and low inflation ($\alpha = 0.1$ and $j^{max}+1 = 5$ quarters)

	$y^{Quadratic\ Detrended}$		$y^{Hodrick-Prescott}$	
	Low Inflation	High Inflation	Low Inflation	High Inflation
$\pi^{CPI\ inflation}$	(Time$\geq$ 1982$Q4$)	(Time$<$ 1982$Q4$)	(Time$\geq$ 1982$Q4$)	(Time$<$ 1982$Q4$)
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.37	0.58	0.36	0.56
	(0.058)	(0.032)	(0.059)	(0.042)
$\pi^{Core\ inflation}$	(Time$\geq$ 1982$Q4$)	(Time$<$ 1982$Q4$)	(Time$\geq$ 1982$Q4$)	(Time$<$ 1982$Q4$)
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.30	0.49	0.27	0.53
	(0.041)	(0.033)	(0.031)	(0.042)
$\pi^{GDP\ deflator}$	(Time$\geq$ 1982$Q4$)	(Time$<$ 1982$Q4$)	(Time$\geq$ 1982$Q4$)	(Time$<$ 1982$Q4$)
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.37	0.49	0.37	0.53
	(0.044)	(0.024)	(0.051)	(0.033)
Average	0.35	0.52	0.33	0.54
	(0.048)	(0.030)	(0.048)	(0.039)
In quarters	2.9	1.9	3.0	1.9

The sample period is 1971Q1-2007Q4. Standard errors are in parenthesis.

Time threshold model

Set a threshold model in which time is the threshold variable:

$$\pi_t = \begin{cases} \frac{\lambda_1 \alpha}{1-\lambda_1} y_t + \lambda_1 \sum_{j=0}^{j^{max}} (1-\lambda_1)^j E_{t-1-j}[\pi_t + \alpha \Delta y_t] + u_t & \text{if} \quad \text{Time} \geq \tau \\ \frac{\lambda_2 \alpha}{1-\lambda_2} y_t + \lambda_2 \sum_{j=0}^{j^{max}} (1-\lambda_2)^j E_{t-1-j}[\pi_t + \alpha \Delta y_t] + u_t & \text{if} \quad \text{Time} < \tau, \end{cases} \tag{3}$$

where λ_1 and λ_2 are information rigidity parameters for low and high inflation periods, respectively; and τ is the threshold parameter.

Time threshold model

Table : Information rigidity in high and low inflation ($\alpha = 0.1$ and $j^{max}+1 = 5$ quarters)

	$y^{Quadratic\ Detrended}$		$y^{Hodrick-Prescott}$	
	Low Inflation	High Inflation	Low Inflation	High Inflation
$\pi^{CPI\ inflation}$	(Time$\geq$ 1981$Q4$)	(Time$<$ 1981$Q4$)	(Time$\geq$ 1980$Q3$)	(Time$<$ 1980$Q3$)
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.33	0.54	0.34	0.59
	(0.049)	(0.033)	(0.042)	(0.042)
$\pi^{Core\ inflation}$	(Time$\geq$ 1981$Q4$)	(Time$<$ 1981$Q4$)	(Time$\geq$ 1981$Q4$)	(Time$<$ 1981$Q4$)
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.29	0.51	0.27	0.55
	(0.036)	(0.034)	(0.028)	(0.043)
$\pi^{GDP\ deflator}$	(Time$\geq$ 1981$Q2$)	(Time$<$ 1981$Q2$)	(Time$\geq$ 1975$Q3$)	(Time$<$ 1975$Q3$)
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.36	0.50	0.44	0.66
	(0.039)	(0.024)	(0.035)	(0.039)
Average	0.33	0.52	0.35	0.60
	(0.042)	(0.031)	(0.035)	(0.041)
In quarters	3.1	1.9	2.9	1.7

The sample period is 1971Q1-2007Q4. Standard errors are in parenthesis.

Inflation threshold model

A model in which high inflation is determined for inflation rates higher than a threshold value:

$$\pi_t = \begin{cases} \frac{\lambda_1\alpha}{1-\lambda_1} y_t + \lambda_1 \sum_{j=0}^{j^{max}} (1-\lambda_1)^j E_{t-1-j}[\pi_t + \alpha\Delta y_t] + u_t & \text{if} \quad \pi_{t-1} \leq \gamma \\ \frac{\lambda_2\alpha}{1-\lambda_2} y_t + \lambda_2 \sum_{j=0}^{j^{max}} (1-\lambda_2)^j E_{t-1-j}[\pi_t + \alpha\Delta y_t] + u_t & \text{if} \quad \pi_{t-1} > \gamma, \end{cases} \tag{4}$$

where λ_1 and λ_2 are information rigidity parameters when the inflation is low and high, respectively; and γ is the threshold parameter.

Inflation threshold model

Table : Information rigidity in high and low inflation ($\alpha = 0.1$ and $j^{max}+1 = 5$ quarters)

	$y^{Quadratic\ Detrended}$		$y^{Hodrick-Prescott}$	
	Low Inflation	High Inflation	Low Inflation	High Inflation
$\pi^{CPI\ inflation}$	$(\pi_{t-1} \leq 1.7\%)$	$(\pi_{t-1} > 1.7\%)$	$(\pi_{t-1} \leq 1.7\%)$	$(\pi_{t-1} > 1.7\%)$
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.37	0.57	0.39	0.61
	(0.047)	(0.034)	(0.061)	(0.042)
$\pi^{Core\ inflation}$	$(\pi_{t-1} \leq 2.5\%)$	$(\pi_{t-1} > 2.5\%)$	$(\pi_{t-1} \leq 2.2\%)$	$(\pi_{t-1} > 2.2\%)$
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.39	0.80	0.38	0.68
	(0.061)	(0.026)	(0.042)	(0.053)
$\pi^{GDP\ deflator}$	$(\pi_{t-1} \leq 2.3\%)$	$(\pi_{t-1} > 2.3\%)$	$(\pi_{t-1} \leq 2.3\%)$	$(\pi_{t-1} > 2.3\%)$
	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$	$\widehat{\lambda}_1$	$\widehat{\lambda}_2$
	0.42	0.71	0.48	0.65
	(0.023)	(0.042)	(0.035)	(0.062)
Average	0.39	0.69	0.42	0.65
	(0.046)	(0.035)	(0.047)	(0.053)
In quarters	2.5	1.4	2.4	1.5

The sample period is 1971Q1-2007Q4. Standard errors are in parenthesis.

In our work ...

- We provide direct estimations of the degree of information rigidity following the sticky information theory (λ parameter).
- Our results suggest different degrees of information rigidity across countries and across different time periods.
- We argue that the estimated levels of information rigidity appear to be driven primarily by state-contingent conditions of low- and high-inflation scenarios.
- In other words, in low-inflation environments, agents tend to be more inattentive to macroeconomic conditions.