Inflation Dynamics in Malaysia [*]

Abstract

Low and stable inflation has been one of the main features of the Malaysian economy in the last two decades. Nevertheless, the abandonment of the explicit anchor represented by the seven-year-old exchange rate peg in July of 2005 and the recent rise in inflation underscores the need for a better understating of inflation dynamics in Malaysia. Firstly, this paper attempts to fill this gap by reviewing the behavior of inflation in the last decade and a half and estimating inflation models that can be used for forecasting. We analyze the behavior of inflation in Malaysia during 1991-2006, paying particular attention to the subcomponents of the CPI responsible for the significant changes in inflation; we then propose two measures of Core Inflation. Secondly, we econometrically uncover the dynamics of inflation from two different perspectives. An error correction model shows that money growth, nominal effective exchange rate, unit labor costs growth, deviations from mark-up pricing, and excess money supply have significant effects on inflation. The second approach is based on the New Keynesian Phillips Curve (NKPC). Estimates of the NKPC reveal that inflation has sizeable backward looking component (inertia) but it also depends on expected inflation rate, the exchange rate, and a measure of demand pressure. The results appear to be relatively robust with the inclusion of a survey-based proxy to measure inflation expectations and distinct measures of demand pressure.

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Introduction

This study tries to shed some light on the dynamics of inflation in Malaysia. Malaysia has been relatively successful in balancing strong economic growth with moderate levels of inflation in the periods preceding and following the Asian Crisis. Yet, the exit from the seven-year-old exchange rate peg in July 2005 and the recent adjustment in administered fuel prices call for a better understanding of the determinants of inflation. Understating the dynamics of inflation will also be important for assessing the appropriate macroeconomic policy mix.

The aim of the paper is twofold. First, the paper analyzes in detail the behavior of headline inflation, its subcomponents, and core inflation during the 1991-2006 period. A study of long-term trends, including comparison with neighboring countries is also performed. The data analysis also accounts for the contribution of the subcomponents of the Malaysian CPI to the overall rate of inflation during a series of different sub-periods. The paper then moves on to construct two measures of core inflation based on less volatile components of the CPI. Second, the paper presents two econometric approaches to uncover the determinants of inflation in Malaysia. The first approach is represented by an Autoregressive Distributed Lags model augmented to incorporate inflationary pressures steaming from deviations in the long run equilibriums. The second econometric approach is based on the New Keynesian Phillips Curve. These modeling frameworks allow one to consider the effects of expectations, inertia, demand pressures, and (in its open economy variant) the exchange rate on inflation.

The paper is divided in four sections. The first section contains the analysis of long term trends and a regional perspective as well as the effects of the different subcomponents on overall inflation. The second section builds on the analysis of the subcomponents and proposes two measures of core inflation. The third section discusses the data and methodology underlying the empirical inflation models estimated for Malaysia. The final section concludes.

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SECTION 1

In this section, we describe the facts behind the evolution of inflation in consumer prices as well as other related macro variables and policies in the Malaysian economy.

Graph 1 shows the evolution of Inflation in Malaysia in the last 10 years. From this graph we observe that Inflation reached a six-year-high at the end of 2005. The fact that Core Inflation has increased moderately, but has remained relatively subdued points to recent adjustments in the administered prices of fuel and other consumption items as possible causes of this sudden rise. The recent acceleration in headline inflation has created a gap of more than 1 percentage point between the two variables since May 2005. This discrepancy provides a gauge of the cost-push shock stemming primarily from higher oil price.

Despite the recent acceleration in inflation, with the obvious exception of the Asian Crisis where inflation increased to levels above 5½ percent, Malaysia has experienced remarkably low and stable inflation since 1991 averaging approximately 2.9 percent in annual inflation. Comparing across different exchange rate regimes, we clearly see that, statistically, annual inflation rates were at their minimum during the peg to the US dollar averaging 1.8 percent during those seven years (Oct 1998-Jul 2005). Although not as low, the recorded managed float period prior to the Asian Crisis (Jan 1995 – Jul 1997) was also characterized by relatively low annual inflation rates. The Average inflation for this period was around 3 percent. Finally, despite the small quantity of observations since the end of the Ringgit peg to the US dollar (Jul 2005 – Jun 2006), the recorded average inflation, around 3.6 percent, is to some extent closer to the previous managed float levels than to the exiting regime.

Looking beyond the simple sub period averages, we observe that the period under the peg had inherited what seems to be a clear downward trend springing from the earlier managed float period. Also the recent upward trend in inflation originated two years prior to the abandonment of the peg (February of 2003).

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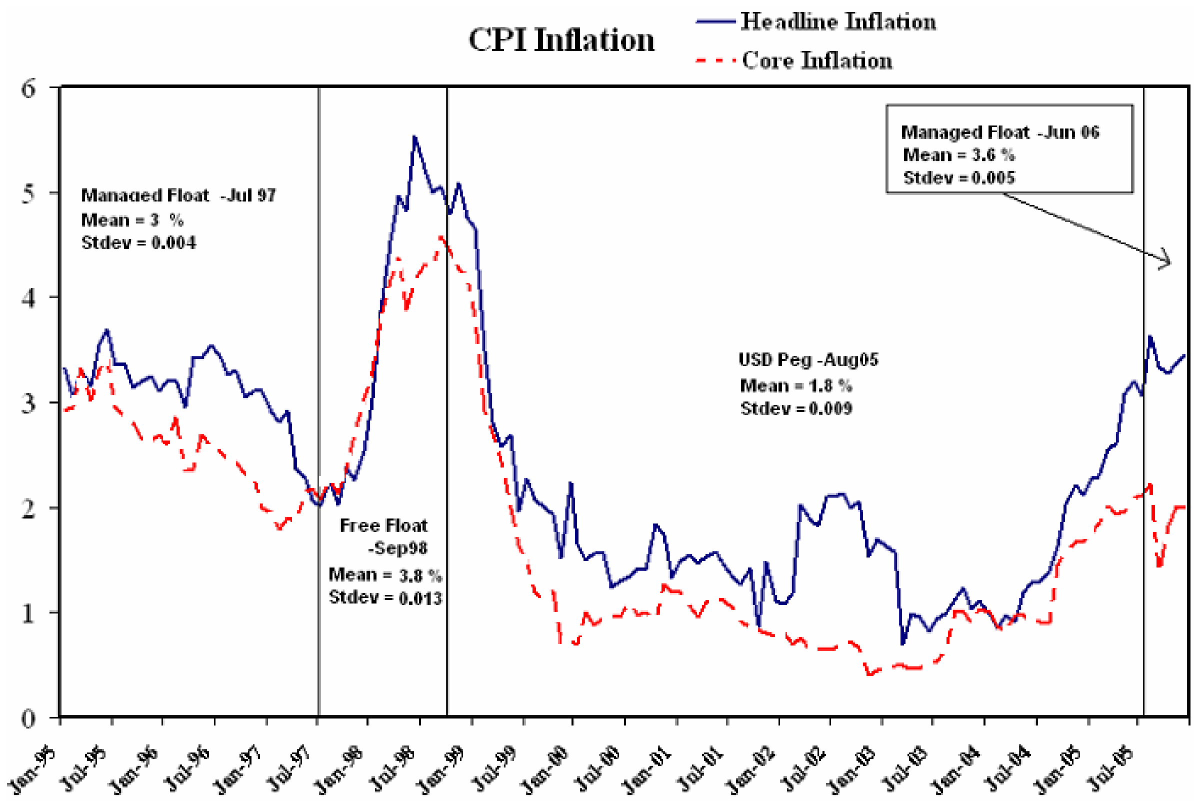

Graph 1: Headline vs. Simple Exclusion Based measure of Core Inflation

In terms of Inflation volatility, measured in standard deviations, across exchange rate regimes we see that ~~the~~ inflation during the managed float regime in the first half of the nineties was more stable than during the fixed exchange rate regime in the subsequent years. Again with very few observations, we draw that the volatility of the new managed float is closer to the previous managed float regime levels than to the fixed exchange rate regime.

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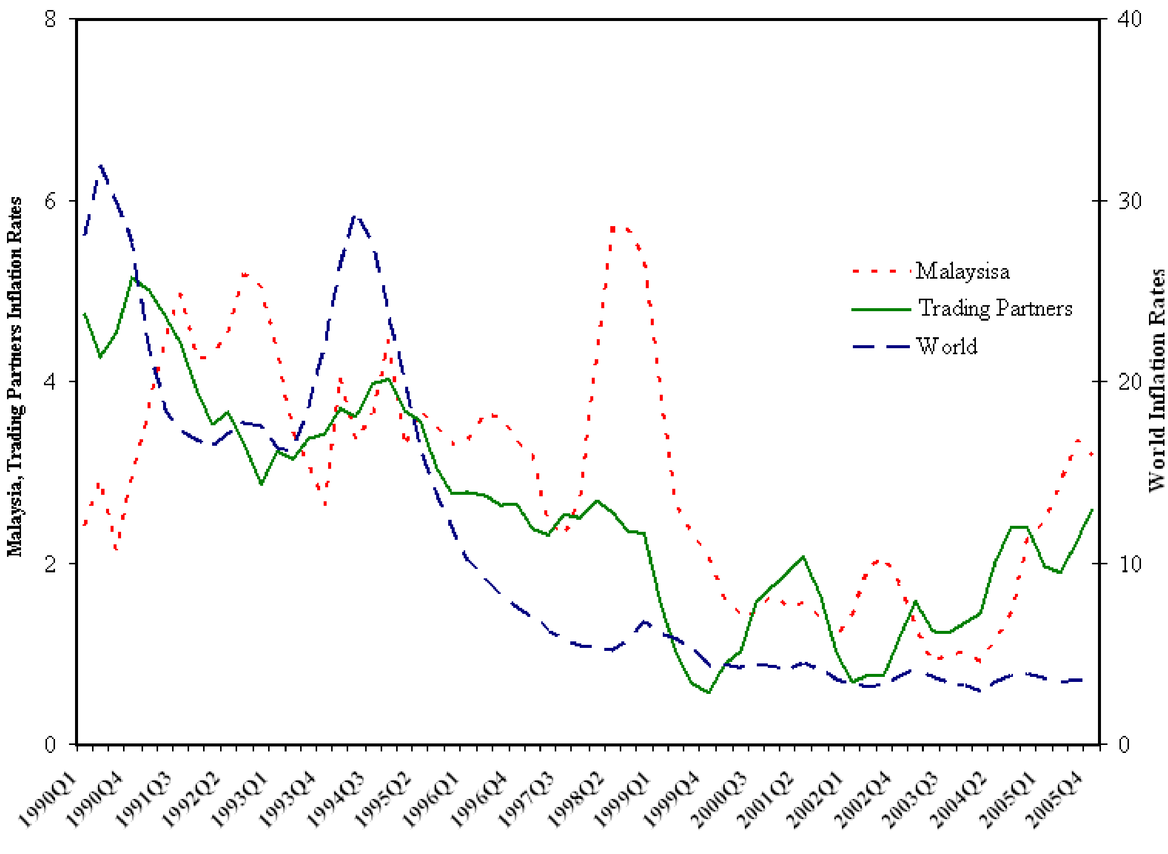
Global Trends of Inflation

With the exception of the effects of the financial crises at the beginning of the nineties (i.e. Japan, Euroland), there has been a global disinflationary trend in the last 15 years (see graph 2 on the right scale). Inflation in Malaysia and in its trading partners has been below the global average for the whole sample period and it followed the global trend up to 2003. From this date onward, the recent upward inflation trend in Malaysia and in its trading partners has forced a faster conversion towards the world average inflation at approximately 3.5 percent.



Graph 2: Malaysia vs. World and Trading Partners Inflation

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Regional Comparison

How do Malaysian Inflation rates compare to those of similar economies in the region? To answer this question we select Singapore, Thailand, Korea, Indonesia and Philippines as the base countries for a cross-country study.

Table 1 presents the following results: Malaysia is only second to Singapore in terms of lowest average inflation in the region during the distinct sub periods. Both countries display inflation rates comparable to those of Industrial countries and far from other non-oil developing economies. In terms of volatility, Malaysian inflation has experienced the lowest volatility among its regional counterparts in the last decade and a half. For the first five years of the sample period Malaysian inflation volatility was even lower than that in Industrial economies.

	CPI INFLATION							
Countries	**MEANS**				**VOLATILITIES**			
	91-96	**97-99**	**00-05**	**All Period**	**91-96**	**97-99**	**00-05**	**All Period**
Indonesia	8.77	29.32	8.40	12.73	1.42	28.88	4.04	15.25
Korea	6.01	4.26	3.16	4.52	1.82	2.96	0.82	2.20
Malaysia	3.89	3.56	1.71	2.95	0.66	1.40	0.68	1.33
Philippines	9.91	7.44	4.46	7.24	4.21	2.25	2.87	4.14
Singapore	2.37	0.59	0.77	1.37	0.82	1.26	0.82	1.22
Thailand	4.98	4.67	2.15	3.79	1.21	3.77	1.44	2.42
Industrial Countries	2.89	1.63	2.04	2.30	0.86	0.34	0.44	0.80
Non-Oil Develop.Ctys	45.63	10.31	5.55	22.53	18.31	1.59	0.83	22.28
Malaysian Trade Partners	2.56	3.50	1.96	1.57	1.20	0.64	0.78	0.57

Table 1: Inflation across selected economies in the same region as Malaysia

To conclude this regional comparison of inflation behavior, we look at a snapshoot of the Asian Crisis (1997, 1998 and 1999) to compare the effect on Inflation of an economic recession that affected each country very differently. Graph 4 shows how Malaysia, having the same or higher economic slump as countries such as Korea and Philippines, experienced a significantly lower increase in the inflation than its regional neighbors

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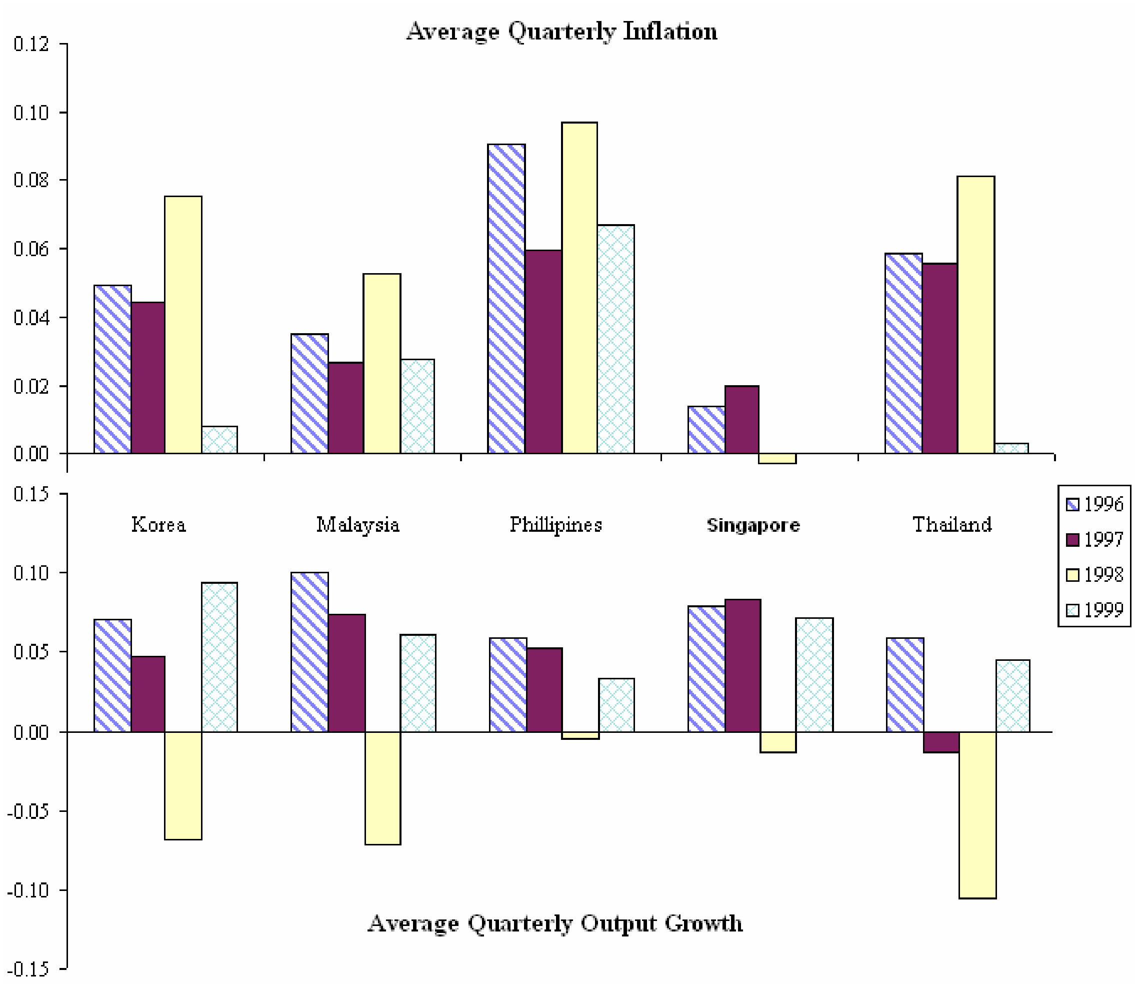
(Indonesia is not shown for clarity due to its relatively high rates of Inflation during the crisis. Singapore represents again the eternal exception).



Graph 3: Average Inflation and Output Growth during the Asian Crisis

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SECTION 2: Underlying structure of Inflation in Malaysia: An analysis of subcomponents

In this section we use the data to calculate the contribution of each subcomponent to the overall changes in the general price index. Data availability allows us to decompose the CPI index in 52 subgroups of consumption goods and services for the period 1995 to 2006 on a monthly basis. Two approaches are used to study the impact of each subcomponent on headline inflation. First, we show the monthly evolution of headline inflation (y/y) during the whole sample along with the contribution of each component. Second, we compare average contributions of each component of the CPI across sub-periods, emphasizing differences across exchange rate regimes.

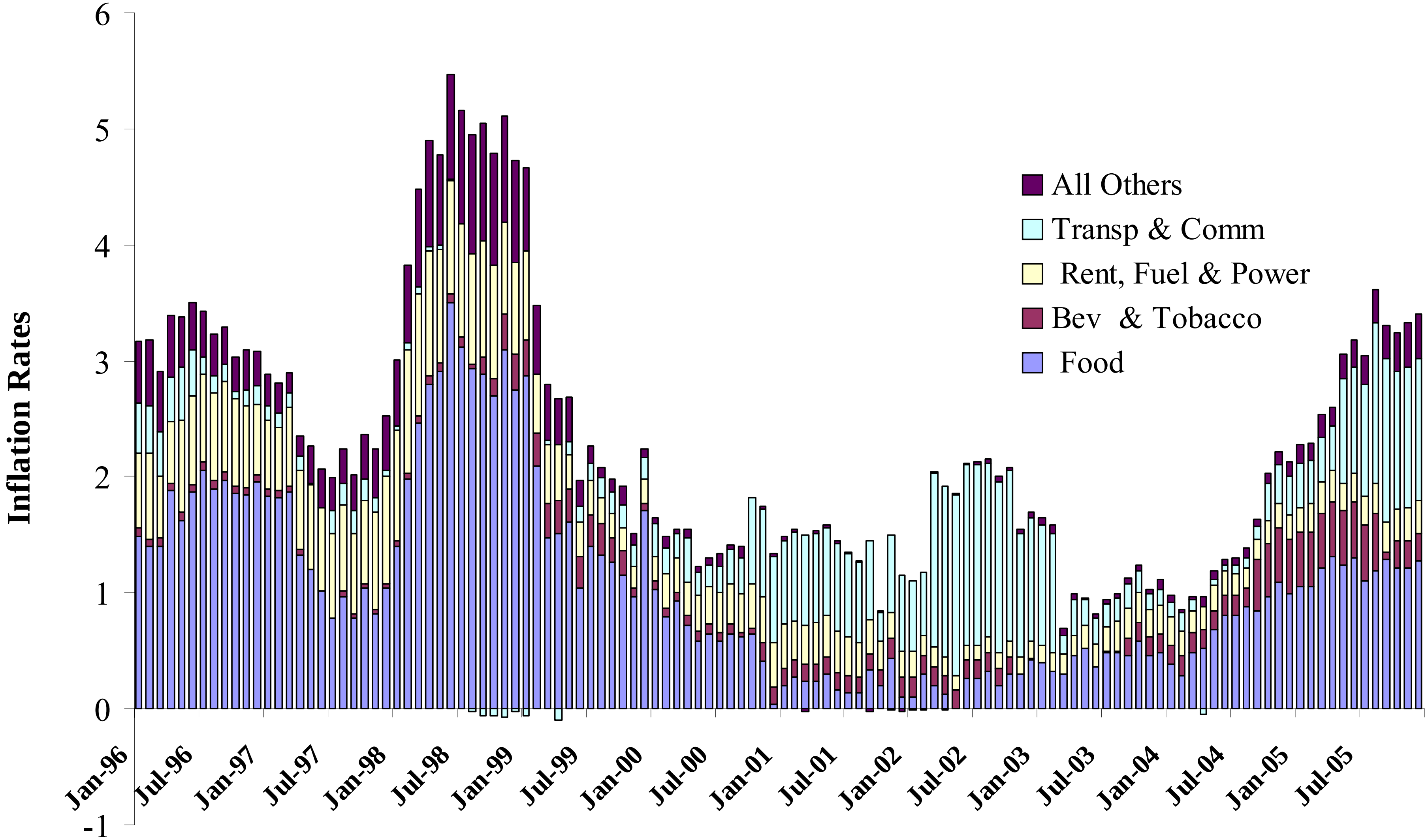
Box 1: Subcomponent Methodology

To study the direct link between percentage price changes in the CPI subcomponents and percentage changes in the general index we need to modify the weights to compensate for the level of prices (due to the percentage nature of the inflation definition). Therefore, if we define the general CPI at a period t as $P_t = \sum_{i=0} w_i p_{it}$ where $W = [w_1, ..., w_n]$ is the vector of weights associated to the n subcomponents of the CPI and $P = [p_{1t}, ..., p_{nt}]$ the vector of subcomponent prices at period t then,

$P_t - P_{t-1} = \sum_{i=0} w_i p_{it} + \sum_{i=0} w_i p_{it-1} = \sum_{i=0} w_i (p_{it} - p_{it-1})$ Finally dividing both sides by P_{t-1},

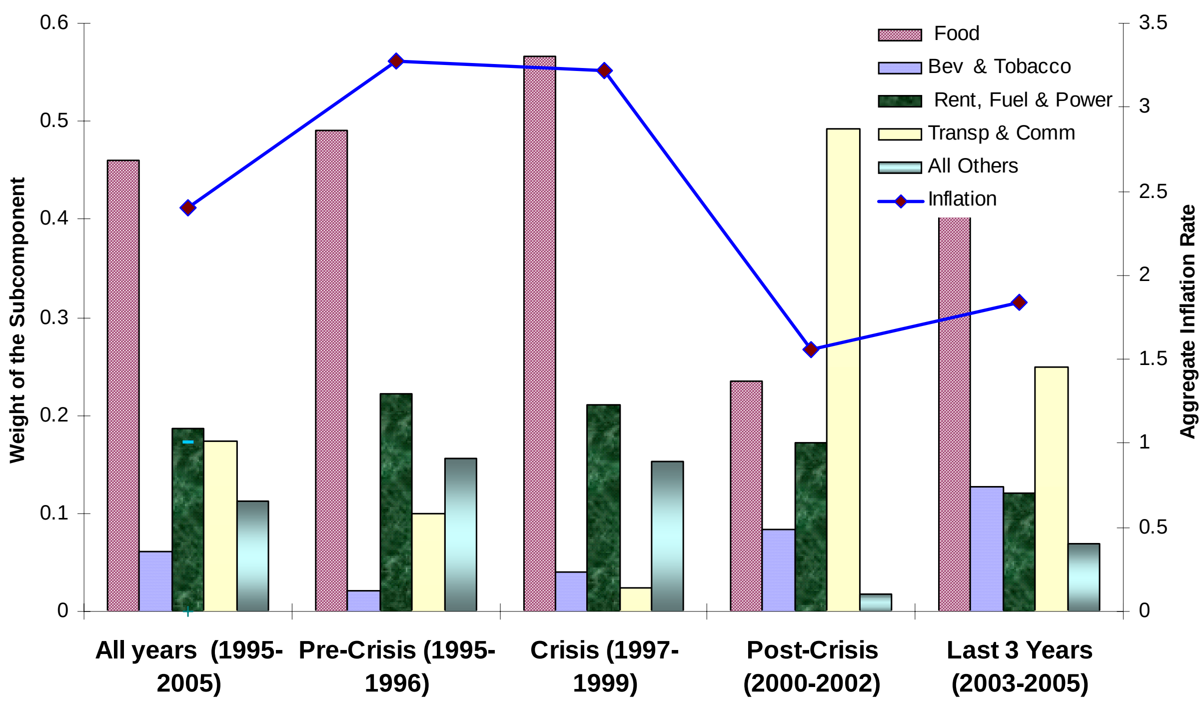
$\Pi_t = \frac{P_t - P_{t-1}}{P_{t-1}} = \sum_{i=0} w_i \left(\frac{p_{it} - p_{it-1}}{p_{it-1}} \right) \frac{p_{it}}{P_{t-1}} = \sum_{i=0} \left(w_i \frac{p_{it}}{P_{t-1}} \right) \pi_{it}$,where capital pi represents the general CPI inflation and small pi represents the subcomponent i price inflation. The new weights used to link these two measures of inflation are the old expenditure weights adjusted for the relative price level of each subcomponent at time t.

We interpret $\left(w_i \frac{p_{it}}{P_{t-1}} \right) \pi_{it}$ as the impact of element i's inflation on the general CPI inflation at period t. By aggregating this measure across periods we find the cumulative effect of a single expenditure subgroup on the general headline and Core inflation.



Graph 4: Monthly evolution of Headline inflation by 1 digit subcomponents

In Graph 4, we see that during the first four years of the sample period (1996-1999) the Food and Fuel and Rent subcomponents were in charge of around 80 percent of total inflation playing a key role during the high inflation period of the Asian crisis. From the beginning of the year 2000, we observe how the subcomponent Transport and Communications (which includes gasoline) takes over all mayor spikes in inflation. This subcomponent alone accounts for almost 60 percent of inflation during the spike in 2002 and about 40 percent in the most recent rise total inflation during 2005. From 2003 onwards, there seems to be a key difference in the composition of inflation. This last acceleration episode as well as the ones in previous years has as main actor the increase in gas prices. One the other hand and contrary to previous episodes, other components including food and beverages also contribute to the inflationary spike. Graph 5 gives us a similar, but more detailed picture of the components.



Graph 5: Inflation Components by 3 Year Averages

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During 1995-2005, the Food, Fuel and Transport components contributed to most of the variation of inflation. While the Food component accounted for almost half of the total observed inflation during 1995-2005, Transport gained importance in episodes of accelerating inflation (excluding the Asian crisis [1997-1999], where most of the weight was carried by Food and Fuel components), in 2002, and more recently in [2003-2005].
For the 1994-1997 sub-period, during which Malaysia followed a managed exchange rate regime, the Food component accounted for about ½ of headline inflation, despite having a weight on the CPI basket of ⅓. Fuel and Rent and Transport and Communication followed the Food group in importance, each with a contribution of approximately 20 percent to headline inflation.

In the Asian crisis interval (1997-1999), the Food and Fuel components accounted for the bulk of inflation (about 80 percent), while the contribution of all the other components remained insignificant.

Throughout the low inflation period after the crisis (characterized by the fixed exchange rate regime (1999-2005), we observe Food and Fuel dropped in importance, while the Transport and Communication component gained weight, especially in times of relatively higher inflation. We also observe how the Beverage and Tobacco component gained weight (up to 10 percent) during this period.

Core Inflation

In this part we briefly review the concept of core inflation and present two measures of core inflation. The first is an exclusion-based measure, where the subcomponents excluded are those displaying a higher volatility during the different sub-periods in the sample. On the basis of preliminary data analysis, the excluded components would include certain food supplies and transportation.
The second proposed measure of core inflation is a symmetric trimmed mean, similar to a simple weighted median. In the former, a certain percentage of the observations at both ends of the distribution of price changes for the components of the CPI basket will be discarded.

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These measures of core inflation will be compared to the headline inflation and will play a significant role in the paper since later they will be used for fitting the econometric regressions and as alternative measures in order to forecast headline inflation.

Core Inflation (CI) developed into a well known concept after the 70's global supply shocks. During those years, it became apparent that sector specific disturbances, which temporarily increased volatility, could cloud the underlying reality of price growth in any given economy. Obtaining a measure of price inflation not subject to volatile temporary shocks may be a key factor not only for monetary policy where central bankers try to anchor the economy around a meaningful economic measure. It also may have an important effect on the dynamics of inflation expectations and thus affect the future path of prices in the economy.

The theoretical ground in which CI is explained is tightly related to a monetarist approach to macroeconomics. The implicit assumption of fully anticipated and flexible prices will force any temporary shock to be absorbed through instantaneous changes in relative prices and quantities. Therefore, only changes in the Money Supply should affect the inflation mean (See Silver 2006).

Before reviewing the wide range of CI definitions and methodologies, we find a common ground in the distinction between two components of the observed rate of inflation (see Silver 2006 and von der Lippe 2002):

a) A persistent, common and systematic monetary inflation component
b) A transitory, sector specific, irregular component caused by non-monetary factors embodied in all measures and methodologies of CI is the goal of separating the signal of inflation from the transitory noise.

Methodology

Exclusion based on Volatility

We build a measure of global volatility over the whole sample by using the standard deviation around a twenty-four-month moving average. Then, we order all the subcomponents, on an axis from higher to lower volatility and arbitrarily eliminate the high volatility items as well as those components subject to price control. We, then, scale the weights of the remaining components and calculate our measure of Core Inflation

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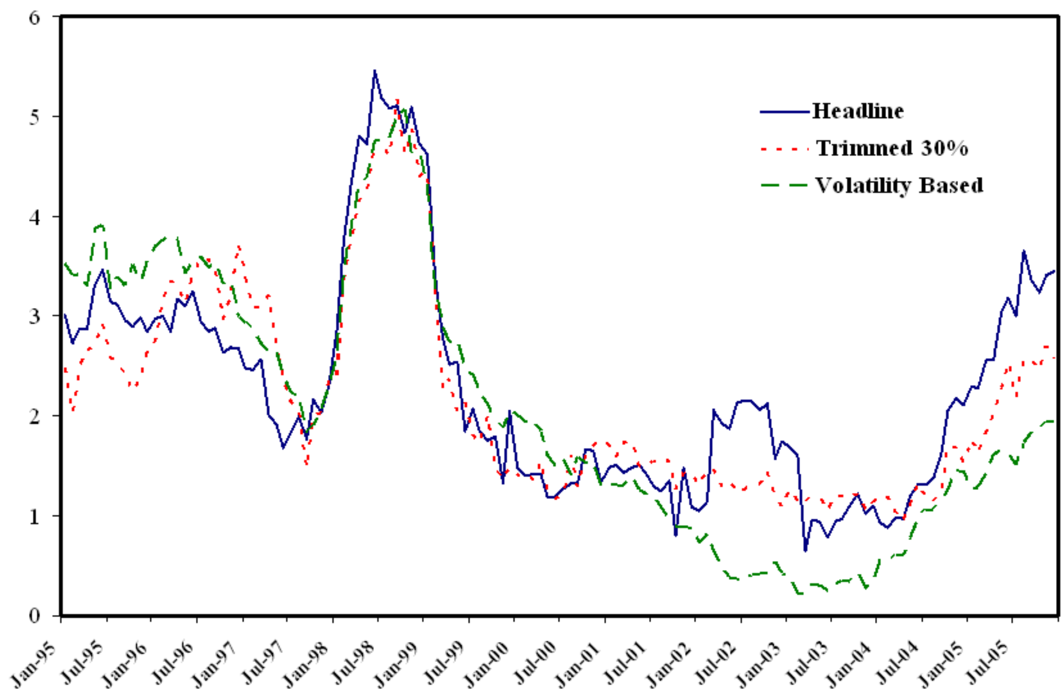
Trimmed mean: To calculate our second measure of core inflation, we arrange all subcomponents based on those suffering the most drastic absolute value changes in their prices in each period. Then, we eliminated an arbitrary mass from both ends of the distribution (in this case we eliminate 40 percent of the distribution in a symmetric way). Finally, we scale the weights of the remaining elements and we recalculate our measure of Core CPI and Core Inflation.



Graph 6: Headline vs. Volatility-Exclusion-Based Core Inflation

Comparing both measures of Core Inflation

Comparing both measures, the Trimmed mean outperforms the Volatility-Exclusion-Based measure in a series of statistical tests (see table 2). Moreover, we observe that this measure has the desirable quality of crossing the headline inflation often. This indicates that there may be some degree of reversion of the headline indicator to its core measure and the differences between both lines are just transitory shocks.

On the other hand, the Volatility-Exclusion-Based measure excludes the same elements for the whole sample period; thus, it is easier to explain to the public.

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	Mean (Percent)	Volatility (Percent)	RMSE (Percent)	Correlation (Percent)
Headline	2.28	…	…	…
Volatility EB	2.08	1.43	1.72	0.85
Trimmed	2.16	1.02	1.36	0.91
Simple EB	1.81	1.10	1.66	0.90

Table 2: Performance test for the two measures of Core Inflation

Section 3

Two Models of Inflation Dynamics in Malaysia

In this section, we introduce two complementing models of inflation dynamics for Malaysia. Firstly, we look at an Autoregressive Distributed Lag (ADL) model augmented with error correction terms to emphasize both, short and long term determinants of inflation. This manner of modeling inflation also helps us uncover the long run relationships among the key determinants of inflation in Malaysia.

Secondly, we estimate a New Keynesian Phillips Curve (NKPC). This second micro-founded approach focuses on short term determinants of inflation and incorporates the role of expectations, proven to play a leading role as a determinant in key macroeconomic variables.

The Augmented ADL Model

The methodology used in this section follows Juselius (1992) in combining pressures steaming from long run cointegrated relations and short term dynamics in the analysis of inflation. Although there is a body of literature approaching inflation from a single side of the economy (see Brouwer and Ericsson (1995) for Australia), we try to uncover a series of long run equilibriums sourcing both, the demand and supply sides of the economy[1] .

[1] See Lim and Papi (1997), Toshitaka (2001), Ramakrishnan and Vamvakidis (2002) for the cases of Turkey, Japan and Indonesia respectively.

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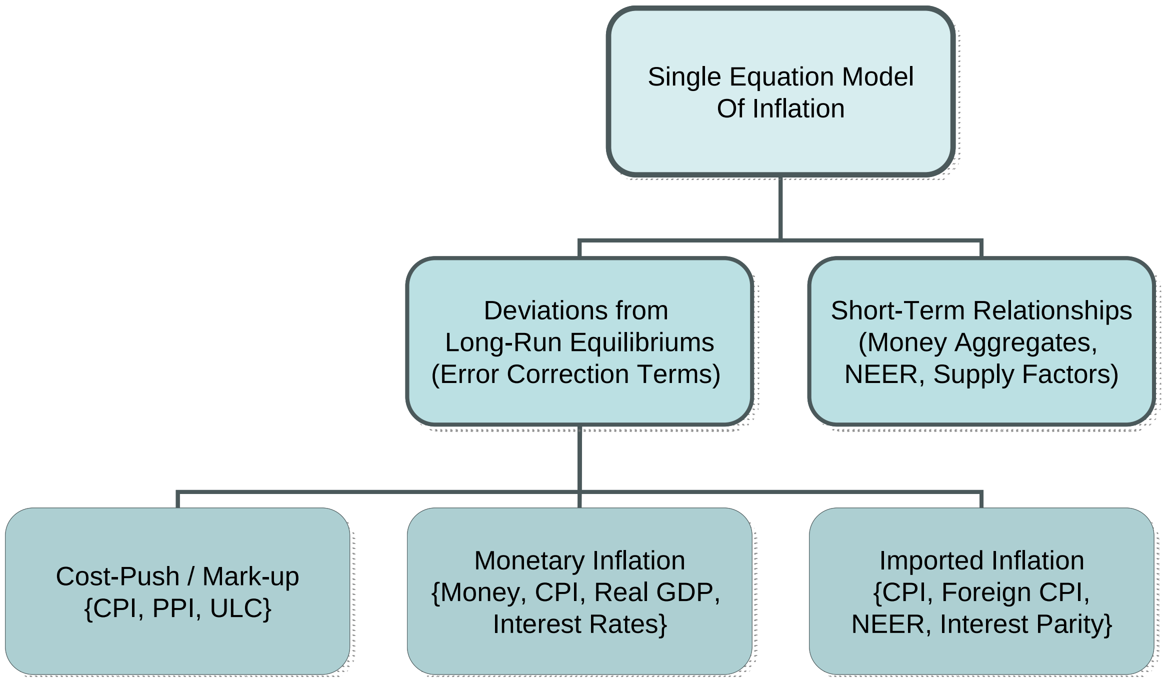
In our paper, the error correction terms included in the ADL model represent misalignments in the supply side of the economy (represented by a mark up equation), money market and import and export markets.

A simple schematic of the augmented ADL model is represented in graph 7.



Graph 7: The Augmented ADL Model as a single error correction equation

Long Run Equilibrium Relationships

Mark-Up Equation

For our first long run equilibrium, we assume that the general price level is a mark-up over total unit costs, including unit labor costs and intermediate inputs prices:

$$P = \mu(PPI)^{\gamma}(ULC)^{1-\gamma} \Rightarrow p = \ln(\mu) + \gamma(ppi) + (1-\gamma)(ulc)$$

Where the assumption of linear homogeneity has been imposed, we proxied intermediate input prices with the Production Price Index and linearized the equation by taking natural logs.

The next step is finding whether the variables in this relationship are cointegrated. In such case, then, there is a long run stable relationship among them and any deviation from this long run bond will be transitory and associated with pressures to revert to its original equilibrium.

Across this paper we use two sorts of cointegration tests. Due to the limited amount of data, a simple Engel-Granger cointegration test (Engel and Granger (1982)) proofs to be a robust measure. Moreover, in the appendix, we construct a VECM to which we apply the Johansen cointegration test (Johansen (1991)

OLS			**Phillips-Perron test**		
Regressant:					
cpi	**Unrestricted**	**Restricted**	**Series**	**I(0)**	**I(1)**
μ	1.14**	1.17**		**Prob.**	**Prob.**
ppi	0.83**	0.82**	**cpi**	0.15	0.00
uls	0.22**	0.18**	**ulc**	0.52	0.00
			ppi	0.99	0.00
			Residuals	0.04	

Table 3: Engle-Granger Cointegration Test for the Markup Equation

The right side of table 3 shows that the series are cointegrated, since all are I(1) and the error from the OLS regression is I(0). A quick look at the unrestricted coefficients tells us that even without imposing linear homogeneity, the coefficients are robust around 1. Although the coefficients from both, the restricted and unrestricted markup equations, seem~~s~~ to point ~~at~~/ to input cost inflation as the most important source of CPI inflation, we need to be cautious interpreting these coefficients since the PPI parameter may also reflect labor costs and; thus, absorb more weight than that exclusively corresponding to intermediate input costs free of labor.

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The Johansen test shown in appendix B is robust with these results. Furthermore, the VECM model shows that the cointegrated vector is weakly exogenous to labor costs and to the PPI allowing us to combine the terms in the single error correction ADL equation.

Monetary Inflation

In order to model monetary inflation, we assume a simple demand for real balances based on a measure of income and a measure of the opportunity cost of holding money:

$$\frac{M^d}{P} = \frac{M^d}{P}(Y, i)$$

We proxy real income with real GDP and the opportunity cost with the rate of return of three month T-Bills. Assuming the equilibrium condition Money Supply =Money Demand and taking natural logs we estimate the following long run equilibrium:

$$Ln(M^s) - Ln(P) = \alpha + \beta_1 Ln(Y) - \beta_2 i$$

As in the case of the Markup Equation, the series are cointegrated. Looking at the results from the VECM approach, the coefficients seem highly sensitive to changes in real output (the elasticity of real money demand to output is around 2 for most specifications) and very inelastic to nominal interest rates. Again, the results from the VECM show that the cointegrating vector is weakly exogenous money supply thus allowing us to use these two key determinants of inflation together in the single equation model.

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OLS			Phillips-Perron test		
Regressand: Real Money Balances				I(0)	I(1)
	Coeff	T-Stat	Series	Prob.	Prob.
constant	-11.18	-18.57	**m**	0.38	0.00
y	1.78	32.96	**p**	0.15	0.00
i	-0.0009	-0.14	**y**	0.46	0.00
			i	0.52	0.00
			Residuals	0.02	

Table 4: Engle-Granger Cointegration Test for the Equilibrium in the Money Market

Imported Inflation

A direct source of information from the inflationary pressures coming through the international goods and financial markets are the equilibrium conditions outlined by the Purchasing Power Parity (PPP) and the Uncovered Interest Parity (UIP). Due to active capital controls in the Malaysian financial markets we center our attention in the goods market and the PPP condition.

PPP assumes equal prices across borders when the goods are denominated in the same currency. Following this statement, PPP tell us that the real exchange rate is constant and equal to 1 (0 if we look at the equation in logs). PPP has been empirically rejected in the short run although there is some evidence that holds in the long run

The long run equilibrium in the PPP assumes that domestic prices, foreign prices and nominal exchanges rates are cointegrated; in other words, that the real exchange rate is stationary.

In terms of the series, the Real Effective Exchange Rate for Malaysia seems to be an integrated series of order 1 (see Appendix C). To overcome this problem, we assume that inflationary pressures in the international goods markets can be represented by the deviations of the real exchange rate from its trend, these deviations show stationary around zero.

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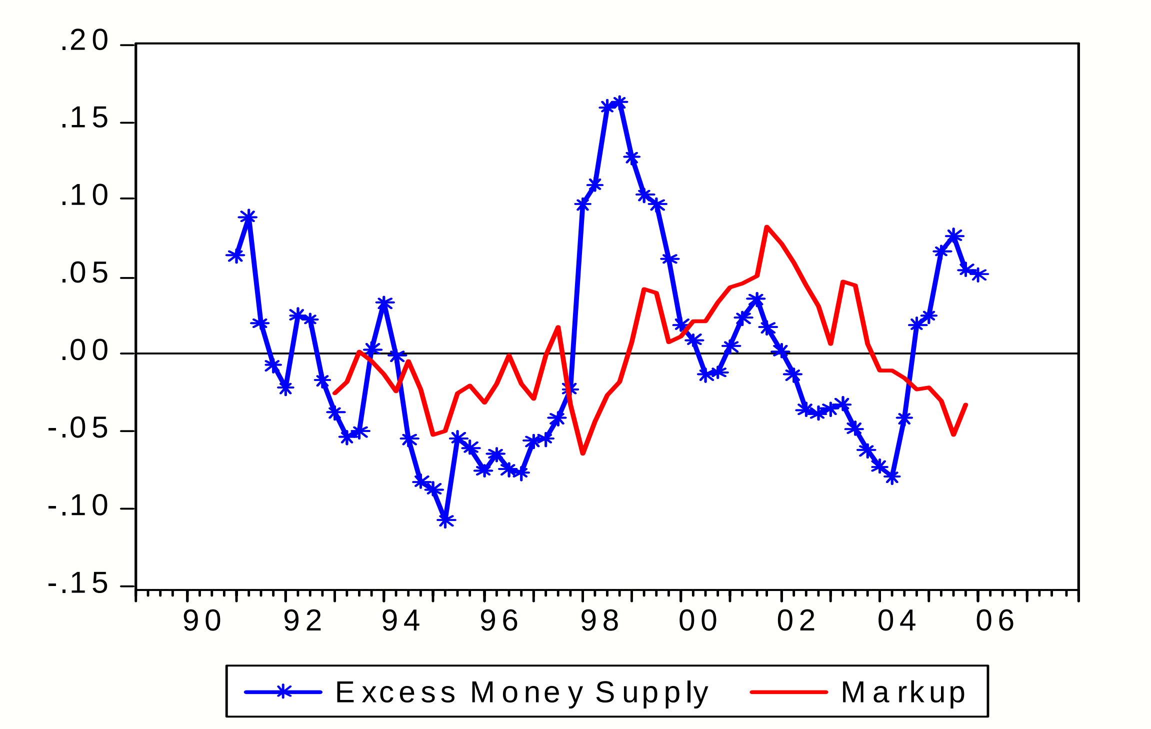
A Single Equation Model of Inflation

Given the weak exogeneity of the long run relationships we can avoid the difficult interpretation of more complex VAR models and estimate directly the relationship of inflation with the selected key economic indicators.



Graph 8: Deviations from the Money Market and Markup Long Run Equilibriums

The deviations from the internal and monetary long run equilibriums (see graph 8), demonstrate that, as predicted, excess money supply positively correlates with inflationary pressures; whereas positive deviations from the markup equilibrium has a negative correlation with inflation (prices tend to return to the equilibrium values). Interestingly enough, coinciding with the recent spike in inflation, we observe an increase in the excess money supply curve and a growing wedge between input costs and consumer prices that may help us understand how misalignments from long run equilibriums may affect present price inflation.

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The methodology behind our single equation model is a Generic-to-Specific approach to an Autoregressive Distributed Lags (ADL) Model augmented with the long run equilibrium relationships:

$$\Delta LogP_t = \alpha + \sum_{1}^{j=5}\sum_{i=0}^{i=4}\beta_{ji}\Delta Log(X)_{jt-i} + \sum_{i=1}^{3} ECM_{it-1} + v_t$$

Where X = { Money, NEER, ULC, PPI, Foreign CPI} and ECM = { Excess Money supply, Markup, PPP}

Table 5 represents the results of three different specifications of the single equation model of inflation. While the first specification does not include any form of past inflation, specification 2 uses an aggregate measure of the previous four quarters of inflation[2] and specification 3 utilizes individual lagged terms of inflation[3].

The results from the three specifications robustly conclude way that:

1. Inflation inertia is an important determinant of actual inflation
2. Money is not neutral in the very short run. Money growth has a significant and positive effect on price inflation. As shown in previous studies, this effect may lack up to four quarters.
3. Cost effects are also an key determinant of consumer price inflation.
4. Nominal effective appreciation has a negative impact on domestic inflation in accordance with a certain degree of pass-through.
5. The Error correction terms are correctly signed showing a negative pressure from equilibrium markup and PPP deviations and positive effect from excess money supply. The ECM representing deviations from PPP is statistically insignificant across specifications; thus, it is not included in the last specification

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[2] The actual term is a year-on-year difference on the CPI since this is equal to the aggregate of the four previous quarters of inflation :

$$\Delta_4 LogCPI_t = LogCPI_t - LogCPI_{t-4} = (LogCPI_t - LogCPI_{t-1}) + (LogCPI_{t-1} - LogCPI_{t-2}) + (LogCPI_{t-2} - LogCPI_{t-3}) + (LogCPI_{t-3} - LogCPI_{t-4})$$

[3] All specifications include seasonal dummies and oil dummies representing the changes in the administrated price of gas. The coefficients of these dummies are not reported in table 5

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	Lag	Specification 1 Coefficient	Specification 1 t-Statistic	Specification 2 Coefficient	Specification 2 t-Statistic	Specification 3 Coefficient	Specification 3 t-Statistic
ECM(Money)	1	0.008	2.146	0.016	2.041	0.009	2.242
ECM (Markup)	1	-0.010	-0.934	-0.005	-0.348	-0.050	-5.086
ECM (PPP)	1	-0.000	-0.808	-0.000	-1.271		
Y/Y Inflation	0			0.081	1.908		
Lagged Inflation	1					0.167	1.716
	3					-0.225	-2.872
Money Growth	0	0.081	6.813	0.094	5.456		
	1			-0.043	-2.502		
	3					0.040	2.861
	4	0.074	5.236	0.062	3.803		
ULC Growth	0	0.012	1.559	0.019	2.797	0.023	3.124
	3	0.025	3.833	0.015	2.067	0.015	1.794
	4	0.015	2.049	0.023	3.620	0.035	5.355
NEER % Change	1	-0.030	-3.230	-0.043	-5.095	-0.052	-6.583
	2	-0.061	-5.641	-0.036	-3.505		
	4	0.022	2.216	0.024	2.663		
Adjusted R-squared		0.757		0.881		0.870	
Sum squared residiuals		0.000		0.000		0.000	
Log likelihood		234.078		311.200		300.470	
Akaike info criterion		-9.408		-12.562		-12.499	
Schwarz criterion		-8.896		-11.932		-11.982	

Table 5: Results from the single equation model of Inflation

In graph 9, we can see that the preferred specification (specification 3) closely fits the actual sample. However, towards the end of the sample the model seems to miss a peak in 2004 and reacts ahead of the actual inflation during 2005.

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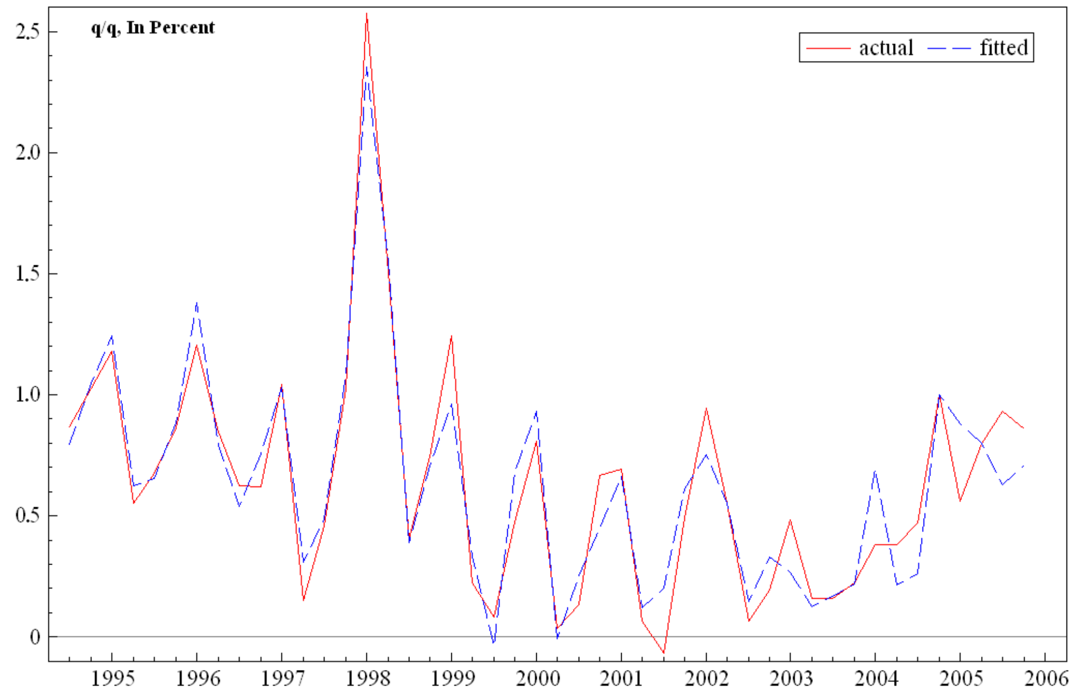

Graph 8: Actual vs. Fitted Values of the Preferred Specification

Forecasting Power of the Model

Using a Dynamic Out-of-Sample forecast of the last 16 quarters (2003-2006) we observe that the model behaves adequately during the first four quarters. Nevertheless, it starts lagging behind the actual inflation during the remaining quarters. A simple explanation for these discrepancies may be the fact that changes in administrated prices are key to headline inflation is represented as exogenous shocks in the model. These shocks may be responsible for most of the distance between the actual inflation and our forecast. In this sense, using a measure of Core Inflation where these transitory shocks are discarded may grant better results in terms of forecasting.

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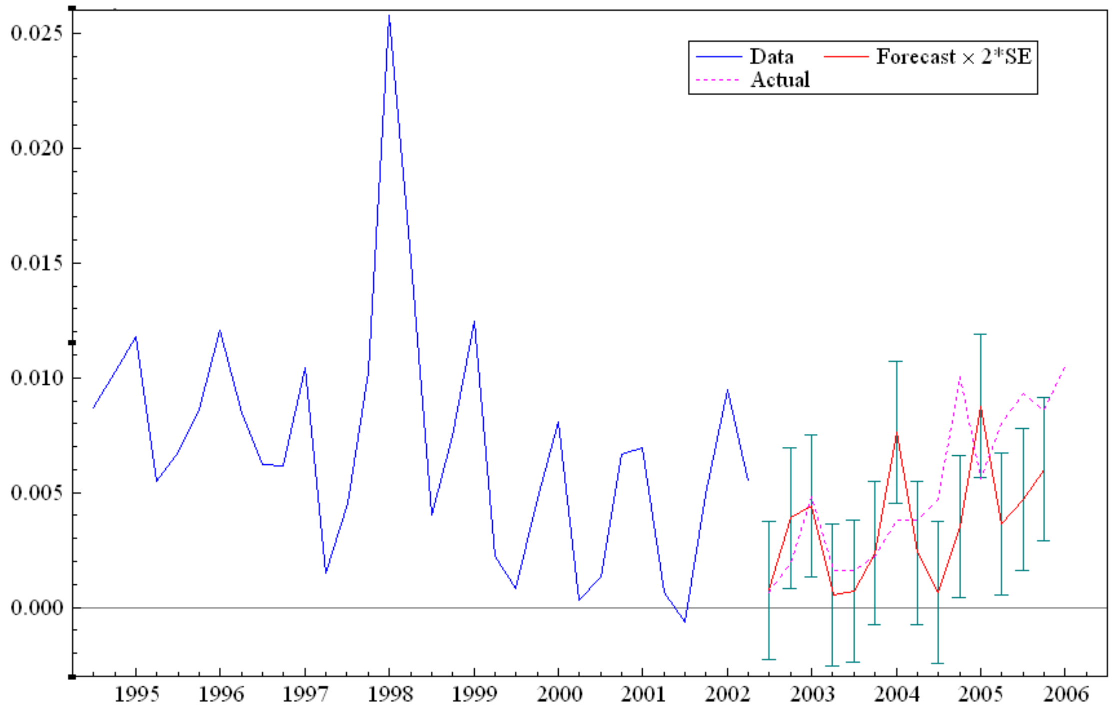

Graph 10: Dynamic Forecasts (2003-2006)

New Keynesian Phillips Curve (NKPC)

The second model applied in this paper is the New Keynesian Phillips Curve (NKPC)
The NKPC combines the traditional PC with optimizing behavior by price setters and rational expectations (RE). A clear advantage of using this methodology is that estimated parameters have "structural" interpretation. Typically estimation of NKPC has attracted the attention of policymakers by emphasizing the role of inflation expectations.
The NKPC typically replaces the distributed lags on past inflation in the traditional PC with expected inflation; cyclical position is proxied by the output gap term (or marginal cost).

$$\pi_t = \beta E_t \pi_{t+1} + \lambda (y_t - y_t^P) \qquad \text{with} \qquad \beta \sim 1, \lambda > 0$$

`

Most of the empirical work has focused on estimating NKPC for developed countries[4]. In these papers good fit typically requires inclusion of lagged inflation (much like in the traditional Phillips Curve):

$$\pi_t = \gamma_f \beta E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda(y_t - y_t^P)$$

where γ_f is the fraction of firms who set their prices according to their expected marginal cost schedule. In this NKPC framework the sensitivity of inflation to the output gap is given by:

$$\lambda = \theta^{-1}(1-\theta)(1-\theta\beta)$$

where *theta* reflects the average degree of price rigidity in the economy (large *theta* => frequency of price adjustment is low)

Estimating the NKPC

When estimating the NKPC model, GMM is a **c**onvenient and intuitive method under RE. Consider simple NKPC

$$E_t\{[\pi_t - \beta E_t \pi_{t+1} - \lambda(y_t - y_t^P)]z_t\} = 0$$

where z is a vector of instruments, typically 4 lags of inflation (dating depends on what is estimated), output gap, NEER and a constant term

Data generally covers 1991Q1-2006Q1,

- output gap is based on HP filter, other measures (quadratic detrended GDP and BP filter) were also used in preliminary estimations
- Initially estimations with headline inflation (q/q, s.a.)

[4] See Gali, Gertler (1999, 2005) are amongst the seminal papers, Parrado (2004) presents some evidence for Singapore

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– Dummies for Asian crisis and increases in administered fuel prices are included in the preliminary estimations

New Keynesian Phillips Curve - GMM estimates 1/

Variable	Coefficients	t-statistic
	Baseline Estimates	
Expected inflation (β)	1.0**	27.9
Output gap (λ)	<0.001	0.1
J-statistic = 0.1 (p-value=0.8)		
	Hybrid NKPC	
Expected inflation ($\beta\gamma_f$)	0.5**	4.3
Output gap (λ)	<0.001	0.4
Lagged inflation (γ_b)	0.5**	3.6
J-statistic = 0.1 (p-value=0.8)		

Sources: Fund staff estimates.

1/ For readability, only selected variables—e.g. dummies are excluded—are presented. Sample period is 1991Q1–2006Q1. An * (**) denotes significance at 10 (5) percent.

NKPC – Estimates

- In-sample fit of the hybrid model is good
- results show that expected inflation is important determinant of inflation
- the coefficient on the output gap is very small
- Backward looking component is also important for understanding inflation dynamics

Open Economy NKPC

Our previous derivation of the NKPC is **not** based on any assumptions related to the degree of openness of the economy but some intermediate inputs (for final output) are imported, information about their relative price is likely to improve the marginal cost proxy. This argument suggests incorporating the exchange rate directly into the NKPC.

Open economy NKPC can be written as:

$$\pi_t = \gamma_f \beta E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda (y_t - y_t^P) + \sum_i \phi_i \Delta NEER_{t-i}$$

`

Nelson and Kara (2005) also suggest including the level of the NEER

$$\pi_t = \gamma_f \beta E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda(y_t - y_t^P) + \sum_i \phi_i \Delta NEER_{t-i} + \varsigma NEER_t$$

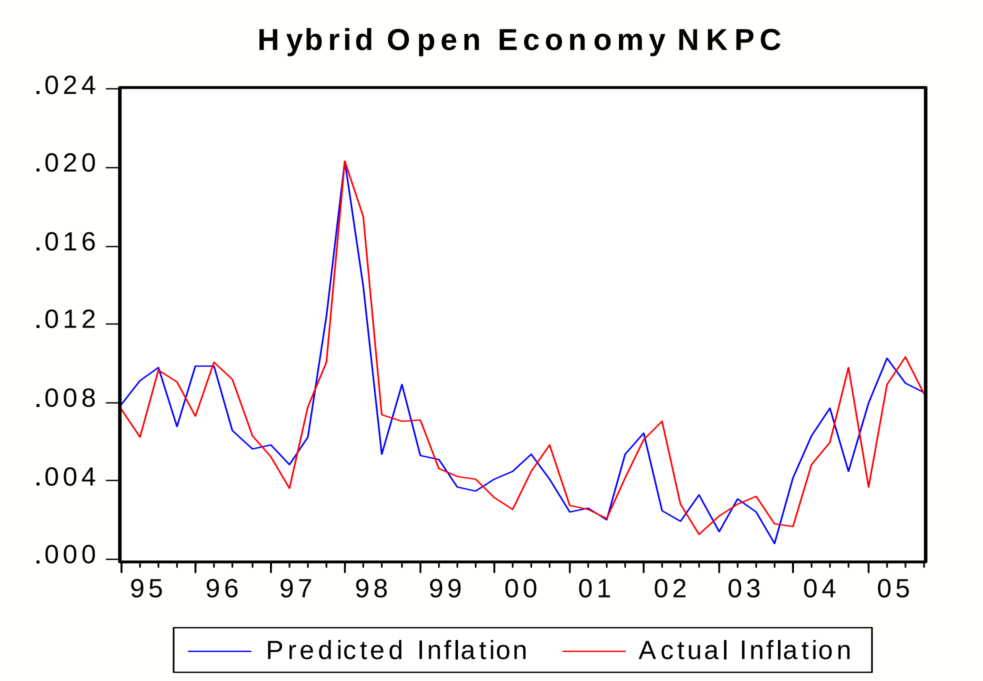
The results of this model can shed light on the degree of pass-through

New Keynesian Phillips Curve - GMM estimates 1/

Variable	Coefficients	t-statistic
Open Economy Hybrid NKPC		
Expected inflation ($\beta\gamma_f$)	0.6**	9.1
ULC (λ)	<0.001	0.4
Sum of NEER coefficients	-0.015	No rejection
Lagged inflation (γ_b)	0.4**	3.9
J-statistic = 0.1 (p-value=0.8)		

Sources: Fund staff estimates.

1/ For readability, only selected variables—e.g. dummies are excluded—are presented. Sample period is 1995Q1–2006Q1. An * (**) denotes significance at 10 (5) percent.



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Concluding Remarks

From both econometric models seems clear that expected Inflation is an important determinant of actual inflation (especially in OE specifications).

Backward looking component of inflation is generally at least as important

Cyclical measures of activity have usually a small and statistically insignificant effect

Accounting for changes in the NEER tends to improve the explanatory power of the NKPC (consistent with some degree of pass-through).

Clear monetary policy communication is important given the significance of expected inflation across all NKPC estimations

Controlling the money growth might help curb inflation, as indicated by the ADL model estimates. These, estimates suggest that allowing the exchange rate to appreciate may have only a modest impact on inflation.

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APPENDIX B

Markup: VECM Approach

(1) Cointegrated Vector in VECM

Regressant: cpi	**µ**	**ppi**	**ulc**		
Coeff	1.75	0.74	0.26		
SE	0.29	0.04	0.04		
T-Stat	[-6.1]	[-16.6]	[-5.9]		

(2) Normality

Jarque-Bera		df	Prob.
Joint	6.95	6.00	0.33

(3) No Residual Autocorrelation (LM Test - 12 Lags)

(4) Johansen Cointegration Test

Hypothesized No. of CE(s)	Trace Statistic	Prob.**	Hypothesized No. of CE(s)	Eigenvalue	Prob.**
None *	42.75	0.01	None *	0.37	0.04
At most 1	19.98	0.05	At most 1 *	0.29	0.04
At most 2	3.12	0.56	At most 2	0.06	0.56

(5) Tests of cointegration restrictions: Linear Homogenity

Hypothesized No. of CE(s)	Restricted Log-likehood	LR Statistic	Degrees of Freedom	Probability
1.00	428.95	1.29	1.00	0.26

(6) Weak Exogeneity

CI Vector	**D(LCPI)**	**D(LPPI)**	**D(LULC)**
Coeff	-0.07	0.01	-0.21
SE	0.02	0.10	0.17
T-Value	[-4.4]	[0.1]	[-1.2]

`

Excess Money Supply: VECM Approach

(1) Cointegrated Vector in VECM

Regressand: money	**constant**	**p**	**y**	**i**
Coeff	15.18	1.00	2.13	-0.0004
SE	0.75		0.07	0.01
T-Stat	[20.2]		[-32.1]	[0.05]

(2) Normality

	Joint	df	Prob.
Jarque-Bera	23.79	8.00	0.00
Kurtosis	18.51	4.00	0.00
Skewness	5.28	4.00	0.26

(3) No Residual Autocorrelation (LM Test - 12 Lags) at 5%

(4) Johansen Cointegration Test

Hypothesized No. of CE(s)	Trace Statistic	Prob.**	Hypothesized No. of CE(s)	Eigenvalue	Prob.**
None *	0.54	0.00	None *	43.01	0.00
At most 1 *	0.36	0.00	At most 1 *	24.81	0.02
At most 2 *	0.30	0.02	At most 2 *	19.33	0.01
At most 3	0.06	0.52	At most 3	3.31	0.52

(5) Tests of cointegration restrictions

Hypothesized No. of CE(s)	Restricted Log-likehood	LR Statistic	Degrees of Freedom	Probability
1.00	577.48	0.11	1.00	0.74

(6) Weak Exogeneity

CI Vector	**dm**	**dp**	**dy**	**di**
Coeff	-0.13	0.05	-0.09	-4.05
SE	0.09	0.02	0.08	3.15
T-Value	[-1.4]	[3.1]	[-1.0]	[-1.2]

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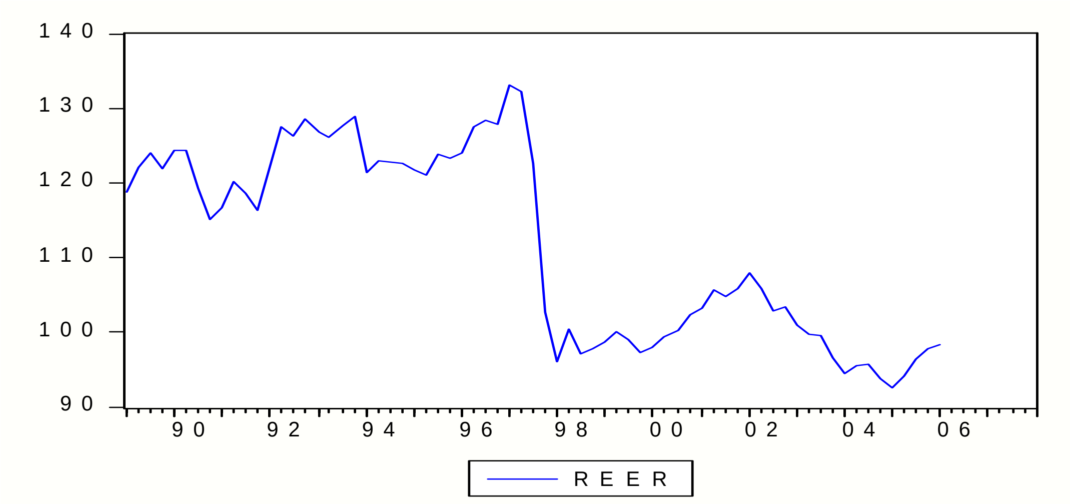
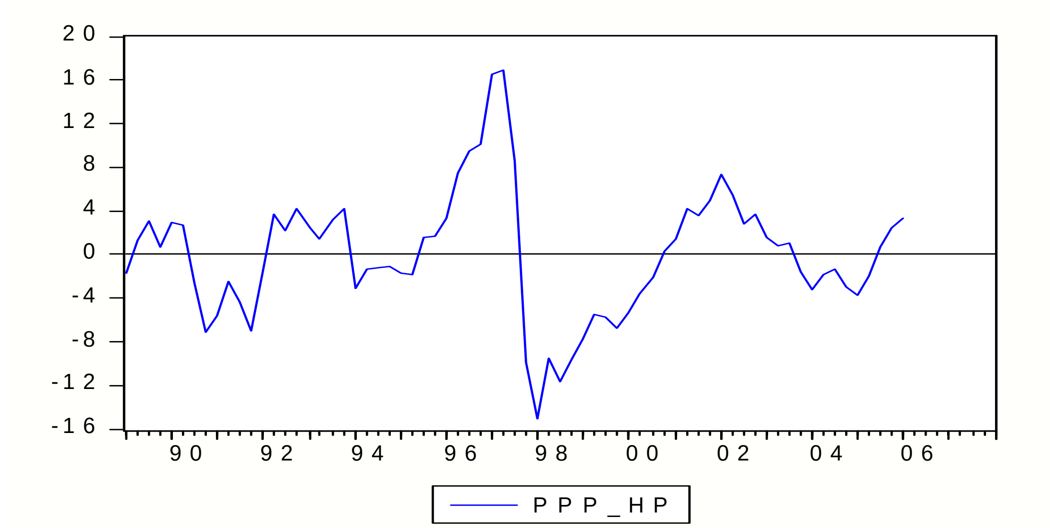
APPENDIX C



Regressand: D(REER)	Coefficient	Std. Error	t-Statistic	Prob.
REER(-1)	-0.06	0.03	-1.64	0.11
D(REER(-1))	0.36	0.12	3.08	0.00
C	5.93	3.79	1.56	0.12



Regressand: D(PPP_HP)	Coefficient	Std. Error	t-Statistic	Prob.
PPP_HP(-1)	-0.27	0.07	-3.87	0.00
D(PPP_HP(-1))	0.43	0.11	3.80	0.00
C	0.00	0.38	-0.01	0.99