Exploring the Formation of Inflation Expectations in Jamaica:

A Pragmatic Approach

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Abstract

The study utilizes a two-stage procedure to explore the dynamics of how inflation expectations are formed among businesses in Jamaica. In this context, a SARIMA model was utilized to estimate expected inflation in the country which was compared to survey data on inflation expectation for consistency. A reduced form equation was then estimated to evaluate the major determinants of inflation expectations in Jamaica which indicated that the SARIMA model provides a good estimate of inflation expectation for Jamaican businesses. Additionally, the reduced form equation revealed that monetary policy variables have a statistically significant but small impact on inflation expectations, as against exchange rate depreciation which had a more significant impact. Similarly, international fuel prices in real terms were also found to have a positive impact on expectations.

JEL Classification: C53, E31, E37, G10

[1] The views expressed in this paper are not necessarily those of the Bank of Jamaica.

1.0 Introduction

Measuring and understanding the dynamics of inflation is a critical component in the operation of all central banks as it enables the effective adjustment of monetary policy by reducing uncertainty in an otherwise volatile environment. Persons' perception of future inflation plays a crucial role in the outcome of inflation. Hence, being able to estimate inflation expectations can be a valuable tool in the implementation of monetary policy. As noted by Deacon and Derry (1994), sound knowledge of inflation expectations assists the monetary authority to gauge the market's perception of the credibility of monetary policy.

The inflation expectations of different economic participants represent a critical component in determining macroeconomic outcomes and more specifically, monetary policy outcomes. Ben Bernanke, former chairman of the United States Federal Reserve, noted that inflation expectation greatly influences the central bank's ability to achieve price stability (Bernanke 2007). Potter (2012) extended this notion by arguing that since inflation expectation forms such a critical component in achieving price stability, it is a key link in the monetary transmission mechanism. Deacon and Derry (1994) further highlighted that by comparing market expectations with the central bank's target, it is possible to get an insight into the credibility of monetary policy. He noted that the psychology of inflation is a major obstacle in the fight against inflation and that such expectations usually have a self-fulfilling characteristic. Knowledge of inflation expectations can also assist the monetary authority to determine the effectiveness of issuing fixed or variable rate debt instruments as well as information on the public's perception of inflation control. With these added advantages, it is no surprise that most central banks have sought to understand, estimate and when necessary counter inflation expectations.

Against that background, this paper seeks to identify the major determinants of inflation expectation in Jamaica with a view to enable the Bank of Jamaica to better estimate the market's perception of future inflation. The paper adopts a combination of the methodologies employed by Patra and Ray (2010) and McCulloch and Stec (2000), which utilizes ARMA and expanding window OLS models of forecasting inflation to develop an estimate of inflation expectation. The paper develops on the approach of Patra and Ray (2010) to derive estimates of inflation expectation from lagged values of inflation and subsequently assess its determinants. There are currently two surveys on inflation expectations conducted in Jamaica. The first is the Survey of

Business Conditions conducted by the Jamaica Chamber of Commerce (JCC). This is a general survey conducted quarterly on business confidence and businesses' and consumers' perception on a number of economic variables. The survey was first conducted in the March 2001 quarter. Secondly a bi-monthly survey of Businesses Inflation Expectation is conducted by the Statistical Institute of Jamaica on behalf of the Bank of Jamaica (BOJ). This survey is more focused on expectations about a smaller number of macroeconomic variables than the JCC's survey, however, it has only been in existence since January 2006. The results of both surveys are continuously compared in this paper to assist in the robustness of the analysis.

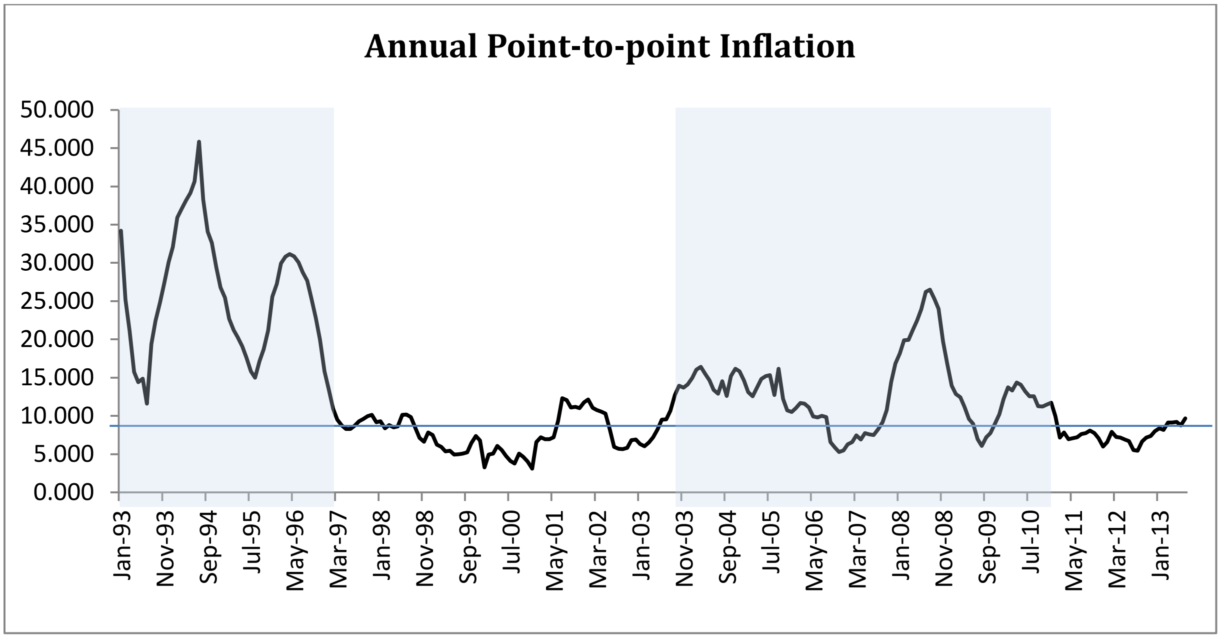
The paper proceeds as follows: in Section 2.0 an overview of the stylized facts on inflation and inflation expectations is presented. In section 3.0 we present a review of the existing literature. Section 3.0 gives an outline of how the model is developed while Section 4.0 describes the data, presents the estimation of the model parameters and explains how these are used to extract estimates of inflation expectations. The results are presented in Section 5.0 and conclusions are drawn in Section 6.0.

2.0 Stylized facts on inflation in Jamaica

The evolution of inflation in Jamaica over the last two decades can be seen as having gone through 4 distinct eras as outline in figure 1 below. The first era which can be viewed as prior to 1997 was contextualized by high and volatile inflation partly explained by the onset of the financial crisis which occurred in Jamaica in the late 1990s. During the period the Government of Jamaica also liberalized the domestic currency which depreciated significantly over the period. Subsequent to the first period there was a period of low and relatively stable inflation during which time inflation trended on average below the 10 per cent or double digit marker.

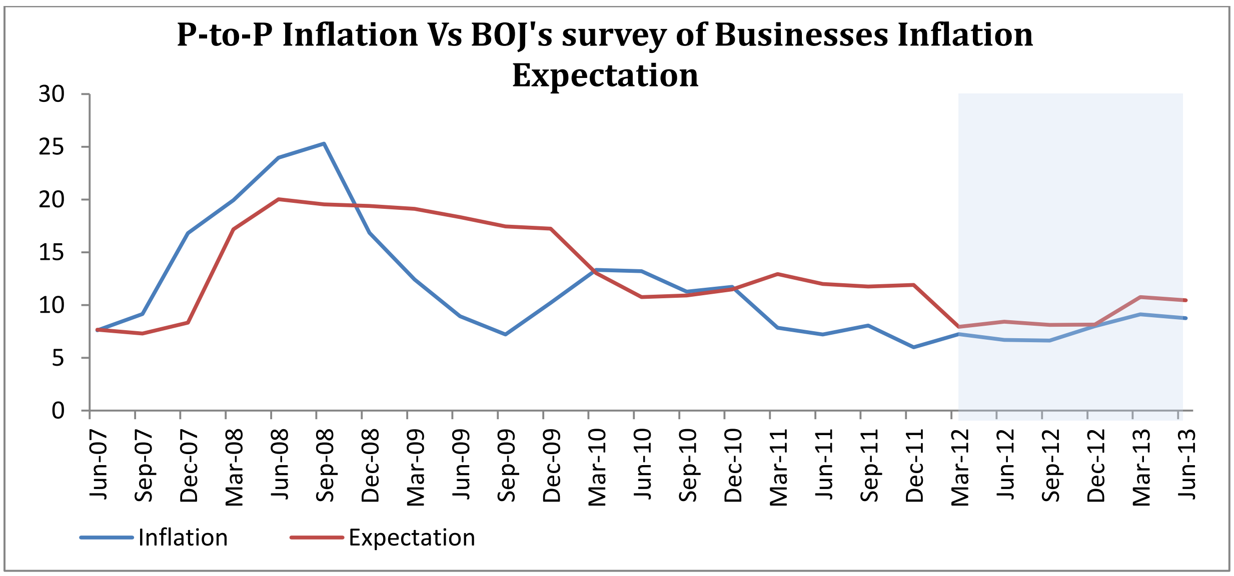
For the period 2003 to 2010 annual inflation exhibited signs of increased volatility due in part a to sequence of macroeconomic shocks. In 2003 the rate of inflation was impacted by a significant depreciation in the domestic currency the impact of which was augmented in subsequent years by weather related and international commodity shocks. In 2008, the rate of inflation increased considerably potentially due to sharp increases in crude oil prices which reached record levels during the period. Notably, at no point during this period did the rate of inflation return to the volatility levels observed during the first period. The final period which is preceded by the global financial crisis is characterized by low and stable inflation levels. In this regard for the entire final period the rate inflation has not gone above the 10 per cent or single digit marker.

Figure 1



The evolution of inflation over the decades has led to an increased desire to understand the dynamics of its movements. In particular to better understand the macroeconomic conditions that prevails during the periods of high and low inflation. Additionally, the expectations of businesses during each period could give valuable insights on the level of inertia and self-fulfilling expectations that characterize these periods. In this context, it can be figure 2 shows that between 2007 to mid-2008, as the rate of inflation increased inflation expectations also increased despite at a slightly slower pace. However, towards the end of 2008 and throughout 2009 the rate of inflation showed moderate declines while inflation expectations declined very marginally over the period. This can be attributed to a reduction confidence levels as the country struggled to cope with the impact of the financial crisis in the aftermath of the shock to crude oil prices. During 2010 as the country negotiated an International Monetary Fund (IMF) agreement the level of confidence improved and as a consequence inflation expectations declined and converged to towards actual inflation. This convergence was disrupted in 2011 as the IMF agreement stalled leading to increased uncertainty and a divergence in inflation expectations and actual inflation. However, over the last 2 years there have been low and relatively stable inflation rates. This was in the context of significant fiscal restraint which included a wage freeze under a new IMF agreement coupled with increased levels of unemployment and idle capacity amidst below par international economic growth. Over this period there has been a convergence between the actual inflation rate and inflation expectations, as measured by BOJ's survey of Businesses Inflation Expectation (see figure 2). This may have aided the relatively low levels of inflation observed over the period and gives credence to the objective of this paper to explore the formation of expectations.

Figure 2



3.0 Literature Review

Despite the importance and attention that has been afforded to the topic, the measurement of inflation expectations has proven to be very difficult. Early models, following the theory of adaptive expectation, sought to estimate expectations using distributive lagged equations of past inflation. Figlewski (1981) postulated that the adaptive expectation theory assumes that expectation about future inflation by economic agents can be fully explained by observing and modeling past values of inflation. These models, however, failed to adequately account for changes in inflation expectations. To remedy this glaring deficiency, the rational expectation theory was proposed as a more superior means of determining how exactly expectations are formed. Lucas (1972) and Sargent (1993) proposed that individuals could anticipate the effects of economic policies and make decisions based on the current environment. The rational expectations theory therefore assumes that economic agents have full information and form future expectations based on all information available in the public domain. De Grauwe (2006), in summarizing the two preceding theories, noted that the former assumed human beings were "stupid", and the latter - that they were all knowledgeable.

In an effort to capture the rational expectation of economic agents, the use of survey instruments was introduced, where individuals were allowed to give their expectations about future inflation. One of the earliest such survey, the Livingston survey, collected macroeconomic data in the United States of America on a semiannual basis from economists in businesses, academia and government. The use of such surveys has become widespread in recent decades and to date, virtually all central banks, including the Bank of Jamaica, conduct some variation of these inflation expectations surveys. Carlson & Parkin (1975) and Aroujo & Gaglianone (2010) used an estimation technique that developed a distribution for the qualitative data obtained from the survey and subsequently converted the responses to quantitative data (inflation expectations). This analysis was based on data taken from surveys conducted by central banks in Japan and Brazil, respectively. Potter (2012) noted that inflation surveys can give good approximations of inflation expectations but when used in isolation are inadequate to properly estimate future inflation. Akira (2009), in criticizing the findings presented by Carlson and Parkin (1975), posited that the paper suffered from a number of specification errors and as such did not provide robust indicators of inflation expectation. Specifically, she noted that:

"Because survey research restricts responses into specific classifications and respondent's response density may not be uniform, survey data surely include a specific error. In addition, because the distribution assumed in the Carlson-Parkin method may not fit the respondent's distribution, this may also produce measurement error"

Figlewski and Wachtel (1981) also contended that the responses on expectations from the Livingston survey were irrational and as such failed to deliver on its manifested premise to provide information on rational expectations of the economic agents. Mankiw et al (2004) noted further that different economic agents have different expectations and as such the assumption that individuals have the same "rational expectation" is flawed. In his analysis he showed that surveys issued to consumers and economists not only defied rationality but also included substantial disagreement about expected future inflation, auto-correlated forecast errors and insufficient sensitivity to recent macroeconomic news. Deacon and Derry (1994) contended further that survey results typically suffer from the following limitations:

- ✓ They take time to compile and analyze and therefore may not give current information;
- ✓ Some results have been proven to be irrational;
- ✓ Accuracy is limited by duration and hence they tend to give short term indications;
- ✓ Market participants have little or no incentive to provide accurate information; and
- ✓ The results of surveys are susceptible to measurement errors.

In a bid to rectify the divide between these two theories, economists have sought to develop models that endogenise a learning process in the adaptive expectations model. Therefore, rather than assume that information is fully symmetric, these models assume that individuals gain and incorporate information over time based on the learning process. These models, popularly referred to as learning processes, allow agents to revise their forecasting rules over time as new data becomes available. Additionally, they provide some latitude for individuals to incorporate regime shifts in the formation of expectations. These models, however, still include some amount of model bias.

More recent economic models have sought to utilize market data (particularly financial market data) to estimate inflation expectation. The main motivation is that financial markets tend to be very sophisticated and with agents incorporating most information available within the public domain, it is therefore one of the closest markets to the theoretical notion of "perfect information". The financial market has the added advantage that it is closely knitted with monetary policy. Deacon and Derry (1994) utilize a financial market analysis to illustrate how United Kingdom gilts can be used to derive estimates of inflation expectations based on the "break even inflation rate" [2]. The breakeven inflation rate is calculated by

[2] Gilts are inflation indexed UK treasury bonds.

comparing the rate of return on an inflation indexed bond with the nominal return on a conventional bond of a similar maturity. The difference in the rate of return of the inflation linked bonds and the return on a nominal bond would offer a market-based measure of inflation expectations.

Deacon and Derry (1994) was, however, quick to highlight that a limitation of the "break even" inflation methodology is the assumption that the rate of return on index linked Treasury bonds did not include risk or liquidity premia. They also noted that in most economies there are a limited number of and in some cases no inflation indexed securities. Additionally, where these securities exist it is difficult to exactly match their maturity with a conventional bond. It was also indicated that bonds typically have different coupon payments and individual risk factors that could distort the results. In an effort to overcome the difference in coupon payments and the idiosyncrasies inherent in individual bonds they derived an *Inflation Term Structure* based on the estimation of an implied forward rate curve[3]. This was used to extrapolate a term structure for inflation expectation.

Given the absence of readily traded inflation indexed securities in the Jamaican economy and the BOJ's relatively new inflation expectation survey; this paper utilizes a pragmatic approach to measuring inflation expectation as proposed by Patra and Ray (2010). That paper pursued an approach involving an unbiased and parsimonious modeling of the actual inflation process and then employing an expanding window approach to generate a time series of expectations for next period inflation. In this regard, a Seasonal Autoregressive Moving Average model (SARIMA) was used to estimate inflation expectation. The SARIMA model was utilized because it is parsimonious and does not assume knowledge of any underlying driver or structural relationship. The estimated inflation expectations series is then modeled using a new Keynesian type Phillips curve model which adopts a reduced form equation to determine the major economic variables that assists in explaining movements in inflation expectations. Kiley (2009) added that these models provide a plausible explanation for the dynamics of inflation expectations and have been widely used in the analysis of monetary policy. The results of the paper is also augmented by applying a similar new Keynesian type Phillips

[3] For a more detail exposition on inflation term structure models see Campbell and Shiller (1991) Dai and Singleton (2003) and Thornton (2004).

curve model to the inflation expectations obtained from the JCC survey in an effort to support the robustness of the results. The paper represents the first empirical estimate of inflation expectation in Jamaica.

4.0 Methodology

The paper follows the approach of Patra and Ray (2010) and utilizes a SARIMA model to estimate inflation expectation for the Jamaican economy. The approach also has theoretical roots in the works of McCulloch and Stec (2000), Akhter (2013) and Juntilla (2001). The approach taken can be viewed as a two-stage procedure; where the first stage involves estimating inflation expectation while the second stage analyses some of the determinants and dynamics of the estimated series. Though it can be argued that basing the analysis on the estimated inflation expectation series may contain inherent model errors and biases, the analysis represents the most robust estimate that can be attained in the absence of an established survey and traded inflation indexed securities. From the review of the literature it should also be evident that all measures of inflation expectations have inherent biases.

The estimation of inflation expectation follows a model of actual inflation which then utilizes an expanding window to approximate the next period's inflation expectation. The analysis assumes that the behaviour of economic agents is rational to the extent that all available information at time t is used to project price changes at time $t+1$, but assumes money is non-neutral in the short run[4]. The model utilizes annual point-to-point inflation calculated from the monthly Consumer Price Index (CPI) for the period January 1985 to June 2013. Given the properties of the inflation series a SARIMA (1, 0, 2) framework was selected and expanding window approach utilized to estimate the next period inflation expectation. The SARIMA model serves the objective that it is unbiased and parsimonious, two qualities that are necessary to give a realistic estimate of rational expectations. Using the annual point-to-point inflation the model estimates inflation expectation as follows.

[4] For a more detailed analysis of rational expectations and its impact on monetary policy see Lucas (1972) and Fischer (1977)

Step 1: Estimated inflation over the period January 1985 to December 1999. This estimation resulted in the following model:

$$\pi_t = \beta_0 AR(1) + \beta_1 MA(1) + \beta_2 MA(2) + \beta_4 SMA(12) + \varepsilon_t \qquad (1)$$

Step 2: A recursive expanding window was then utilized to estimate the inflation expectations series over the period January 2000 to June 2013. The series is therefore generated as:

$$\pi^e_{t+1} = \hat{\pi}_{t+1}$$

Where: π^e_{t+1} is the expected inflation in month *t* and reflects the model forecast at month *t*. The AR, MA, SAR and SMA terms are the autoregressive, moving average, seasonal autoregressive and seasonal moving average terms, respectively, while ε_t is a white noise error term. The numbers in brackets represent the number of lags in the respective processes, such that an AR (1) process is an autoregressive process with one lag. Notably the SARIMA model was chosen as opposed to the general ARIMA model to account for an observed cyclical pattern in the inflation series. In this regard, the SARIMA model was chosen as the most robust parsimonious model of all the alternatives considered. The inflation expectation series is obtained from calculating a recursive one period ahead forecast of the above model and represents a wide-sense covariance stationary series.

Subsequently, the generated inflation expectation series was modeled as a function of country specific monetary and macroeconomic variables as well as lags of inflation to deduce its major determinants. In this regard, a new Keynesian type Phillips-curve analysis was estimated to ascertain the relationship between inflation, inflation expectation and other monetary and macroeconomic variables. The analysis was performed on monthly time series where variables published on a quarterly basis were transformed using the quadratic (match sum) interpolation methodology. The estimated equation takes the following form:[5]

[5] Notably a number of other variables such as M1, real effective exchange rate, nominal effective exchange rate, investment etc. were also considered and rejected as insignificant.

$$\pi_t^e = f\left[\sum_i^n \pi_{t-i}, \sum_i^n rgap_{t-i}, \sum_i^n \mathrm{rfisc}_{t-i}, \sum_i^n xr_{t-i}, \sum_i^n fuel_{t-i}, \sum_i^n grains_{t-i}, \sum_i^n r_{t-i}, \sum_i^n RM_{t-i}\right] \qquad (2)$$

Where:

π_t^e = the estimated inflation expectation for period *t*

$(rgdp)_{t-1}$ = lags of GDP gap defined as actual GDP minus trend GDP

$rfisc_{t-i}$ = lags of annual changes in real fiscal expenditure

xr_{t-i} = lags of annualized changes in the exchange rate

$fuel_{t-i}$ = lags of annual changes in the average Brent fuel prices

$Grains_{t-i}$ = lags of annual changes in the BOJ's grain index

R_{t-i} = lags of real interest rate (proxied by the 6-month Treasury bill rate)

RM_{t-i} = lags of annual changes in the real money supply (M1).

In light of the possible model bias involved in using the model estimated inflation expectation series, Equation 2 was also estimated on the 12 month-ahead inflation expectation index obtained from the JCC survey. This was done in a bid to ascertain if the determinants would be consistent across expectation measures and to evaluate possible deviations. The JCC survey is conducted on a quarterly basis and data are available since its inception in 2001. It should be noted, however, that the survey data have inherent biases, similar to those highlighted in Section 2. Specifically, the survey index for inflation expectation was calculated from binary ("up" and "down") responses. Additionally, there is no referenced index, as respondents merely indicate the direction in which they expect prices to move, hence the expectations are not necessarily related to the CPI or any specific index.

5.0 Model Implementation and Results

The Augmented Dickey-Fuller (ADF) test suggests that the annualized inflation series and the estimated inflation expectation series are integrated of order one I(1) while the Phillips-Perron test suggests that the series is integrated of order zero I(0). The finding that the inflation series is at most I(1) is common in the literature. McCulloch et al, (2000) highlights the possibility that annualized monthly inflation series can be a trending series where the trend could be time varying. As such, the series would be non-stationary at least for various time periods in the data. Further, Stock (1990) and Cochrane (1991) noted that standard unit root tests do not have the power to distinguish between a series with a unit root and one with a near unit root. In this regard, Patra and Ray (2010) note that over-differencing the series can lead to the loss of vital information as well as inefficient parameter estimates. The paper therefore uses the level form of the annual inflation series where the expected inflation series is broad sense covariance stationary. All the other series utilized in the model were found to be I(0) at the 5 per cent level of significance. This is consistent with theory as the variables would already be in difference form.

Figure 3

Variable	ADF	PP
Inflation annualized change	-2.6449	-3.5529*
JCC annualized change	-3.8107*	-3.0808*
Estimated inflation expectation	-2.1410	-2.7266**
GDP Gap	-4.6256*	-5.2779*
Real fiscal expenditure annualized change	-2.8519**	-3.7401*
Exchange rate annualized change	-2.1231**	-2.8329**
Average Brent annualized change	-4.1476*	-3.7750*
Grains index annualized change	-3.1718*	-3.5946*
Real interest rate	-2.8426**	-2.9385*
Real M1 annualized change	-4.0737*	-4.6184*

Where * and ** represents significance at the 1% and 5% levels, respectively.

The lag structure for the SARIMA model was determined based on Akaike and Schwarz-Bayesian information criterion coupled with an analysis of the auto-correlation function. Additionally, the partial auto correlation function suggests that the series exhibit a cyclical pattern hence the seasonal MA term was included in the model. White standard errors were used to control for heteroskedasticity while both the Breusch-Godfrey serial correlation test and an evaluation of the auto-correlation function suggest that there is no serial correlation in the model (see: figure 2, and figure A in appendix). The roots of the AR and MA terms were also within the unit circle indicating that the process is stable (see Figure B in appendix). All other diagnostic tests conducted suggested that the model is adequately specified.

Figure 4

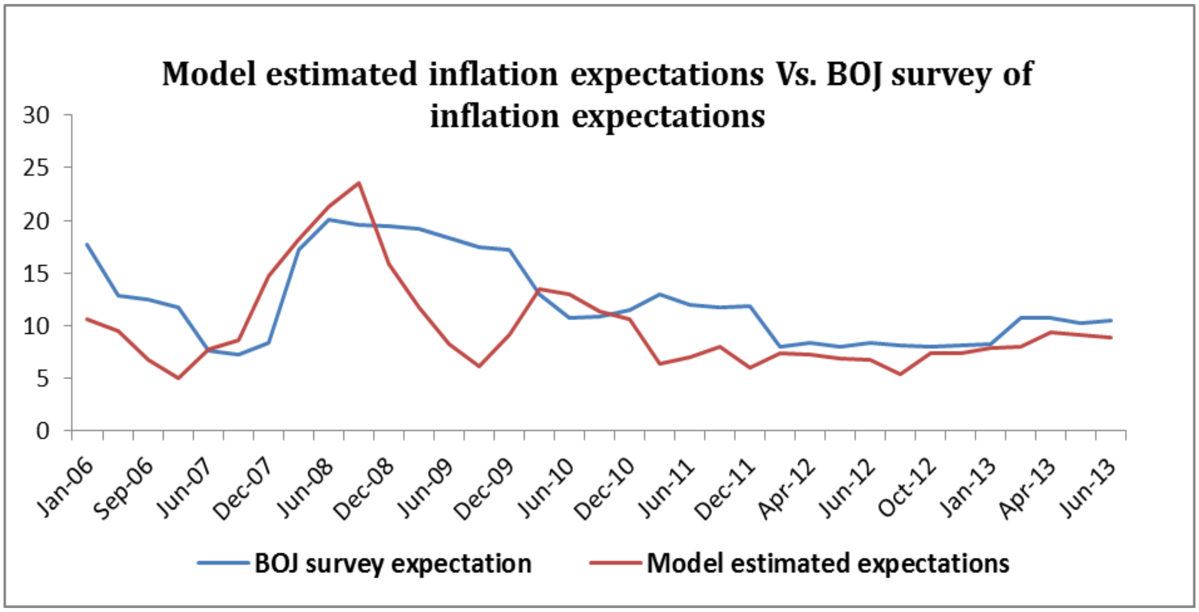
Estimated Inflation Expectations Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.151059	0.023965	6.303406	0.0000
AR(1)	1.854973	0.048728	38.06775	0.0000
AR(2)	-0.856416	0.048526	-17.64876	0.0000
MA(1)	-0.476833	0.091538	-5.209122	0.0000
SMA(12)	-0.886224	0.025043	-35.38865	0.0000

R-squared	0.988839	Mean dependent var	0.152879
Adjusted R-squared	0.988752	S.D. dependent var	0.111869
S.E. of regression	0.011864	Akaike info criterion	-6.021032
Sum squared resid	0.072774	Schwarz criterion	-5.980249
Log likelihood	1576.489	Hannan-Quinn criter.	-6.005058
F-statistic	11450.95	Durbin-Watson stat	1.895830
Prob(F-statistic)	0.000000		

Figure 3 below depicts a comparison of the inflation expectation obtained from the BOJ's inflation expectation survey and the estimated inflation expectation series derived from the above model. The graph shows a very strong correlation between the two measures over the limited sample space. This correlation adds to the validity of the estimated inflation expectation series. In this regard, the estimated series could also be broadly viewed as an instrumental variable for the limited sample size of the BOJ's inflation expectation survey.

Figure 5



The result from the reduced form equation was able to explain a large portion of the movements in the estimated inflation expectation series as well as the inflation expectation obtained from the JCC's survey. The optimal solution to the model was selected using the general to specific approach where the Akaike and Schwarz-Bayesian information criterion was used to select the most parsimonious model. The models which were also tested to ensure proper specification revealed a number of significant policy sensitive results which are outlined below. Figure 4 below shows a summary of the results by summing the coefficients on the variables considered.

Figure 6

Variables	Estimated expectation model	JCC expectations
INFA	0.9296	0.2343
GAP	(0.0000)	0 .0001
Fuel	0.0030	0.0067
Grains	0.0090	(0.0553)
R	(0.0003)	(0.0016)
XR	0.0531	0.2320
Rfisca		(0.1302)
M	0.0077	0.1050
JCCA	-------------	0.7769

The Analysis revealed that inflation inertia (persistence) is a significant contributor to inflation expectation in both of the models assessed. For the equation that used the model estimated inflation expectations, lags of annual inflation contributed approximately 93 per cent to inflation expectations. Similarly, in the equation that that used the JCC expectations data, lags of the dependent variable accounted for approximately 78 per cent to the JCC inflation expectations while lags of inflation contributed approximately 23 per cent. This significant level of inertia could suggest the slow rate of adjustment of expectations by individuals over time as well as the possibility that other factors may be driving the variables. The possibility of other factors driving expectations was most evident in the model using the JCC expectations data where one lag of the dependent variable was highly significant. The high level of inflation inertia is also supported by the results of Patra and Ray (2010) who found that inflation inertia contributed approximately 50 per cent of inflation expectations in their model.

Notably, the sum of the coefficients on fuel prices was also positive in both models confirming theoretical a priori that oil prices, a marginal cost in most production processes would stimulate expectations for price increases. The impact of movements in oil prices filtered through the inflation expectations model after an average of 8 lags while in the JCC expectations model it was observed far more quickly, after just one lag. The sum of the coefficients on international grains prices was also positive in the estimated expectations model further supporting the a priori notion that primary commodity prices would stimulate upward pressure on prices. The findings are consistent with those of Patra and Ray (2010) who also found a positive relationship for primary commodity prices. However, the sum of coefficients on the grains index in the JCC expectations model was negative though relatively small. This could possibly be due to the high levels of volatility that is sometimes evidenced in grains prices. The ambiguous result could also be due to countervailing pressures from the mix of commodities within the index, which is a weighted measure of corn, wheat and rice.

With regard to real fiscal expenditure, the sum of the coefficients was insignificant in the estimated expectations model but negative in the JCC expectations model. This result is inconsistent with a priori expectations and could suggest a lack of confidence in the sustainability of fiscal spending. The ambiguous result was also found by Patra and Ray (2010), however, their result was explained in a context where the government had generally increased taxes relatively in line with expansion in expenditure.

The sum of the coefficients on the output gap was positive in the JCC expectations model but negative for the estimated expectations model. In both models the sum of the coefficients was also very small implying that individuals give little regard to the output gap when forming expectations. It is also worthwhile to note that the sum of the coefficients on monetary policy variables in both models was relatively small though significant. This could suggest that monetary policy actions have a small impact on inflation expectations and hence large changes on the part of the BOJ would be required to gain meaningful results. Of note, the sum of the coefficients on real interest rates in both models was negative and in line with expectations which could suggest that the BOJ does have some control over expectations despite the relatively small reaction function.

For money supply, the sum of the coefficients was positive in both models though also small. This result is consistent with expectations and suggests that inflation expectation reacts positively to movements in money supply. Though the sum of coefficients on both of the monetary policy variables is small, the coefficient on money supply is larger in both models indicating that money supply could be a better tool for monetary policy than the Treasury bill rate. Further contextual analysis would, however, be required to draw such a conclusion. With regard to the exchange rate, the coefficients in both models were positive and significant. This is also in line with theory where a depreciation of the exchange rate is likely to lead to higher domestic prices and hence a rise in expectations. The reaction of changes in the exchange rate creates another avenue for the BOJ to consider in its attempt to influence expectations.

6.0 Conclusion and Recommendations

The results of the analysis showed that lags of inflation are a significant contributor to inflation expectations. This was the largest positive contributor to expectations in both models and depicts the level of inertia that is evident in expectations. Inertia was also reflected in the JCC inflation expectations survey with the significant positive coefficient on lags of the dependent variable as well as inflation. Similarly, international oil and grains prices were significant in driving inflation expectations. This result is consistent with theoretical arguments that primary commodity prices, which are marginal costs in most domestic consumables, would stimulate upward pressure on price expectations. The coefficient on the output gap was positive but insignificant in the JCC expectations model; however, it was negative but also insignificant for the estimated expectation model. The negative sum of coefficients in the estimated inflation model and the small magnitude in both models, however, does warrant some analysis and could indicate the need for a different proxy variable for movements in respondents' perceptions of income/demand such as income tax receipts or real wages.

Both models suggested that monetary policy variables, specifically real money supply, have only a small but significant impact on inflation expectations. This result suggests that the BOJ is constrained somewhat in its ability to influence the inflation expectation of the public via monetary policy without making large changes to its policy instruments. The results from the model also indicated that expectations respond moderately to movements in the domestic exchange rate. In this regard, the exchange rate could be used as a supplemental policy tool when conducting monetary policy.

The results from this analysis present a solid framework on which to develop an empirical proxy for inflation expectations. In particular, the study creates a reasonably proxy and a platform on which to assess the BOJ's inflation expectations once a sufficient sample size is achieved. Additionally, as the financial market develops, the use of inflation indexed bonds can be used to augment the results of this analysis.

Bibliography

Adrian, Tobias, and Hao Wu. "The Term structure of Inflation Expectation." The Federal Reserve Bank of New York (2009). Accessed December 4, 2012. http://www.newyorkfed.org/research/staff_reports/sr362.pdf.

Akhter, Tahsina. "Short-Term Forecasting of Inflation in Bangladesh with Seasonal ARIMA Processes." *Munich Personal RePEc Archive* 4372. Accessed September 6, 2013. http://mpra.ub.uni-muenchen.de/43729/.

Akira, Terai. "Measurement Error in Estimating Inflation Expectations from Survey Data: An Evaluation by Monte Carlo Simulations." *OECD Journal: Journal of Business Cycle Measurement and Analysis* (2009): 133-56.

Alonso, Francisco, Robert Blanco, and Ana del Rio. "Estimating Inflation Expectations using French Government inflation-Indexed Bonds." Bank of Spain. 2012. Accessed November 30, 2012. http://www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesSeriadas/DocumentosTrabajo/01/Fic/dt0111e.pdf.

Araujo, Carlos H., and Wagner Gaglianone. "Survey-based Inflation Expectations in Brazil." Bank for International Settlements . Accessed December 3, 2012. http://www.bis.org/publ/bppdf/bispap49g.pdf.

Bernanke, Ben S. "Inflation Expectations and Inflation Forecasting." The Federal Reserve. Accessed December 3, 2012. http://www.federalreserve.gov/newsevents/speech/bernanke20070710a.htm.

Campbell, John Y., and Robert J. Shiller. "Yield Spreads and Interest Rate Movements: a Bird's Eye View." , *Review of Economic Studies* 58, no. 3 (1991): 495-514.

Carlson, John A., and Michael Parkin. "Inflation Expectations." *Economica* 42, no. 166 (May 1, 1975): 123-38.

Chernov, Mikhail, and Philippe Mueller. "The Term structure of Inflation Expectations." Bank of Canada (2008). Accessed December 4, 2012. http://www.bankofcanada.ca/wp-content/uploads/2010/09/chernov_mikhail.pdf.

Cochrane, J. H. (1991). Volatility tests and efficient markets. *Journal of Monetary Economics, 27*, 463-485.

De Grauwe, Paul. "Central Banking Model for neither Gods nor Monkeys." (2006). Accessed December 3, 2012. http://economistsview.typepad.com/economistsview/2006/07/adaptive_expect.html.

Deacon, Mark, and Andrew Derry. "Deriving Estimates of Inflation Expectations from the Prices of UK Government Bonds." *Bank of England Working paper* 23 (1994) Accessed November 7, 2012. http://www.bankofengland.co.uk/publications/Documents/workingpapers/wp23.pdf.

Figlewski, Stephen, and Paul Wachtel. "The Formation of Inflationary Expectations." *Review of Economics & Statistics* 63, no. 1 (February 1981): 1.

Findley, Richard, and Sebastian Wende. "Estimating Inflation Expectations with a Limited Number of Inflation-Indexed Bonds." *International Journal of Central Banking* (June 2012): 111-42. http://www.ijcb.org/journal/ijcb12q2a4.pdf.

Fischer, Stanley. "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule." *Journal of Political Economy* 85, no. 1 (February 1977): 191-205.

Haubrich, Joseph G. "A new Approach to Gauging Inflation Expectations." Federal Reserve Bank of Cleveland. Accessed November 30, 2012. http://www.clevelandfed.org/research/commentary/2009/0809.cfm.

Haubrich, Joseph G., George J. Pennacchi, and Peter r Ritchken. "Inflation Expectations, Real Rates, and Risk Premia: Evidence from Inflation Swaps." Federal Reserve Bank of Cleveland. 1991. http://www.clevelandfed.org/research/workpaper/2011/wp1107.pdf.

Junttila, Juha. "Structural Breaks, ARIMA Model and Finish Inflation Forecasts." *International Journal of Forecasting* 17, no. 2 (June 2001): 203-30.

Loleyt, Anna, and Ilya Guro. "The Process of Inflation Expectationsí Formation." Bank of Russia. Accessed November 30, 2012. http://www.bis.org/ifc/events/5ifcconf/gurov.pdf.

Lucas, Robert E. "Expectations and the Neutrality of Money." *Journal of Economic Theory* 4, no. 2 (April 1972): 103-24.

Mankiw, Gregory N., Ricardo Reis, and Justin Wolfers. "Dissagreement about Inflation Expectations." *NBER Macroeconomics anual 2003* 18 (July 2004): 209-70. http://www.nber.org/chapters/c11444.pdf.

McCulloch, J. Huston, and Jeffery A. Stec. "Generating Serially Uncorrelated Forecasts of Inflation by Estimating the Order of Integration directly." Ohio State University. Accessed September 6, 2013. www.econ.ohio-state.edu/jhm/inflexp.doc.

Meyler, Aidan, Geoff Kenny, and Terry Quinn. "Forecasting Irish Inflation Using ARIMA models." *Central Bank and Financial Services Authority of Ireland Technical Paper Series* 1998, no. 3/RT: 1-48.

Patra, Michael D., and Partha Ray. "Inflation Expectations and Monetary Policy in India: An Empirical Eploration." IMF Working Paper series. Accessed September 6, 2013. www.imf.org/external/pubs/ft/wp/2010/wp1084.pdf.

Remolona, Eli M., Michael R. Wickens, and Frank F. Gong. "What Was The Market's View of UK Monetary Policy? Estimating Inflation Risk and Expected Inflation with Indexed Bonds." Federal Reserve Bank of New York. 2012. Accessed November 30, 2012. http://www.ny.frb.org/research/staff_reports/sr57.pdf.

Resler, David H. "The Formation of Inflation Expectations." Federal Reserve Bank of St. Louis (April 1980). Accessed November 16, 2012. http://research.stlouisfed.org/publications/review/80/04/Formation_Apr1980.pdf.

Robinson, Wayne. "Forecasting Inflation Using VAR Analysis." Bank of Jamaica. Accessed September 6, 2013. http://208.163.60.226/uploads/pdf/papers_pamphlets/papers_pamphlets_forecasting_inflation_using_var_analysis.pdf.

Simon, Potter. "Improving the Measurement of Inflation Expectations." Federal Reserve bank of New York. Accessed December 3, 2012. http://www.newyorkfed.org/newsevents/speeches/2012/pot120607.html.

Sargent, Thomas J. “Bounded Rationality in Macroeconomics.” Clarendon Press: Oxford University Press, 1993.

Stock, J. H. (1991, December). Bayesian Approaches to the 'Unit Root' Problem: A Comment. *Journal of Applied Econometrics*, *6*(4), 403-411.

Thornton, Daniel L. "Tests of the Expectations Hypothesis: Resolving the Campbell-Shiller Paradox." Federal Reserve Bank of ST. Louis. http://research.stlouisfed.org/wp/2003/2003-022.pdf.

1.0 Appendix

Figure A: Correlogram for the AR model.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.043	0.043	0.9914	
		2	-0.078	-0.080	4.2178	
		3	-0.049	-0.042	5.4662	
		4	0.015	0.013	5.5892	
		5	0.058	0.051	7.3971	0.007
		6	-0.004	-0.008	7.4040	0.025
		7	0.024	0.034	7.7012	0.053
		8	-0.005	-0.004	7.7144	0.103
		9	0.020	0.023	7.9287	0.160
		10	0.040	0.038	8.7888	0.186
		11	0.031	0.031	9.3027	0.232
		12	-0.042	-0.041	10.252	0.248
		13	-0.092	-0.081	14.780	0.097
		14	0.010	0.009	14.830	0.138
		15	0.024	0.002	15.130	0.177
		16	0.001	-0.009	15.131	0.234
		17	0.005	0.013	15.143	0.298
		18	-0.009	-0.003	15.185	0.366
		19	0.048	0.049	16.454	0.353
		20	-0.028	-0.031	16.885	0.393
		21	-0.016	-0.007	17.020	0.453
		22	0.032	0.037	17.575	0.484
		23	0.065	0.067	19.873	0.402
		24	0.048	0.046	21.164	0.388

Figure B: Unit circle of the ARIMA model

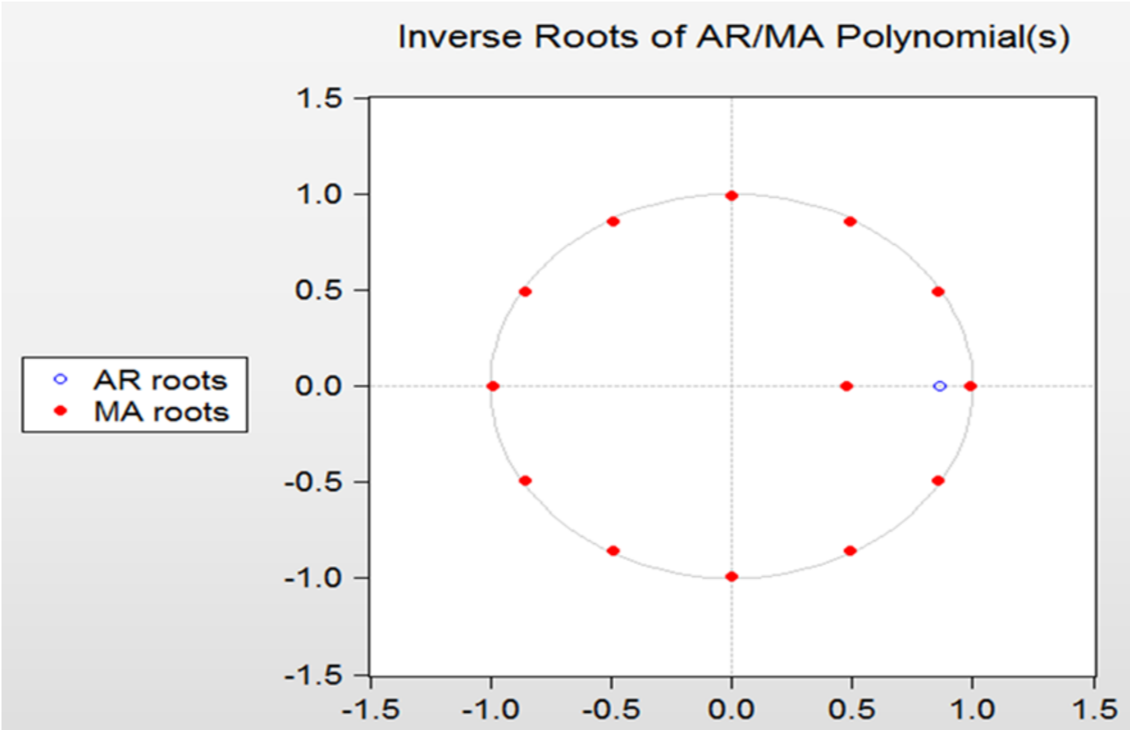


Figure C: Reduced form model result for the estimated inflation model and the JCC model

Estimated expectations	
Variables	***Coefficients***
BRENTA(-6)	-0.004577
BRENTA(-9)	0.007607
C	0.008623
G_IDXA(-5)	0.008999
GDPGAP(-1)	-0.000006
GDPGAP(-2)	0.000005
GDPGAP(-3)	-0.000003
GDPGAP(-7)	-0.000005
GDPGAP(-8)	0.000004
GDPGAP(-9)	-0.000003
INFA(-1)	1.094261
INFA(-4)	-0.084921
INFA(-8)	-0.079700
INT_180(-1)	-0.000265
RM1A(-1)	0.023387
RM1A(-7)	-0.015700
XRA(-3)	0.089601
XRA(-6)	-0.086348
XRA(-9)	0.049864

JCC expectations	
Variables	***Coefficients***
BRENTA(-1)	0.0457390
BRENTA(-10)	0.0586820
BRENTA(-5)	-0.0976960
G_IDXA(-2)	-0.0552950
GDPGAP(-1)	0.0000312
GDPGAP(-10)	0.0000285
GDPGAP(-4)	0.0000258
GDPGAP(-7)	0.0000325
INFA(-11)	0.6414800
INFA(-3)	0.8260820
INFA(-6)	-1.2332650
INT_180(-10)	-0.0060380
INT_180(-5)	0.0044160
JCCBA(-1)	0.7769380
RFISCA(-1)	0.0867620
RFISCA(-10)	-0.0818980
RFISCA(-7)	-0.1350150
RM1A(-8)	0.1049610
XRA(-10)	0.5427540
XRA(-4)	0.4143380
XRA(-7)	-0.7251060