An Empirical Look into Inflation Dynamics through Real and Financial Sector Lenses for Emerging Market Economies

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Abstract

I estimate six equations already posited within the literature that aim to measure inflation and its relation to various factors from both the standpoint of the real portion and the financial portion of the economy. Therefrom, I develop and estimate a model addressing issues found in the literature around the impact that globalization has on the inflation process. All seven model specifications are treated with two sorts of expectation decomposition- that found in the methodology outlined by Pindyck and Rubinfeld (1998) and that adapted from Kalman (1960). This is undertaken for Israel, South Korea, Mexico and South Africa- a handful of emerging market economies.

Treating all estimations thusly, a few stylized facts need to be brought to light; firstly, the new model posited by this paper (the Trade –Seigniorage synthesis) appears a robust way in which to map inflation while controlling for the impact that globalization and world income growth might have on its (inflation's) movement across time. Furthermore, contra the position held by Fama (1981), this research has pointed out that- for these particular emerging markets- models rooted in the real portion of the economy are, on average, more robust in digesting information, and may thus lead to mapping inflation expectations with more accuracy than models rooted in the financial sector of the economy. Finally, it could be argued that- although both inflation expectation decompositions have their respective flaws- inflation expectations in these emerging markets need not be perfectly rational (focusing on all information within the dataset), but instead imperfectly rational (instead, more accurate expectations are governed by only a limited memory of data within the dataset).

Contents

1. Inflation Dynamics; an Introduction

The understanding of both inflation and expectations regarding what inflation will do in the future are pivotal in the study of Macroeconomics currently. The archetypal study of inflation- undertaken by Phillips (1958) – shed light on how an increase in unemployment would decrease wage-bargaining power and, ultimately spur on a decrease in the inflation rate inherent to an economy. This classical reflection on inflation did not, however, accommodate the role that expected inflation played in the formation of current inflationary pressure.

The omission of expected inflation only found its way into the mainstream literature much later on, where it was thought that expected increases in inflation informed rational economic agents to increase their demand for goods and services currently and, inadvertently, bid up the inflation rate in self-fulfilling-prophecy fashion as well (Sargent & Wallace, 1975). Therefrom, the literature evolved to account for other drivers of inflation; above and beyond unemployment (or expected inflation), it was found that previous inflation, as well as shocks to aggregate demand and supply, all added to the complexity in modelling inflation (Stock & Watson, 2008).

A question then arises in the mind of the layperson; why is it necessary to place so much emphasis on the analysis of inflation? Semantically, one could argue that price rises affect all who act in the economy (admittedly, moreso the impoverished than the more affluent); but to the economist, the accurate analysis of both current and expected inflation is paramount to the fine-tuning of both monetary and fiscal policy aimed at curbing economic volatility and keeping economic growth prospects in check. This policy acts as a more well-orchestrated way of maintaining the ability of the poor to afford goods and services, while simultaneously making the prospects of investment in a domestic economy more lucrative.

To this end, the current paper utilizes a gap in the current body of knowledge as its footing; although inflation and its expected value have been a key point of research both now and in the past, the literature does not yet posit a model of inflation which adequately incorporates the impact that large open economies have on smaller, emerging market economies' inflation rates.

Furthermore, the literature does not analyse each of the model specifications outlined within the current schema (using both features from the real and financial sectors of the economy) through the lens of emerging market economies, or compare them in any meaningful way. Importantly; Israel, South Korea, Mexico and South Africa are the emerging markets whose inflation dynamics are being studied. This is due, in part, to the idea that these emerging markets have sound financial market structures, most able (within the emerging market schema) to either prove or refute Fama's 1981 hypothesis linking the financial sector and robust inflation expectation decomposition. Furthermore, these emerging markets trade largely with large open market economies (such as the USA, UK and Germany) making them apt for analysis when gauging spill over effects from larger to smaller economies. It further appears that treatment of expected inflation in a comparative narrative has also not yet been undertaken in a meaningful way with these emerging market analysis in mind.

As such, this current paper's aims and objectives are multifarious; apart from the replication of already-established estimation methods of inflation in the emerging market context, this paper posits a novel way with which to model inflation while using information from the perspective of worldwide economic activity (henceforth, the Trade-Seigniorage synthesis). The abovementioned gap in the literature is also somewhat cemented over by the current paper's implementation of techniques from the economics and engineering literatures, aimed at measuring expected inflation from each model specification used within the current structure. The former is then augmented to encapsulate economic modelling which relies on the relation between inflation and variation in the short (or long) term interest rate. This analysis is encompassed in a general framework of comparison between measures of inflation which are based in the real sector of the economy and the financial sector of the economy alike.

Concerning the structure of the current paper then, an historical overview of inflation and its relevant research is undertaken, prior to setting out a methodology for measuring inflation as found in the literature already. This is followed by the proposition of the aforementioned novel approach to estimating inflation using the impact of globalization on its (inflation's) formation. Concurrently, each estimation will be decomposed into its observable and inherently latent (inflation expectations) components through the use of methodologies outlined by Pindyck and Rubinfeld (1998), and Kalman (1960), so as to come up with an holistic view of how inflation is measured in the emerging market sense. Penultimately, each estimation is analysed from both a theoretical and mean square error perspective (in order to ascertain within-sample forecasting and expectation-decomposition accuracy), prior to concluding with comments on policy recommendation and general findings from the research undertaken.

2. An Overview of the Study of Inflation

Generally, the price of any good or service is seen as equivalent to the value of that particular good or service, with inflation- the relative rise in the price of that good or service- previously seen as following a simple upward trend over time (especially in the early- and mid-1900s). It was presupposed that the price level in a particular time period was roughly at the same level in the following time period in addition to some inertia, making inflation relatively stable over that time. In this light, one would be able to form inflation expectations in a backward-looking manner (Mankiw, 1990).

This general trend allowed for the study of inflation in a relatively simplistic way, with the arguable zenith of inflation research at the time coming in the form of the unemployment-inflation trade-off posited in the late 1950s. One could argue that- at least in the Neoclassical equilibrium-seeking motif- unemployment was subject to deviations from its natural (long run equilibrium) rate due to oscillations in the business cycle, and thereafter, deviations from this natural rate were met with changes in the price level (Phillips, 1958).

If, for instance, unemployment in a particular time was higher than its estimated equilibrium level at that time, the workforce and, thus, the economy was seen to be under strain. This, it was argued, decreased the general level of wages payable to employees in the economy through a decrease in their respective bargaining powers, decreasing their collective spending capabilities and forcing the economy into a contraction, with a concomitant decrease in prices to be expected. On the other hand, if unemployment tended to be lower than its equilibrium rate, an increased number of employed in the economy tended to bolster bargaining power for the working class and with it, economic activity, bidding up the wage bill payable to those employed in a nation, their consumption capabilities and thus the price of goods and services as well (Phillips, 1958).

This implied inverse relation between inflation and the deviation of unemployment from its equilibrium/natural level has since then been dubbed “The Phillips Curve” and was then used to estimate and forecast the inflation rate with much accuracy between its inception and the mid-1960s. This Phillips Curve performed extremely well in a time where inflation was in fact relatively consistent, and where previous inflation was seen as being an adequate proxy for current inflation, with current inflation being an extremely reliable forecast for future inflation. In this manner, inflation expectations were both relatively stable and relatively unimportant to model for, considering this “absolute knowledge” regarding what the inflation rate would do (Mankiw, 1990).

To this end, one could argue that the performance of the Phillips relation hinged very heavily upon the fact that inflation could be held at relatively high levels while unemployment could be held at relatively low levels through monetary policy decisions. Integrally, the backward-looking expectations of inflation tended to make for adequate estimation and forecasting thereof, implying an ability of the policymaker to change inflation, and thus, unemployment through well-timed monetary policy contractions or expansions. This, however, proved not to be the case in the periods to follow (Phelps, 1968).

As was found, maintaining high inflation rates through monetary policy lead to instability within the macroeconomy; in particular, the advent of stagflation (high unemployment rates coupled with high rates of inflation) in the late 1960s lead to the break-down of the Phillips Relation and a dramatic decrease in its forecasting capabilities. This occurrence also challenged the notion that expectations for inflation could be solely backward looking as well (Friedman, 1968), and created a rift in the common practice of macroeconometric modelling at the time which would later be dubbed “the breakdown in the macroeconomic consensus” (Mankiw, 1990).

At this, theoretical studies on inflation were undertaken with special attention being paid to the impact that monetary and fiscal policy decisions have on price level stability. From the perspective of monetary policy, one could argue that the price level inherent to any economy is influenced largely by the repurchase rate (among other monetary policy instruments)- which influences the short (and long) term interest rate. This influence falls predominantly on aggregate demand through both the investment and exports-import portions of the economy (Taylor, 1995).

If, for instance, the interest rate were to increase, one would expect two things to follow suit (from at least the Keynesian perspective); firstly, due to the cost of borrowing being higher than when the interest rate was low, the demand for loanable funds (in a simplistic way at least) would tend to drop, given that paying back loans would be more costly for a firm wanting to invest. This increased cost of borrowing relates to a decrease in domestic investment, dropping the level of aggregate demand in the economy and pushing the price level (and thus, inflation) in the economic system down (Blanchard & Johnson, 2014).

Secondly from the open-economy perspective, one could argue that investors from abroad tend to favour higher interest rates (a higher interest rate relative to one's own country signals interest rate gains from saving in that foreign country). If this holds true, one could argue for an influx of capital to a particular (domestic) economy whose interest rates/repurchase rates are hiked. This bids the value of the country up, increasing the cash inflows to the domestic economy from abroad and- in most cases- bids the value of the currency up as well (assuming of course that exchange rates in the domestic economy are flexible). This appreciation of the domestic currency is coupled with a decrease in demand for exported goods (exports become more expensive from foreign perspectives) and increased demand in imported goods from other countries (imports now being relatively cheaper due to increased domestic purchasing power), further bidding down aggregate demand and the inflation rate alike (Appleyard, et al., 2008).

This simple monetary policy transmission mechanism is integral to the accurate forecasting of price changes over time. Furthermore, changes in monetary policy- especially if the central bank in a particular country is credible- aids in the formation of expectations for inflation over the short (and, often, long) term (Taylor, 1995).

From the fiscal standpoint then, one could argue that fiscal policy is able to alter the rate of inflation extant in an economic system through either changes in government spending or changes in taxation. In a simple manner, one could argue that increases in government spending tend to bolster economic activity through the demand side of the economy. This generally tends to raise the price in the market, increasing the inflation rate inherent to the economy. By contrast, an increase in tax rates tends to worsen the balance sheet of core members in the economy, decreasing their disposable income and thus their individual demand for goods and services in the economy. Across the whole economy, this relates to a decreased level of aggregate demand, bidding down the price level and correlating to deflation in a system (Keynes, 1936).

This method for understanding the relationship between inflation and fiscal policy can itself be extended to debt in the public sector with particular heed being paid to the budget deficit in a particular country. Assuming that Seigniorage (the financing of government debt through the printing of money) is kept in check, one could argue that the goal of balancing the budget of the fiscus (or in fact, running a surplus in some instances) can be helped through the price mechanism.

If, for instance, the fiscus' budget was in surplus, one could suggest the occurrence of a negative wealth effect influencing the constituents of an economy to spend less, due to their idea that the economy itself is in some form of contraction (an increased tax rate can be thus seen as a signal for the economy to decrease wasteful expenditure). This negative wealth effect implies lower tax revenues flowing into the coffers of the fiscus, decreasing the surplus to- one could speculate- a balanced budget, and should theoretically link to a decreased price level in an economic system (Rother, 2004).

From this, one should look at the budget deficit and- ipso facto- its influence on output growth as a signal to suggest whether the inflation inherent in an economy increases or decreases. If credible, the fiscus' actions (either contractionary or expansionary) then create expectations for the immediate future regarding the inflation rate (Rother, 2004)[1].

Regarding expectations explicitly then, one could reiterate that, underpinning the seminal Phillips Curve, was the notion that expectations on future inflation were formed by looking at previous levels of inflation. This, one could argue, was inconsistent in the event of inflation deviating from its past value due to anything other than inertia. As such, it was argued that expectations were formed in a more holistic manner, looking at information gleaned from the past *and* present. This rang especially true with increasingly more complex policy decisions undertaken globally (Sargent & Wallace, 1975).

It then became integral to use different types of Phillips relation, controlling for a plethora of variables, in order for a more robust inference on inflation and its expected course in the near future to be made. One could, to this end, allude to a reformulation of the Phillips Curve (which is now the general trend in the literature), mapping current inflation's relationship with inflation in previous time periods, shocks to the cost of import prices, the deviation of output from its trend value (see work done by Roberts (1995)) and changes in the labourer's share of production (Malikane & Mokoka, 2014), while including attempted decompositions of expected inflation, to name but a few augmentations to the standard Phillips relation.

These above-embellished Philips relation augmentations, however, look at inflation forecasting and expectations through one lens- the lens encompassing the real sector of the economy. These relations do not, however, take into consideration the role that financial variables have on the

[1] This theoretical notion is used to augment the Pindyck-Rubinfeld expectation decomposition in section 3.4.1 of the current paper

adequate forecasting of inflation, or the part that financial variables have to play in the formulation of expectations on inflation.

From the perspective of financial markets and the inclusion of their dynamics in Philips-Curve-type analysis then, it is argued that the public purchasing of treasury bills (or any other such financial asset) and any subsequent change of their purchasing habits regarding those assets should alter if inflation has altered their real return in some way (Fisher, 1930). From the perspective of Fama (1975), giving credence to Fisher's aforementioned revelation; "In a world of uncertainty where foresight is imperfect, the nominal rate of interest can be thought of as the equilibrium expected real return plus the market's assessment of the expected rate of inflation" (Fama, 1975, p. 269).

Furthermore, and, if in fact, the financial sector is at least as efficient, if not more efficient, in processing information than the real sector of the economy (as the efficient market hypothesis would have us believe), it stands to reason that inflation expectations can be modelled for using short term interest rate fluctuations in a more robust manner than if inflation were simply seen to be an isolated real sector phenomenon (Fama, 1975).

Considering this short term structure of the interest rate, one could argue for the inclusion of both shorter (and longer) term interest rates based off of various financial instruments (treasury bills, zero-coupon bonds, derivatives and so on) whose forecasting (and expectations-decomposition) capabilities may enhance that of the archetypal set up as outlined when simply using short term (3-month) yields (Ang, et al., 2007).

A natural progression to this term structure approach of modelling inflation is inclusion of the differential between the short and long term interest rates/yields of various financial instruments in order to gauge how this yield spread tended to fair when controlled for. To this end, controlling for short term rates, long term rates or the spread between the two (over varying time horizons) was found to dramatically increase forecasting precision in more evolved financial markets across different countries (Kozicki, 1997).

These methods using term structure for different financial assets, however, come under scrutiny when the financial system of a particular country is underdeveloped- it is argued that, in fact, with an underdeveloped financial system, these assets might not efficiently factor inflation into calculation in a holistic way. This lead to yet another augmentation of inflationary modelling based on commodity prices; in general, the commodities making up the consumer price index

-like agricultural products, oil prices and the like- are argued to trend in much the same way that the consumer price index does, making expectations based on these commodities quite robust in lieu of weakened financial market structure (Chen & Turnovsky, 2014).

Although encapsulating both real and financial sector analyses of inflation, the aforementioned approach found in the more general literature may not be rigorous enough to sate the applied econometrician whose aim is to make robust and accurate forecasts of the current inflation rate (or its expected value in the future). The above, some argue, falls prey to inaccuracy in the event of the omission of vital information- especially information regarding the impact that globalization has on macroeconomic variables in emerging market economies.

In this light, general literature seeks to mirror approaches of understanding domestic inflation through the use of inflation and output variability (using output gaps of the New-Keynesian type, predominantly) for both domestic and foreign countries (Ball, 2006). As such, both domestic and foreign output deviations from steady state and inflationary pressure alike need to act as explanatory variables in order to holistically curb the aforementioned problem of endogeneity (Ihrig, et al., 2010) (linked to the omission of important information, and its concomitant bias of estimation results (Gujarati & Porter, 2009)).

The problem with each of these additions posited in the literature is one of collinearity; although economic theory suggests the ability of foreign countries' policy to influence domestic countries' macroeconomic variables, the general literature finds large co-movement between measures of foreign output and foreign inflation alike, which further bias estimation if used simultaneously (Ihrig, et al., 2010). Furthermore, in estimating models with both foreign and domestic output, one runs the risk of large correlations between the two from the perspective of trade (Thirlwall, 1979), further biasing estimates.

Above and beyond these estimations, and even when using all possible observable data, comes the true omitted variable able to unhinge even most well-fit model- the estimation of the latent (unobservable) *De Jure* expected inflation variable.

The literature sees a plethora of attempts at mapping these expectations; most simply (and ubiquitously) of which are the use of trend-cycle decompositions (like the Hodrick-Prescott-HP- filter) or the use of survey-data on opinion about the expected inflation rate in an attempt to isolate expected inflation (Pearce, 1979). It is found, however, that expectations formed when using surveys tend to utilize only a portion of the information in the data set (going back only a few months or quarters, as opposed to looking at the entire time horizon of data), making them imperfectly rational in their formation (Pearce, 1979). Furthermore, with the use of the HP filter comes the creation of spurious cycles in data which may indeed have none- this allows the untrained or uninformed econometrician the ability to infer information from an HP filtered expected inflation variable where there is little truth (Hamilton, 2017).

In order to curb these problems, the economics literature and engineering literature alike have created two very distinct ways (amongst others) with which to extract expected inflation; the methodology posited by Pindyck and Rubinfeld (1998), and the work on state-space modelling adjusted from Kalman (1960).

From the economics literature, the Pindyck-Rubinfeld methodology attempts to decompose the error term of any regression (considering each error term has embedded in it the missing information from a regression, with this missing/unobservable information being expected inflation) so as to ascertain expected inflation in a usable manner (Malikane & Mokoka, 2012).

The aeronautical engineering literature, however, makes use of an algorithmic approach to understanding latent/unobservable variables such as expected inflation; information about current inflation is observed, and as time passes, this information is updated- the updating of this information creates variability able to be used in the formation of expected inflation (Kalman, 1960).

In lieu of the literature above-analysed, it is fitting to treat every equation below-mentioned with means to extract expected inflation accurately, so as to improve on and add to the current body of knowledge in a meaningful way.

3. Methodology: The Measurement of Inflation

As has been the general position in the literature, inflation can either be estimated using the variation in output from the perspective of aggregate demand and supply within the economy (the real sector of the economy, dealing with changes in output) or the variation in variables which influence the financial sector of the economy (bond yields, their spreads and so forth). The ensuing methodology attempts to first look at understanding a set of inflation-estimation methodologies dealing with the real sector, prior to looking at methods for measuring inflation underpinned by variation in financial-sector related variables. Thereafter, a position on the impact that globalization has on inflation (from a tentative synthesis between financial and real sector variables) is taken, prior to embellishing on the manner in which expected inflation will be estimated. This can be seen below and henceforth:

3.1. Real Sector Inflation Measurement

The archetype of modelling inflation, the Phillips relation, is a widely-accepted benchmark when forecasting. As such, one should follow a similar formulation to Phillips (1958), with some additional input from current macroeconomics in order to relay in the most robust manner the path followed by inflation over time. As such, one could augment this empirical framework from Phillips (1958) to look at how both output (not unemployment), and previous inflation influence current inflation as per Romer (2012), outlined in equation 1 below:

$$\pi_t = \theta_0 + \theta_1 \pi_{t-1} + \theta_2 \frac{(Y_t - Y_t^*)}{Y_t^*} + \theta_3 \pi_t^e + \varepsilon_t \qquad (1)$$

Importantly, π_t and π_{t-1} represent the current inflation rate (the growth rate of the Consumer Price Index) and the lagged inflation rate respectively. Y_t is the current level of output (Gross Domestic Product) and Y_t^* is the potential level of output in the same time period (Romer, 2012).

It is expected that the inertia from inflation in the previous time period should positively impact the inflation rate currently, making recent lags in inflation expectedly positively related to current inflation. Put differently, a high inflation rate in the previous quarter should feed into the current inflation rate through its general inertia, making the case for positivity in θ_1 (Romer, 2012).

Furthermore, considering this specification in equation 1 to encapsulate the demand side of the economy, one could argue for a positive relationship between the output gap ($\frac{(Y_t - Y_t^*)}{Y_t^*}$) and current inflation as well. Assuming output to be above its natural rate, the economy would experience an upswing in the business cycle coupled with an expected increase in aggregate demand. This bolsters inflation, allowing for an expectedly positive θ_2 (Romer, 2012).

What is perhaps a more novel augmentation to this model specification is the inclusion of expected inflation (π_t^e) as a regressor. It is expected that, if inflation is expectedly high in a future period, consumers will tend to behave in such a way so as to bid the price up now and fulfil those expectations at least to some degree. Put differently, if prices are going to be high in the next quarter, consumers would purchase and consume contemporaneously due to the lower price level, bidding up aggregate demand and increasing the price level, making inflation expectations some self-fulfilling prophecy if found to be significant (Fair, 2008). Thus, θ_3 is expected to be positive where significant.

Building from this base, one could account (at least minimally) for the supply side of the economy as suggested by Gordon (1997), seen in equation 2 overleaf:

$$\pi_t = \theta_0 + \theta_1\pi_{t-1} + \theta_2\frac{(Y_t - Y_t^*)}{Y_t^*} + \theta_3 z_t + \theta_4\pi_t^e + \varepsilon_t \tag{2}$$

Holding expectations on all previously expanded variables the same, the inclusion of z_t encapsulates movement in crude oil prices (crude oil inflation). Simply, from a theoretical perspective, there exists a direct link between aggregate supply and inflation, which is omitted in the event that only a variable such as the output gap is included in the study of inflation dynamics. This makes the case for the inclusion of aggregate supply drivers (like oil prices) in order to better specify analysis and curb endogeneity bias as best as possible (Gordon, 1997). One could argue that, considering an increase in the price of oil, one would expect an increase in the inflation rate (through more expensive production and decreased aggregate market supply, prices would tend to increase), making a case for positivity in θ_3 (Gordon, 1997).

Building from this simple base, it is of utmost importance to include more information in the analysis of inflation while attempting to maintain its parsimony. As such, what may be valuable to the literature is the formation of a similar inflation relation to equation 2 above where, instead of inflation inertia, one could look at a moving average of inflation as a new explanatory variable. This New-Keynesian trend in the literature was generally the first to create Microeconomic foundations for the expectations placed on inflation and has sated the critique suggesting this to be a problem with previously posited knowledge (see (Lucas, 1976). Much work has been done in this vein through works by Jordi Gali, Mark Gertler, Richard Clarida and other well-renowned economists between the 1990s and now. One such New-Keynesian thinker, Ray Fair (in (2008)), has posited equation 3 below as a means to holistically understand inflation dynamics:

$$\pi_t = \theta_0 + \theta_1\pi_{t,ma} + \theta_2\frac{(Y_t - Y_t^*)}{Y_t^*} + \theta_3 z_t + \theta_4\pi_t^e + \varepsilon_t \tag{3}$$

As seen above, $\pi_{t,ma}$ is the moving average of inflation. This moving average, aimed at incorporating a longer memory for inflation, is taken over four previous quarters and is of the form:

$\pi_{t,ma} = \frac{\pi_{t-1}+\pi_{t-2}+\pi_{t-3}+\pi_{t-4}}{4}$

It is thus expected that a longer memory of inflation and its average inertia is expected to positively relate to current inflation. On average, if the previous four quarters of inflation were high, each should contribute to the current level of inflation positively (Stock & Watson, 2008). Thus, θ_1 is expected to be positive where significant.

3.2. Financial Sector (Term Structure) Inflation Measurement

Previously, real sector methods forecasting inflation were posited from the literature. It is argued, however, that the real portion of the economy factors inflation expectations into its happenings in a more sluggish manner than the financial sector, assuming of course that financial markets tend to be efficient in the processing of news and market shocks (Fama, 1975). As such, it is of use to gauge, in particular, three financial-market-centric approaches to modelling inflation.

As such, one could suggest the first of these to be a fairly simple term-structure approach of understanding inflation, as posited by Fama (1981), seen in equation 4 below:

$$\pi_t = \gamma_0 + \gamma_1\pi_{t-1} + \gamma_2 i_t^{short\ term} + \gamma_3\pi_t^e + \varepsilon_t \qquad (4)$$

Equation 4 suggests that the current inflation rate is dependent on (above and beyond previous inflation rates and the expected rate of inflation as previously described), the level of the short term (3 month) yield on treasury bills($i_t^{short\ term}$). It is suggested in literature that a higher short term interest rate is conducive to more financial flows in the financial market (with higher interest rates yielding the ability to attract foreign capital) signalling the abovementioned positivity in γ_2. Considering the advent of inflation targeting (well after Fama (1981)) however, one could make the case for short term interest rates negatively associating with inflation as well; if short term interest rates increase, interest sensitive expenditures (which bolster aggregate demand) would decline, spurring on deflation through aggregate demand depression. At this, one could suggest the possibility of negativity in $\gamma_2$as well (Stock & Watson, 2008).

In a rudimentary sense, however, it may be argued that the long term (5 year) yield of a bond ($i_t^{long\ term}$) can act as a weighted average of a bond's short term yields. When subscribing to this term structure theory of financial instrument yields, including long term bond yields as opposed to their short term counterparts implies the inclusion of an extremely long memory of short term bond yields while obtaining a parsimonious model specification. This, coupled with the inclusion of inertial inflation, yields equation 5 as per Stock and Watson (2003) overleaf:

$$\pi_t = \gamma_0 + \gamma_1 \pi_{t-1} + \gamma_2 i_t^{long\ term} + \gamma_3 \pi_t^e + \varepsilon_t \tag{5}$$

In this instance, the long term interest rate is strictly assumed to positively relate to the current inflation rate as per the Fisher relation. It is argued that, although a central bank is able to influence short term bond yields; in the long term, there is a sense of monetary neutrality (short term interest rates return to their expected equilibrium due to the presence of foreign exchange and price effects on the real money supply (Blanchard & Johnson, 2014)). This suggests the long term rate to only change inflation through the channel of long term foreign direct investment, implying that strict positivity in γ_2 is a justified assertion. If, for instance, the long term yield were to increase, investment from foreign nations is expected to increase, bidding up economic activity both now and in the future, and pushing up inflation through this domestic expansion of economic activity (Stock & Watson, 2003).

This process, however, comes under scrutiny in that the true efficacy of the term structure of interest rates may be underutilized. Simply, it is argued that the use of the spread between short and long term interest rates produces a more robust ability to forecast inflation (as well as changes in output), considering this spread's ubiquity in the measurement and forecasting of recessionary pressure (Estrella & Trubin, 2006). As such, a methodology for measuring inflation can be suggested so as to include the yield spread, as adapted from Kozicki (1997), in equation 6 below:

$$\pi_t = \gamma_0 + \gamma_1 \pi_{t-1} + \gamma_2 spread_t + \gamma_3 \pi_t^e + \varepsilon_t \tag{6}$$

$spread_t$ in this instance denotes the difference between the long and short term bond yields in the particular time period. It is expected that- in times of economic prosperity- the difference between the long and short term yields be positive (considering the future to be more uncertain than the present, yields in the short term should be lower than longer term yields) (Estrella & Trubin, 2006). It is thus expected that, as the spread increases, so too should the inflation rate (through the demand side of the economy), implying expected positivity in γ_2 where significant (Kozicki, 1997).

There also exists a case for negativity in γ_2; if the long term bond yield were smaller than the short term bond yield (implying volatility to returns in the short term in excess of the volatility expected in the long term), the spread between the two would be negative. If there exists a negative spread between the two yields, one could argue for less confidence in investment (and in fact, general economic) outcomes in the short run, yielding decreased aggregate demand and transitively a decreased inflation rate in the short run (Estrella & Trubin, 2006).

3.3. A Novel Approach to Inflation Measurement: The Trade-Seigniorage Synthesis

Up to this point, one could suggest the minimal influence that international trade has on the specification of relations aimed at estimating the inflation rate- all measures of inflation tend to be mainly concerned with what influences the growth rate of the domestic economy along with expected and inertial inflation; emerging market economies, however, are all heavily influenced by what happens in the rest of the world. Emerging market economic growth (and *ipso facto* inflation) can, however, be derived from the growth of the major world economies (Thirlwall, 1979).

Furthermore, small open economies often use the printing of money (at least in a minimal way) to influence their foreign debt paths; this printing of money (Seigniorage) ensures a change in the short term interest rate inherent to the economy concomitant with a decrease in the debt payable to external economies, making the printing of money a factor which affects both real and financial determinants of inflation itself (Montiel, 2011).

One could, in this vein, propose a model aimed at understanding the dynamics of inflation encompassing the above theoretical considerations. This synthesis can be understood more clearly in equation 7 below:

$$\pi_{t,domestic} = \varphi_0 + \varphi_1\pi_{t-1,domestic} + \varphi_2 z_t + \varphi_3\pi_{t,foreign} + \varphi_4 gY_{t,foreign} + \varphi_5 e_t + \varphi_6 e_{t-1} + \varphi_7 e_{t-2} + \varphi_8 m_t + \varphi_9 \pi^e_{t,domestic} + \varepsilon_t \quad (7)$$

Where the domestic inflation rate ($\pi_{t,domestic}$) is dependent on its one-quarter past value ($\pi_{t-1,domestic}$), oil price inflation (z_t) and expected inflation ($\pi^e_{t,domestic}$) as previously embellished upon, above and beyond a foreign inflation aggregate most able to permeate into the inflation rate of the emerging economy framework ($\pi_{t,foreign}$), foreign output growth ($gY_{t,foreign}$)[2], exchange rate growth (e_t) in both its contemporaneous and lagged forms, and growth in narrow money (m_t).

[2] From a methodological standpoint, in order to curb any possible multicollinearity between foreign income growth and foreign inflation (which would risk biased estimation (Gujarati & Porter, 2009)), foreign income growth is calculated as a

Importantly, placing this formulation in the literature, one could argue for its vast difference from already-posited panel and time series regressions. Instead of using foreign output gaps or foreign inflation rates- which are highly correlated to those foreign output gaps as per the current literature (see works done by Ball (2006) or Ihrig, et al. (2010)) - the above-posited Trade-Seigniorage approach makes use of non-collinear measures of foreign income growth and inflation[3]. These, in tandem, act as an extremely reliable proxy for domestic (emerging market) income growth, yielding the ability to omit actual domestic output gaps (which themselves fall prey to inaccuracies when using the HP filter) (Thirlwall, 1979).

This acts, above and beyond the obvious inclusion of various innovations in the form of the exchange rate growth, narrow money growth and inflationary expectations, as a testament to the Trade-Seigniorage model's novelty across the literature, which both deepens the already-known and expands the frontier into the unknown alike.

If, for instance, inflation in a large foreign open economy were to increase, one would expect aggregate demand for domestically produced goods to be higher (due to the price differential between nations) which therefore bolsters the price level of those domestic goods and accordingly, the inflation rate domestically as well (suggesting $\varphi_3$to be positive) (Ihrig, et al., 2010).

In the grand scheme of things, this could also signal a "global-Phillips-relation" to hold, where an increase in world inflation correlates to economic growth from the demand side of the world economy, and thus an increased ability to purchase from emerging markets. This is in line with the notion that economic spillovers from developed open economies tend to influence the economic activity of smaller open economies, furthering the case for positivity in φ_3.

In much the same vein, an increase in foreign income simply tends to increase the amount of domestic goods demanded, therefore sustaining an increased growth rate in domestic prices as well through an increase in aggregate demand (suggesting $\varphi_4$to be positive) (Thirlwall, 1979).

Furthermore, regarding φ_5, φ_6 and φ_7, one could make an argument for positivity and negativity when significant over differing periods of time. For instance, one could look at a

cumulative growth rate (taking the growth rate of the summation of American, British and German GDP), while foreign inflation is an average inflation rate across those countries (summing American, British and German CPI, obtaining the average over the three countries and then taking the growth rate of that average CPI).

[3] Whose cross-correlation sits at approximately 5 percent, juxtaposed to the general literature's 50-percent-and-above correlation when using both foreign inflation and foreign output gaps/growth concurrently.

depreciation of the currency as being positive growth of the exchange rate (positive growth in the exchange rate implies an increase in the price of purchasing one unit of foreign currency). As such, to some extent, this depreciation would enhance trade (with exports being relatively cheaper to foreign parties and imports being relatively more expensive to domestic parties) and bid up the inflation rate inherent to the domestic economy through an increase in aggregate domestic demand (Alexander, 1952).

This, however, does not account for the fact that contracts on exports and imports are generally finalized with a particular exchange rate in mind- a depreciation of the domestic currency would yield lower real returns for exporters and higher real returns for importers who have fixed an exchange rate through the use of a forward or futures contract, implying an initial worsening of the trade balance and a drop in the general price level inherent to the economy. This implies some lag structures to be negatively related to inflation due to contractual obligation as well (Appleyard, et al., 2008), and can be understood as the J-Curve phenomenon.

Ultimately looking at φ_8, one could suggest a positive relation between increases in the growth rate of high powered money and the inflation rate. It is suggested that, with an increase in high powered money, short term nominal interest rates tend to decrease (as previously suggested), spurring on demand and increasing the price level through the interest-sensitive expenditure mechanism (Blanchard & Johnson, 2014).

Moreover, one could argue that an increase in Seigniorage tends to lend itself- at least in part- to the running down of a government's debt; this signals an increased general level of wealth in the economy and with it, expectations that pressures on debt will be alleviated, suggesting an increase in economic activity (Montiel, 2011). It is argued that, when fiscal policy surrounding the servicing of debt is not conducted with the aid of monetary policy, the likelihood of increased inflation is limited (Buiter, 1985)- as such; it is of import to assess the significance of the growth rate in narrow money as a proxy for the decrease in a central bank's (in)dependence from the fiscus as well. If the growth rate of narrow money is found to be statistically significant in the inflation formation process, one could argue that the central bank in question is somewhat less independent in servicing state debt.

3.4. **Inflation Expectations**

Up to this point, the methodology laid out has made an attempt to find the most robust model able to assess inflation in the most holistic way from both the real and financial sector perspectives. These formulations, however, only glance over a methodology for extracting inflation expectations.

To this end, it is important to suggest an empirically robust methodology aimed at measuring the otherwise latent set of inflation expectations. One could extract this π_t^e from each equation in one of two ways:

3.4.1. <u>Pindyck and Rubinfield (1998)</u>

Considering the residual in each model specification to include inflation expectations, one should look at each equation's error component as:

$$\varepsilon_t = \pi_t^e + \nu_t \tag{a}$$

Where the error/residual term (ε_t) is made up of both a measurable component (π_t^e) and an innovation (ν_t) which is assumedly white noise. One could apply this to any general specification of inflation measurement:

$$\pi_t = \sum_{i=1}^{n} \theta_i \pi_{t-i} + \sum_{i=0}^{n} \delta_i X_{t-i} + \varepsilon_t \tag{b}$$

The above specification suggests that a general process determining the dynamics of inflation is one which has both an autoregressive (π_{t-i}) and a controllable (X_{t-i}) component (which is a vector of all controls in each respective equation laid out in the above methodology), coupled with an error component which is governed by equation (a). Importantly, considering the construction of each model, the use of *mostly* (save for the exchange rate variable in equation 7) contemporaneous controls and single autoregressive components suggests that, in essence, each control equation found in the above-embellished methodology (sections 3.1, 3.2 and 3.3) should explicitly be of the form:

$$\pi_t = \theta_0 + \theta_1 \pi_{t-1} + \delta_0 X_t + \varepsilon_t \tag{c}$$

From this, one could estimate the residual $(\widehat{\varepsilon_t})$as:

$$\pi_t - \theta_0 - \theta_1 \pi_{t-1} - \delta_0 X_t = \widehat{\varepsilon_t} \tag{d}$$

According to Malikane and Mokoka (2012) then: "… Inflation expectations contained in $\widehat{\varepsilon_t}$ respond to changes in the short term nominal interest rate. Note that the disturbance term

ν_t does not respond to changes in this nominal interest rate. The reason for this is that $E_t(\pi_t^e \nu_t) = 0$" (Malikane & Mokoka, 2012, pp. 2-3). Thus, one could set up a proxy for inflation expectations through the use of a simple OLS equation as outlined below:

$$\widehat{\varepsilon_t} = \sum_{i=1}^{a} \eta_i \, \widehat{\varepsilon_{t-\iota}} + \sum_{i=1}^{b} \kappa_i \, \Delta i_{t-i}^{short\ term} + \sum_{i=1}^{c} \lambda_i \, X_{t-i} + \epsilon_t, \qquad \text{(e)}[4]$$

Where, above and beyond autoregressive residual terms $(\widehat{\varepsilon_{t-\iota}})$ and control variables (X_{t-i}) found in each equation as per the previously outlined methodology, the ability of the contemporaneous residual $(\widehat{\varepsilon_t})$ to act as a proxy for de jure inflation expectations hinges upon the statistical significance of the difference–stationary short term interest rate and lags thereof (Δi_{t-i}). If significant, this differenced interest rate acts as a signal that the reserve bank is credible in its policy creation- the error term (and ipso facto, inflation expectations) react to changes in the short term interest rate (Pindyck & Rubinfeld, 1998).

With this all in mind, it is important to understand that- in estimation- two problems reveal themselves. The first is that, by construction, all $\widehat{\varepsilon_{t-1}}$ will be correlated to all missing factors in the same time period $(t-1)$, making the use of all controls and interest rate differences where $i = 1$ a potential bias to the system. As such, one could curb this problem by simply extending the lag structure of each control to $i = 2$ and beyond. This current paper uses a simple Autoregressive Distributed Lag Model of the above error measurement equation of the form:

$$\widehat{\varepsilon_t} = \eta_0 + \eta_1 \widehat{\varepsilon_{t-1}} + \sum_{i=2}^{4} \kappa_i \Delta i_{t-i} + \sum_{i=2}^{4} \lambda_i X_{t-i} + \epsilon_t, \qquad \text{(f)}[5]$$

In this way, forecasting this error from the above specification yields a good proxy for inflation expectations which can be used in each original equation[6] as an expectations variable, as per the suggestion of Pindyck and Rubinfeld (1998):

$$\pi_t = \beta_0 + \beta_1 \pi_{t-1} + \beta_2 X_t + \beta_3 \widehat{\varepsilon_t} + \upsilon_t \qquad \text{(g)}$$

[4] Lag length is chosen based on Akaike and Schwartz-Bayesian information criteria, as is done in general practice (see Gujarati & Porter, 2009). The lag length chosen for each instrument is also an attempt to realize parsimony in the instrument variable's specification

[5] Selected coefficients for the differenced interest rate and GDP growth rate from equation f above are analysed in Appendix 1.

[6] Considering equation 3, the moving average of inflation has four prior values of inflation in its construction; as such, in order to curb possible simultaneity between $\widehat{\varepsilon_t}$ and X_{t-i}, 4-6 lags are taken for the moving average of inflation rather than 2-4. In the case of the exchange rate growth as per equation 7, only lags 3 and 4 are included in estimation of equation (f) above.

β_3 can then be interpreted as the role that inflation expectations play on the current inflation rate (Pindyck & Rubinfeld, 1998).

A second problem when attempting to undertake the analysis from Pindyck and Rubinfeld's 1998 perspective comes when attempting to measure expectations given term structure models of inflation- considering them to contain short term interest rates, one may argue that the use of interest rates in the instrument equation (equation f) could lead to simultaneity and bias in the measurement of the proxy for inflation expectations. One could then augment equation (f) to include the growth rate of GDP (gY_{t-i}) rather than the differenced interest rate- if GDP grows, inflationary pressure is expected from the demand side of the economy; due to increases in GDP through various channels (investment and consumption as well as fiscal policy importantly), one could argue for an adequate proxy of inflation expectations coming in the form of the inclusion of output growth. Interestingly enough, this novel augmentation posited by this current paper also allows a theoretical probe (albeit simplistically) into the credibility of fiscal policy and its ability to foster economic growth (Rother, 2004).

Perhaps, a more pressing theoretical problem when using the Pindyck-Rubinfeld framework is one of rationality, though. Considering each instrument to only contain twice-lagged variables (as well as deeper lags), one may argue that not all data in the time horizon is used, making the expectations decomposed therefrom only partially rational. As such, one could utilize a methodology posited by Kalman (1960), outlined below, in order to curb this "imperfect rationality" in the formulation of expectations on inflation.

3.4.2. Kalman (1960)

A possible limitation regarding the proposed method as outlined in Pindyck and Rubinfeld (1998) is the risk that the true *rational* expectations for inflation are not the only latent factor pulled from the error term- especially if changes in the interest rate or the growth rate of output are statistically insignificant in the formulation of the instrument equation.

As such, one could take inspiration from the aeronautical engineering literature as an attempt to model for factors only updated periodically (in this instance, inflation being updated in quarters). To this end, one could posit the adaptation of the Kalman filter and Kalman smoother from the 1960s as a means with which to extract unobservable information given the information at one's disposal.

In this instance, it is important to note the measures above to model inflation based on what is explicitly known (using previous inflation, interest rates, exchange rates and the like). Thus, the equations 1-7 above can be grouped as the deterministic component of the system which adaptations on the Kalman methodology propose. One could then model the latent factor (inflation expectations) as a parsimonious autoregressive process while accounting for all other factors affecting inflation in the aforementioned deterministic component of the analysis.

More formally, one could posit a general measurement equation encapsulating inflation from autoregressive and deterministic (known) components below:

$$\pi_t = \sum_{i=1}^{n} \theta_i \pi_{t-i} + \sum_{i=0}^{n} \delta_i X_{t-i} + \varepsilon_t \tag{h}$$

While simultaneously modelling the state (unknown) variable- inflation expectations- in an autoregressive manner below:

$$\pi_t^e = \Omega_1 \pi_{t-1}^e + \varepsilon_t \tag{g}$$ [7]

In this way, through the process outlined by Kalman (1960), one can enter into a process of observing data in a time period, modelling inflation expectations within that time period, observing new data over time, updating the modelling of these expectations and iterating the process such that one could measure the equation of interest below:

$$\pi_t = \sum_{i=1}^{n} \theta_i \pi_{t-i} + \sum_{i=0}^{n} \delta_i X_{t-i} + \alpha_1 \pi_t^e + \varepsilon_t \tag{i}$$

Where α_1 acts as the responsiveness of actual inflation to expected inflation (using all possible information from the data moving forward and backward through the time horizon); this expected inflation, one could argue, is then truly rational in its formation due to the continuous updating process throughout the time series. In this way, the use of all possible data seems to be more robust in practice (when measuring latent factors) against even structural changes to the economy (regime changes, recessions and the like), making it arguably one of the most important tools in the social sciences (of which, many factors under scrutiny are simply unobservable) (Canova, 2007).

Importantly, as is general practice, constraints should be placed on each data generating process so as to allow for optimal initialization of the Kalman algorithm and estimation of inflation expectations (the latent factor), while simultaneously allowing the system to converge (with

[7] Appendix 2 in the current paper deals with the estimation of equation (g) and its analysis

the arguable black-box of the Kalman filter process coming from maximum likelihood estimation and the constrained optimization thereof) (Durbin & Koopman, 2001).

Considering this, the initial constraint (and, in fact the sole constraint on most models) is that previous inflation expectations factor into current inflation expectations positively; put differently, Ω_1 in equation (h) above is constrained to be greater than 0. This, more than an argument based on theory, is an argument based on logic. If one is to accept that expectations are at least relatively rational in their formulation, one could agree that- conservatively- an economic agent's expectations should not change by a drastic amount over time, lest economic fluctuations surrounding expectations be extreme (which is generally not the case). Instead, expectations should form with positive inertia from previously formed expectations (Melnick, 2016).

Another constraint to be imposed deals directly with equation 3 in the methodology; due to the deepening of the lag structure when using moving averages, one could argue that dynamic convergence of the system may be more difficult to attain. As such, in the cases of both Korea and South Africa, the moving average components' elasticity with respect to the inflation rate are constrained to 0.75 and 0.5 respectively. This is in line with conservative estimates of each model using the Pindyck-Rubinfeld methodology (which is embellished upon in the analysis section of the current paper). In this way, convergence of the iterative Kalman process is guaranteed with all other elasticities in the model matching their Pindyck-Rubinfeld counterparts to a large degree.

A penultimate constraint imposed on the system is the constraint on the Mexican short term interest rate; although unconstrained in all other cases, it is theoretically within reason to assume that a change in the short term interest rate has no contemporaneous impact on the inflation rate, but rather an impact on the inflation rate after 2 to 6 quarters of being altered (Blanchard & Johnson, 2014). As such, the coefficient on the short term Mexican interest rate is set to 0 in order to aid in the convergence of the Kalman algorithm.

Regarding the final constraint, one could turn attention to the Trade-Seigniorage approach posited by the current paper; in the case of Korea, constraints are placed on current inflation's elasticity with respect to previous inflation (at 0.750 percent) and contemporaneous oil price inflation (set at 0.000 percent). The former restriction is imposed in line with conservative Pindyck-Rubinfeld estimations of the impact that previous inflation has on current inflation, while the imposition of the restriction regarding crude oil inflation is one mirrored by its general insignificance in each Korean estimation across the current paper (as will be seen).

As such, it is important to realise that each restriction and constraint pulls the researcher away from the absolute truth regarding the data and general relations between variables; nevertheless, each restriction is imposed in order to obtain a part of *the truth* regarding inflation and its formulation.

4. Empirically Analysing Inflation Measurement Techniques

Prior to the estimation of each model, it is apt to point out some stylized facts about the transformation of all data and the use of each particular country within the study.

Initially, when looking at the particular countries of interest (Israel, Mexico, South Africa and South Korea), one could argue that there exists a relatively well-formed financial sector within each country. This, coupled with relatively well reported data in both the financial and real sectors makes for a compelling inclusion of each country. What is, perhaps, most important though, is their relative emerging market status- due to prior periods of socioeconomic unrest coupled with each country's penchant to be affected by foreign policy, there is a case to be made for the above-posited trade-seigniorage synthesis, emphasising the plausibility of larger country's policy changes to influence emerging market macroeconomies through spillovers across borders.

Looking at the data itself, all information is extracted from either data.oecd.org or fred.stlouisfed.org, with data being observed in a quarterly manner from between quarter four of 1995 and quarter four of 2015. Although a relatively long time series, one should be cognizant of the fact that the number of observations may limit the generalizability of commentary in this paper to other emerging markets.

With regards to the transformation of the data extracted from the abovementioned databases, this paper employs similar techniques as are involved in general macroeconometric practice. Explicitly, inflation is created as the difference between the naturally logged levels of contemporaneous and four-quarter-lagged consumer price index, while exchange rate growth is created in a synonymous way (taking the natural log of the direct exchange rate relative to the US dollar contemporaneously, and subtracting from that its four-quarter-lagged counterpart). Considering oil price inflation, the natural-logged difference between current and four-quarter lagged crude oil prices is taken. Penultimately, output (measured using seasonally adjusted Gross Domestic Product) is used in its level form, with its trend value being measured through the use of the ubiquitous Hodrick-Prescott filter. Finally, the term spread is created as the difference between long term (5 year) and short term (3 month) bond yields.

Bearing this all in mind, one could now start by analysing the ever-present Phillips relation found in Romer (2012), as per table 1a and 1b below:

Table 1a- Romer (2012), Equation 1 (Pindyck and Rubinfeld)

	Israel	Korea	Mexico	South Africa
Constant	0.012***	0.001	0.002	0.008***
	(0.000)	(0.876)	(0.121)	(0.000)
Inflation Lagged	0.332***	0.956***	0.930***	0.841***
	(0.009)	(0.000)	(0.000)	(0.000)
Output Gap	0.170**	0.248***	-0.014	0.458***
	(0.018)	(0.000)	(0.636)	(0.000)
Expected Inflation	0.723***	-0.019	1.026***	1.005***
	(0.000)	(0.913)	(0.000)	(0.000)
R Squared	0.820	0.837	0.967	0.912
F Statistic	92.784	88.892	527.575	239.234
Durbin Watson Statistic	1.318	1.874	1.863	2.075

Significant at 1%***, 5%** and 10%, p-values in parentheses

Table 1b- Romer (2012), Equation 1 (Kalman)

	Israel	Korea	Mexico	South Africa
Constant	0.008**	0.003	0.003	0.015***
	(0.011)	(0.337)	(0.203)	(0.000)
Inflation Lagged	0.627***	0.866***	0.920***	0.718***
	(0.000)	(0.000)	(0.000)	(0.000)
Output Gap	0.023	0.197**	-0.007	0.463**
	(0.865)	(0.015)	(0.907)	(0.028)
Expected Inflation	0.609***	0.895***	-1.077	1.041***
	(0.000)	(0.000)	(0.999)	(0.000)
R Squared	0.761	0.797	0.958	0.872

Significant at 1%***, 5%** and 10%*, p-values in parentheses

Starting first with goodness of fit, one could suggest that the R Squared values in table 1a range from 0.82 to 0.97 suggesting that between 82 to 97 percent of all variation inflation is explained by the simplistic model specification set out by Romer (2012), when accounting for inflation expectations ala Pindyck-Rubinfeld. Looking at South Africa in particular, approximately 91 percent of the variation in inflation is explained by changes in previous and expected inflation as well as the output gap.

Looking at table 1b in juxtaposition, R squared values range from 0.76 to 0.96, suggesting that- on average- between 76 and 96 percent of the variation of inflation is explained by variation in the model specification itself. In this way, one could tentatively point to the fact that the average goodness of fit is lower (albeit marginally) when using the Kalman filter.

Scrutinizing the F-statistic (noting the inability to extract either an F-statistic or Durbin Watson statistic when modelling in the state-space framework), one could argue that each statistic greatly exceeds the rule-of-thumb 10, signalling each model to be robust when holistically looked at; each model has robust explanatory power in this regard and all coefficients are jointly significant in explaining inflation. Ultimately, focusing at the Durbin-Watson statistics across the board, one could argue that- only in the instance of Israel- a statistic further away from 2 is indicative of positive autocorrelation, with all other statistics for South Africa, Korea and Mexico tending closely to 2 (Gujarati & Porter, 2009).

This autocorrelation, although commonly overlooked in the greater literature, tentatively suggests some possible bias in the size of the estimated slope coefficients or their direction of relation (positive or negative) to current inflation (Gujarati & Porter, 2009). As will be seen shortly, however, most coefficients throughout the paper tend to be of the correct size and sign, suggesting the influence of this serial correlation between errors over time to be minimal.

Treating the constant now (as will be the only treatment of the constant throughout the paper, although the same logic will apply henceforth); one could argue that, when there is no inflation inertia or zero-expected inflation, and when the business cycle is at steady state (when actual and trend output are the same), the constant acts as the level of inflation in the system. In the case of South Africa, for instance, considering an expected inflation rate of zero percent, inflation in the previous quarter as being zero percent and a steady state in the business cycle, inflation would then be between 0.008 and 0.015 percent in the system (across the two methodologies).

Paying attention to each slope coefficient then, it is argued that- using both estimation techniques- inflation inertia positively influences current inflation in an extremely significant manner across every country (at the 1 percent level) - this is in accordance to a priori expectations (Romer, 2012). From table 1a, a percentage increase in one-quarter-previous inflation from the Korean perspective correlates to a 0.96 percent increase in current inflation. From table 1b, a percentage increase in previous inflation associates to a more subdued 0.87 percent increase in current inflation.

With the output gap in mind, one could argue that demand pressure (an increase in output above its steady state value) relates positively to current inflation where statistically significant across the two tables. This reaction is statistically significant at between the 1 and 5 percent levels. Interestingly, an Israeli increase in the output gap by 1 percent (which would correlate to a 0.17 percent increase in current inflation as per table 1a) is not a statistically significant reaction when using the Kalman filter. Importantly, though, it appears that the output gap- instead of being negatively related to inflation as has been perversely recorded in many studies (for instance, as per Du Plessis & Burger, (2006) in the South African case)- relates positively to inflation, as *a priori* expected. This trend continues throughout the current paper.

Perhaps, most importantly though, is the relationship between current inflation and variation in expected inflation. In the Pindyck-Rubinfeld sense, most (save for Korean) expected inflation increases current inflation in an extremely significant manner. An expected increase in inflation by 1 percent correlates to an increased current Mexican inflation rate by roughly 1.03 percent. This gives rise to evidence of the aforementioned self-fulfilling prophecies (with expected rises in price comes economic activity- an increase in demand- which ends up boosting process now, fulfilling these expectations) (Fair, 2008).

This reaction is paralleled in the Kalman filter sense, with all countries (excluding Mexico) yielding extremely significant partial slope coefficients given a rise in inflation expectations- in the Korean case, an increase in expected inflation by 1 percent relates to an increase in current inflation by approximately 0.895 percent.

Considering the case of Mexico, it appears that expectations surrounding inflation react more in line with reality in the Pindyck-Rubinfeld sense (see Ramos-Francia & Torres, (2008)), while from the perspective of Korea, it appears that expected inflation reacts closely (although, with a larger coefficient) to studies already conducted when using the Kalman filter (see Zhang, et al., (2009)).

In lieu of the above, it is prudent to represent tables 2a and 2b with the addition of crude oil price shocks, marking the analysis of Gordon (1997) overleaf:

Table 2a- Gordon (1997), Equation 2 (Pindyck and Rubinfeld)

	Israel	Korea	Mexico	South Africa
Constant	0.014***	0.002	0.004***	0.008***

	(0.000)	(0.479)	(0.003)	(0.002)
Inflation Lagged	0.220*	0.876***	0.905***	0.851***
	(0.063)	(0.000)	(0.000)	(0.000)
Output Gap	0.184***	0.194**	0.010	0.468***
	(0.003)	(0.012)	(0.789)	(0.000)
Oil Price Inflation	0.009***	0.004	-0.002	0.002
	(0.001)	(0.122)	(0.426)	(0.449)
Expected Inflation	0.831***	0.064	0.929***	1.007***
	(0.000)	(0.713)	(0.000)	(0.000)
R Squared	0.865	0.848	0.965	0.926
F Statistic	95.759	71.291	389.971	211.502
Durbin Watson Statistic	1.556	1.912	1.784	2.030

Significant at 1%***, 5%** and 10%*, p-value in parentheses

Table 2b- Gordon (1997), Equation 2 (Kalman)

	Israel	Korea	Mexico	South Africa
Constant	0.008**	0.003	0.004	0.017***
	(0.027)	(0.193)	(0.154)	(0.000)
Inflation Lagged	0.605***	0.870***	0.918***	0.690***
	(0.000)	(0.000)	(0.000)	(0.000)
Output Gap	0.002	0.147*	0.048	0.439**
	(0.988)	(0.097)	(0.427)	(0.019)
Oil Price Inflation	0.005	0.004	0.005	0.003
	(0.276)	(0.129)	(0.260)	(0.654)
Expected Inflation	0.442***	0.029***	0.927***	0.097***
	(0.000)	(0.000)	(0.002)	(0.000)
R Squared	0.764	0.806	0.959	0.870

Significant at 1%***, 5%** and 10%*, p-value in parentheses

With respect to tables 2a and 2b- the variation in inflation explained by the model inclusive of crude oil inflation stands at between 85 and 97 percent with respect to the Pindyck-Rubinfeld methodology, and between 76 and 96 percent when using the Kalman filter. All F-statistics (when available) exceed 10, suggesting robust explanatory power across the board for each model. Importantly, in most cases (save for Israel), the inclusion of crude oil inflation decreases the average F-statistic across the board, making the incremental contribution to statistical power of crude oil inflation relatively low. Looking finally at the Durbin-Watson statistic, one could argue that each statistic across each country tends more closely to 2, suggesting the circumvention of potential positive autocorrelation (which was a potential risk in the Israeli estimation of equation 1a).

In all instances, as a priori expected, an increase in previous-quarter inflation correlates to increased current inflation- this reaction, throughout tables 2a and 2b, is highly significant at the 1 percent level (save Israel, whose reaction is only significant at the 10 percent level and extremely subdued). Looking at South Africa, a unit increase in one-quarter lagged inflation correlates to a 0.85 percent increase in current inflation using the Pindyck-Rubinfeld methodology or a 0.69 percent increase in current inflation using the Kalman filter.

In similar fashion to the analysis from equation 1, the output gap experiences mixed significance (at between 1 and 10 percent across the board) for both the Pindyck-Rubinfeld and Kalman methodology alike while maintaining expected positivity where significant. Looking at Korea, a unitary increase in the output gap could correlate to between a 0.147 or a 0.194 percentage increase in inflation, from Kalman and Pindyck-Rubinfeld perspectives respectively.

Additionally, one could argue that the introduction of crude oil inflation is- on average- a relatively poor one. In only one instance is crude oil inflation statistically significant; a unitary increase in the rise in crude oil prices yields a 0.009 percent increase in current inflation which is significant at the 1 percent level for Israel (Gordon, 1997). Importantly, this crude oil price is left in dollars. Thus, where significant in other analyses, it may be due to movement in the exchange rate (when converting the dollar crude oil price to domestic currency prices) rather than movements in the actual price of crude oil in dollars. This is accounted for in the Trade-Seignorage approach by including both exchange rate growth and crude oil inflation alike.

Finally, as before, looking at inflation expectations- one could argue that their introduction is highly significant almost wholly across the board (with positive feedback into current inflation maintained as previously expected). Interestingly, although insignificant when outlined in the Pindyck-Rubinfeld manner, expectations play a very minor (yet highly significant) role in increasing Korean inflation- an expected inflationary increase of one percent in the next quarter relates to a 0.03 percent increase in inflation currently. This does not adequately mirror the influence that expected inflation has on current inflation in other studies (Zhang, et al., 2009), suggesting the need for a more robust model formulation.

The same can be said in the South African case when looking at the Kalman filter's results- although significant, the coefficient on South African expectations is underwhelming in comparison to already-established studies (see Malikane & Mokoka, (2012) or Du Plessis & Burger, (2006)). All other coefficients across the board, encouragingly, appear to relate closely to previously estimated results. Integrally, the above-embellished estimations have not taken into account a longer memory that inflation may have in influencing current inflation. Thus, tables 3a and 3b- looking at four-quarter moving average inflation- from Fair's (2008) work can be seen below:

Table 3a- Fair (2008), Equation 3 (Pindyck and Rubinfeld)

	Israel	Korea	Mexico	South Africa
Constant	0.011***	0.002	0.014***	0.023***
	(0.000)	(0.355)	(0.000)	(0.000)
Moving Average Inflation	0.320***	0.871***	0.654***	0.563***
	(0.000)	(0.000)	(0.000)	(0.000)
Output Gap	-0.028	0.289***	-0.067**	0.942***
	(0.686)	(0.000)	(0.047)	(0.000)
Oil Price Inflation	0.014***	0.002	0.002	-0.003
	(0.000)	(0.259)	(0.493)	(0.355)
Expected Inflation	1.044***	1.007***	1.001***	1.023***
	(0.000)	(0.000)	(0.000)	(0.000)
R Squared	0.820	0.909	0.825	0.902
F Statistic	61.522	112.248	60.038	142.386
Durbin Watson Statistic	1.324	2.023	1.784	1.414

Significant at 1%***, 5%** and 10%*, p-value in parentheses

Table 3b- Fair (2008), Equation 3 (Kalman)

	Israel	Korea	Mexico	South Africa
Constant	0.020**	0.005**	0.011	0.027***
	(0.039)	(0.020)	(0.101)	(0.000)
Moving Average Inflation	0.079	0.750	0.712***	0.5
	(0.639)	(-)	(0.000)	(-)
Output Gap	-0.122	0.207**	-0.098	0.719**
	(0.478)	(0.033)	(0.364)	(0.029)
Oil Price Inflation	0.009	-0.001	0.001	-0.005
	(0.106)	(0.781)	(0.904)	(0.477)
Expected Inflation	0.574***	1.040***	0.340***	0.561***
	(0.000)	(0.000)	(0.000)	(0.000)
R Squared	0.680	0.764	0.906	0.756

Significant at 1%***, 5%** and 10%*, p-value in parentheses

Initially, when using the moving average of inflation as an explanatory variable, one could comment on conventionally prescribed facts as before; considering the goodness of fit, the amount of variation in inflation explained by each explanatory variable ranges from between

82 and 91 percent in the Pindyck-Rubinfeld manner or between 68 and 91 percent in the Kalman sense across the four emerging markets. In all instances where applicable, each F-statistic, although above 10 (indicative of good explanatory power of each model across countries), has decreased substantially in comparison to specifications from equations 1 and 2. Importantly, most Durbin-Watson statistics have worsened, indicating possible positive autocorrelation for Israeli and South African regressions in particular.

In all instances, the moving average of inflation across four quarters is positively related to current inflation and extremely significant (at the 1 percent level across the board) when using the Pindyck-Rubinfeld method for extracting inflation expectations (looking at South Africa, a moving average increase by 1 percent should yield a 0.56 percent increase in current inflation). Due to the constraints imposed on the moving average component in both South Africa and Korea however (as have been embellished upon in section 3.4.2 of the current paper), one can neither prove nor disprove their significance in the dynamics of current inflation, nor ascertain their respective elasticities save for the analysis underpinning Mexico. In that instance, a percentage increase in the moving average of inflation yields an extremely significant increase in current inflation of roughly 0.71 percent.

Furthermore, although the output gap is statistically significant in both the Pindyck-Rubinfeld and Kalman iterations of equation 3 and positively related to inflation for Korea and South Africa, what is perhaps perverse is the negative, yet statistically significant relationship between the output gap and the inflation rate in the Mexican analysis found within table 3a. In this schema, an increase in the output gap by 1 percent (a boom in the business cycle of that magnitude) yields a decrease in current inflation by approximately 0.07 percent.

Importantly, it appears that serial correlation does not play a part in the perversion of the relationship between the output gap and current inflation in the Mexican sense (as the Durbin-Watson statistic closely relates to 2); thus, other reasons regarding this negative relationship should be looked at simplistically. At this, it is possible to point to a particular problem regarding the use of the HP filter; one could suggest that the use of the HP filter may extract spurious cycles from data where there may be none (and with that, bias in estimation of coefficients which deeply rely on the HP filter as a means to extract trend data) (Hamilton, 2017). Furthermore, in practice, some estimations of the Mexican Phillips curve sees a significant and negative elasticity of the inflation rate with respect to the output gap; especially when estimation includes a deeper lag structure of inflation, which the moving average consists of (Ramos-Francia & Torres, 2008) Thus, this perversion in the estimated output gap slope coefficient is not without prior experience.

Furthermore, expected inflation reacts as *a priori* expected- a unitary increase in expected inflation correlates to an increase in current inflation by approximately 1 percent across the board using the Pindyck-Rubinfeld methodology. That same unitary increase in expected inflation yields a more subdued increase in current inflation of between 0.34 and 1 percent using the Kalman filter with every reaction being significant at the 1 percent level.

What is perhaps an obvious, albeit necessary flaw to point out though when using the moving average of inflation is the need for restrictions in order to obtain convergence with the use of the Kalman filter. Without the use of restrictions to the coefficient underpinning the moving average component of inflation, results for the Kalman filter would be extremely different (or, the system itself may not converge) (Durbin & Koopman, 2001). Thus, when using a moving average for inflation, a researcher should be cognizant of these inherent problems to the methodology and should attempt to choose these restrictions based on alternative estimates done when attempting to extract expectations in a different manner.

Importantly, it appears as though both Korean and South African slope coefficients tend to map what has already been done in this area quite closely (see Zhang, et al., (2009) or Malikane & Mokoka (2012) once more), although the South African coefficient regarding expected inflation is perhaps a slightly more subdued version of reality than has been posited before. This gives, at least, some credence to the constraints imposed.

Nevertheless, with this estimation, and all aforementioned estimations of the inflation rate in mind, one could suggest that the manner in which the real sector and changes in market prices interplay has been understood for the time being. Instead of this, one could outline the measurement of inflation from the financial sector perspective. The natural starting point from this analysis is the archetypal financial sector model adapted from Fama (1981) in tables 4a and 4b:

Table 4a- Fama (1981), Equation 4 (Pindyck and Rubinfeld)

	Israel	Korea	Mexico	South Africa
Constant	0.008***	-0.003	0.002*	0.010***
	(0.002)	(0.186)	(0.084)	(0.000)
Inflation Lagged	0.223***	0.804***	1.016***	0.912***
	(0.000)	(0.000)	(0.000)	(0.000)
Short Term Interest Rate	0.086**	0.271***	-0.044**	-0.063**
	(0.011)	(0.007)	(0.049)	(0.043)
Expected Inflation	0.742***	-0.084	1.050***	1.000***
	(0.000)	(0.541)	(0.000)	(0.000)
R Squared	0.838	0.808	0.965	0.904
F Statistic	102.016	72.924	534.478	216.291
Durbin Watson Statistic	1.440	1.532	2.164	2.074

Significant at 1%***, 5%** and 10%*, p-value in parentheses

Table 4b- Fama (1981), Equation 4 (Kalman)

	Israel	Korea	Mexico	South Africa
Constant	0.005	-0.003	0.003	0.022***
	(0.274)	(0.415)	(0.326)	(0.000)
Inflation Lagged	0.581***	0.518***	0.921***	0.726***
	(0.000)	(0.000)	(0.000)	(0.000)
Short Term Interest Rate	0.036	0.428***	0.000	-0.073
	(0.520)	(0.000)	(-)	(0.450)
Expected Inflation	0.725***	0.903***	0.658***	6.362***
	(0.000)	(0.000)	(0.000)	(0.000)
R Squared	0.746	0.830	0.958	0.864

Significant at 1%***, 5%** and 10%*, p-value in parentheses

As has been thematic to the current paper, and prior to analysis of individual slope coefficients, one could initialize with stylized facts. Looking to goodness of fit, between 75 and 97 percent of the variation in inflation is explained by the variation in inflation inertia, the short term interest rate and the expected inflation rate alike (across both expectation decompositions). In most instances, it appears that- although parsimonious- the model has extremely robust explanatory capabilities, as is indicated by the extremely large F statistic values (especially noting the F-statistic for Mexico). This benefit incurred by the increase in explanatory power is marginally offset by the suspected presence of positive autocorrelation in estimation for Israel and Korea.

From the above, it also appears that- irrespective of methodology- inflation inertia is both positively and significantly related to current inflation; interestingly, considering Israel, the role that inflation inertia plays in altering current inflation is somewhat subdued (juxtaposed to the real sector analysis outlined previously) in the Pindyck-Rubinfeld sense, correlating to a 0.22 percent increase in current inflation juxtaposed to a less subdued 0.58 percent in the Kalman sense, of which the latter better resembles studies already undertaken (see work done by Binyamini, (2007) in this instance).

From a financial-markets perspective, the role that the short term interest rate plays in determining inflation appears to be robust in table 4a across the board (with changes in the interest rate being significant at between the 1 and 5 percent levels across the board), while underwhelming in its ability to adequately explain inflation when looking at results using the Kalman filter (with only a significant reaction for the Korean estimation). Considering the case for Israel first, one could argue that a 1 percent increase in the interest rate relates to an increase in the inflation rate by approximately 0.09 percent (looking at table 4a). This suggests that, with an increase in the short term interest rate, financial inflows (due to more attractive short term investment) may bolster economic activity, and thus inflation alike (Fama, 1981).

On the other hand, however, an increase in the short term South African interest rate relates to a decrease in the inflation rate by approximately 0.06 percent. In this way, although an increase in the short term interest rate may attract capital inflows from both domestic and foreign financial markets which may increase the inflation rate, short term interest rate increases tend to decrease interest sensitive expenditure as well. This decrease in interest sensitive expenditure is a mechanism through which the financial sector influences real economic activity, decreasing a country’s output and pulling down inflation from the demand side of the economy by a larger extent than the expected bolstering of financial market activity (Carlin & Soskice, 2005).

Importantly, using the Kalman filter warrants restriction in order to obtain convergence once more- in the case of Mexico, it is the short term interest rate which needs to be constrained to zero in order to obtain convergence in the framework. In general, it is argued that the short term interest rate has a very limited contemporaneous effect on the current inflation rate (Fama, 1975), making the restriction one which is theoretically robust, albeit uninformative and naïve in terms of the financial market’s impact on inflation.

With this restriction in mind, one could look to the role that expectations play in the framework as well; in the Pindyck-Rubinfeld mind-set, expectations remain highly statistically significant save for expectations estimated for Korea. In each instance, expectations feed into inflation in a relatively believable manner (with a unitary increase in expected inflation relating to between a 0.75 and 1.05 percent increase in current inflation).

Using the Kalman filter, however, yields highly significant reactions between expectations on inflation and actual inflation for every country, Korea included. Nevertheless, what may be a perverted version of reality is the oversized coefficient regarding inflation expectations for South Africa (Du Plessis & Burger, 2006). In this vein, a unitary increase in expected inflation relates to a 6.36 percent increase in current inflation. With incomplete information in the financial sector and/or missing variables (like the previously significant output gap, among others) in the estimation process, bias in the size of the slope coefficient regarding inflation expectations may occur (Orphanides, 2003), as has arguably happened in this current case, warranting a case for South African inflation modelling to be done including other pertinent variables.

This analysis, however, only looks at the short term interest rate and thus the information processing abilities of the short term financial market. As per Stock and Watson (2003) then, one could augment the above methodology to include long (instead of short) term financial interactions as per tables 5a and 5b:

Table 5a- Stock and Watson (2003), Equation 5 (Pindyck and Rubinfeld)

	Israel	Korea	Mexico	South Africa
Constant	-0.011***	0.000	0.008**	-0.002
	(0.000)	(0.841)	(0.040)	(0.728)
Inflation Lagged	0.289**	0.789***	0.601***	0.861***
	(0.021)	(0.000)	(0.000)	(0.000)
Long Term Interest Rate	0.454***	-0.042	0.115***	0.091*
	(0.000)	(0.659)	(0.005)	(0.087)
Expected Inflation	0.660***	0.242	1.024***	1.021***
	(0.000)	(0.119)	(0.000)	(0.000)
R Squared	0.865	0.790	0.737	0.887
F Statistic	134.935	65.072	43.071	180.978
Durbin Watson Statistic	1.474	1.375	1.664	2.153

Significant at 1%***, 5%** and 10%*, p-value in parentheses

Table 5b- Stock and Watson (2003), Equation 5 (Kalman)

	Israel	Korea	Mexico	South Africa
Constant	-0.185	0.001	0.012***	0.002
	(0.466)	(0.874)	(0.001)	(0.820)
Inflation Lagged	0.467***	0.557***	0.492***	0.700***
	(0.000)	(0.000)	(0.000)	(0.000)
Long Term Interest Rate	0.550	0.257***	0.120**	0.139
	(0.311)	(0.002)	(0.045)	(0.127)
Expected Inflation	0.880***	0.712***	1.292	0.987***
	(0.000)	(0.000)	(0.659)	(0.000)
R Squared	0.786	0.801	0.624	0.869

Significant at 1%***, 5%** and 10%*, p-value in parentheses

In very concise summary, both methodologies see a relative worsening of their goodness of fit juxtaposed to previous model specifications, with the goodness of fit ranging from between 0.62 and 0.87 using the Kalman filter, and at a maximum of 0.89 using the Pindyck-Rubinfeld methodology. All F-statistics exceed the rule-of-thumb value, suggesting robustness in the explanatory power of Stock and Watson's 2003 formulation of what drives inflation; this explanatory power is, however, low relative to other model specifications previously embellished upon. It also appears to be that positive autocorrelation has now become a more pressing issue across most countries (excluding South Africa), as their respective Durbin-Watson statistics strayed from 2.

In all instances across both methodologies, previous inflation is extremely significant from at least the 5 percent level, with all expected relations between this inflation inertia and current inflation maintaining positivity as *a priori* expected. From the Korean perspective, a unitary increase in previous inflation relates to either a 0.79 or 0.56 percent increase in current inflation as per the methodology found in Pindyck-Rubinfeld and Kalman respectively.

In addition to this, it appears that the inclusion of the long term interest rate yields statistically significant results when using both methodologies (more so in table 5a than 5b). Considering Mexico, a 1 percent increase in the long term interest rate correlates to an increase in the current inflation rate by approximately 0.12 percent in each methodology. If the long term interest rate had to increase, one could argue that volatility in the long run would be expected to increase. This increase spurs on financial activity in the arguably more certain short term, bolstering the contemporaneous inflation rate as a result (Stock & Watson, 2003).

Above and beyond this, what is at this stage no surprise is the general significance (at the 1 percent level) of expected inflation, when decomposed using either methodology. This general significance is marred by both table 5a's Korean estimation and table 5b's Mexican estimation.

Nevertheless, it appears that expected inflation relates to current inflation positively by between approximately 0.66 and 1 percent across each methodology and country.

As is argued in the literature, however; estimations of equations 4 and 5 do not use all possible variation in the term structure of interest rates. One could correct for this by estimating the interaction between the inflation rate and the spread between long and short term yields *a la* Kozicki (1997) in the following manner:

Table 6a- Kozicki (1997), Equation 6 (Pindyck and Rubinfeld)

	Israel	Korea	Mexico	South Africa
Constant	0.015***	0.014***	0.009***	-0.003
	(0.000)	(0.000)	(0.004)	(0.356)
Inflation Lagged	0.177	0.439***	0.764***	1.000***
	(0.193)	(0.001)	(0.000)	(0.000)
Yield Spread	-0.048	-0.180**	0.073**	0.341***
	(0.103)	(0.035)	(0.027)	(0.000)
Expected Inflation	0.824***	0.483***	1.002***	1.001***
	(0.000)	(0.000)	(0.000)	(0.000)
R Squared	0.848	0.83	0.741	0.908
F Statistic	109.327	84.362	43.880	226.161
Durbin Watson Statistic	1.509	1.676	1.697	2.064

Significant at 1%***, 5%** and 10%*, p-value in parentheses

Table 6b- Kozicki (1997), Equation 6 (Kalman)

	Israel	Korea	Mexico	South Africa
Constant	0.009***	0.016***	0.010***	0.006
	(0.008)	(0.001)	(0.007)	(0.421)
Inflation Lagged	0.599***	0.480***	0.741***	0.849***
	(0.000)	(0.000)	(0.000)	(0.000)
Yield Spread	-0.016	-0.240*	0.051	0.273**
	(0.774)	(0.092)	(0.128)	(0.024)
Expected Inflation	0.672***	0.711***	0.558*	0.838***
	(0.000)	(0.000)	(0.082)	(0.000)
R Squared	0.743	0.787	0.609	0.873

Significant at 1%***, 5%** and 10%*, p-value in parentheses

From the above, it appears that the R squared (save for the South African estimation where between 87 and 91 percent of the variation in inflation is explained by the variation in the model specification across methodologies) has decreased across the board, suggesting a relatively worsened fit between realised inflation and the model specification. The F statistic in each of the estimations, although above 10, is still on a general decline, suggesting a drop in the explanatory capabilities of Kozicki's 1997 formulation. This relative decline is the opportunity cost of a marginally improved Durbin-Watson statistic across each country, indicative of less serial correlation in table 6a vis-à-vis the aforementioned financial sector analyses.

As previously held, inflation inertia positively and significantly relates to current inflation where, in the South African context, a unitary increase in previous-quarter inflation associates to a 1 percent increase in current inflation in the Pindyck-Rubinfeld sense, or a 0.84 percent increase in current inflation when using the Kalman filter.

In a more novel light, however, the yield spread (the differential between long and short term government bond rates) appears significant in most instances (at between the 5 and 10 percent level) for all countries with the exception of Israel. Considering South Africa specifically, one could argue that a unitary percentage increase in the spread relates to an increase in the current inflation rate by between 0.273 and 0.371 percent across expectation decompositions. Classically, this signals the long term to be more volatile than the short term (the long term bond yield thus being higher than the short term bond yield), creating financial inflows and an increase in economic activity in the short term, pushing up the inflation rate (Kozicki, 1997).

What is perhaps staggering, considering South Korea's continued economic growth over the estimation time horizon, is the yield spread's relation to inflation in the Korean case- a unitary increase in the yield spread correlates to a decrease in the inflation rate of between 0.18 and 0.24 percent across methodologies. This indicates the short term rate to be larger than the long term rate- the signal of a recession and poor economic outcomes (Estrella & Trubin, 2006).

Fortunately, this surprising outcome can be explained; although the yield spread acts as an indicator for how well financial markets fare, what is Korea-centric is the fact that changes in the yield spread (irrespective of which yield is used) negatively impact production from the demand side of the economy through the yield's ability to influence lending rates (Domac & Ferri, 1998). An increase in the short term interest rate above the long term rate (and thus, a negative spread) pushes the cost of acquiring capital goods up enough to offset any gains that the Korean financial market might face from the general growth trend experienced by the nation. Thus, inflation linked to financial market expansion through developmental state success may be offset by deflation related to decreases in production, and thus, aggregate demand in Korea (Domac & Ferri, 1998).

Ultimately, expected inflation is- as expected- positively and extremely significantly related to current inflation. Considering each partial slope coefficient, a unitary increase in expected inflation for Korea is met by an increase in current inflation (through the aforementioned self-fulfilling prophecy mechanism) by 0.48 and 0.71 percent in tables 6a and 6b before.

Noting the analysis outlined above then, one could suggest that their place in the literature is cemented. The innovation which has not yet found its place in the body of knowledge is introduced in the current paper as the Trade-Seigniorage synthesis; this is expanded upon in tables 7a and 7b:

Table 7a- Trade-Seigniorage Synthesis, Equation 7 (Pindyck and Rubinfeld)

	Israel	Korea	Mexico	South Africa
Constant	-0.032***	0.013***	0.010***	-0.005
	(0.000)	(0.000)	(0.004)	(0.399)
Inflation Lagged	0.837***	0.236**	0.742***	0.716***
	(0.000)	(0.050)	(0.000)	(0.000)
Oil Price Inflation	0.003	0.002	-0.000	0.003
	(0.530)	(0.283)	(0.872)	(0.675)
Developed Market Inflation	1.160***	0.713***	0.045	0.938***
	(0.000)	(0.000)	(0.730)	(0.001)
Developed Market Income growth	0.009	-0.118**	-0.108***	0.035
	(0.874)	(0.047)	(0.001)	(0.602)
Exchange Rate Growth	-0.056*	0.002	-0.000	-0.032
	(0.097)	(0.856)	(0.946)	(0.126)
Exchange Rate Growth Once-Lagged	0.126***	0.015	0.006	0.039*
	(0.004)	(0.118)	(0.260)	(0.060)
Exchange Rate Growth Twice-Lagged	-0.053*	-0.004	-0.001	0.049***
	(0.068)	(0.558)	(0.791)	(0.001)
Growth of Money	0.073***	-0.020	0.021***	-0.021
	(0.000)	(0.233)	(0.009)	(0.135)
Expected Inflation	0.129*	0.601***	0.320***	0.341***
	(0.052)	(0.000)	(0.000)	(0.000)
R Squared	0.834	0.916	0.963	0.900
F Statistic	30.248	56.007	150.258	60.138
Durbin Watson Statistic	1.080	2.401	2.257	1.210

Significant at 1%***, 5%** and 10%*, p-value in parentheses

Table 7b- Trade-Seigniorage Synthesis, Equation 7 (Kalman)

	Israel	Korea	Mexico	South Africa
Constant	-0.024**	0.001	-0.001	-0.012
	(0.013)	(0.882)	(0.782)	(0.295)
Inflation Lagged	0.753***	0.750	0.891***	0.712***
	(0.000)	(-)	(0.000)	(0.000)
Oil Price Inflation	0.003	0.000	-0.006	-0.004
	(0.588)	(-)	(0.185)	(0.618)
Developed Market Inflation	0.908**	0.457***	0.306	1.162***
	(0.011)	(0.000)	(0.104)	(0.008)
Developed Market Income Growth	0.071	0.002	-0.057	0.119
	(0.433)	(0.976)	(0.231)	(0.378)
Exchange Rate Growth	-0.054**	-0.006	-0.000	-0.036*
	(0.032)	(0.660)	(0.977)	(0.072)
Exchange Rate Growth Once-Lagged	0.154***	0.013	0.010*	0.045**
	(0.000)	(0.227)	(0.069)	(0.011)
Exchange Rate Growth Twice-Lagged	-0.064**	-0.005	-0.005	0.031**
	(0.041)	(0.536)	(0.206)	(0.011)
Growth of Money	0.063***	-0.021	0.008	-0.007
	(0.001)	(0.361)	(0.410)	(0.658)
Expected Inflation	0.583***	0.432***	2.206***	0.612***
	(0.000)	(0.000)	(0.000)	(0.000)
R Squared	0.852	0.854	0.964	0.912

Significant at 1%***, 5%** and 10%*, p-value in parentheses

Initially (and for the last time), one could comment on the Trade-Seigniorage approaches relative standing with respect to all other models examined in the current research. Commenting on the goodness of fit, on average, modelling equation 7 sees an improved R squared across the board (especially when using the Kalman filter) - in the Pindyck-Rubinfeld sense, between 83 and 96 percent of the variation in inflation is explained by the model across countries, while in the Kalman sense, between 85 and 96 percent of the same variation in inflation is explained by variation in the model specification. This is an improvement, on average, in comparison to most other specifications estimated in the current schema.

This improved goodness of fit does come at the expense of both robustness in explanatory power (with all F-statistics exceeding 10, but being lower than other parsimonious models) and possible positive serial correlation for Israel and South Africa alike.

Initializing the more formal analysis with inflation inertia, one could maintain its general significance (at the 1 percent level generally) for all countries, save for Korea, when using the Kalman filter. Given estimation of equation 7; a previous-quarter inflation rate of 1 percent correlates to an approximate 0.71-0.72 percent increase in current inflation rate for South Africa.

As an already apparent limitation when using the Kalman filter however, one could argue that constraining inflation inertia (at least in the Korean sense) to having a slightly non-conservative 0.75 percent positive relationship with current inflation (and imposing a further restriction that the elasticity of price inflation with respect to crude oil inflation is statistically 0) may not be ideal- instead, further research should aim to constrain the Trade-Seigniorage model more appropriately for Korea, or elongate the sample size so as to better the chances of convergence within the system, *without* major constraints to the slope coefficients in the model.

Nevertheless and following on from this, as is apparent in most other model specifications that include crude oil inflation without exchange rate conversion, the dollar crude oil inflation rate is weak as an explanatory variable- its inclusion warrants no statistical significance across the board (making the imposition of the constraint on the Korean estimation somewhat realistic).

Considering the first "new variable" included in estimation therefrom, one could argue that- from the Thirwallian perspective- world inflation correlates to domestic inflation as expected; this is significant from at least the 5 percent level for Israel, Korea and South Africa across expectation-decomposition methodologies. It is argued that, when developed world inflation rises, so too should the demand for goods and services from the developing world, and thus, so too should the price levels of the developing world increase (Thirlwall, 1979). From the perspective of Israel, a 1 percent increase in this developed world inflation correlates to a 0.91 percent increase in domestic inflation as per the Kalman filter and a 1.16 percent increase in domestic inflation when using the Pindyck-Rubinfeld expectation decomposition.

What is less significant (and in fact, not significant at all when using the Kalman filter) is the introduction of developed world income growth. Where significant at the 1 and 5 percent level in table 7a, a contradiction of expectation occurs; a unitary increase in developed world income growth decreases domestic (emerging market) inflation in Korea and Mexico by 0.12 and 0.11 percent respectively.

What was expected was an increase in developed-market economic growth, and thus an increase in the inflation rate of emerging markets from the demand side of the economy (through trade). Instead, one could posit two explanations for the unexpected relation between domestic inflation and developed world income growth; the optimistic explanation (one regarding a decrease in transactions costs through globalization) and the pessimistic explanation (one of income inequality and oligopolization of trade across countries).

From the optimistic perspective, an increase in income growth of developed economies allows for bettered prospects of globalization; with globalization comes an ever increasing ability to trade at cheaper cost. This cheaper cost may filter into the supply side of the economy, pushing down production costs, and decreasing the inflation rate- hence the negative relation between world income growth (acting as a signal for globalization) and domestic inflation (Carlin & Soskice, 2005).

In juxtaposition, the pessimistic view is one of trade competitiveness and oligopolization. From a fairly simplistic standpoint, one could argue that increased income growth in the more developed world can be paralleled to a capitalist's accumulation of capital in the microeconomy. If the balance sheet of that capitalist is large enough, an increased income allows the ability of the more capital-endowed capitalist (the developed nation) to undercut smaller capitalists (the emerging market), pushing them out of the market (decreasing trade, and thus income, within emerging markets) (Marx, 2013 (1867)).

Thus, with this anecdote, one thing is certain- from a Marxian perspective, the larger the more developed nation (in terms of income), the more its ability to inflict policy which is "beggar-thy-neighbour" (exploitative) in nature. This continuous undercutting of the emerging market forces its (the emerging market's) aggregate demand down, pushing down the inflation rate (and economic growth alike).

From this, turning now to growth in the exchange rate (where positive exchange rate growth is indicative of a depreciation in the domestic currency), one could suggest that the empirical analysis (which is well specified in terms of its goodness of fit) yields statistically significant evidence of the J-curve phenomenon taking place (to varying degrees) in Israel and South Africa (where all coefficients on exchange rate growth are significant and swop between positivity and negativity across the time horizon); these results are mirrored in both the Pindyck-Rubinfeld and Kalman estimation alike.

In a more specific manner, a 1 percent depreciation of the R and contemporaneously correlates to a decrease in the current inflation rate (looking at table 7b particularly) by approximately 0.036 percent, while that same unitary percentage depreciation yields an increase in current inflation by 0.04 and 0.03 percent when looked at in both its once, and twice lagged states. Put differently, an initial depreciation in the rand sees a worsening of the trade balance (due to contractual obligation, a depreciation in the currency pushes down export value, raises the import value, decreases output and pushes down the price level), but this depreciation sees an improvement in trade (and thus demand-pull inflation) over a 3 and 6 month time horizon as goods and services from the domestic economy become cheaper (Appleyard, et al., 2008). Interestingly, contemporaneous relations between currency depreciation and inflation are not significant in the Pindyck-Rubinfeld schemas, suggesting tentatively that the Kalman filtered results are more able to pick up the J-curve phenomenon in this framework.

What is, perhaps, a bit more novel is the “controlled J-curve” experienced in the estimation for Israel. Due to the Israeli central bank’s partial target of the exchange rate, an Israeli depreciation sees mirrored results to South Africa in the current and once lagged time periods. What is different is the fact that, when a depreciation of the currency occurs two quarters prior to the current time period, the central bank would increase the interest rate (in order to appreciate the currency somewhat), and in so doing, push down aggregate demand (through decreases in interest sensitive expenditure) (Mishkin, 2001), decreasing inflation in that period across both Pindyck-Rubinfeld and Kalman methodologies. Hence, the original J-curve relation is governed over time by the mandate of the central bank to control exchange rates, and the initial onset of a depreciation in the currency is met by an almost immediate change in the interest rate in order to somewhat negate the inflationary impact of that depreciation.

Penultimately, looking at the growth rate of high powered money, one could argue for its limited significance in both the Pindyck-Rubinfeld and Kalman senses save for Israeli and Mexican estimations (the latter, only being significant in table 7a at the 1 percent level). For instance, considering Israel, a 1 percent increase in the growth rate of narrow money yields an increase in inflation by between 0.06 and 0.07 percent across methodologies. Above and beyond an increase in the printing of money influencing a decrease in the interest rate (along with a concomitant demand-pull wave of inflation occurring through the increase in interest sensitive expenditure (Blanchard & Johnson, 2014)), this could signal a semblance of dependence between the central bank of Israel and its government debt as well (Buiter, 1985).

In a more detailed manner, it is argued that- from the Monetarist perspective at least- only an increase in broad money (currency as well as short and long term deposits) can influence a change in the inflation rate, unless a change in narrow money lends itself to changing the growth rate of output from the standpoint of servicing part of government expenditure (and, ipso facto, its debt) (Montiel, 2011).

Finally, it appears as though an increase in expected inflation has a much more subdued relation to current inflation when looking at table 7a as opposed to 7b. In all instances though, expected inflation is positively and extremely significantly related to current inflation. For Mexico, an expected 1 percent inflation rate associates to a 0.32 percent increase in current inflation using the Pindyck-Rubinfeld expectation decomposition, but a more extreme 2.21 percent increase in current inflation when using the Kalman filter.

In lieu of the above analysis, it is important to suggest that each model specification is not without merit or flaw. At this, it is of utmost importance to run diagnostics on each model specification, and gauge statistically whether one is more appropriate to use than the other. Thus, outlined from hereon is an analysis on the precision of each model's ability to forecast within sample and obtain expected inflation in terms of a one-quarter-ahead forecast.

5. Diagnostics for Inflation Forecasting and Expectation Precision

In order to determine the accuracy with which each model forecasts within sample, it is of utmost importance to construct a simple mean square error (MSE) for each estimation. With this, one could argue- at least simplistically- as to which model specification is most apt at forecasting within sample. An MSE can be calculated as per Gujarati and Porter (2009) below:

$$Mean\ Square\ Error = \frac{\sum_{t=1}^{n}(\pi_{actual,t} - \pi_{forecast,t})^2}{n}$$

In this way, one could further suggest that the minimum difference between actual inflation ($\pi_{actual,t}$) experienced in a time period and forecasted inflation ($\pi_{forecast,t}$) for that same time period (correcting for sample size n) yields a measure for precision of forecasting; the larger this MSE, the larger the error in within-sample forecasting (Gujarati & Porter, 2009).

This methodology can be supplemented with the replacement of forecasted inflation for expected inflation from each methodology (both Kalman and Pindyck-Rubinfeld) in an attempt to gauge how accurate each measure of expected inflation would be, from the perspective of expectations made in the current time period about inflation one quarter ahead[8].

8

As such, a natural starting point would be to first gauge within-sample forecast mean squared errors for each model as per tables 8a and 8b below:

Table 8a: Mean Square Error (Pindyck-Rubinfeld)

	Israel	Korea	Mexico	South Africa
Equation 1	0.000079	0.000019	0.000012	0.000041
Equation 2	**0.000059**	0.000018	0.000012	**0.000035**
Equation 3	0.000070	0.000011	**0.000009**	0.000050
Equation 4	0.000069	0.000015	0.000011	0.000074
Equation 5	0.000060	0.000017	0.000014	0.000086
Equation 6	0.000065	0.000013	0.000013	0.000071
Equation 7	0.000067	**0.000010**	0.000011	0.000079

Table 8b: Mean Square Error (Kalman Filter)

	Israel	Korea	Mexico	South Africa
Equation 1	0.000114	0.000025	0.000036	0.000101
Equation 2	0.000112	0.000024	0.000036	0.000103
Equation 3	0.000143	0.000028	0.000048	0.000188
Equation 4	0.000112	0.000021	0.000036	0.000110
Equation 5	0.000104	0.000025	**0.000021**	0.000106
Equation 6	0.000113	0.000027	0.000022	0.000102
Equation 7	**0.000063**	**0.000019**	0.000033	**0.000071**

Simply, when looking at tables 8a and 8b, one could suggest that, from the Pindyck-Rubinfeld methodology, equation 2 (inclusive of oil price inflation) tends to perform the most robustly when within-sample forecasting across both South Africa and Israel. From a Mexican standpoint, within sample forecasting is done most accurately when using inflation in its four-quarter moving average form (implying precision in estimating inflation through the use of equation 3 of the methodology). For the developmental state of Korea, it appears that the newly proposed Trade-Seigniorage synthesis appears most robust at within sample forecasting. As a stylized fact, it appears that real sector models of inflation are most precise in a mean square error sense when utilizing the Pindyck-Rubinfeld methodology than their financial sector counterparts.

When using the Kalman filter, it appears as though the new Trade-Seigniorage synthesis is most able to predict variability in inflation from an MSE perspective. This is for all countries except for Mexico, who sees accuracy in its within-sample forecasts when including the long term interest rate as an explanatory variable (found through the use of equation 5 in section

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$$Mean\ Square\ Expectation\ Error = \frac{\sum_{t=1}^{n}(\pi_{actual,t} - \pi_t^e)^2}{n}$$

3.2). It further appears that, on average, MSEs using the Kalman filter appear to be marginally larger than when using the Pindyck-Rubinfeld analysis.

Tables 8a and 8b do not, however, make mention of each model's ability to extract accurate inflation expectations; as such, tables 8c and 8d below summarize each model's ability to estimate inflation expectations one quarter in the future:

Table 8c: Mean Square Expectation Error (Pindyck-Rubinfeld)

	Israel	Korea	Mexico	South Africa
Equation 1	0.000542	0.000609	0.003608	0.003776
Equation 2	0.000593	0.000760	0.003569	0.004069
Equation 3	**0.000537**	0.000779	0.002098	**0.003262**
Equation 4	0.000668	**0.000078**	0.003609	0.003862
Equation 5	0.000724	0.000078	**0.001805**	0.003826
Equation 6	0.000624	0.000615	0.001826	0.003833
Equation 7	0.000837	0.000865	0.003618	0.003745

Table 8d: Mean Square Expectation Error (Kalman Filter)

	Israel	Korea	Mexico	South Africa
Equation 1	**0.000639**	0.000838	0.004185	0.003514
Equation 2	0.000757	0.028826	0.004040	0.017170
Equation 3	0.000753	**0.000735**	0.003470	**0.003178**
Equation 4	0.000667	0.000836	0.004057	0.003717
Equation 5	0.000774	0.000815	**0.001845**	0.003479
Equation 6	0.000657	0.000772	0.001852	0.003480
Equation 7	0.000741	0.000914	0.003711	0.003595

From the inflation expectations perspective, one trend is perhaps clear throughout the mean square expectation error analysis; models using information from the real sector of the economy appear to formulate expectations more accurately on average. For instance, equations 1 and 3 are most able to accurately estimate inflation expectations most often across both Kalman, and Pindyck-Rubinfeld methodologies.

More specifically, Mexican term structure estimations tend to perform better than their real sector counterparts across both Pindyck-Rubinfeld and Kalman methodologies while Israeli and South African real sector analyses tend to outperform their financial sector counterparts across the board. Interestingly, the Korean estimation of favour starts off as a financial-sector estimation in the Pindyck-Rubinfeld methodology, but alters to favour real sector analysis when using the Kalman filter.

It also appears that, on average, the Kalman filter less accurately relates actual inflation experienced in a following quarter to expected inflation measured (when compared to the Pindyck-Rubinfeld expectation decomposition). The Pindyck-Rubinfeld methodology, however, is constrained in that the instrument used as a proxy for expected inflation does not utilize all possible information in the dataset (equation (f) in the Pindyck-Rubinfeld methodology does not use current or once-lagged explanatory variables), which contradicts the classical definition of rational expectations on inflation (Sargent & Wallace, 1975). This signals, at least in part, the ability of the Kalman filter to extract a more *De Jure* type of rational inflation expectations as it seeks to use all information in the dataset. Further research on the matter could be done in assessing whether accurate expectations regarding inflation are perfectly or "imperfectly" rational from the standpoint of other countries.

Thus, it appears as though estimations of expected inflation for Israel, Korea and Mexico see accuracy in the measurement of imperfectly rational expectations (using most, but not all of the information in the data, implying the general accuracy of the Pindyck-Rubinfeld decomposition juxtaposed to the Kalman filter) while only South Africa (with the Kalman filtered expectation errors being smaller across most equations in comparison to the Pindyck-Rubinfeld expectation errors) seems to adhere to the classical definition of forming fully rational expectations on inflation. This may not, however, be a problematic result if the goal of a policy maker's analysis is to come up with accurate estimations of expected inflation irrespective of rationality.

6. Policy Recommendations and Concluding Remarks

The current paper has attempted to model inflation as accurately as possible for four different emerging markets, from both the perspectives of the real and financial sectors of the economy. Therefrom, the Trade-Seigniorage approach has been posited as novel with respect to the current body of knowledge surrounding the interplay between inflation and globalization, created with emerging markets specifically in mind. This has been followed by two different perspectives on how to extract inherently latent expectations regarding inflation.

Initially, considering each model specification in more detail, it appears as though most specifications are estimated in line with *a priori* expectation. Thus, one could suggest that general theory regarding the measurement of inflation is able to fit the estimation of inflation in the seemingly more economically volatile emerging market framework.

In lieu of this, when using the Pindyck-Rubinfeld methodology, it appears that modelling inflation based on the real sector appears most accurate from the perspective of within-sample forecasting, while using the Kalman filter sees a more accurate measure of inflation coming from the newly introduced Trade-Seigniorage method.

Importantly, this Trade-Seigniorage approach to understanding inflation appears more robust than other relationships in the literature which aim to map correlation between globalization (income growth of foreign economies and the concomitant demand-pull inflation experienced from that increased income growth) and inflation. This was previously due to the presence of estimation-biasing multicollinearity when using foreign output gaps and inflation in tandem (Ihrig, et al., 2010); a problem which the current paper has curbed (while maintaining the integrity of the relationship between domestic inflation, foreign income growth and foreign inflation).

It is found that inflation experienced in foreign (large) open economies feeds into emerging market inflation in a highly significant manner (with foreign inflation inducing domestic inflation to increase). The same can be said (albeit, to a lesser extent) with regards to income growth in large, foreign economies. As such, a policy maker- now faced with the task of creating policy to maintain inflation in an emerging market setup- should be aware that this task is influenced largely by the foreign sector; it is thus of utmost importance to make policy (interest rate rules and rules which govern government debt, to name a few) with this in mind.

Furthermore, it is found that some states in emerging markets may service some of their debt through the use of seigniorage- a robust discussion of the positives and negatives of this servicing of debt (and, in fact, the extent to which public debt is serviced by central banks or to what extent central banks act independently from the fiscus) is a natural extension of the Trade-Seigniorage methodology, and room for future research in line with earlier work by Montiel (2011). Furthermore, evidence is found for the persistence of a J-Curve regarding inflation in some emerging markets, which takes less time to manifest itself (0-6 months) than its output-based archetype (taking over 12 months to become apparent (Appleyard, et al., 2008)). This differential in timing between J-Curves should also filter into decisions regarding exchange rate policy.

Importantly, this current paper has also shed light on the fact that (at least in the Pindyck-Rubinfeld sense) some emerging market central banks and some governments are not as credible and able to influence inflation expectations as they would hope[9]. A policy maker should be cognizant of this fact, especially if the role of the each institution encompasses the steering of expectations (inflationary, or otherwise) to a particular level. Research in this vein, as per Malikane and Mokoka (2012), has already been done for the credibility of central banks specifically; instead, new research could see the scrutiny of the fiscus' credibility in fostering economic growth.

With this in mind, in an attempt to inform future users of the methodology found in Pindyck and Rubinfeld (1998), this current paper has also posited a possible solution for estimating expectations when looking at models which include any form of interest rate. Whereas the initial methodology outlined as per Pindyck and Rubinfeld attempted to analyse the reactions of expected inflation to central bank credibility, the current paper has attempted to utilize a rudimentary, albeit novel, theoretical consideration found in work done by Rother (2004)- the ability of the fiscus to guide expectations on economic growth from the demand side of the economy, and thus, expected inflation. As such, a policy maker utilizing this methodology is able to refine estimation of expected inflation, even in cases where modelling inflation incurs the use of the variation in interest rates.

Ultimately, moving on to the analysis of these inflationary expectations, some facts drawn from the current paper are of utmost importance to outline:

Firstly, it appears as though models which attempt to model inflation from the perspective of the real sector are more able (on average) to extract accurate inflation expectations than their financial sector counterparts. This, it could be argued, contests Fama's hypothesis regarding efficiency in expectation-decomposition when using financial sector models, suggesting instead that the financial sector of an emerging market economy is indeed less able to accurately process information which may influence inflation than the real sector of the economy.

Secondly, it appears as though the Kalman filter is less accurate at extracting inflation expectations- on average- than Pindyck and Rubinfeld's 1998 attempt at expectation decomposition. As has been embellished upon previously however, the Pindyck-Rubinfeld methodology omits information about current and once-lagged variables, making the expectations estimated therefrom imperfectly rational. The Kalman filter used in the estimation

[9] See Appendix 1

of expected inflation runs through the data both forward and backward in time, without omitting time periods- this makes the Kalman filter's version of inflation expectations more rational in the strictest sense.

With this in mind, a policy maker should be able to use each methodology (noting that, in some instances, and seemingly above and beyond the rational expectations limitations above embellished, the Pindyck-Rubinfeld methodology may come out as more accurate in the formation of expected inflation), but should make sure to note the Kalman filter's efficacy in the general formation of expected inflation from the perspective of some emerging markets.

At last, it must be noted that inflation is perhaps one of the key indicators of the health of the macroeconomy; its understanding is inherently paramount to the wellbeing of the general populous influenced by its volatility. In an emerging market setup, the importance of understanding these inflation dynamics is no different. As such, the light shed by this paper on part of the truth about inflation dynamics should be a base to understand a deeper truth about the beating heart of the macroeconomy. With a deeper understanding of the way in which the general growth or decay of prices relates to the inner workings of the economy, comes the development of that economy; this deeper understanding of inflation (as well as any macroeconomic variable) ultimately aids in policy which is the onset of transition between emerging market and developed market status.

7. Appendices

Appendix 1: Pindyck-Rubinfeld Estimation (Selected Coefficients from equation f)

	Equation 1	Equation 2	Equation 3	Equation 7		Equation 4	Equation 5	Equation 6
Israel								
Δi_{t-2}	0.017	0.015	0.001	-0.007	gY_{t-2}	-0.317***	-0.249**	-0.335***
	(0.76)	(0.796)	(0.988)	(0.933)		(0.005)	(0.026)	(0.003)
Δi_{t-3}	-0.037	-0.011	0.052	-0.033	gY_{t-3}	0.396**	0.271	0.404**
	(0.303)	(0.761)	(0.431)	(0.375)		(0.019)	(0.120)	(0.020)

Δi_{t-4}	0.018	-0.024	-0.036	-0.108*	gY_{t-4}	-0.150	-0.070	-0.159
	(0.626)	(0.643)	(0.580)	(0.071)		(0.179)	(0.536)	(0.159)
Korea								
Δi_{t-2}	0.013	-0.051	-0.164	0.238	gY_{t-2}	0.058**	0.033	0.113*
	(0.956)	(0.810)	(0.497)	(0.212)		(0.020)	(0.124)	(0.085)
Δi_{t-3}	-0.184	-0.193	-0.436**	0.198	gY_{t-3}	-0.045	-0.011	-0.059
	(0.414)	(0.291)	(0.023)	(0.255)		(0.218)	(0.688)	(0.468)
Δi_{t-4}	-0.193	-0.164	-0.265	0.063	gY_{t-4}	0.046**	0.039**	0.003
	(0.273)	(0.358)	(0.201)	(0.689)		(0.023)	(0.038)	(0.957)
Mexico								
Δi_{t-2}	-0.001	-0.004	-0.154**	0.089**	gY_{t-2}	0.157***	-0.071	0.039
	(0.980)	(0.928)	(0.038)	(0.022)		(0.004)	(0.238)	(0.512)
Δi_{t-3}	-0.069**	-0.062*	-0.160**	-0.067***	gY_{t-3}	-0.204**	0.011	-0.035
	(0.042)	(0.082)	(0.025)	(0.006)		(0.015)	(0.886)	(0.664)
Δi_{t-4}	-0.056	-0.058	-0.073	0.026	gY_{t-4}	0.082	-0.084	-0.020
	(0.139)	(0.193)	(0.314)	(0.397)		(0.139)	(0.125)	(0.678)
South Africa								
Δi_{t-2}	-0.444***	-0.543***	-0.703***	-0.476***	gY_{t-2}	-0.053	-0.108	0.090
	(0.000)	(0.000)	(0.000)	(0.000)		(0.776)	(0.651)	(0.622)
Δi_{t-3}	0.008	-0.130	-0.364**	0.162	gY_{t-3}	0.047	0.165	-0.052
	(0.928)	(0.132)	(0.013)	(0.139)		(0.861)	(0.653)	(0.845)
Δi_{t-4}	0.030	-0.058	-0.171	-0.068	gY_{t-4}	0.049	-0.034	0.095
	(0.764)	(0.610)	(0.253)	(0.600)		(0.755)	(0.875)	(0.529)

Significant at 1***, 5**, and 10* percent levels, p-value in parentheses

Considering the above, it appears as though very few changes in the interest rate are significant in the Israeli estimation for each pertinent real-sector equation save for equation 7 (whose residual arguably holds inflation expectations), suggesting the mixture of both inflation expectations and other missing variables in the attempt to decompose the error term. This limited ability to extract *De Jure* inflation expectations also finds itself in the estimation for Korea, where differenced interest rates are insignificant in the estimation of equation (f) in general. This statistical insignificance could also signal the lack of credibility of the central bank in managing inflation through the inflation-targeting framework.

The same cannot be said for Mexican and South African estimations; with extremely significant results across twice and three-times-lagged differenced interest rates, it is argued that inflation expectations decomposed in the Pindyck-Rubinfeld manner are robust (and that each country's respective central bank is extremely credible in maintaining inflation expectations) (Malikane & Mokoka, 2012).

Ultimately, the growth rate of output- when looking at the financial sector analysis of inflation- is highly significant for most estimations of equations 4-6 in the Israeli, Korean and Mexican senses (although the latter case is more limited in its general significance). This suggests a possible use for the growth rate of output as an isolating factor when attempting to understand inflation expectations, and further signals the credibility of each country's respective fiscus to maintain a semblance of output growth concomitant with the inflation it should yield.

The same cannot be said for South Africa; considering the lack of significance in each output growth variable in the South African estimation, one could argue that the fiscus in South Africa is not credible in its ability to create economic growth and, thus, inflation (or expectations thereof) from the demand side of the economy.

Appendix 2: Kalman Autoregressive Latent Factor Results

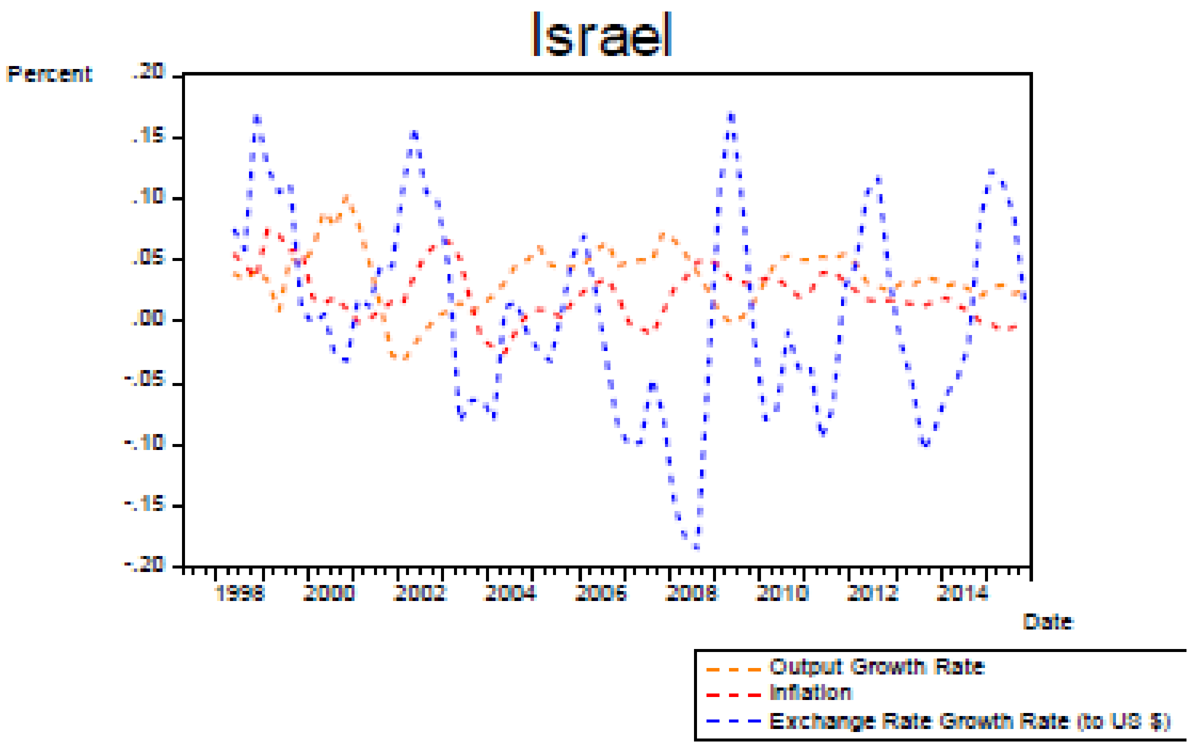
	Israel	Korea	Mexico	South Africa
π_{t-1}^{e} (Equation 1)	0.538***	0.249	0.308	0.595***
	(0.000)	(0.382)	(0.229)	(0.000)
π_{t-1}^{e} (Equation 2)	0.549***	0.198	0.299	0.624***
	(0.000)	(0.386)	(0.304)	(0.000)
π_{t-1}^{e} (Equation 3)	0.844***	0.709***	0.611**	0.748***
	(0.000)	(0.000)	(0.010)	(0.000)
π_{t-1}^{e} (Equation 4)	0.514***	0.711***	0.384	0.697***
	(0.000)	(0.000)	(0.131)	(0.000)
π_{t-1}^{e} (Equation 5)	0.792**	0.514***	0.605***	0.685***
	(0.015)	(0.002)	(0.002)	(0.000)
π_{t-1}^{e} (Equation 6)	0.523***	0.820***	0.553**	0.615***
	(0.000)	(0.000)	(0.026)	(0.000)
π_{t-1}^{e} (Equation 7)	0.711***	0.822***	0.044	0.566***
	(0.000)	(0.000)	(0.807)	(0.000)

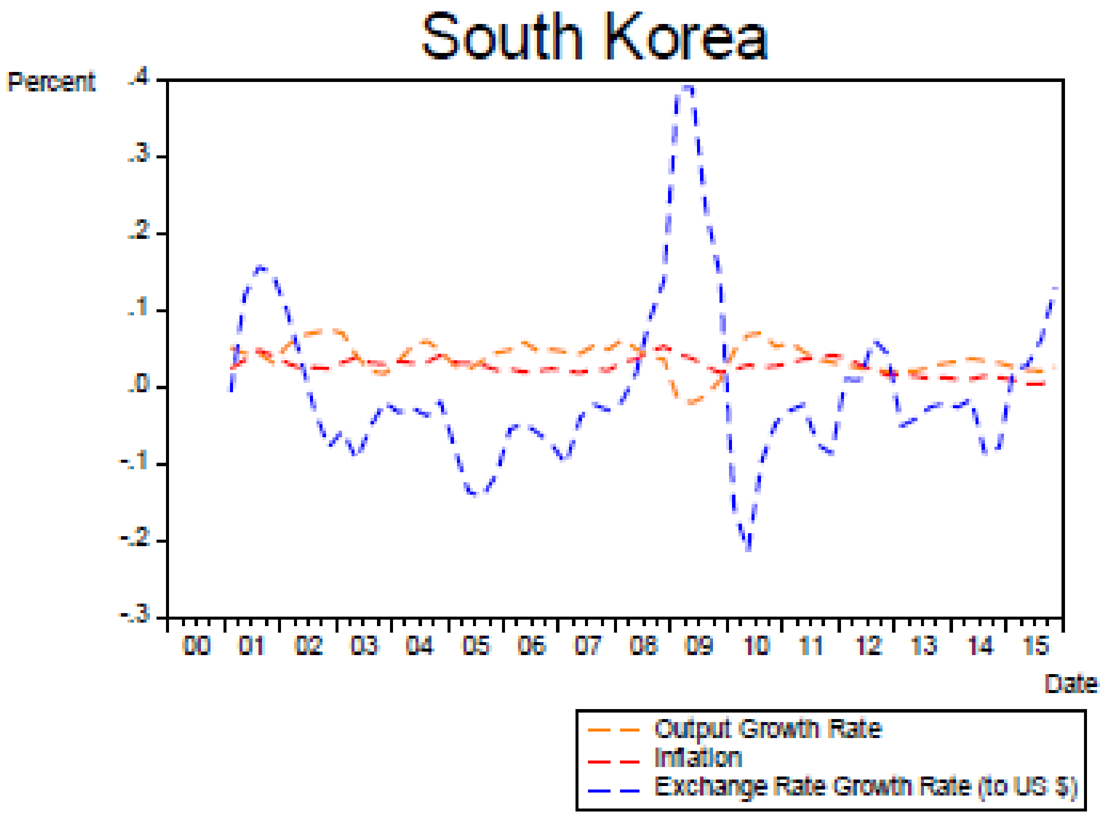
Significant at 1***, 5**, and 10* percent levels, p-value in parentheses

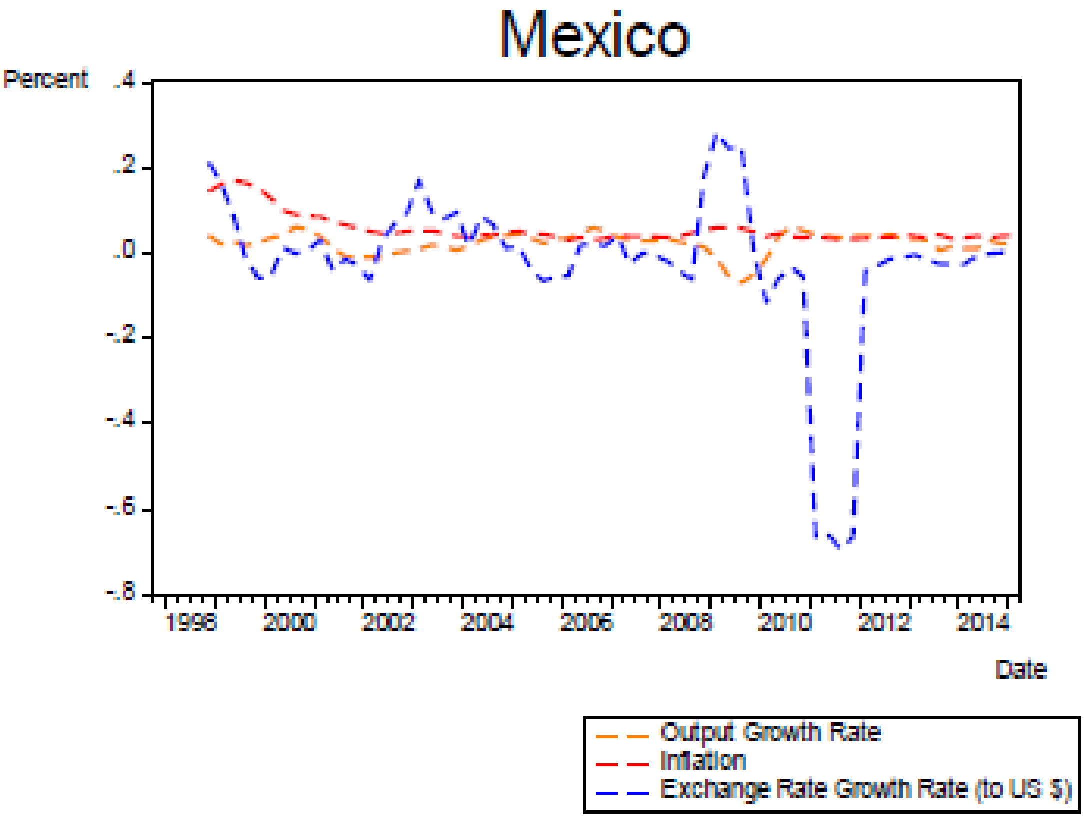
The above looks at the estimation of equation (g) in the Kalman methodology. In concise summary, it should hold that previous expectations on inflation permeate into current inflation expectations in a positive manner (Melnick, 2016). In every case, inertia from previous inflation expectations positively influences expectations in the current time period. Interestingly, in all cases where the coefficient on the autoregressive term is highly significant (which is admittedly in most cases save for the parsimonious model specifications for Korea and Mexico, and the Mexican Trade-Seigniorage estimation), it appears that previous inflation expectations filter into current inflation expectations by more than 50 percent. This suggests that, for the most part, inflation expectations are created in a backward looking manner with more than 50 percent of current expectations coming from previous expectations and realizations thereof.

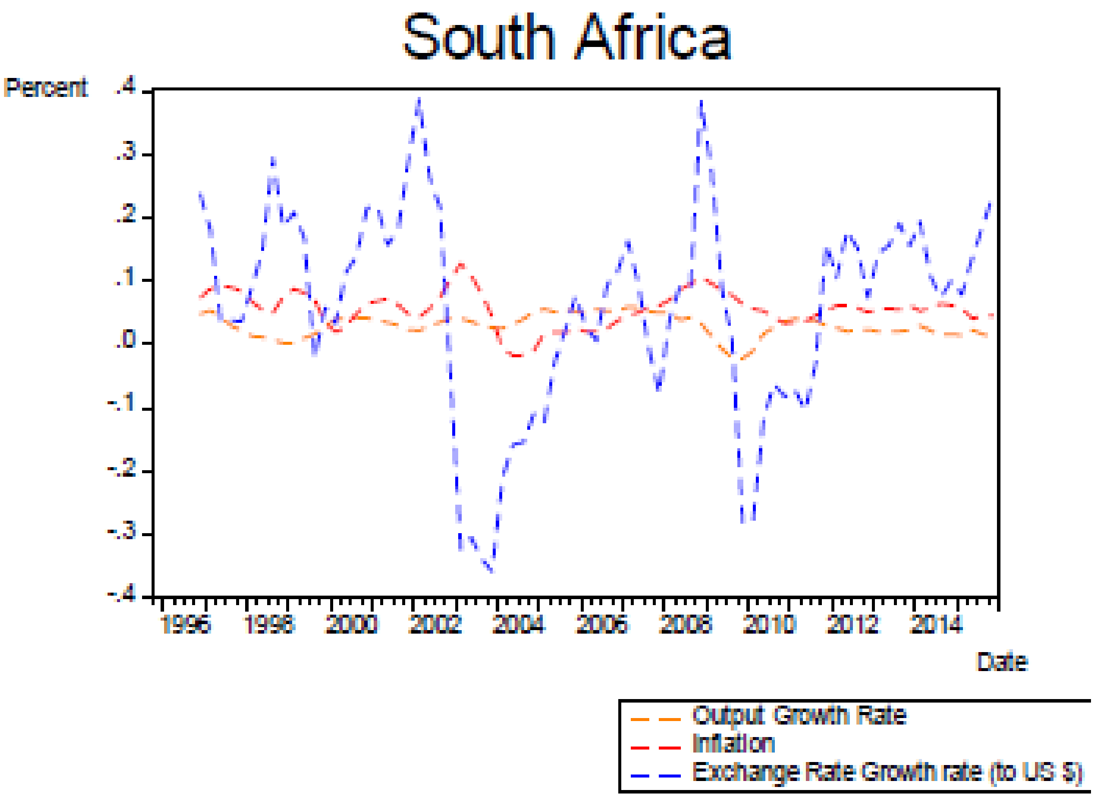
For the non-significant slope coefficients in the above appendix, one could suggest that the latent factor in every non-significant case could instead be created in a manner which is autoregressive of the second (and not the first) order (Melnick, 2016) which leaves room for future research. This implies the necessity for more information to be processed over a longer time horizon in order to create robust (and significant) inflation expectations in those insignificant cases.

Appendix 3: Graphing Output Growth, Inflation and Exchange Rate Volatility






Mexico
Percent
.4
.2
.0
-.2
-.4
-.6
-.8
1998
2000
2002
2004
2006
2008
2010
2012
2014
Date
Output Growth Rate
Inflation
Exchange Rate Growth Rate (to US $)


South Africa
Percent
.4
.3
.2
.1
.0
-.1
-.2
-.3
-.4
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Date
Output Growth Rate
Inflation
Exchange Rate Growth rate (to US $)

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