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THE EXPECTATIONS HYPOTHESIS OF THE TERM STRUCTURE IN THE PHILIPPINES: AN EMPIRICAL NOTE (2001-2017)

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ABSTRACT

This paper provides a first assessment about the Expectations Hypothesis of the Term Structure (EHTS) in the Philippines. In line with the EHTS, there is strong support for cointegration between interest rates at different maturities, while no significant risk premium components are detected. However, the "symmetry" restriction, assuming equi-proportional yields movements, is strongly rejected. Finally, there is strong evidence of unidirectional causality from short to long-term interest rates. The main policy implications are that: (a) monetary policy should be mainly focused on the management of longer term maturities; (b) monetary policy should rely on interest rates smoothing, in order to prevent potentially destabilizing effects.

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Contribution/ Originality: This study contributes in the existing literature analyzing the validity of the Expectations Hypothesis of the Term Structure (EHTS) in the Philippines since the beginning of the new inflation targeting regime in 2002. I find strong support for the EHTS although the "symmetry restriction, assuming equi-proportional yield movements, is rejected.

1. INTRODUCTION

The Expectations Hypothesis of the Term Structure (EHTS) of interest rates states that the return on a long-term financial asset is an average of current and expected short-term interest rates on this asset over the corresponding maturity.

Earlier versions of this theoretical framework emphasized the role of market expectations (the so called "Pure Expectations" theory), while subsequent extensions introduced a risk premium component as a further relevant factor affecting long-term interest rates dynamics (the so called "Liquidity Premium" theory).

At the macroeconomic level, one relevant implication of the EHTS is related to the effectiveness of the monetary policy transmission mechanism. The modern approach to monetary policy assumes in fact that the Central Bank controls a short-term policy rate, and that monetary impulses are transmitted to the real sector through the no arbitrage condition implied by the EHTS (Bernanke and Blinder, 1992); (Clarida *et al.*, 1999).

Focusing on emerging economies, applied research on the EHTS received a major impetus in recent years, as a consequence of widespread financial markets liberalization and the adoption of inflation targeting policies relying on a short-term policy rate management.

Applied research on these economies has produced variegated empirical evidence. Konstantinou (2005) and Koukouritakis and Michelis (2008), for instance, provide strong support for the EHTS, respectively for Poland and a large group of countries recently joining the European Union. However, the "Pure" version of this theory has often been rejected (see, among others, Cooray (2003) for Sri Lanka; Tabak (2009) for Brazil; Buigut and Rao (2010)) for Hong Kong, and Tronzano (2015a;2015b) for India).

This paper performs a first assessment about the EHTS, focusing on the Philippines experience since the beginning of the last decade.

This country represents an interesting case-study because it implemented a financial system liberalization since the early 1990's, paving the way to the introduction of financial instruments which significantly affected the monetary policy transmission mechanism (Guinigundo, 2008). In this context, the Philippine Central Bank progressively changed its monetary policy framework since the mid-1990's, having been accorded greater autonomy and flexibility in carrying out its commitment to price stability. Since the mid-1990's the monetary targeting approach was modified, implementing a transition phase towards an inflation targeting regime which was officially introduced in 2002.

The existing empirical evidence on the impact of this new policy regime on the monetary transmission mechanism is, however, relatively limited and rather uninformative.

There is some evidence that, during the initial phase of the inflation targeting regime, there has been an increase in the interest rate pass-through, although the strength of this channel has been limited by some structural factors, notably the relative shallowness of financial markets, as witnessed by the illiquidity of longer-term bonds (Claveria *et al.*, 2009). Further econometric evidence shows that domestic monetary authorities retained their capability to influence market interest rates during the inflation targeting regime. This influence, however, was mostly confined to the short-end of the yield curve, while the key issue remains of whether changes in market interest rates were of the same magnitude of those of policy rates (Dakila and Claveria, 2006).

Overall, to the best of my knowledge, no empirical contribution has still explored in full detail the validity of the EHTS for the Philippines, namely the existence of a long-run equilibrium relationship between nominal interest rates at different maturities, as well as the validity of the restrictions associated with alternative versions of the EHTS. Moreover, no empirical contribution has still investigated the direction of the causal relationships between yields at various maturities, a crucial issue for the proper working of the interest rate channel of monetary policy.
The purpose of this article is to fill these relevant gaps in the literature.

The outline of the paper is as follows. Section 2 implements cointegration tests on the Philippine term structure and investigates the restrictions on parameters associated with alternative versions of the EHTS. The analysis is firstly carried out inside a bivariate framework, and subsequently extended to a multivariate set up. Section 3 performs some causality tests between yields at different maturities, focusing both on short and on long-run interactions among nominal yields. Section 4 concludes the paper, outlining its main policy implications and some directions for future research.

2. COINTEGRATION TESTS, PARAMETERS ESTIMATES AND RESTRICTIONS ON PARAMETERS

2.1. Data Set

The data set includes monthly data on Philippine Treasury Bills yields from 2001.4 to 2017.2, corresponding to a total of 191 observations. I focus on Treasury Bills data at 3-months, 6-months and 12-months maturities. Both the choice of the time period and that of yields maturities are dictated by the availability of reliable interest rates data.[1] In the context of the present investigation, therefore, the 3-month interest rate represents a proxy for the policy rate, whereas the remaining variables correspond to nominal rates at longer maturities.

Figure 1 plots these data over the selected sample period.

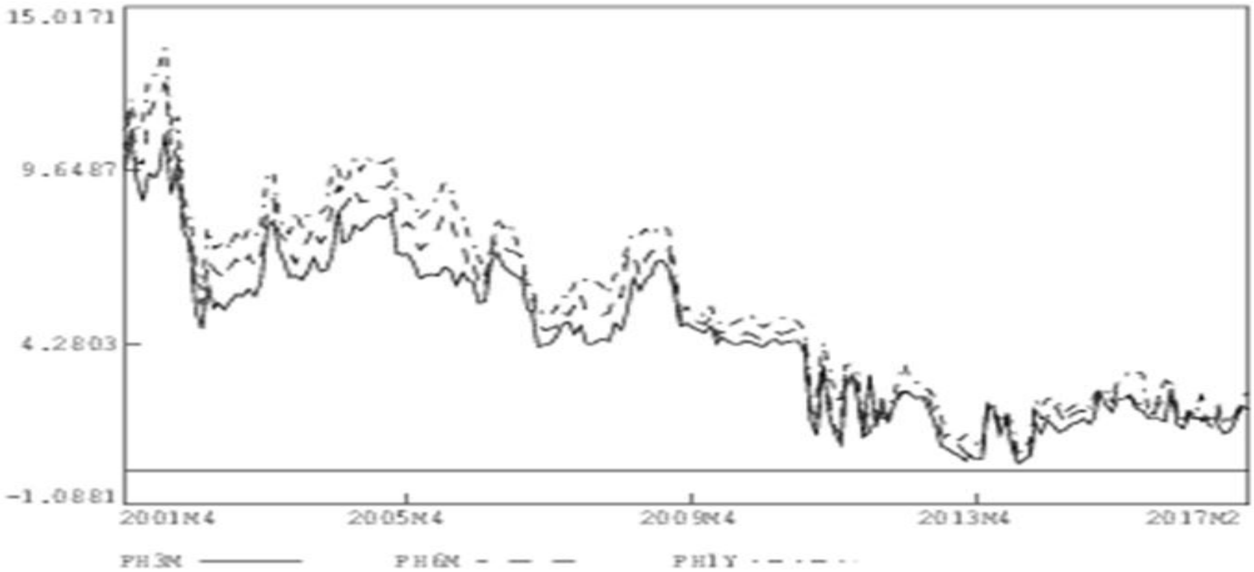

Figure-1. Philippine Term Structure of Interest Rates Monthly Data: 2001.4 – 2017.2

Source: Author's elaboration on Thomson Reuters data

As shown in this figure, the dynamics of nominal yields exhibits a clear downward trend. Since 2011, moreover, all interest rates series oscillate around notably low values, approximately around 1-2%, mainly as a consequence of the large liquidity injections implemented by major industrialized countries to counter the 2007-2008 international financial crisis.

Strong co-movements between assets yields are documented, particularly during the second half of the sample. On the whole, this pattern provides some informal evidence supporting the existence of cointegration. Moreover, no significant structural break is apparent from the overall dynamics of the Philippine term structure.

As a prerequisite for cointegration analysis, these series were submitted to standard unit root tests which, in all cases, provided robust evidence that they are integrated of order one (I(1)). This finding is in line with the bulk of the applied literature and offers a sound motivation for the use of a cointegration-based approach to explore the validity of the EHTS.

2.2. Bivariate Analysis

Let $i_t^{(n)}$, $i_t^{(m)}$ denote, respectively, the long term and the short term interest rates (m < n). Assuming the existence of a (constant) risk premium component (θ_{nm}) that may vary with the maturity of rates, the EHTS may be formally be expressed as:

$$i_t^{(n)} = 1/k \sum_{i=0}^{n} E_t\left(i^{(m)}_{t+i}\right) + \theta_{nm} \qquad [1]$$

[1]Nominal interest rates are obtained from Thomson Reuters – Datastream and are expressed in percentage per annum. The codes for these series are the following: Treasury Bill Yields 3-Months (TRPH3MT); Treasury Bill Yields 6-Months (TRPH6MT); Treasury Bill Yields 12-Months (TRPH1YT).

The literature analyzing the validity of the EHTS through a bivariate approach relies on the following reparametrization of equation [1]:

$$i_t^{(n)} = \alpha + \beta\, i_t^{(m)} + \varepsilon_t \qquad [2]$$

Since nominal interest rates are typically I(1) variables, the validity of the EHTS is usually explored assessing the existence of a long-run equilibrium relationship between $i_t^{(n)}$ and $i_t^{(m)}$ with a cointegrating vector (1, -1) (see Campbell and Shiller (1987) and Taylor (1992)) seminal papers). This restriction is commonly known as the "symmetry " or "zero-sum" restriction, and expresses the existence of a one-to-one long-run relationship between interest rates at different maturities. Additionally, testing the further restriction $\alpha = 0$ in equation [2], allows to disentangle between the "Pure" EHTS version ($\alpha = 0$) and the "Liquidity Premium" specification ($\alpha > 0$) positing significant risk premium components at all temporal horizons.

Drawing on the above discussion, I explore the existence of long-run equilibrium relationships between two alternative interest rates pairs involving, respectively, the short-term (3-months) rate and long-term interest rates at 6-months and 12-months maturities. As underlined in the literature, alternative estimators are crucial in order to ensure the robustness of cointegration results (see, e.g. (Narayan, 2005)). In this perspective, three alternative estimators are used to estimate the long-run elasticities inside the Philippine term structure, namely Ordinary Least Squares (OLS), the Phillips and Hansen (1990) Fully Modified Estimator (FM-OLS), and the Dynamic Ordinary Least Squares (DOLS) estimator outlined in Stock and Watson (1993).

FM-OLS and DOLS overcome some drawbacks of OLS in the presence of serial correlation in the error term and endogeneity of regressors. These estimators provide therefore optimal estimates of the cointegrating regression and robust statistical inferences from tests on parameters restrictions.

FM-OLS differs from the static Engle-Granger OLS estimator since the cointegrating vector is estimated taking into account the short-run dynamics. This is done through a non-parametric correction which accounts for residuals autocorrelation and potential endogeneity of right-hand-side variables.

The DOLS approach, on the other hand, controls for the endogeneity of explanatory variables by inserting leads and lags of the changes of exogenous variables. By inserting leads and lags of the exogenous variables in first-differences, the explanatory variables in levels become super-exogenous and the regression results are unbiased (Wooldridge, 2009).[2]

The results of cointegration tests and of a quantitative assessment of various parameters restrictions are summarized in Tables 1 and 2.

Table-1. Bivariate Cointegration Results and Tests on Parameters Restrictions (6 Months – 3 Months Maturities) (Monthly Data: 2001.6 – 2017.2)

Alternative Estimators	α	β	$\alpha = 0$	$\beta = 1$	$\alpha = 0 ; \beta = 1$	Cointegration Tests
OLS	0.034 (0.61)	1.11 (101.9)	0.38 [0.537]	118.8 [0.000]	504.0 [0.000]	-6.09***
FM-OLS	-0.028 (-0.33)	1.13 (67.0)	0.11 [0.737]	63.3 [0.000]	227.4 [0.000]	-6.28***
DOLS	-0.047 (-0.88)	1.14 (101.8)	0.77 [0.378]	164.9 [0.000]	593.6 [0.000]	-7.83***

Cointegrating regressions normalized on the long-term interest rate:
$i_t^{(n)} = \alpha + \beta\, i_t^{(m)} + \varepsilon_t$ (see equation [2]); n = 6-months , m = 3-months.
Critical values for ADF cointegration tests are from Engle and Yoo (1987) Table 3, and refer to a sample of 200 observations: -3.78 (1%); -3.25 (5%); -2.98 (10%).
***: test statistic significant at a 1% level.
t-statistics in parentheses below estimated parameters values ; p-values in square brackets.

[2] The use of DOLS, finally, can also be motivated on the basis of the (relatively) small dimension of the data set. Monte Carlo experiments carried out in Stock, J.H. and M.W. Watson, 1993. A simple estimator of cointegrating vectors in higher order integrated systems. Econometrica, 61(4): 783-820. show that DOLS perform better in small samples, relatively to other asymptotically efficient estimators.

Table-2. Bivariate Cointegration Results and Tests on Parameters Restrictions (1 Year – 3 Months Maturities) (Monthly Data: 2001.6 – 2017.2)

Alternative Estimators	α	β	α = 0	β = 1	α = 0 ; β = 1	Cointegration Tests
OLS	0.21 (2.7)	1.20 (80.8)	7.35 [0.007]	190.9 [0.000]	1013.1 [0.000]	-5.65***
FM-OLS	0.091 (0.70)	1.23 (47.7)	0.496 [0.481]	81.5 [0.000]	359.4 [0.000]	-5.63***
DOLS	0.075 (1.07)	1.24 (85.2)	1.16 [0.280]	284.4 [0.000]	1288.9 [0.000]	-6.00***

Cointegrating regressions normalized on the long-term interest rate:
$i_t^{(n)} = \alpha + \beta\, i_t^{(m)} + \varepsilon_t$ (see equation [2]); n = 12-months , m = 3-months.
See Table 1 for other explicative notes.

All cointegrating regressions are estimated inserting the short-term policy rate proxy on the right-hand-side. The former table refers to the bivariate relationship between the policy rate and the long-term rate at a 6-month horizon, whereas the latter table involves a longer maturity (1 year). The empirical findings from the OLS estimator appear in the first rows of these tables, while the remaining rows report the results from the more efficient estimators outlined above.[3]

The most salient feature of these tables is the strong homogeneity in the results produced by alternative estimation techniques. This homogeneity involves both the evidence from cointegration tests and the empirical findings about parameters restrictions.

The existence of a long-run equilibrium relationship between nominal yields at various maturities is strongly supported by data. As documented in Tables 1 and 2, the 6-months and the 12-months interest rates are always cointegrated with the short-term policy rate according to all cointegration tests.

Cointegration among nominal yields is thus a pervasive feature of the Philippine term structure, thus corroborating the visual evidence of section 2.1 and supporting one important empirical implication of the EHTS.

Turning to parameters estimates, the long-term interest rates responses to policy rate movements (β coefficients) are consistently higher than one. These estimates clash with the "symmetry" restriction implied by the EHTS, which assumes an equi-proportional dynamics between short and long-term interest rates. The Wald tests implemented through alternative estimators consistently reject the null that β = 1 for all maturities, thus strongly supporting the above conclusion.

The constant terms in the cointegrating regressions (α coefficients) are never significantly different from zero[4], thus suggesting the absence of significant liquidity premia components at all horizons. In line with this evidence, the Wald tests for the restriction that α = 0 in equation [2] are almost never able to reject the null hypothesis.

The empirical evidence of Tables 1 and 2 is therefore in line with the "Pure" version of the EHTS. This evidence differs from that recently obtained for other Asian countries, which usually supports the "Liquidity Premium" version of this theory (see e.g. Tronzano (2015a)) for India, and Tronzano (2015c)) for Malaysia). A likely reason for this discrepancy is that the present study focuses on relatively short temporal horizons (6-months, 12-months) whereas Tronzano (2015a;2015c) consider a wider spectrum of assets maturities, extending beyond a 1-year horizon.

A final result of this section is that the joint hypothesis of α = 0 and β = 1 is consistently rejected. Given the absence of risk premia components, this result is clearly driven by the rejection of the "symmetry" restriction.

[3] As regards the DOLS estimator, given the relatively small dimension of the sample, the maximum number of leads and lags for first-differenced variables was initially set to 4, progressively lowering this leads/lags structure to 1 in some preliminary estimates. The final DOLS specification was then set to 4, on the basis of the Akaike Information Criterion.

[4] The only exception is the α coefficient for the 12-month maturity obtained under OLS estimates (see Table 2, first row). However, since the remaining estimators are more efficient, the existence of significant risk premia components can safely be excluded in the present empirical investigation.

Overall, this section documents the existence of significant long-run equilibrium relationships inside the Philippine term structure, but shows that long-terms yields tend to systematically over-react to the monetary impulses stemming from the policy rate. On the whole, therefore, these findings are only partially supportive of the EHTS.

The next section assesses the robustness of these results, extending the empirical analysis inside a multivariate cointegration framework.

2.3. Multivariate Analysis

The present section replicates the previous analysis inside a multivariate cointegration framework. The existence of long-run equilibrium relationships and parameters restrictions are therefore reassessed jointly inspecting all interest rates maturities. This approach has strong empirical underpinnings.

The EHTS predicts that each yield series is cointegrated with the short-term policy rate ($i^{(m)}_t$). Therefore, considering a system of (N) interest rates, the (N-1) spread vectors belonging to the set [(-1,1,0,….,0)', (-1,0,1,0,…..,0)', ..., (-1,0,……0,1)'] are linearly independent and underlie a cointegration space of rank (N - 1). Testing the EHTS in a multivariate cointegration framework exploits, consequently, one basic implication of this theory, namely that a system of (N) non-stationary yields should have one common stochastic trend driving interest rates (see e.g. Hall *et al.* (1992)).

A multivariate approach, moreover, delivers more accurate inferences than the literature investigating interest rates in pairs, since term structure innovations jointly affect the whole spectrum of interest rates maturities (see, among others, Hall *et al.* (1992); Engsted and Tanggaard (1994); Konstantinou (2004); Masih and Ryan (2005).

The analysis of the present section relies on the standard Full Information Maximum Likelihood approach proposed in Johansen (1995). Although alternative methodologies are available to determine the number of common trends, this approach provides the most straightforward way to test the hypotheses on the cointegrating vectors (Engsted and Tanggaard, 1994).

The optimal lag order (p) in the Cointegrating VAR is chosen through standard model selection criteria. On this basis, both multivariate cointegration tests and Likelihood Ratio tests on parameters restrictions are obtained setting p = 2.[5] Diagnostic checks on the Cointegrating VAR (2) reveal that, at this lag structure, no equation suffers from residuals serial correlation.

Table 3 summarizes the results from multivariate cointegration tests.

Table-3. Philippine Government Bond Yields (Monthly Data: 2001.6 - 2017.2; 189 Observations)
Multivariate Cointegration Tests

Null	Alternative	λ_{max}
r = 0	r = 1	64.68**
r ≤ 1	r = 2	40.92**
r ≤ 2	r = 3	4.14

Null	Alternative	λ_{trace}
r = 0	r ≥ 1	109.74**
r ≤ 1	r ≥ 2	45.06**
r ≤ 2	r ≥ 3	4.14

λ_{max} and λ_{trace} are the two statistics for the test of the cointegration rank.
The data vector includes nominal interest rates on government bonds at 3-months, 6-months, and 1-year maturities.
Cointegration with restricted intercepts and no trends in the VAR. Optimal lag length: p = 2.
** indicates significance at the 5% level.
The 95% critical values for λ_{max} are: r = 0, 22.04; r ≤ 1, 15.87; r ≤ 2, 9.16. The 90% critical values for λ_{max} are: r = 0, 19.86; r ≤ 1, 13.81; r ≤ 2, 7.53. The 95% critical values for λ_{trace} are: r = 0, 34.87; r ≤ 1, 20.18; r ≤ 2, 9.16. The 90% critical values for λ_{trace} are: r = 0, 31.93; r ≤ 1, 17.88; r ≤ 2, 7.53.

[5] Whereas both the Akaike Information Criterion and Likelihood Ratio tests of a (p) versus a (p + 1) specification support p = 2 as optimal lag order, the Schwarz Bayesian Criterion suggests a lower lag structure (p = 1). Therefore, as a robustness check, the whole analysis was redone assuming p = 1. The empirical evidence is unaffected imposing this shorter lag structure.

The Maximum Eigenvalue and the Trace Test reject the null hypotheses that there are at most zero or one cointegrating vectors. These tests, therefore, strongly support the existence of two cointegrating vectors, fully in line with previous results.

The existence of one common stochastic trend supports one basic implication of the EHTS in a multivariate cointegration perspective. This finding implies that the Philippine term structure displays a cointegration property that prevents nominal yields from drifting too far apart, thus eliminating the occurrence of persistent profitable opportunities. This is clearly in line with the arbitrage condition underlying the validity of the EHTS.

Overall, therefore, the results of Table 3 reiterate the accuracy of previous findings inside a more powerful econometric framework.

In line with the previous analysis, three restrictions on the cointegrating vectors are now addressed. The first, denoted "Zero Risk Premia", assumes the absence of significant term premia components at all temporal horizons, setting to zero all intercept terms (θ_{ls}). The second, named "Symmetry", assumes an equi-proportional long-run dynamics between yields at various maturities. The third restriction, finally, involves the joint validity of those outlined above.

Table 4 contains the relevant Likelihood Ratio statistics.

Table-4. Philippine Term Structure

EHTS Restrictions: (a) Zero Risk Premia

	Vector 1	Vector 2
$i^{(3m)}$	1.142 (0.010)	1.270 (0.015)
$i^{(6m)}$	-1.000	0.000
$i^{(1y)}$	0.000	-1.000
θ_{ls}	0.000	0.000
Likelihood Ratio Test of Zero Risk Premia: 3.032 [0.220]		

EHTS Restrictions: (b) Symmetry

	Vector 1	Vector 2
$i^{(3m)}$	1.000	1.000
$i^{(6m)}$	-1.000	0.000
$i^{(1y)}$	0.000	-1.000
θ_{ls}	0.590 (0.152)	1.156 (0.258)
Likelihood Ratio Test of Symmetry Restrictions: 32.74 [0.000]		

EHTS Restrictions: (c) Symmetry and Zero Risk Premia

	Vector 1	Vector 2
$i^{(3m)}$	1.000	1.000
$i^{(6m)}$	-1.000	0.000
$i^{(1y)}$	0.000	-1.000
θ_{ls}	0.000	0.000
Likelihood Ratio Test of Symmetry and Zero R.P: 42.77 [0.000]		

Cointegration with restricted intercepts and no trend in the VAR.
Order of Cointegrating VAR: p = 2.
θ_{ls} indicates the intercept term in the Cointegrating VAR.
Conditional standard errors in parentheses below parameters estimates.
p-values in square brackets behind Likelihood Ratio (LR) test statistics.
The LR test for the Zero Risk Premia restriction (a) is distributed as a χ^2 with 2 degrees of freedom.
The LR test for the Symmetry restriction (b) is distributed as a χ^2 with 2 degrees of freedom.
The LR test for the joint restrictions of Symmetry and Zero Risk Premia (c) is distributed as a χ^2 with 4 degrees of freedom.

The Likelihood Ratio test for "Zero Risk Premia" (Table 4, upper section (a)) is very low, and the joint restriction that $\theta_{ls} = 0$ for all cointegrating vectors cannot be rejected at standard significance levels. This evidence provides therefore further support to the "Pure" EHTS version.

The Likelihood Ratio statistics for "Symmetry" (Table 4, middle section (b)) is instead very high, leading to a strong rejection of this restriction. In line with previous results, a significant and systematic over-reaction of long-term interest rates to short-term policy rate movements is documented.

The joint restrictions (Table 4, lower section (c)), finally, are strongly rejected. Given the absence of significant risk premia components, this result is again clearly driven by the rejection of the "Symmetry" restriction.
Overall, these results are fully consistent with those derived in the previous section.

The coefficient estimates of cointegrating vectors provide further interesting insights. Table 5 displays these estimates, with cointegrated vectors normalized on long-term yields.

Table-5. Philippine Term Structure
Exactly Identified Cointegrating Vectors

	Vector 1	Vector 2
$i^{(3m)}$	1.156 (0.021)	1.272 (0.031)
$i^{(6m)}$	-1.000	0.000
$i^{(1y)}$	0.000	-1.000
θ_{ls}	-0.081 (0.10)	-0.009 (0.149)

Cointegration with restricted intercepts and no trend in the VAR.
Order of Cointegrating VAR: p = 2.
θ_{ls} indicates the intercept term in the Cointegrating VAR.
Conditional standard errors in parentheses below parameters estimates.

As shown in this table, the intercepts terms are always insignificantly different from zero, in line with the estimates derived from a bivariate econometric framework. Moreover, for both cointegrating vectors, slope coefficients are significantly higher than one and increasing in the time to maturity (more specifically, 1.16 for the 6-month maturity, and 1.27 for the 1-year maturity). Quite interestingly, these coefficients are almost identical to those obtained through the DOLS estimator.

This finding underlines the importance of using alternative estimation techniques, inside a bivariate econometric framework, in order to obtain reliable parameters estimates. In a more general perspective, moreover, the estimated values of slope coefficients document that the overshooting of long-term nominal yields is a robust empirical result in the context of the present econometric investigation.

3. CAUSALITY TESTS

The results obtained in the previous section document that cointegration between nominal yields is a robust feature of the Philippine term structure. Although cointegration implies the existence of causality, cointegration analysis is not sufficient to establish the direction of causality among variables. This issue, however, is crucial to evaluate the effectiveness of the interest rate channel of monetary policy.

Since 2002, which approximately corresponds to the beginning of our sample, the Philippine Central Bank has officially adopted an inflation targeting regime relying on the short-term policy rate management. Inside this new monetary policy framework, the interest rate channel, capturing the transmission of the policy rate to market interest rates and to the real economy, represents the more relevant mechanism of monetary transmission.[6]

[6] Although this paper focuses on the interest rate channel, this is by no means the only channel of monetary policy transmission. The modern approach to monetary policy has identified several other channels, since the empirical literature has documented that the macroeconomic impact of policy rates movements is much larger than that implied by the standard interest rate channel. These alternative channels include: the credit channel (amplification of the effects of policy rate movements through bank lending and balance sheets effects); the exchange rate channel (effects of policy rate movements on the domestic currency and hence on competitiveness and aggregate demand); the asset price channel (wealth effects associated with bonds and equities price variations induced by policy rate movements); and the expectations channel (forward-looking agents expectations correlated with Central Bank's policy decisions).

The interest rate channel of monetary transmission assumes the validity of the EHTS and the existence of a causal relationship from the short-term policy rate to longer term market rates. This short to long causality pattern ensures that monetary impulses are efficiently transmitted to market interest rates at progressively longer maturities, thus ultimately affecting the interest sensitive components of aggregate demand (consumption, investment) and hence output and inflation.

Causality in the reverse direction (i.e. from long to short rates), or bi-directional causality, would instead hinder the smooth working of this relevant channel of monetary transmission, since the policy rate would no more be an exogenous policy instrument, and the ultimate effects of monetary policy would become more uncertain due to complicated feedbacks effects.

Drawing on the above remarks, this section explores the direction of causality through a standard Vector Error Correction Model (VECM). More specifically, since short and long-term yields are cointegrated, a bivariate VECM for these variables may be specified as follows:

$$\Delta\, i^{(m)}_t = \delta_1 + \gamma_1 RES_{t-1} + \text{lagged}(\Delta i^{(m)}_t\,, \Delta i^{(n)}_t\,) + \varepsilon_{1t} \qquad [3]$$

$$\Delta\, i^{(n)}_t = \delta_2 + \gamma_2 RES_{t-1} + \text{lagged}(\Delta i^{(m)}_t\,, \Delta i^{(n)}_t\,) + \varepsilon_{2t} \qquad [4]$$

where, as before, $i^{(m)}_t$ and $i^{(n)}_t$ represent, respectively, the short and the long-term interest rate. Moreover, Δ indicates the first-difference operator; RES_{t-1} is the lagged error correction term from the cointegrating equation; δ_1 and δ_2 are constant parameters; γ_1 and γ_2 are speed of adjustments coefficients; and ε_{1t} , ε_{2t} are white-noise residuals.

In the context of the present investigation, $i^{(m)}_t$ corresponds to the 3-months interest rate (i^{3M}) assumed as a proxy for the Central Bank short-term policy rate; $i^{(n)}_t$ is instead a long-term interest either at a 6-month (i^{6M}) or at a 1-year (i^{1Y}) maturity.

This VECM specification allows to disentangle between different sources of causality related to long and short-run dynamics.

The error correction parameters (γ_1 , γ_2) provide information about the direction of long-run causality, since they are related to the intensity of the adjustment process towards the long-run equilibrium. A negative and significant error correction parameter implies that the left-hand variable in the corresponding VECM equation adjusts to eliminate deviations from long-run equilibrium. This analysis is usually defined as a test of weak exogeneity (Engle *et al.*, 1983); (Engle and Granger, 1987).

Short-run causality can instead be inferred testing the joint significance of lagged coefficients in each VECM equation, in line with the standard approach outlined in Granger-Sims causality tests.

A joint test for the null hypotheses that an error correction parameter is equal to zero and lagged parameters are equal to zero provides, finally, a test for strong exogeneity of the left-hand variable in the corresponding VECM equation.

The VECM outlined in equations [3]-[4] is estimated for two interest rates pairs including the short-term policy rate, namely (i^{3M}, i^{6M}) and (i^{3M}, i^{1Y}).

The optimal VECM order is selected on the basis of standard model selection procedures (Akaike Information Criterion and Schwarz Bayesian Criterion) and in order to ensure satisfactory residuals diagnostics for all estimated equations. On this basis, an optimal VECM order of one ($p = 1$) is selected for both bilateral interest rates pairs.

Diagnostic checks point out that a VECM(1) specification provides satisfactory results in terms of functional form, residuals serial correlation and heteroscedasticity tests.

Table 6 summarizes the empirical evidence from VECMs in terms of parameters estimates, Likelihood Ratio tests for short-run causality, and Wald statistics for strong exogeneity.

Table-6. Vector Error Correction Models for Short and Long-Term Nominal Interest Rates

	(i^{3M}, i^{6M})	(i^{3M}, i^{1Y})
γ_1	-0.249 (-1.61)	-0.111 (-0.94)
γ_2	-0.621^{***} (-4.14)	-0.366^{***} (-3.29)
Null Hp: Lagged values of $\Delta\, i^{(n)}_t = 0$ in equation normalized on $\Delta\, i^{(m)}_t$	10.92^{***} [0.001]	3.335^{*} [0.068]
Null Hp: Lagged values of $\Delta\, i^{(m)}_t = 0$ in equation normalized on $\Delta\, i^{(n)}_t$	4.05^{**} [0.044]	0.982 [0.322]
Strong exogeneity: $\Delta i^{(m)}_t$ Strong exogeneity: $\Delta i^{(n)}_t$	11.09^{***} [0.004] 17.30^{***} [0.000]	3.424 [0.180] 10.87^{***} [0.004]

$i^{(m)}_t$: short-term policy rate (proxied by the 3-month nominal interest rate i^{3M})
$i^{(n)}_t$: long-term interest rates at a 6-month (i^{6M}) and a 1-year (i^{1Y}) maturity.
Estimated VECMs are specified as follows:
$\Delta\, i^{(m)}_t = \delta_1 + \gamma_1 RES_{t-1} + \text{lagged}(\Delta i^{(m)}_t, (\Delta i^{(n)}_t)) + \varepsilon_{1t}$
$\Delta\, i^{(n)}_t = \delta_2 + \gamma_2 RES_{t-1} + \text{lagged}(\Delta i^{(m)}_t, (\Delta i^{(n)}_t)) + \varepsilon_{2t}$
***: significant at a 1% level; **: significant at a 5% level; *: significant at a 10% level.
Numbers in parentheses below estimated parameters values are t-statistics.
Numbers in square brackets behind Wald statistics are marginal significance levels.

The most relevant result involves the estimated error-correction coefficients. The error-correction parameter in VECM equations normalized on the short-term policy rate (γ_1) is never statistically significant, whereas the same parameter in the equations normalized on the long-term interest rate (γ_2) is always highly significant.

These findings provide strong evidence of unidirectional long-run causality form the policy rate to longer term maturities, documenting that the Philippine policy rate is weakly exogenous.

The estimated value of γ_2 for the shorter temporal horizon (6-months), moreover, is much larger than that for the longer horizon (1-year). This implies, in line with economic intuition, that the speed of adjustment to an exogenous monetary impulse is faster at the short end of the yield curve.

This robust evidence for a "short-to-long" causality pattern is consistent with the new inflation targeting regime introduced in 2002, since it ensures that policy rate variations are efficiently transmitted along yield curve maturities, without destabilizing feedback effects.

Focusing on the central rows of Table 6, the bilateral interest rate pair for the shortest maturity (6-months) supports the existence of short-run bi-directional causality, whereas an opposite result is obtained for the bilateral pair at the longest maturity (1-year).

These results are still consistent with a monetary policy relying on a short-term policy rate instrument, although they reveal that, at the shortest maturities, this monetary policy could give rise to temporary feedback effects.

This policy implication is confirmed by the empirical findings about strong exogeneity (Table 6, last row).

These results show that, focusing on the longest maturity of the term structure (1-year), the null hypothesis of strong exogeneity of the policy rate is not rejected. The same conclusion, however, does not hold at the short end of the yield curve (6-month), given the existence of short-run dynamic interactions between the policy rate and the 6-month nominal interest rate.

4. CONCLUDING REMARKS AND POLICY IMPLICATIONS

This paper provides a first assessment about the validity of the EHTS in the Philippines.

This country represents an interesting case-study because it implemented a progressive financial markets liberalization since the early 1990's and introduced a new monetary policy regime in 2002, based on the management of a short-term policy rate. Moreover, notwithstanding some empirical work addressing the impact of this new policy regime, the validity of the basic assumptions of the EHTS has never been investigated in full detail. The empirical findings may be summarized as follows.

There is a strong support for the existence of cointegration between nominal interest rates and, in line with the "Pure" EHTS version, no significant risk premium component is detected. However, contrary to one basic implication of the EHTS, the "symmetry" restriction, assuming equi-proportional movements between nominal yields at various maturities, is rejected. All these results, firstly derived inside a bivariate econometric framework, are robust to an extension of the analysis inside a multivariate econometric framework.

Turning to causality tests, Vector Error Correction Models provide strong evidence of unidirectional causality from the short-term interest rate (assumed as a proxy for the policy rate) to longer term maturities. Overall, these results imply that the short-term policy rate is weakly exogenous. Additional evidence provided by standard Granger-Sims causality tests, moreover, points out the existence of short-run bidirectional causality between the policy rate and the 6-month nominal interest rate, whereas this short-run causality pattern vanishes at longer temporal horizons.

There are two relevant policy implications to be drawn from the present research. The former is related to the findings from causality tests, while the latter involves the empirical evidence pointing to a strong rejection of the "symmetry" restriction.

As regards the former issue, the existence of "short-to-long" causality implies that the new monetary regime introduced in 2002 is fully consistent with the empirical evidence, since this unidirectional causality pattern ensures a smooth transmission to the real economy of the exogenous monetary policy impulses.

However, since the strong exogeneity of the policy rate holds only for longer term yields, an additional implication is that monetary policy should be mainly focused on the management of longer term maturities. A major focus on longer term yields would indeed prevent potentially destabilizing effects stemming from the short-run interactions between the policy rate and shorter term yields. This policy prescription is consistent with the bulk of the applied literature, documenting that aggregate consumption and investment decisions are mainly affected by the dynamics of longer term maturities.

The latter policy implication is related to the rejection of the "symmetry" restriction, namely to the absence of equi-proportional movements between the exogenous policy rate and market interest rates. More specifically, according to our estimates, both the 6-month and the 1-year interest rate tend to systematically overshoot policy rate dynamics.

Notwithstanding the absence of significant risk premium components, these overshooting effects complicate the implementation of monetary policy, since its ultimate effects on market interest rates cannot accurately be predicted. In other words, although causality runs in the "right" direction, final monetary policy targets might significantly depart from their optimal values in the presence of an over-reaction of market interest rates.

The lack of support for the "symmetry" restriction calls for a gradualist approach in the implementation of a monetary policy focused on longer term maturities. In the presence of systematic overshooting effects, a gradual policy rate adjustment allows to smooth out the impact of policy rate movements on the term structure, thus preventing unforeseen monetary policy effects and excessive volatility in market interest rates.

A monetary policy strategy relying on interest rate smoothing is therefore another relevant policy implication of this paper, in line with the policy implications recently put forward for other Asian countries (see, respectively, Tronzano (2015c) for Malaysia, and Tronzano (2018) for Korea).

This paper can be profitably extended along many research directions.

This empirical investigation includes a relatively small number of asset maturities, due to the poor availability of reliable interest rates data. Some straightforward extension of the present paper include, therefore, an increase in the number of asset maturities, the use of data sampled at different frequencies, and an analysis of the term structure relative to financial instruments different from government bond yields.

Recent work has emphasized the effects of nonstandard monetary policies on international yields relationships (Belke *et al.*, 2017) and the influence of international spillovers in the interest rates setting of central banks (Beckmann *et al.*, 2017). In this perspective, another interesting research topic is represented by an investigation about the influence of some important interest rates (such as US or Japanese rates) on the cointegrating relationships characterizing the Philippine term structure.

A joint empirical analysis of the Philippines and other Asian countries which recently implemented financial liberalization measures represents, finally, another promising research direction. Guerello and Tronzano (2016) use panel data techniques and provide robust evidence supporting the EHTS for a small sample of Asian emerging economies including the Philippines. Further research efforts along these lines are worthwhile, extending the cross-sectional dimension of the sample of Asian countries, and exploring the role of common global factors and of international interest rates spillovers.

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REFERENCES

Beckmann, J., A. Belke and C. Dreger, 2017. The relevance of international spillovers and asymmetric effects in the Taylor rule. Quarterly Review of Economics and Finance, 64(2): 162-170. *View at Google Scholar* | *View at Publisher*

Belke, A., I. Dubova and U. Volz, 2017. Long-term interest rates spillovers from major developed economies to emerging Asia. ADBI Working Paper No. 705. Tokio: Asian Development Bank Institute.

Bernanke, B. and A. Blinder, 1992. The federal funds rate and the channels of monetary transmission. American Economic Review, 82(4): 901-921. *View at Google Scholar*

Buigut, S. and V.K. Rao, 2010. Expectations hypothesis and the term structure of Hong Kong interbank rates. International Research Journal of Finance and Economics, 39: 72-85. *View at Google Scholar*

Campbell, J.Y. and R.J. Shiller, 1987. Cointegration and tests of present value models. Journal of Political Economy, 95(5): 1062-1088. *View at Google Scholar* | *View at Publisher*

Clarida, R., J. Galí and M. Gertler, 1999. The science of monetary policy: A new Keynesian perspective. Journal of Economic Literature, 37(2): 1661-1707. *View at Google Scholar*

Claveria, R.A., E.T. Glindro and N. Tuano-Amador, 2009. Some perspectives on the monetary policy transmission mechanisms in the Philippines. Bangko Sentral Review, 6(1): 17-40.

Cooray, A., 2003. A test of the expectations hypothesis of the term structure of interest rates for Sri Lanka. Applied Economics, 35(17): 1819-1827. *View at Google Scholar* | *View at Publisher*

Dakila, F.G. and R.A. Claveria, 2006. The impact of BSP policy interest rates on market interest rates. Bangko Sentral Review, 3(1): 1-6. *View at Google Scholar*

Engle, R.F. and C.W.J. Granger, 1987. Cointegration and error correction: Representation, estimation and testing. Econometrica, 55(2): 251-276. *View at Google Scholar* | *View at Publisher*

Engle, R.F., D.F. Hendry and J.F. Richard, 1983. Exogeneity. Econometrica, 51(2): 277-304. *View at Google Scholar*

Engle, R.F. and R.F. Yoo, 1987. Forecasting and testing in co-integrated systems. Journal of Econometrics, 35(1): 143-159. *View at Google Scholar* | *View at Publisher*

Engsted, T. and C. Tanggaard, 1994. Cointegration and the US term structure. Journal of Banking and Finance, 18(1): 167-181. *View at Google Scholar* | *View at Publisher*

Guerello, C. and M. Tronzano, 2016. The expectations hypothesis of the term structure of interest rates and monetary policy: Some evidence from Asian countries. Applied Economics, 48(55): 5405-5420. *View at Google Scholar* | *View at Publisher*

Guinigundo, D.C., 2008. Transmission mechanism of monetary policy in the Philippines. BIS Papers No. 35: 413-425.

Hall, A.D., H.M. Anderson and C.W.J. Granger, 1992. A cointegration analysis of treasury bill yields. Review of Economics and Statistics, 74(1): 116-126. *View at Google Scholar* | *View at Publisher*

Johansen, S., 1995. Likelihood-based inference in cointegrated vector autoregressive models. Oxford: Oxford University Press.

Konstantinou, P.T., 2004. Term structure dynamics: A daily view from the hungarian foreign currency deposits markets. Economia Internazionale, 57(3): 315-331. *View at Google Scholar*

Konstantinou, P.T., 2005. The expectations hypothesis of the term structure. A look at the polish interbank market. Emerging Markets Finance and Trade, 41(3): 70-91. *View at Google Scholar*

Koukouritakis, M. and L. Michelis, 2008. The term structure of interest rates in the 12 newest EU countries. Applied Economics, 40(49): 479-490. *View at Google Scholar | View at Publisher*

Masih, A.M.M. and V. Ryan, 2005. The term structure of interest rates in Australia: An application of long run structural modelling. Applied Financial Economics, 15(8): 557-573. *View at Google Scholar | View at Publisher*

Narayan, P.K., 2005. The saving and investment nexus for China: Evidence from cointegration tests. Applied Economics, 37(17): 1979-1990. *View at Google Scholar | View at Publisher*

Phillips, P.C.B. and B.E. Hansen, 1990. Statistical inference in instrumental variables regressions with I(1) processes. Review of Economic Studies, 57(1): 99-125. *View at Google Scholar | View at Publisher*

Stock, J.H. and M.W. Watson, 1993. A simple estimator of cointegrating vectors in higher order integrated systems. Econometrica, 61(4): 783-820. *View at Google Scholar | View at Publisher*

Tabak, B., 2009. Testing the expectations hypothesis in the Brazilian term structure of interest rates: A cointegration analysis. Applied Economics, 41(21): 2681-2689. *View at Google Scholar | View at Publisher*

Taylor, M.P., 1992. Modelling the yield curve. Economic Journal, 102(412): 524-537. *View at Google Scholar | View at Publisher*

Tronzano, M., 2015a. The term structure of interest rates in India: Evidence from the post-liberalization period (1996-2013). Economia Internazionale, 68(2): 275-295.

Tronzano, M., 2015b. The expectations hypothesis of the term structure: Further empirical evidence for India (1996-2013). Economia Internazionale, 68(3): 401-421.

Tronzano, M., 2015c. The expectations hypothesis of the term structure in emerging financial markets: Some evidence for Malaysia (1999-2015). Economia Internazionale, 68(4): 521-550.

Tronzano, M., 2018. Does the expectations hypothesis of the term structure hold in Korea after the Asian financial crisis? Some empirical evidence (1999-2017). Economia Internazionale, 71(2): 1-34.

Wooldridge, J.M., 2009. Introductory econometrics: A modern approach. 4th Edn., United Kingdom: Cengage Learning Inc.

BIBLIOGRAPHY

Lütkepohl, H., P. Saikkonen and C. Trenkler, 2000. Maximum eigenvalue versus trace tests for the cointegrating rank of a VAR process. Discussion Paper, Interdisciplinary Research Project 373: Quantification and Simulation of Economic Processes, No. 2000, 83.

Toda, H.Y., 1994. Finite sample properties of likelihood ratio tests for cointegrating rank of a VAR process with an intercept. Review of Economics and Statistics, 76(1): 66-79. *View at Google Scholar | View at Publisher*