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A GARCH Approach to Modeling Chilean Long-Term Swap Yields

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ABSTRACT

This paper econometrically models the dynamics of the Chilean interbank swap yields based on macroeconomic factors. It examines whether the month-over-month change in the short-term interest rate has a decisive influence on the long-term swap yield after controlling for other factors, such as the change in inflation, change in the growth of industrial production, change in the log of the equity price index, and change in the log of the exchange rate. It applies the generalized autoregressive conditional heteroskedasticity (GARCH) approach to model the dynamics of the long-term swap yield. The change in the short-term interest rate has an economically meaningful and statistically significant effect on the change of the interbank swap yield. This means that the Banco Central de Chile's (BCCH) monetary policy exerts an important influence on interbank swap yields in Chile.

KEYWORDS: Interest Rate Swaps; Swap Yield; Short-Term Interest Rate; Banco Central de Chile (BCCH); Chile

JEL CLASSIFICATIONS: E43; E50; E58; E60; G10; G12

I. INTRODUCTION

Interbank interest rate swaps are an important component of the global over the counter (OTC) derivatives market. The notional value of outstanding interest rate swaps amounts to more than $370 trillion[1] as of the second half of 2021, while the gross market value of interest rate swaps was $8 trillion during the same period, according to the Bank for International Settlements (BIS) (2022). Interest rate swaps constitute more than 60 percent of over the OTC outstanding derivatives by notional value and almost 64 percent of outstanding derivatives by the gross market value. Yet, careful and detailed empirical analysis of the determinants of interbank swap yields has been limited. Even though there is considerable literature on swaps, there is a dearth of empirical modeling of interbank swap yields not just for emerging markets, such as Chile, but also for the interbank interest rate swap yields in advanced countries.

Interest rate swaps are increasingly important for financial markets and financial institutions even in emerging markets. While the bulk of interest rate swaps are denominated in the major currencies, such as the US dollar, the euro, the British pound, and the Japanese yen, the amount of outstanding interest rate swaps in other currencies, including emerging market currencies, is still substantial. As of the second half of 2021, BIS (2022) reports that for nonmajor currencies the notional amount of outstanding interest rate swaps is $60 trillion and the gross market value is over $720 billion.

As financial markets develop in emerging markets and these emerging markets undergo financialization, the analysis of the dynamics of interbank swap yields in emerging markets shall warrant vigilant attention and econometric analysis. This paper initiates this inquiry. It fills a consequential gap in the empirical literature regarding the macroeconomic determinants of interbank swap yields. The dynamics of Chilean long-term swap yields are analyzed in this paper through examining whether the month-over-month change in the short-term interest rate has an influence on the month-over-month change in the long-term swap yields after controlling for other factors, such as the change in inflation, the change in the growth of industrial production, the change in the log of the equity price index, and the change in the log of the exchange rate.

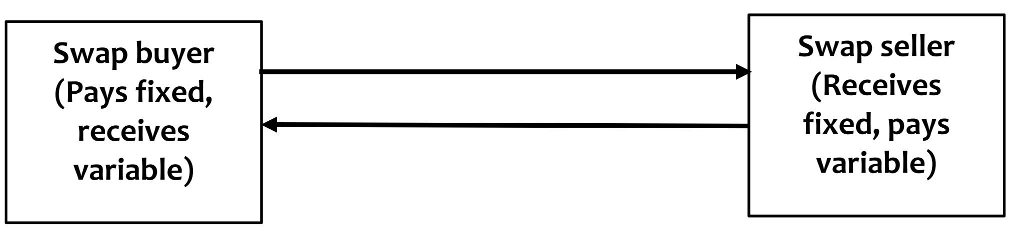
[1] All figures are in US dollars unless specified otherwise.

This paper is arranged as follows. Section II explains what an interest rate swap is. It also briefly reviews the literature on interest rate swaps. Section III presents a simple model that connects the interbank swap yield to the short-term interest rate and other macroeconomic factors. Section IV provides the macroeconomic backdrop to the evolution of the interbank swap yield in Chile. Section V gives the data sources of the variables used in the econometric modeling of the swap yield, explains these variables, and undertakes unit root and stationarity tests. Section VI reports the findings from the econometric modeling of the interbank swap yield. Section VII briefly discusses the implications of these findings. Section VIII concludes.

II. INTEREST RATE SWAPS AND A BRIEF REVIEW OF THE LITERATURE

A swap is a type of a financial contract. In an interbank interest rate swap contract, two parties exchange cash flows with different characteristics. Usually two banks (and/or other any financial institutions) exchange cash flows on two different types of interest payments. The principal amount is the same for both banks. This is known as the notional principal. One bank typically pays a fixed interest rate on the principal amount to the other bank, while in return it a receives a variable interest rate from the other bank. The bank that *receives* the variable interest rate buys the interbank swap, whereas the bank that *pays* the variable interest rate sells the interbank swap (figure 1).

Figure 1. The Bank That Buys the Interbank Interest Rate Swap Makes a Payment Based on a Fixed Interest Rate and Receives a Payment Based on a Variable Interest Rate



If a bank expects the interest rate to rise it would buy the swap because it would lock in the amount that it would have to pay in exchange for the variable interest rate payments that it would receive from the other bank. Likewise, if a bank expects the interest rate to decline, it will sell the swap because it would lock in the amount that it would receive in exchange for the variable interest rate payments it would pay to the other bank.

The fixed interest rate payment of the swap is paid semiannually for the maturity tenor of the swap. This is known as the *swap yield* or the *swap rate* for the tenor under consideration. The variable interest rate payment is linked to some benchmark interest rate. As the benchmark interest rate changes, the variable interest rate also changes. The variable payments are calculated based on the variable interest rate. In each quarter the benchmark interest rate is registered to determine the variable interest rate and the variable interest payment. The variable interest payment is made at the end of the quarter. The present value of the fixed and variable legs of the swap are the same at its inception. Swaps are conducted among the contracting parties over the counter rather than on a financial exchange. The tenor of the swaps can vary, ranging from overnight to over 30 years.

There is substantial literature on interest rate swaps. Bicksler and Chen (1986) give an economic analysis of interest rate swaps and their use in finance and business. They describe alternative uses of and the appropriate valuation procedure for interest rate swaps. Corb (2012) provides a broad overview, explains the concepts behind interest rate swaps, and explores key themes concerning swaps, such as their risk characteristics, traditional use, and pricing, as well as swaptions and recent innovations in swaps. Remolona and Wooldridge (2003) survey euro-denominated interest rate swaps. They examine the size of the euro swap market, the role of swaps as benchmark instruments, and the pricing of swaps. Chernenko and Faulkender (2011) canvass firms on the use of interest rate swaps. They report that hedging of interest rate risk is concentrated among high-investment firms. They also find that firms appear to use interest rate swaps to manage earnings and sometimes to engage in speculation. Duffie and Huang (1996) develop a model that relates the credit quality of a corporation to the swap yield. Kim and Koppenhaver (1993) find that the likelihood and extent of swap market participation by low-capitalized banks is less than for other banks. Visvanathan (1998) finds that firms that expect high financial distress costs use swaps to transform short-term debt into long-term fixed-rate debt. Debt maturity structure is significant in the decision to use a swap. Empirical research on swaps, such as Lekkos and Milas (2001), has been confined to relating the swap yield to business cycle conditions rather than fundamental macroeconomic and financial variables. Duffie and Singleton (1997) develop a multifactor econometric model of the term structure of interest rate swap yields. They report that both credit and liquidity factors are crucial drivers of the swap yield, but they too do not analyze the macro dynamics of the swap yield. It is apparent that the scholarly literature on interest rate swaps has revealed many insights but the relationship between the short-term interest rate and the long-term swap yield have not been explored in the finance literature.

The relationship between the short-term interest rate and the long-term government bond yield, which has been thoroughly investigated, provides a useful basis for examining the dynamics of the long-term swap yield from a macroeconomic vantage point and filling a consequential gap in the literature. Keynes (1930, [1936] 2007) maintains that the central bank's actions have decisive effects on the long-term government bond yield, primarily through the influence of the policy rate on the short-term interest rate. Keynes's conjecture about this relationship drew upon Riefler's (1930) inference, which came from detailed statistical analysis of interest rate dynamics in the 1920s in the United States and Keynes's own observations about interest rate dynamics in the United Kingdom during the same period. Kregel (2011) explores and reprises Keynes's views on the influence of the central bank's policy rate on long-term government bonds yields, investors' behavior in financial behavior, and fundamental uncertainty.

Recent empirical research on long-term government bonds yields, such as Akram and Li (2020a, 2020b, 2020c), has bolstered support for the conjecture that the short-term interest rate is a key driver of the long-term government bond yield. Moreover, these researchers and others show that the change in the short-term interest rate is a key driver of the change in the long-term government bond yield. Keynes's conjecture that relates monetary policy actions to the dynamics of the long-term government bond yield provides a fecund theoretical and empirical basis for modeling the swap yield as a function of the short-term interest rate and examining whether there is an empirical relationship between the short-term interest rate and the swap yield after controlling for relevant macroeconomic and financial variables.

III. A MODEL OF THE INTERBANK SWAP YIELD

A model of the interbank swap yield is presented here. Akram's (2021, 2022) models operationalize Keynes's insight that the short-term interest rate is the primary driver of the long-term government bond yield. The model presented here modifies Akram's (2021, 2022) models to make them suitable for analyzing the dynamics of the long-term swap yield.

The long-term interbank swap yield is S_{LT}. The short-term interest rate is i_{ST}. The central bank's policy rate is i_{CB}. The inflation is π, while the central bank's inflation target is $\bar{\pi}$. χ represents financial market volatility, while $\tau(t)$ is an exogenous shock. $W(t)$ is the Weiner process. The parameters of the models are: $\alpha_1, \alpha_2, \beta, \gamma, \delta$.

$$dS_{LT}(t) = \left(\alpha_1 i_{ST}(t) + \alpha_2 \pi(t)\right)dt + \chi(t)\sqrt{i_{ST}(t)}dW(t) \qquad [1]$$

$$di_{ST}(t) = \beta(i_{CB}(t) - i_{ST}(t))dt + \chi(t)\sqrt{i_{ST}(t)}dW(t) \qquad [2]$$

$$d\pi(t) = \gamma(\bar{\pi} - \pi(t))dt + \chi(t)\sqrt{\pi(t)}dW(t) \qquad [3]$$

$$d\chi(t) = \delta(\bar{\chi} - \chi(t))dt + \tau(t)\sqrt{\chi(t)}dW(t) \qquad [4]$$

Equation [1] relates the dynamics of the long-term swap yield to the change in the short-term interest rate, the change in inflation, and the change in the Weiner process adjusted by the volatility of financial markets and the short-term interest rate. Equation [2] expresses the dynamics of the short-term interest rate as a function of (1) the difference between the central bank's policy rate and the short-term interest rate, and (2) the Weiner process adjusted by the volatility of the financial market and the short-term interest rate. Equation [3] relates the dynamics of inflation to (1) the difference between the central bank's inflation target and inflation, and (2) the Weiner process adjusted by the volatility of financial market and inflation. Equation [4] relates the dynamics of the financial market's volatility to a mean reverting process and the Weiner process adjusted by an exogenous shock and the volatility of the financial market.

The above model ties the dynamics of the interbank swap yield to fundamental macroeconomic and financial variables, such as the change in the short-term interest rate, change in inflation, and financial market volatility. It can be seamlessly extended to incorporate any other pertinent macroeconomic factor, such as the change in the growth of industrial production, change in the logarithm of the equity price index, and change in the logarithm of the exchange rate, if these factors are deemed as important drivers of the interbank swap yield.

Later in this paper the standard GARCH(1,1) approach is applied to econometrically model the dynamics of the swap yield and relate it to the change in the short-term interest rate and other macroeconomic and financial variables.

IV. MACROECONOMIC BACKDROP TO THE EVOLUTION OF THE INTERBANK SWAP YIELD IN CHILE

Even a perfunctory analysis of the stylized facts of macroeconomic and financial data would reveal that monetary policy and overall interest rate dynamics have a profound influence on the change in the swap yield. Chile's interbank swap yield follow similar patterns.

Figure 2 shows the evolution of the interbank swap yield and the short-term interest rate in Chile between 2005 and 2021. Between 2005 and 2007, the interbank swap yield on swaps of different maturity tenors steadily increased as the Banco Central de Chile (BCCH) raised its policy rate. The interbank swap yield declined sharply during the global financial crisis (GFC) as the short-term interest rate declined in lockstep with the BCCH's policy rate. The interbank swap yield gradually rose from early 2009 to mid-2011. From mid-2011 to 2019 the interbank swap interest yield gradually declined. As BCCH cut its policy rate in response to the global lockdown during the COVID-19 pandemic, the interbank swap yield fell markedly. Since mid-2021 the interbank swap yield rose noticeably as the BCCH raised its policy rate.

Figure 2. The Evolution of Interest Rate Swap Yields and the Short-term Interest Rate in Chile, 2005–21

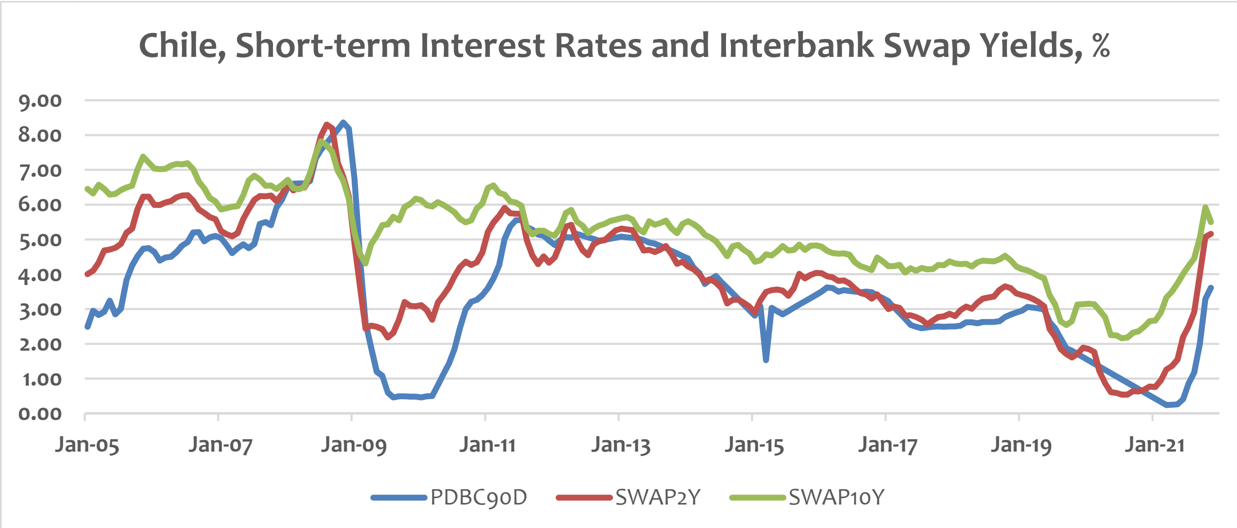


Figure 3 displays the coevolution of the interbank swap yield and consumer price index (CPI) inflation in Chile. The swap yield and inflation generally appear to move together, though the relationship between the swap yield and inflation is often rather weak.

Figure 3. The Coevolution of 10-year Interbank Swap Yield and CPI Inflation, 2005–21

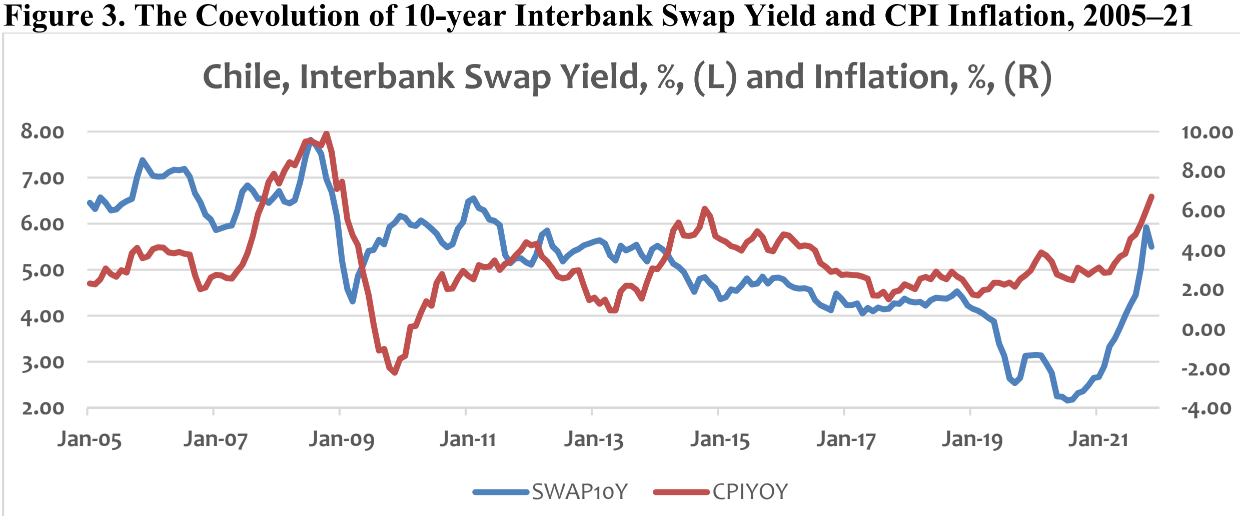


Figure 4 shows the evolution of inflation and core inflation in Chile from 2005 to 2021. Overall inflation and core inflation tend to move together. Inflation rose sharply in mid-2007 and continued to rise until later in 2008. Inflation fell between 2009–10. Except for a brief spell of high inflation between late 2014 and early 2015, inflation stayed in the range of 2–4 percent year over year between mid-2010 and mid-2021. Inflation began rising in mid-2021. By late 2021, inflation exceed 6 percent, while core inflation was just shy of 6 percent.

Figure 4. Inflation and Core Inflation in Chile, 2005–21

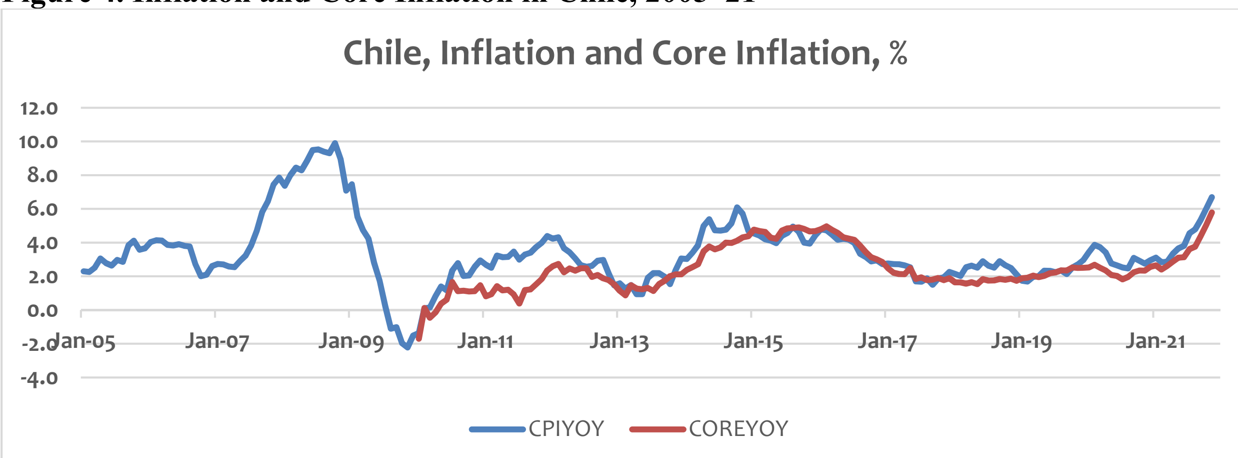


Figure 5 displays the growth of industrial production. The growth of industrial production is a useful indicator of business cycle conditions of economic activity in Chile. The time series on the growth of industrial production is volatile, but it shows that industrial production usually trends to grow. However, industrial production declined during the GFC. Industrial production rose in the subsequent quarters, exhibiting recovery from the GFC. However, between early 2013 to late 2019 the country's industrial production exhibited considerable volatility from month to month. During the global lockdown, industrial production declined sharply amid restrictions and social distancing but its growth resumed as restrictions were later scaled back and the pandemic subsided.

Figure 5. The Growth of Industrial Production in Chile, 2005–21

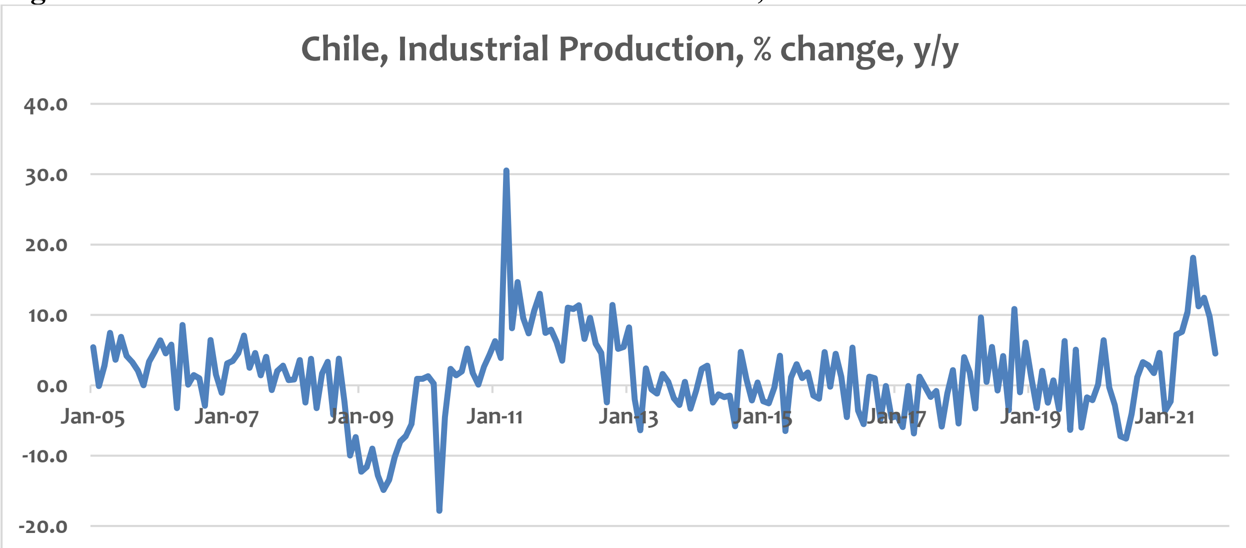


Figure 6 exhibits the evolution of the Chilean peso against the US dollar. The Chilean peso appreciated more than 20 percent between January 2005 to mid-2008. It subsequently depreciated sharply about 40 percent between mid-2008 and early 2009. This depreciation was reversed between 2009 and early 2011. The peso remained steady for the next two years. The peso depreciated between early 2013 to early 2016, followed by moderate appreciation until early 2018. It depreciated from April 2018 to April 2020, followed by appreciation until May 2021. However, the peso soon reversed course; it depreciated from mid-2021 to the end of the year.

Figure 6. The Evolution of the Chilean Peso, USDCLP, 2005–21

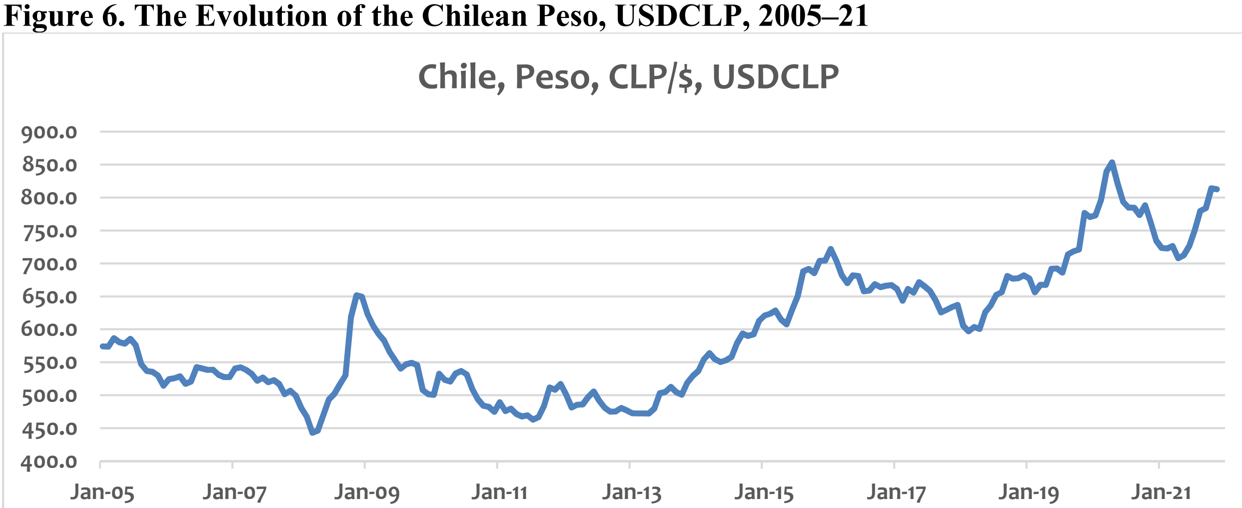
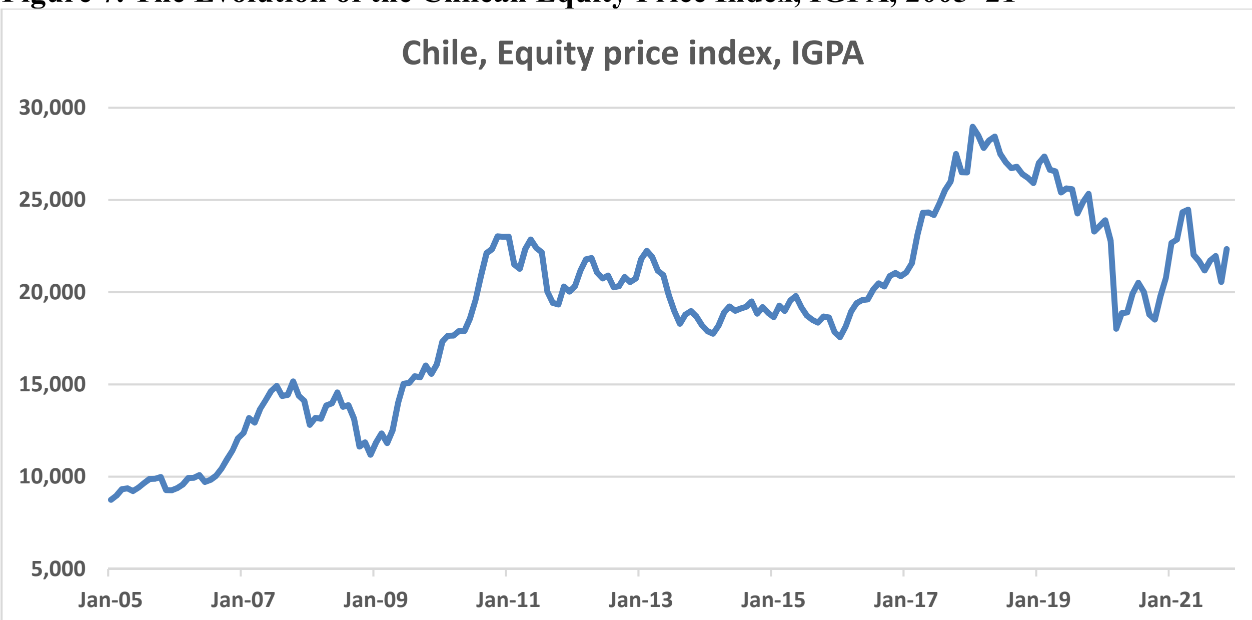


Figure 7 displays the evolution of the Chilean equity price index, as measured by the Indice General de Precios de Acciones (IGPA), between 2005–21. It was generally rising throughout the period, though there were some periods during which IGPA either declined or stayed flat. For instance, between mid-2007 until late 2008 it declined. It was range bound between mid-2011 and mid-2016. After climbing from early 2016 to early 2018, the index declined until mid-2020. It was range bound from 2020 until the end of 2021.

Figure 7. The Evolution of the Chilean Equity Price Index, IGPA, 2005–21



V. DATA DESCRIPTION, UNIT ROOT TESTS, AND STATIONARITY TESTS

Table 1 below provides a summary of the variables used in the paper. The first column lists the variable names. The second column gives the data description and the date range for the data. The third column enumerates the data frequency and indicates whether high frequency data have been converted to low frequency data. The final column provides the source of the data.

Two different variables are used for the short-term interest rate. These short-term interest rates are based on the Pagaré Descontable del Banco Central de Chile (PDBC) instruments, which are discountable promissory notes issued by the BCCH, the nation's central bank. There are three different interbank swap yields in two-year, five-year, and ten-year maturity tenors. Inflation is measured using both total inflation and core inflation. Total inflation is based on the total CPI, while core inflation is the total CPI excluding food and energy prices. Economic activity is measured by the growth of industrial production year over year. The exchange rate is based on the value of Chilean peso per US dollar. IGPA general is the equity price index.

Monthly data for the above-mentioned variables are used. For all variables (except core inflation) the data's time range is from January 2005 to December 2021, consisting of more than 200 observations.

Table 1. Summary of the Data

Variables	Data description, date range	Frequency	Sources
Short-term interest rates			
PDBC30D	Interest rate on BCCH instrument, PDBC 30 days, %, Jan 2005–Dec 2021	Daily; converted to monthly	Banco Central de Chile
PDBC90D	Interest rate on BCCH instrument, PDBC 90 days, %, Jan 2005–Dec 2021	Daily; converted to monthly	Banco Central de Chile
Long-term swap rates			
SWAP2Y	Interbank swap yield, 2 year, %, January 2005–December 2021	Daily; converted to monthly	Banco Central de Chile
SWAP5Y	Interbank swap yield, 5 year, %, January 2005–December 2021	Daily; converted to monthly	Banco Central de Chile
SWAP10Y	Interbank swap yield, 10 year, %, January 2005–December 2021	Daily; converted to monthly	Banco Central de Chile
Inflation			
CPIYOY	Consumer price index, all items, seasonally adjusted, 2018 = 100, % change, y/y, January 2005–December 2021	Monthly	Instituto Nacional de Estadística de Chile
COREYOY	Consumer price index, all items excluding food and energy, seasonally adjusted, 2018 = 100, % change, y/y, January 2010–December 2021	Monthly	Instituto Nacional de Estadística de Chile
Economic activity			
IPYOY	Industrial production index, seasonally adjusted, 2014 = 100, % change, y/y, January 2005–December 2021	Monthly	Sociedad de Fomento Fabril
Financial variables			
CLP	Exchange rate, Chilean peso per U.S. dollar, USDCLP, January 2005–December 2021	Daily; converted to monthly	Banco Central de Chile
IGPA	Equity price index, IGPA General, 12/31/1980 = 100, January 2005–December 2021	Daily; converted to monthly	*Financial Times*

Note that in the text below, LNIGPA indicates the (natural) logarithm of IGPA. Likewise, LNCLP is the (natural) logarithm of CLP, the exchange rate.

Table 2A and table 2B provide the summary statistics of these variables. Table 2A displays the summary statistics of the variables, while table 2B provides the summary statistics of the first differences of the same variables. Table 2A shows that most variables, except for CPIYOY, IPYOY, LNIGPA, and LNCLP, are not normally distributed. However, table 2B reveals that the first differences of all the variables are all normally distributed.

Table 2A. Summary Statistics of the Variables

	Obs	Mean	Std. Dev.	Max	Min	Skewness	Kurtosis	J-B	Probability
SWAP2Y	204	4.03	1.62	8.30	0.54	-0.01	2.74	0.56	0.76
SWAP5Y	204	4.65	1.43	7.94	1.17	-0.32	2.89	3.52	0.17
SWAP10Y	204	5.15	1.26	7.82	2.16	-0.31	2.67	4.27	0.12
PDBC30D	204	3.43	1.80	8.74	0.24	0.27	3.00	2.55	0.28
PDBC90D	204	3.51	1.80	8.36	0.24	0.18	2.80	1.47	0.48
CPIYOY	204	3.42	2.03	9.90	-2.22	0.79	5.00	55.28	0.00
COREYOY	144	2.48	1.34	6.42	-1.70	0.39	3.23	3.97	0.14
IPYOY	204	1.28	5.95	30.53	-17.84	0.32	5.81	70.61	0.00
LNIGPA	204	9.80	0.30	10.27	9.08	-0.79	2.73	21.57	0.00
LNCLP	204	6.38	0.16	6.75	6.09	0.37	2.06	12.13	0.00

Table 2B. Summary statistics of the first differences of the variables

	Obs	Mean	Std. Dev.	Max	Min	Skewness	Kurtosis	J-B	Probability
ΔSWAP2Y	203	0.01	1.09	-1.34	0.30	-0.77	8.12	242.12	0.00
ΔSWAP5Y	203	0.00	0.96	-1.02	0.26	-0.21	5.88	71.76	0.00
ΔSWAP10Y	203	-0.01	0.88	-0.96	0.23	-0.02	5.50	52.84	0.00
ΔPDBC30D	203	0.01	1.26	-2.66	0.37	-2.18	19.47	2454.84	0.00
ΔPDBC90D	203	0.01	1.50	-2.31	0.37	-1.76	16.83	1722.40	0.00
ΔCPIYOY	203	0.02	1.47	-1.92	0.51	-0.63	4.83	41.68	0.00
ΔCOREYOY	143	0.06	0.32	1.82	0.65	1.30	8.58	225.62	0.00
ΔIPYOY	203	-0.01	26.64	-22.41	5.85	0.24	5.52	55.68	0.00
ΔLNIGPA	203	0.00	0.11	-0.23	0.04	-1.23	8.44	301.45	0.00
ΔLNCLP	203	0.00	0.15	-0.07	0.03	1.04	7.84	235.17	0.00

The unit root tests are conducted using the automated Dickey-Fuller (ADF) tests (Dickey and Fuller 1979, 1981), while the stationarity tests are conducted using the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests (Kwiatkowski et al. 1992).

Table 3A displays the results of the unit root tests and the stationary tests for these variables. The results are mixed regarding swap yields, while PDBC rates are stationary with the intercept and trend inclusion in the test equation for an ADF unit root test but nonstationary otherwise. Similar mixed results are obtained in the KPSS stationary tests. Among the control variables, only the growth of industrial production yielded a stationary result in both types of tests. Other control variables are either nonstationary or show mixed results under different assumptions.

Table 3A. Unit Root and Stationarity Tests of the Variables

	ADF Unit Root Tests (H_0: Nonstationary)			KPSS Tests (H_0: Stationarity) tests	
	None	Intercept	Trend	Intercept	Trend
SWAP2Y	– 0.79	– 2.57	– 3.49**	1.11***	0.05
SWAP5Y	– 0.62	– 2.16	– 3.61**	1.42***	0.05
SWAP10Y	– 0.66	– 2.13	– 3.88**	1.52***	0.05
PDBC30D	– 1.00	– 2.67*	– 2.96*	0.60**	0.08
PDBC90D	– 1.17	– 3.21**	– 3.70**	0.65**	0.05
CPIYOY	– 0.53	– 2.38	– 2.27	0.10	0.05
COREYOY	0.82	– 0.99	– 1.26	0.37	0.20**
IPYOY	– 3.38***	– 3.50***	– 3.50**	0.07	0.07
LNIGPA	– 1.47	– 2.39	– 1.78	1.32***	0.24***
LNCLP	– 0.79	– 0.67	– 2.51	1.27***	0.28***

Note: Significance levels *** for 1 percent, ** for 5 percent, and * for 10 percent

Table 3B presents the unit root and the stationarity tests for the first differences of the variables. All the ADF unit root tests indicate the null hypothesis on nonstationarity can be rejected at the 1 percent level of significance for the first differences of all variables. The KPSS tests show that the null hypothesis of stationarity cannot be rejected for the first differences of these variables (except for the growth of industrial production at 10 percent significance under trend inclusion).

Table 3B. Unit Root and Stationarity Tests of the First Differences of the Variables

	ADF Unit Root Test (H_0: Nonstationary)			KPSS Test (H_0: Stationarity)	
	None	Intercept	Trend	Intercept	Trend
ΔSWAP2Y	– 7.11***	– 7.09***	– 7.09***	0.08	0.07
ΔSWAP5Y	– 8.43***	– 8.41***	– 8.40***	0.09	0.08
ΔSWAP10Y	– 8.96***	– 8.94***	– 8.93***	0.08	0.06
ΔPDBC30D	– 7.27***	– 7.24***	– 7.24***	0.05	0.05
ΔPDBC90D	– 5.31***	– 5.30***	– 5.28***	0.06	0.06
ΔCPIYOY	– 6.06***	– 6.06***	– 6.06***	0.06	0.05
ΔCOREYOY	– 5.90***	– 6.09***	– 6.07***	0.20	0.19
ΔIPYOY	– 15.92***	– 15.88***	– 10.15***	0.45	0.50*
ΔLNIGPA	– 12.16***	– 12.25***	– 12.36***	0.26	0.05
ΔLNCLP	– 10.28***	– 10.31***	– 10.39***	0.19	0.03

Note: Significance levels *** for 1 percent, ** for 5 percent, and * for 10 percent

The unit root tests and the stationary tests imply that it is appropriate to econometrically model the month-over-month change in the swap yield using month-over-month change in the short-term interest rate, change in inflation, change in the growth of industrial production, change in the log of the equity price index, and change in the exchange rate.

VI. ECONOMETRIC MODELS AND EMPIRICAL RESULTS

The autoregressive conditional heteroskedasticity (ARCH) Lagrange multiplier (LM) tests on ordinary least square (OLS) regressions of swap yield models are conducted to ascertain whether an ARCH framework is a suitable approach for econometrically modeling the dynamics of the swap yield. These models and their generalized version (GACRH) are specifically designed to model and forecast conditional variances.

ARCH models were introduced by Engle (1982) and GARCH by Bollerslev (1986) and Taylor (1986).[2] In ARCH and GARCH models, the variance of the dependent variable is a function of the past values of the dependent variable and independent, or exogenous, variables. This allows the analyst to model volatility over time.

[2] For additional background information, including the econometric theory and some applications, see Bollerslev, Chou, and Kroner (1992) and Bollerslev, Engle, and Nelson (1994). These two papers provide comprehensive surveys of ACRH and GARCH models and their applications.

The ARCH LM tests are given in table 4. The tests show that the presence of ARCH in the OLS regression models of the month-over-month change in the swap yield of different maturity tenors. These results clearly indicate that an ARCH-type model will be useful for estimating the relationship between the month-over-month change in the swap yield and the month-over-month change in the short-term interest rate in Chile, after controlling for other factors, by modeling the volatility.

Table 4. ARCH LM Test

Models	ΔSWAP2Y	ΔSWAP5Y	ΔSWAP10Y	ΔSWAP2Y	ΔSWAP5Y	ΔSWAP10Y
Lags	ΔPDBC30D			ΔPDBC90D		
1	9.23 (0.00)	7.25 (0.01)	13.85 (0.00)	15.71 (0.00)	9.91 (0.00)	13.38 (0.00)
4	5.14 (0.00)	5.77 (0.00)	6.31 (0.00)	7.73 (0.03)	5.83 (0.00)	6.60 (0.00)
8	2.72 (0.01)	4.05 (0.00)	3.96 (0.00)	4.23 (0.00)	4.33 (0.00)	4.00 (0.00)
12	1.91 (0.04)	2.73 (0.00)	2.84 (0.00)	2.89 (0.00)	3.23 (0.00)	2.96 (0.00)

Note: OLS model includes the change in the short-term interest rate (ΔPDBC30D, ΔPDBC9oD) and the controls (namely ΔCPIYOY, ΔIPYOY, ΔLNIGPA, and ΔLNCLP). *p*-values are in parenthesis.

To address these issues and allow the conditional variance of the error term to depend upon its previous own lags, the following standard GARCH(1,1) model is used here to econometrically analyze the dynamic of the swap yield.

$$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t \quad [5]$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma_1 \sigma_{t-1}^2 \quad [6]$$

Here the current volatility of the error term is explained by the long-run average variance (α_0), the past values of the shocks, and the history of volatility.

The following GARCH(1,1) models are estimated as specified below:

$$\Delta SWAP2Y = \varphi^1(C, \Delta PDBC90D, AR(1)) \quad [7]$$

$$\Delta SWAP2Y = \varphi^2(C, \Delta PDBC90D, \Delta CPIYOY, \Delta IPYOY, AR(1)) \quad [8]$$

$$\Delta SWAP2Y = \varphi^3(C, \Delta PDBC90D, \Delta CPIYOY, \Delta IPYOY, \Delta LNIGPA, \Delta LNCLP, AR(1)) \quad [9]$$

$$\Delta SWAP5Y = \varphi^4(C, \Delta PDBC90D, AR(1)) \quad [10]$$

$$\Delta SWAP5Y = \varphi^5(C, \Delta PDBC90D, \Delta CPIYOY, \Delta IPYOY, AR(1)) \quad [11]$$

$$\Delta SWAP5Y = \varphi^6(C, \Delta PDBC90D, \Delta CPIYOY, \Delta IPYOY, \Delta LNIGPA, \Delta LNCLP, AR(1)) \quad [12]$$

$$\Delta SWAP10Y = \varphi^7(C, \Delta PDBC90D, AR(1)) \quad [13]$$

$$\Delta SWAP10Y = \varphi^8(C, \Delta PDBC90D, \Delta CPIYOY, \Delta IPYOY, AR(1)) \quad [14]$$

$$\Delta SWAP10Y = \varphi^9(C, \Delta PDBC90D, \Delta CPIYOY, \Delta IPYOY, \Delta LNIGPA, \Delta LNCLP, AR(1)) \quad [15]$$

$$\Delta SWAP2Y = \psi^1(C, \Delta PDBC30D, AR(1)) \quad [16]$$

$$\Delta SWAP2Y = \psi^2(C, \Delta PDBC30D, \Delta CPIYOY, \Delta IPYOY, AR(1)) \quad [17]$$

$$\Delta SWAP2Y = \psi^3(C, \Delta PDBC30D, \Delta CPIYOY, \Delta IPYOY, \Delta LNIGPA, \Delta LNCLP, AR(1)) \quad [18]$$

$$\Delta SWAP5Y = \psi^4(C, \Delta PDBC30D, AR(1)) \quad [19]$$

$$\Delta SWAP5Y = \psi^5(C, \Delta PDBC30D, \Delta CPIYOY, \Delta IPYOY, AR(1)) \quad [20]$$

$$\Delta SWAP5Y = \psi^6(C, \Delta PDBC30D, \Delta CPIYOY, \Delta IPYOY, \Delta LNIGPA, \Delta LNCLP, AR(1)) \quad [21]$$

$$\Delta SWAP10Y = \psi^7(C, \Delta PDBC30D, AR(1)) \quad [22]$$

$$\Delta SWAP10Y = \psi^8(C, \Delta PDBC30D, \Delta CPIYOY, \Delta IPYOY, AR(1)) \quad [23]$$

$$\Delta SWAP10Y = \psi^9(C, \Delta PDBC30D, \Delta CPIYOY, \Delta IPYOY, \Delta LNIGPA, \Delta LNCLP, AR(1)) \quad [24]$$

The main results for the GARCH(1,1) models are presented in table 5A and table 5B using ΔPDBC90D and ΔPDBC30D respectively as the month-over-month change in the short-term interest rate. The swap rates for two, five and ten years are modeled by adding various control variables (namely ΔCPIYOY, ΔIPYOY, ΔLNIGPA, and ΔLNCLP). An autoregressive term (AR(1)) is added to control for the autocorrelation in the models. Model diagnostic information and the results of postestimation diagnostic tests are also displayed in these tables. The correlograms (autocorrelations and partial autocorrelations) of the standardized residuals from the estimated GARCH(1,1) models with ΔPDBC90D and ΔPDBC30D, respectively, are provided in appendix A and appendix B.

In the mean equation of table 5A, the effect of ΔPDBC90D on ΔSWAP2Y and ΔSWAP5Y is positive and statistically significant. However, its effect on ΔSWAP10Y is positive but not statistically significant. This means that the change in the short-term interest rate has clear, definitive, and statistically significant effects on the frontend and the belly of the interbank swap yield curve but not on the backend of the swap yield curve. The effects of ΔCPIYOY and ΔIPYOY on the swap yield of different maturity tenors are positive but mostly not statistically significant. Among the control variables, the change in the log of the Chilean equity price index has a positive and statistically significant effect on the change in the swap yield of all maturity tenors. This means as that a rise (fall) in the equity price index is associated with an increase (decline) in the swap yields of different maturities. The results also show the change in the log of the exchange rate of the Chilean peso against the US dollar has a positive and statistically significant effect on ΔSWAP5Y and ΔSWAP10Y. However, its effect on ΔSWAP2Y is negative but not statistically significant. The AR(1) term has positive and statistically significant effect on the swap yield of all three maturity tenors.

The parameters in the variance equation are statistically significant. The significant ARCH coefficient implies that a volatility shock today feeds into the next month's volatility. The significant GARCH coefficient indicates a large shock (either positive or negative) will lead to a large variance in the forecast for a long period of time. The sum of the ARCH and the GARCH coefficients measures the rate at which the volatility effect fades over time. Since the sum is high, the shocks to the conditional variance are persistent and clustered over time.

Table 5B shows that ΔPDBC30D has pretty much the same effect as that of ΔPDBC90D on the swap yield of different maturity tenors. The effect of ΔPDBC30D on not just ΔSWAP2Y and ΔSWAP5Y but also on ΔSWAP10Y is positive and statistically significant. However, the effect's magnitude on the change in the swap yields of longer maturity tenors is smaller. The effects of ΔCPIYOY and ΔIPYOY on the swap yield of different tenors are positive but mostly not statistically significant. The effect of ΔLNIGPA on the swap yield is always positive and statistically significant while the effect of ΔLNCLP on the swap yield is always positive and sometimes statistically significant. The effect of the AR(1) term is always positive and statistically significant.

In the models with ΔPDBC30D, the ARCH and the GACRH coefficients in the variance equation are both statistically significant. The sum of the two coefficients is closer to one than in the models presented earlier in table 5A. This indicates strong evidence of the persistence and clustering of the variance in the error terms. Here, too, the positive and statistically significant ARCH coefficient implies that a volatility shock today feeds into the next month's volatility. The positive and statistically significant GARCH coefficient indicates a large shock (either positive or negative) will lead to a large variance in the forecast for a long period of time.

It is useful to have some perspective on the financial market volatility that can affect the interbank swap yields and financial conditions in Chile. Chile is a high-income emerging market but it is subject to financial shocks, international trade slowdowns, and global economic pressures. Exports of goods and services account for nearly one-third of the country's nominal GDP. Commodities make up nearly 60 percent of Chile's total exports. Copper is the country's main export, providing around 20 percent of government revenue. Due to the high share of exports in nominal GDP and its dependence on the revenue from the export of copper, Chile's financial markets and its economy can exhibit volatility emanating from the uncertainty regarding fluctuations in commodity prices (especially the international price of copper) and global industrial production, as well as turbulence in overseas financial markets and economic shocks.

Postestimation tests for these models show support for the GARCH approach to the econometric modeling of the swap yield of various maturity tenors as evinced by the ARCH LM tests. The models do not have any autocorrelation problems and the standardized residuals are normally distributed. The correlograms in appendix A and appendix B show that there is no remaining autocorrelation in the mean equation and that the chosen models are correctly specified.

The models are re-estimated by replacing inflation with core inflation as a control variable. The results, which are displayed in appendix C, are comparable to the original models.

Table 5A. GARCH (1,1) Model (with ΔPDBC90D)

	ΔSWAP2Y	ΔSWAP2Y	ΔSWAP2Y	ΔSWAP5Y	ΔSWAP5Y	ΔSWAP5Y	ΔSWAP10Y	ΔSWAP10Y	ΔSWAP10Y
Mean Equation									
Intercept	–0.01 (0.84)	–0.01 (0.83)	–0.01 (0.71)	–0.005 (0.83)	–0.01 (0.72)	–0.01 (0.54)	–0.003 (0.84)	–0.005 (0.82)	–0.01 (0.64)
ΔPDBC90D	0.29 (0.00)	0.29 (0.00)	0.31 (0.00)	0.13 (0.00)	0.12 (0.00)	0.13 (0.00)	0.05 (0.24)	0.04 (0.31)	0.04 (0.35)
ΔCPIYOY		0.02 (0.61)	0.02 (0.57)		0.03 (0.31)	0.02 (0.53)		0.02 (0.48)	0.01 (0.81)
ΔIPYOY		0.004 (0.07)	0.003 (0.14)		0.003 (0.25)	0.002 (0.35)		0.002 (0.20)	0.002 (0.18)
ΔLNIGPA			0.81 (0.01)			0.80 (0.03)			0.43 (0.27)
ΔLNCLP			– 0.18 (0.73)			0.98 (0.05)			1.55 (0.00)
AR(1)	0.41 (0.00)	0.40 (0.00)	0.38 (0.00)	0.33 (0.00)	0.33 (0.00)	0.34 (0.00)	0.37 (0.00)	0.35 (0.00)	0.37 (0.00)
Variance Equation									
Intercept	0.01 (0.15)	0.01 (0.16)	0.01 (0.15)	0.01 (0.20)	0.01 (0.21)	0.01 (0.23)	0.01 (0.13)	0.005 (0.13)	0.004 (0.17)
ARCH	0.13 (0.03)	0.15 (0.03)	0.19 (0.04)	0.13 (0.08)	0.13 (0.07)	0.14 (0.08)	0.13 (0.01)	0.13 (0.01)	0.14 (0.02)
GARCH	0.73 (0.00)	0.70 (0.00)	0.67 (0.00)	0.72 (0.00)	0.75 (0.00)	0.75 (0.00)	0.71 (0.00)	0.74 (0.00)	0.77 (0.00)
Model Information									
Obs	202	202	202	202	202	202	202	202	202
Adj R^2	0.43	0.43	0.44	0.26	0.25	0.26	0.19	0.18	0.19
AIC	– 0.14	– 0.13	– 0.14	– 0.20	– 0.19	– 0.19	– 0.35	– 0.34	– 0.36
Diagnostic Tests									
ARCH LM (12 lags)	0.76 (0.69)	0.88 (0.57)	1.06 (0.40)	0.93 (0.51)	0.85 (0.60)	0.67 (0.77)	0.67 (0.78)	0.54 (0.88)	0.42 (0.95)
DW Stat	1.88	1.90	1.90	1.80	1.82	1.82	1.84	1.85	1.82
JQB	46.69 (0.00)	33.78 (0.00)	18.39 (0.00)	13.96 (0.00)	13.61 (0.00)	11.09 (0.00)	7.25 (0.03)	6.73 (0.04)	6.28 (0.05)

Note: all vars are in diff, *p*-values are in parenthesis

Table 5B. GARCH (1,1) Model (with ΔPDBC30D)

	ΔSWAP2Y	ΔSWAP2Y	ΔSWAP2Y	ΔSWAP5Y	ΔSWAP5Y	ΔSWAP5Y	ΔSWAP10Y	ΔSWAP10Y	ΔSWAP10Y
Mean Equation									
Intercept	–0.003 (0.89)	–0.004 (0.86)	–0.01 (0.75)	–0.002 (0.92)	–0.005 (0.82)	–0.01 (0.56)	–0.004 (0.85)	–0.01 (0.76)	–0.01 (0.64)
ΔPDBC30D	0.38 (0.00)	0.38 (0.00)	0.38 (0.00)	0.23 (0.00)	0.23 (0.00)	0.25 (0.00)	0.14 (0.00)	0.14 (0.00)	0.04 (0.35)
ΔCPIYOY		0.02 (0.51)	0.02 (0.50)		0.05 (0.13)	0.03 (0.35)		0.03 (0.33)	0.01 (0.81)
ΔIPYOY		0.003 (0.15)	0.002 (0.19)		0.002 (0.26)	0.002 (0.33)		0.002 (0.19)	0.002 (0.18)
ΔLNIGPA			0.79 (0.01)			0.82 (0.03)			0.43 (0.27)
ΔLNCLP			0.40 (0.50)			1.42 (0.02)			1.55 (0.00)
AR(1)	0.39 (0.00)	0.38 (0.00)	0.37 (0.00)	0.34 (0.00)	0.32 (0.00)	0.34 (0.00)	0.35 (0.00)	0.33 (0.00)	0.37 (0.00)
Variance Equation									
Intercept	0.002 (0.13)	0.002 (0.17)	0.002 (0.17)	0.003 (0.30)	0.002 (0.22)	0.002 (0.28)	0.004 (0.17)	0.002 (0.18)	0.004 (0.17)
ARCH	0.08 (0.03)	0.09 (0.04)	0.10 (0.04)	0.08 (0.08)	0.08 (0.03)	0.09 (0.06)	0.11 (0.03)	0.11 (0.02)	0.14 (0.02)
GARCH	0.88 (0.00)	0.87 (0.00)	0.84 (0.00)	0.85 (0.00)	0.88 (0.00)	0.87 (0.00)	0.79 (0.00)	0.84 (0.00)	0.77 (0.00)
Model Information									
Obs	202	202	202	202	202	202	202	202	202
Adj R^2	0.47	0.47	0.48	0.31	0.30	0.31	0.22	0.21	0.19
AIC	– 0.21	– 0.20	– 0.21	– 0.24	– 0.23	– 0.25	– 0.37	– 0.37	– 0.36
Diagnostic Tests									
ARCH LM (12 lags)	1.46 (0.14)	1.56 (0.11)	1.09 (0.37)	0.46 (0.93)	0.49 (0.92)	0.34 (0.98)	0.51 (0.90)	0.41 (0.96)	0.67 (0.79)
DW Stat	1.88	1.90	1.88	1.80	1.82	1.80	1.82	1.81	1.82
JQB	9.36 (0.01)	8.59 (0.01)	4.60 (0.10)	12.60 (0.00)	11.72 (0.00)	7.22 (0.03)	4.95 (0.08)	4.04 (0.13)	6.28 (0.05)

Note: all vars are in diff, *p*-values are in parenthesis

VII. THE IMPLICATIONS OF THE EMPIRICAL FINDINGS

The empirical findings reported in this paper have consequential implications for macroeconomic and financial theory, monetary policy, banking regulations, asset allocation, and risk management.

First, the findings show that the BCCH's actions on its policy rate and other monetary policy measures can have a noticeable effect on the interbank swap yield through the changes in the short-term interest rate. An increase (decrease) in the short-term interest rate is associated with the rise (fall) in the swap yield. This shows that the BCCH's monetary policy can have a powerful impact on the financial conditions of financial institutions and other enterprises, as well as on the financial system.

Second, the empirical findings show that a rise (decline) in inflation and the growth of industrial production is usually associated with a higher (lower) swap yield, even though these effects are not statistically significant. This means that when the effective demand increases (decreases), which is often associated with inflation and the growth of industrial production, the interbank swap yield will tend to rise (fall).

Third, the findings associate the rise (decline) of the log of the equity price index with a higher (lower) swap yield. This implies that the swap buyer will receive a higher (lower) variable interest payments on swaps when financial markets are buoyant (sluggish) and rising (declining).

Fourth, the findings also relate the depreciation (appreciation) of the log of the exchange rate (the Chilean peso per US dollar) to a higher (lower) swap yield. This means that as the Chilean peso depreciates (appreciates) the buyer of the interest rate swap will receive a higher (lower) variable interest payment from the seller of the interest rate swap.

The empirical findings of the paper reinforce the view that the central bank can exert enormous influence on financial markets. The findings also support the notion that the central bank's actions influence the pricing of fixed income securities and derivatives, such as interbank interest rate swaps, through its monetary policy (Bindseil 2004; Fullwiler [2008] 2017).

VIII. CONCLUSION

The empirical analysis reveals that the month-over-month change in the short-term interest rate has an economically and statistically significant effect on the month-over-month change in the interbank swap yield of different maturity tenors after controlling for the month-over-month changes in several important macroeconomic and financial variables, such as inflation, the growth of industrial production, the logarithm of the equity price index, and the logarithm of the exchange rate. This shows that the central bank's monetary policy action, through its effect on the change in the short-term interest rate, influences the interbank swap yield. This finding demonstrates the central bank's ability to influence financial institutions' borrowing and lending rates over different time horizons. Given the growing importance of interbank interest rate swaps and other derivatives on the banking industry, financial intermediation, financial markets, and corporate finance, it is a substantive finding with implications for monetary policy, bank regulations, asset allocation, and risk management. This finding has repercussions for the private sector's marginal efficiency of capital, investment decisions, profitability, and leveraging decisions.

There is a paucity of literature on the empirical modeling of the interbank swap yield. The findings of this paper illuminate the macroeconomic and financial factors that produce interbank swap yield dynamics. These findings are not only germane to understanding such dynamics in Chile and other Latin American countries, but also elsewhere in both emerging markets and advanced countries. It is hoped that these findings with generate more detailed empirical studies of swap yields in other emerging markets and advanced countries and advance the empirical modeling of long-term swap yields.

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APPENDIX A: CORRELOGRAMS FOR GARCH(1,1) MODELS WITH ΔPDBC90D

Table A1. ΔSWAP2Y = φ^{1}(C, ΔPDBC90D, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.050	0.050	0.5081	
		2	-0.014	-0.017	0.5485	0.459
		3	0.071	0.072	1.5782	0.454
		4	-0.010	-0.018	1.6011	0.659
		5	-0.039	-0.036	1.9232	0.750
		6	-0.008	-0.010	1.9368	0.858
		7	-0.063	-0.062	2.7716	0.837
		8	-0.008	0.004	2.7846	0.904
		9	0.014	0.012	2.8236	0.945
		10	0.002	0.008	2.8241	0.971
		11	-0.027	-0.029	2.9776	0.982
		12	0.009	0.005	2.9949	0.991
		13	-0.027	-0.030	3.1519	0.994
		14	0.039	0.044	3.4870	0.996
		15	0.004	-0.003	3.4908	0.998
		16	-0.115	-0.112	6.4210	0.972
		17	-0.119	-0.116	9.5930	0.887
		18	-0.067	-0.068	10.601	0.877
		19	-0.044	-0.024	11.035	0.893
		20	-0.023	-0.011	11.154	0.919
		21	0.060	0.066	11.968	0.917
		22	-0.143	-0.164	16.622	0.734
		23	0.004	-0.002	16.627	0.784
		24	-0.068	-0.114	17.685	0.774
		25	-0.044	-0.021	18.129	0.797
		26	0.089	0.092	19.969	0.748
		27	-0.041	-0.060	20.368	0.774
		28	-0.067	-0.066	21.417	0.766
		29	0.014	-0.041	21.463	0.806
		30	0.120	0.131	24.888	0.684
		31	0.104	0.120	27.484	0.598
		32	0.002	-0.004	27.485	0.648
		33	0.017	-0.037	27.553	0.691
		34	0.028	-0.026	27.742	0.726
		35	0.069	0.039	28.924	0.715
		36	0.072	0.103	30.210	0.699

Table A2. ΔSWAP2Y = φ^2(C, ΔPDBC90D, ΔCPIYOY, ΔIPYOY, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.047	0.047	0.4557	
		2	-0.026	-0.028	0.5955	0.440
		3	0.084	0.087	2.0513	0.359
		4	-0.022	-0.031	2.1502	0.542
		5	-0.026	-0.018	2.2885	0.683
		6	-0.009	-0.016	2.3067	0.805
		7	-0.066	-0.062	3.2261	0.780
		8	-0.002	0.007	3.2269	0.863
		9	-0.003	-0.007	3.2294	0.919
		10	0.024	0.035	3.3553	0.949
		11	-0.038	-0.046	3.6701	0.961
		12	0.010	0.015	3.6923	0.978
		13	-0.012	-0.023	3.7234	0.988
		14	0.033	0.040	3.9563	0.992
		15	0.005	-0.003	3.9609	0.996
		16	-0.105	-0.104	6.4171	0.972
		17	-0.129	-0.125	10.151	0.859
		18	-0.066	-0.069	11.131	0.850
		19	-0.040	-0.021	11.484	0.873
		20	-0.019	-0.007	11.568	0.903
		21	0.061	0.072	12.412	0.901
		22	-0.147	-0.171	17.337	0.690
		23	0.002	0.004	17.339	0.744
		24	-0.064	-0.121	18.279	0.742
		25	-0.044	-0.013	18.740	0.766
		26	0.089	0.086	20.606	0.714
		27	-0.035	-0.045	20.899	0.747
		28	-0.084	-0.084	22.557	0.709
		29	0.032	-0.022	22.794	0.743
		30	0.101	0.117	25.215	0.667
		31	0.106	0.116	27.920	0.575
		32	-0.003	0.006	27.922	0.625
		33	0.016	-0.046	27.983	0.670
		34	0.027	-0.025	28.157	0.707
		35	0.064	0.034	29.182	0.703
		36	0.066	0.094	30.271	0.696

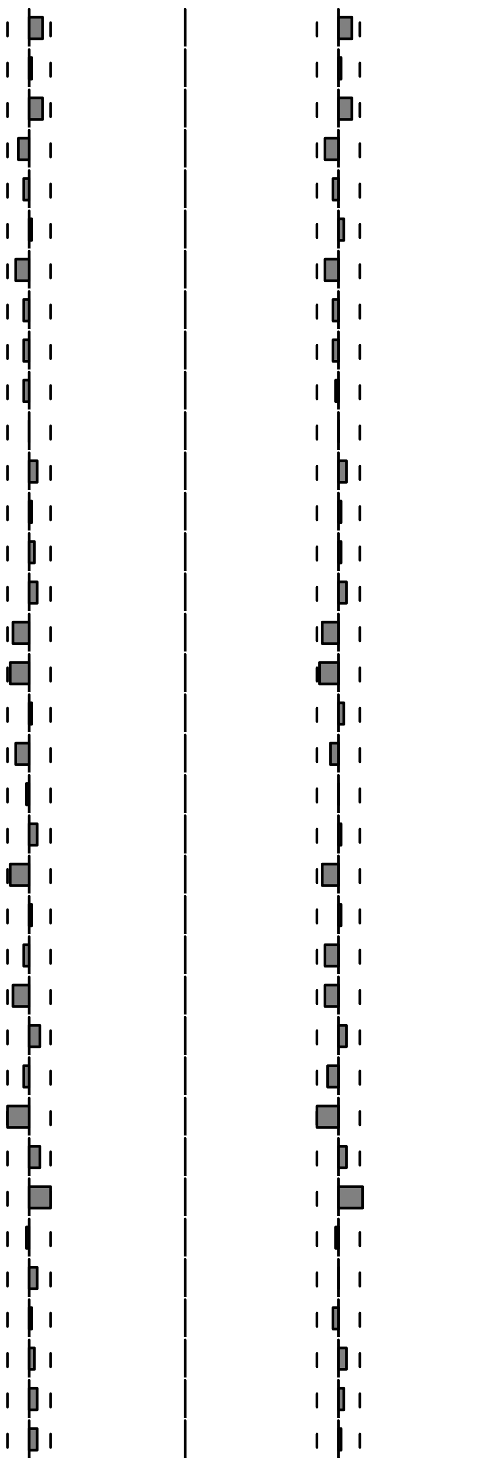
Table A3. ΔSWAP2Y = φ^3(C, ΔPDBC90D, ΔCPIYOY, ΔIPYOY, ΔLNIGPA, ΔLNCLP, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.059	0.059	0.7216	
		2	-0.040	-0.043	1.0479	0.306
		3	0.086	0.091	2.5685	0.277
		4	-0.021	-0.034	2.6598	0.447
		5	-0.047	-0.036	3.1195	0.538
		6	0.005	0.001	3.1255	0.681
		7	-0.069	-0.070	4.1449	0.657
		8	-0.008	0.008	4.1596	0.761
		9	-0.007	-0.016	4.1698	0.841
		10	0.018	0.031	4.2403	0.895
		11	-0.071	-0.080	5.3318	0.868
		12	0.022	0.031	5.4340	0.908
		13	-0.011	-0.027	5.4614	0.941
		14	0.016	0.031	5.5203	0.962
		15	0.030	0.019	5.7138	0.973
		16	-0.113	-0.122	8.5466	0.900
		17	-0.118	-0.100	11.644	0.768
		18	-0.040	-0.056	11.997	0.800
		19	-0.040	-0.016	12.361	0.828
		20	-0.031	-0.023	12.577	0.860
		21	0.082	0.089	14.119	0.824
		22	-0.133	-0.168	18.191	0.637
		23	0.002	0.021	18.192	0.695
		24	-0.086	-0.156	19.909	0.647
		25	-0.045	-0.004	20.374	0.675
		26	0.081	0.077	21.908	0.641
		27	-0.011	-0.041	21.934	0.692
		28	-0.079	-0.070	23.396	0.664
		29	0.029	-0.029	23.601	0.702
		30	0.122	0.140	27.191	0.561
		31	0.106	0.094	29.917	0.470
		32	-0.017	0.001	29.985	0.518
		33	0.038	-0.038	30.332	0.551
		34	-0.011	-0.042	30.362	0.599
		35	0.067	0.050	31.485	0.592
		36	0.101	0.110	34.013	0.516

Table A4. ΔSWAP5Y = φ^4(C, ΔPDBC90D, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.091	0.091	1.7133	
		2	0.035	0.027	1.9643	0.161
		3	0.055	0.050	2.5992	0.273
		4	-0.066	-0.077	3.5013	0.321
		5	-0.058	-0.049	4.2078	0.379
		6	0.027	0.039	4.3646	0.498
		7	-0.091	-0.087	6.1002	0.412
		8	-0.063	-0.049	6.9503	0.434
		9	-0.012	-0.008	6.9816	0.539
		10	-0.046	-0.031	7.4440	0.591
		11	0.002	0.007	7.4447	0.683
		12	0.056	0.041	8.1170	0.703
		13	0.007	0.002	8.1291	0.775
		14	0.031	0.018	8.3348	0.821
		15	0.080	0.061	9.7593	0.780
		16	-0.114	-0.128	12.663	0.628
		17	-0.122	-0.115	15.989	0.454
		18	0.004	0.023	15.993	0.524
		19	-0.092	-0.060	17.883	0.463
		20	-0.008	0.009	17.898	0.529
		21	0.046	0.026	18.378	0.562
		22	-0.128	-0.119	22.104	0.394
		23	0.026	0.037	22.255	0.445
		24	-0.047	-0.091	22.768	0.474
		25	-0.104	-0.094	25.297	0.390
		26	0.069	0.060	26.423	0.385
		27	-0.046	-0.089	26.929	0.413
		28	-0.137	-0.120	31.381	0.256
		29	0.052	0.049	32.020	0.274
		30	0.159	0.172	38.079	0.121
		31	-0.008	-0.012	38.093	0.147
		32	0.052	-0.011	38.747	0.160
		33	0.017	-0.036	38.815	0.189
		34	0.038	0.068	39.162	0.213
		35	0.068	0.036	40.313	0.211
		36	0.059	0.015	41.168	0.219

Table A5. ΔSWAP5Y = φ^5(C, ΔPDBC90D, ΔCPIYOY, ΔIPYOY, AR(1))



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.086	0.086	1.5305	
		2	0.021	0.013	1.6176	0.203
		3	0.085	0.083	3.1069	0.212
		4	-0.081	-0.096	4.4565	0.216
		5	-0.048	-0.036	4.9409	0.293
		6	0.024	0.027	5.0597	0.409
		7	-0.093	-0.084	6.9028	0.330
		8	-0.049	-0.035	7.4118	0.387
		9	-0.032	-0.035	7.6281	0.471
		10	-0.040	-0.016	7.9656	0.538
		11	0.000	0.001	7.9657	0.632
		12	0.054	0.046	8.5973	0.659
		13	0.024	0.016	8.7199	0.727
		14	0.038	0.022	9.0376	0.770
		15	0.063	0.044	9.9057	0.769
		16	-0.099	-0.114	12.099	0.672
		17	-0.130	-0.124	15.868	0.462
		18	0.016	0.033	15.925	0.529
		19	-0.090	-0.061	17.732	0.473
		20	-0.021	0.003	17.829	0.534
		21	0.043	0.024	18.250	0.571
		22	-0.118	-0.102	21.433	0.433
		23	0.012	0.021	21.467	0.492
		24	-0.048	-0.093	21.997	0.520
		25	-0.109	-0.093	24.741	0.420
		26	0.071	0.050	25.920	0.412
		27	-0.040	-0.072	26.295	0.447
		28	-0.153	-0.143	31.852	0.238
		29	0.066	0.061	32.904	0.239
		30	0.137	0.161	37.415	0.136
		31	-0.015	-0.018	37.468	0.164
		32	0.055	-0.005	38.214	0.174
		33	0.024	-0.031	38.357	0.203
		34	0.028	0.052	38.552	0.233
		35	0.065	0.036	39.609	0.234
		36	0.059	0.025	40.470	0.242

Table A6. ΔSWAP5Y = φ^{6}(C, ΔPDBC90D, ΔCPIYOY, ΔIPYOY, ΔLNIGPA, ΔLNCLP, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.090	0.090	1.6652	
		2	0.000	-0.008	1.6652	0.197
		3	0.086	0.087	3.1959	0.202
		4	-0.076	-0.093	4.3825	0.223
		5	-0.045	-0.029	4.8094	0.307
		6	0.036	0.035	5.0825	0.406
		7	-0.075	-0.069	6.2743	0.393
		8	-0.036	-0.022	6.5447	0.478
		9	-0.039	-0.049	6.8762	0.550
		10	-0.038	-0.014	7.1911	0.617
		11	-0.041	-0.042	7.5623	0.672
		12	0.031	0.036	7.7751	0.733
		13	0.030	0.024	7.9651	0.788
		14	0.015	0.008	8.0173	0.842
		15	0.070	0.057	9.1086	0.824
		16	-0.106	-0.130	11.582	0.710
		17	-0.124	-0.103	15.029	0.523
		18	0.020	0.022	15.118	0.587
		19	-0.077	-0.059	16.460	0.560
		20	-0.003	0.019	16.462	0.626
		21	0.049	0.017	17.012	0.652
		22	-0.094	-0.079	19.055	0.582
		23	0.002	0.011	19.056	0.642
		24	-0.050	-0.084	19.637	0.664
		25	-0.113	-0.094	22.601	0.543
		26	0.058	0.048	23.394	0.555
		27	-0.009	-0.043	23.414	0.609
		28	-0.145	-0.148	28.395	0.391
		29	0.070	0.076	29.563	0.384
		30	0.132	0.135	33.740	0.249
		31	-0.018	-0.017	33.822	0.288
		32	0.024	-0.021	33.959	0.327
		33	0.045	-0.017	34.460	0.351
		34	0.023	0.044	34.589	0.392
		35	0.064	0.038	35.612	0.392
		36	0.088	0.047	37.550	0.353

Table A7. ΔSWAP10Y = φ^{7}(C, ΔPDBC90D, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.087	0.087	1.5388	
		2	0.008	0.000	1.5511	0.213
		3	0.017	0.016	1.6108	0.447
		4	-0.072	-0.075	2.6895	0.442
		5	-0.062	-0.050	3.5057	0.477
		6	0.001	0.010	3.5057	0.623
		7	-0.096	-0.095	5.4510	0.487
		8	-0.072	-0.060	6.5511	0.477
		9	-0.012	-0.010	6.5840	0.582
		10	-0.056	-0.055	7.2602	0.610
		11	0.064	0.064	8.1346	0.616
		12	0.035	0.005	8.4065	0.676
		13	0.006	-0.003	8.4148	0.752
		14	-0.026	-0.046	8.5658	0.805
		15	0.084	0.083	10.122	0.753
		16	-0.027	-0.037	10.283	0.802
		17	-0.078	-0.086	11.656	0.767
		18	0.009	0.021	11.676	0.819
		19	-0.072	-0.059	12.859	0.800
		20	-0.023	-0.004	12.978	0.840
		21	0.023	0.010	13.094	0.873
		22	-0.137	-0.146	17.420	0.685
		23	0.095	0.125	19.479	0.616
		24	-0.039	-0.100	19.840	0.652
		25	-0.130	-0.115	23.770	0.475
		26	0.056	0.046	24.504	0.490
		27	-0.062	-0.110	25.409	0.496
		28	-0.080	-0.047	26.934	0.467
		29	0.053	0.020	27.598	0.486
		30	0.109	0.095	30.425	0.393
		31	0.027	0.011	30.603	0.435
		32	0.071	0.018	31.821	0.425
		33	-0.053	-0.059	32.504	0.442
		34	0.032	0.037	32.754	0.479
		35	0.048	0.039	33.333	0.500
		36	0.062	0.050	34.283	0.503

Table A8. ΔSWAP10Y = φ^8(C, ΔPDBC90D, ΔCPIYOY, ΔIPYOY, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.088	0.088	1.5812	
		2	-0.002	-0.010	1.5821	0.208
		3	0.040	0.041	1.9074	0.385
		4	-0.089	-0.097	3.5497	0.314
		5	-0.046	-0.029	3.9946	0.407
		6	-0.007	-0.004	4.0053	0.549
		7	-0.097	-0.090	5.9826	0.425
		8	-0.061	-0.051	6.7825	0.452
		9	-0.033	-0.033	7.0189	0.535
		10	-0.041	-0.032	7.3795	0.598
		11	0.063	0.058	8.2351	0.606
		12	0.033	0.008	8.4781	0.670
		13	0.018	0.009	8.5498	0.741
		14	-0.023	-0.048	8.6621	0.798
		15	0.069	0.075	9.7227	0.782
		16	-0.010	-0.026	9.7451	0.835
		17	-0.092	-0.095	11.640	0.768
		18	0.024	0.036	11.765	0.814
		19	-0.077	-0.069	13.091	0.786
		20	-0.029	0.001	13.277	0.824
		21	0.024	0.006	13.404	0.859
		22	-0.134	-0.134	17.500	0.680
		23	0.080	0.106	18.982	0.646
		24	-0.041	-0.099	19.368	0.680
		25	-0.130	-0.107	23.288	0.503
		26	0.055	0.032	24.002	0.519
		27	-0.055	-0.090	24.725	0.535
		28	-0.091	-0.066	26.688	0.481
		29	0.060	0.024	27.537	0.489
		30	0.093	0.092	29.624	0.433
		31	0.023	-0.006	29.755	0.478
		32	0.069	0.033	30.916	0.470
		33	-0.047	-0.063	31.465	0.494
		34	0.023	0.024	31.599	0.537
		35	0.048	0.046	32.175	0.557
		36	0.061	0.048	33.094	0.560

Table A9. ΔSWAP10Y = φ^9(C, ΔPDBC90D, ΔCPIYOY, ΔIPYOY, ΔLNIGPA, ΔLNCLP, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.092	0.092	1.7420	
		2	-0.020	-0.029	1.8226	0.177
		3	0.063	0.068	2.6464	0.266
		4	-0.085	-0.100	4.1543	0.245
		5	-0.027	-0.005	4.3069	0.366
		6	-0.005	-0.012	4.3124	0.505
		7	-0.066	-0.054	5.2341	0.514
		8	-0.038	-0.033	5.5357	0.595
		9	-0.031	-0.031	5.7404	0.676
		10	-0.038	-0.028	6.0538	0.735
		11	0.025	0.024	6.1871	0.799
		12	-0.008	-0.020	6.2011	0.860
		13	0.035	0.038	6.4653	0.891
		14	-0.037	-0.061	6.7697	0.914
		15	0.047	0.063	7.2633	0.924
		16	-0.014	-0.042	7.3088	0.949
		17	-0.103	-0.090	9.6867	0.882
		18	-0.003	-0.000	9.6885	0.916
		19	-0.053	-0.053	10.332	0.921
		20	-0.014	0.011	10.377	0.943
		21	0.027	0.003	10.543	0.957
		22	-0.113	-0.116	13.462	0.892
		23	0.067	0.091	14.510	0.882
		24	-0.040	-0.094	14.874	0.899
		25	-0.135	-0.103	19.119	0.746
		26	0.059	0.035	19.925	0.751
		27	-0.031	-0.047	20.146	0.785
		28	-0.096	-0.086	22.339	0.720
		29	0.062	0.041	23.267	0.720
		30	0.056	0.051	24.024	0.728
		31	0.028	0.011	24.212	0.762
		32	0.058	0.024	25.024	0.767
		33	-0.041	-0.058	25.435	0.788
		34	0.048	0.046	25.999	0.802
		35	0.048	0.034	26.570	0.814
		36	0.038	0.019	26.927	0.834

APPENDIX B: CORRELOGRAMS FOR GARCH(1,1) MODELS WITH ΔPDBC30D

Table B1. $\Delta SWAP2Y = \psi^1(C, \Delta PDBC30D, AR(1))$

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.035	0.035	0.2502	
		2	0.055	0.054	0.8826	0.347
		3	0.052	0.049	1.4453	0.485
		4	0.004	-0.002	1.4489	0.694
		5	-0.070	-0.076	2.4625	0.651
		6	-0.012	-0.010	2.4922	0.778
		7	-0.005	0.004	2.4974	0.869
		8	-0.065	-0.056	3.3826	0.848
		9	0.032	0.038	3.5999	0.891
		10	-0.005	-0.006	3.6060	0.935
		11	-0.046	-0.046	4.0665	0.944
		12	0.085	0.087	5.6329	0.897
		13	-0.058	-0.068	6.3559	0.897
		14	0.044	0.049	6.7779	0.913
		15	-0.038	-0.044	7.1029	0.931
		16	-0.091	-0.101	8.9180	0.882
		17	-0.157	-0.138	14.424	0.567
		18	-0.072	-0.062	15.592	0.553
		19	-0.062	-0.036	16.445	0.562
		20	-0.055	-0.023	17.129	0.581
		21	0.112	0.105	19.960	0.460
		22	-0.114	-0.134	22.955	0.346
		23	-0.010	-0.022	22.978	0.403
		24	-0.068	-0.106	24.043	0.401
		25	-0.047	-0.043	24.561	0.430
		26	0.056	0.075	25.290	0.446
		27	-0.078	-0.098	26.723	0.424
		28	-0.078	-0.096	28.146	0.403
		29	0.032	0.051	28.394	0.444
		30	0.128	0.114	32.323	0.306
		31	0.061	0.090	33.218	0.313
		32	0.063	0.033	34.175	0.318
		33	0.045	-0.066	34.674	0.342
		34	0.022	0.016	34.792	0.383
		35	0.031	-0.032	35.034	0.419
		36	0.097	0.123	37.385	0.360

Table B2. ΔSWAP2Y = ψ^2(C, ΔPDBC30D, ΔCPIYOY, ΔIPYOY, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.031	0.031	0.1970	
		2	0.046	0.045	0.6307	0.427
		3	0.065	0.062	1.5014	0.472
		4	-0.006	-0.012	1.5098	0.680
		5	-0.060	-0.066	2.2739	0.686
		6	-0.011	-0.011	2.3013	0.806
		7	-0.008	-0.000	2.3143	0.889
		8	-0.054	-0.045	2.9399	0.891
		9	0.016	0.019	2.9913	0.935
		10	0.012	0.012	3.0225	0.963
		11	-0.056	-0.054	3.6925	0.960
		12	0.088	0.087	5.3546	0.913
		13	-0.041	-0.049	5.7150	0.930
		14	0.039	0.043	6.0433	0.945
		15	-0.042	-0.052	6.4327	0.954
		16	-0.083	-0.088	7.9758	0.925
		17	-0.159	-0.149	13.619	0.627
		18	-0.071	-0.054	14.736	0.614
		19	-0.061	-0.040	15.583	0.622
		20	-0.054	-0.025	16.255	0.640
		21	0.112	0.115	19.127	0.514
		22	-0.114	-0.140	22.123	0.392
		23	-0.011	-0.014	22.149	0.451
		24	-0.065	-0.111	23.117	0.454
		25	-0.056	-0.046	23.847	0.470
		26	0.060	0.071	24.689	0.480
		27	-0.072	-0.082	25.898	0.469
		28	-0.092	-0.113	27.916	0.415
		29	0.040	0.059	28.302	0.449
		30	0.113	0.111	31.361	0.349
		31	0.069	0.091	32.504	0.344
		32	0.055	0.038	33.241	0.359
		33	0.046	-0.071	33.757	0.383
		34	0.022	0.014	33.880	0.425
		35	0.025	-0.034	34.039	0.466
		36	0.094	0.117	36.254	0.410

Table B3. ΔSWAP2Y = ψ^3(C, ΔPDBC30D, ΔCPIYOY, ΔIPYOY, ΔLNIGPA, ΔLNCLP, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.039	0.039	0.3167	
		2	0.026	0.025	0.4580	0.499
		3	0.061	0.059	1.2235	0.542
		4	0.001	-0.004	1.2236	0.747
		5	-0.066	-0.069	2.1342	0.711
		6	0.005	0.006	2.1387	0.830
		7	0.003	0.006	2.1404	0.906
		8	-0.066	-0.059	3.0582	0.880
		9	0.028	0.032	3.2239	0.920
		10	0.009	0.005	3.2410	0.954
		11	-0.087	-0.083	4.8841	0.899
		12	0.085	0.091	6.4580	0.841
		13	-0.035	-0.048	6.7283	0.875
		14	0.015	0.029	6.7786	0.913
		15	-0.025	-0.033	6.9167	0.938
		16	-0.093	-0.106	8.8139	0.887
		17	-0.147	-0.128	13.644	0.625
		18	-0.059	-0.047	14.428	0.637
		19	-0.049	-0.040	14.962	0.665
		20	-0.056	-0.024	15.678	0.679
		21	0.131	0.129	19.589	0.484
		22	-0.096	-0.129	21.695	0.417
		23	-0.022	-0.007	21.808	0.471
		24	-0.077	-0.126	23.184	0.450
		25	-0.053	-0.047	23.848	0.470
		26	0.047	0.074	24.367	0.498
		27	-0.040	-0.065	24.752	0.533
		28	-0.085	-0.103	26.460	0.493
		29	0.037	0.060	26.778	0.530
		30	0.124	0.104	30.469	0.391
		31	0.066	0.078	31.509	0.391
		32	0.037	0.036	31.843	0.424
		33	0.067	-0.051	32.946	0.421
		34	0.004	0.005	32.950	0.470
		35	0.033	-0.016	33.215	0.506
		36	0.110	0.114	36.199	0.412

Table B4. ΔSWAP5Y = ψ^4(C, ΔPDBC30D, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.082	0.082	1.3755	
		2	0.039	0.032	1.6838	0.194
		3	0.045	0.040	2.1093	0.348
		4	-0.078	-0.087	3.3695	0.338
		5	-0.093	-0.084	5.1741	0.270
		6	0.031	0.050	5.3820	0.371
		7	-0.067	-0.060	6.3174	0.389
		8	-0.088	-0.081	7.9455	0.337
		9	0.015	0.015	7.9929	0.434
		10	-0.052	-0.045	8.5633	0.479
		11	-0.013	-0.002	8.6005	0.570
		12	0.092	0.072	10.423	0.493
		13	0.011	-0.004	10.451	0.576
		14	0.032	0.026	10.674	0.638
		15	0.052	0.021	11.261	0.665
		16	-0.120	-0.123	14.441	0.492
		17	-0.131	-0.110	18.247	0.310
		18	-0.005	0.009	18.253	0.373
		19	-0.085	-0.052	19.865	0.340
		20	0.002	0.020	19.866	0.403
		21	0.061	0.029	20.717	0.414
		22	-0.115	-0.121	23.740	0.306
		23	0.044	0.057	24.177	0.338
		24	-0.046	-0.100	24.665	0.368
		25	-0.112	-0.111	27.597	0.277
		26	0.045	0.044	28.062	0.305
		27	-0.058	-0.113	28.856	0.318
		28	-0.153	-0.128	34.384	0.155
		29	0.055	0.070	35.118	0.166
		30	0.164	0.162	41.543	0.062
		31	-0.027	-0.020	41.718	0.076
		32	0.075	-0.001	43.079	0.073
		33	0.031	-0.044	43.319	0.087
		34	0.014	0.052	43.369	0.107
		35	0.042	-0.001	43.800	0.121
		36	0.084	0.046	45.548	0.109

Table B5. ΔSWAP5Y = ψ^5(C, ΔPDBC30D, ΔCPIYOY, ΔIPYOY, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.074	0.074	1.1113	
		2	0.035	0.029	1.3580	0.244
		3	0.076	0.071	2.5417	0.281
		4	-0.083	-0.096	3.9842	0.263
		5	-0.089	-0.082	5.6522	0.227
		6	0.030	0.043	5.8383	0.322
		7	-0.061	-0.048	6.6194	0.357
		8	-0.067	-0.058	7.5667	0.372
		9	-0.011	-0.019	7.5910	0.474
		10	-0.054	-0.042	8.2220	0.512
		11	-0.011	0.004	8.2464	0.605
		12	0.092	0.080	10.073	0.524
		13	0.027	0.014	10.231	0.596
		14	0.038	0.022	10.553	0.648
		15	0.032	0.001	10.783	0.703
		16	-0.105	-0.104	13.218	0.585
		17	-0.140	-0.127	17.597	0.348
		18	0.010	0.029	17.619	0.413
		19	-0.089	-0.059	19.408	0.367
		20	-0.020	0.000	19.495	0.426
		21	0.049	0.024	20.046	0.455
		22	-0.106	-0.104	22.602	0.366
		23	0.030	0.044	22.816	0.412
		24	-0.049	-0.099	23.373	0.439
		25	-0.121	-0.121	26.765	0.316
		26	0.048	0.034	27.304	0.341
		27	-0.052	-0.092	27.940	0.361
		28	-0.163	-0.147	34.251	0.159
		29	0.062	0.070	35.180	0.165
		30	0.136	0.150	39.627	0.090
		31	-0.034	-0.023	39.899	0.107
		32	0.071	-0.003	41.132	0.105
		33	0.042	-0.034	41.566	0.120
		34	0.005	0.029	41.572	0.145
		35	0.038	0.005	41.921	0.165
		36	0.087	0.052	43.801	0.146

Table B6. ΔSWAP5Y = ψ^6(C, ΔPDBC30D, ΔCPIYOY, ΔIPYOY, ΔLNIGPA, ΔLNCLP, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.075	0.075	1.1532	
		2	0.017	0.012	1.2144	0.270
		3	0.080	0.079	2.5534	0.279
		4	-0.081	-0.094	3.9295	0.269
		5	-0.077	-0.066	5.1570	0.272
		6	0.041	0.049	5.5134	0.356
		7	-0.031	-0.022	5.7145	0.456
		8	-0.057	-0.052	6.4127	0.492
		9	-0.010	-0.021	6.4352	0.599
		10	-0.055	-0.045	7.0783	0.629
		11	-0.054	-0.037	7.7168	0.656
		12	0.053	0.051	8.3347	0.683
		13	0.038	0.033	8.6538	0.732
		14	0.014	0.008	8.6988	0.795
		15	0.034	0.007	8.9478	0.834
		16	-0.123	-0.134	12.325	0.654
		17	-0.127	-0.103	15.917	0.459
		18	-0.003	0.010	15.920	0.530
		19	-0.069	-0.049	16.981	0.524
		20	0.005	0.016	16.986	0.591
		21	0.059	0.025	17.780	0.602
		22	-0.074	-0.077	19.040	0.583
		23	0.010	0.023	19.064	0.641
		24	-0.049	-0.082	19.614	0.665
		25	-0.126	-0.120	23.302	0.502
		26	0.035	0.029	23.585	0.543
		27	-0.020	-0.060	23.682	0.594
		28	-0.160	-0.159	29.745	0.326
		29	0.064	0.077	30.736	0.329
		30	0.120	0.126	34.191	0.232
		31	-0.034	-0.018	34.477	0.262
		32	0.040	-0.022	34.860	0.289
		33	0.065	-0.016	35.905	0.290
		34	0.006	0.022	35.912	0.334
		35	0.038	0.008	36.267	0.363
		36	0.105	0.058	38.999	0.295

Table B7. ΔSWAP10Y = ψ^7(C, ΔPDBC30D, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.083	0.083	1.4189	
		2	0.010	0.003	1.4396	0.230
		3	-0.003	-0.004	1.4411	0.486
		4	-0.080	-0.080	2.7851	0.426
		5	-0.083	-0.071	4.2240	0.377
		6	-0.000	0.014	4.2240	0.518
		7	-0.091	-0.093	5.9861	0.425
		8	-0.073	-0.066	7.1138	0.417
		9	0.006	0.006	7.1223	0.523
		10	-0.050	-0.057	7.6509	0.570
		11	0.046	0.042	8.1117	0.618
		12	0.058	0.028	8.8500	0.636
		13	0.010	-0.006	8.8710	0.714
		14	-0.019	-0.033	8.9475	0.777
		15	0.063	0.056	9.8260	0.775
		16	-0.031	-0.030	10.038	0.817
		17	-0.089	-0.092	11.814	0.757
		18	0.011	0.022	11.839	0.810
		19	-0.074	-0.060	13.058	0.788
		20	-0.011	0.004	13.087	0.834
		21	0.037	0.020	13.399	0.860
		22	-0.134	-0.149	17.513	0.680
		23	0.104	0.130	19.981	0.584
		24	-0.036	-0.098	20.275	0.625
		25	-0.133	-0.132	24.383	0.440
		26	0.026	0.033	24.546	0.488
		27	-0.070	-0.124	25.689	0.480
		28	-0.089	-0.055	27.573	0.433
		29	0.040	0.010	27.955	0.467
		30	0.123	0.099	31.559	0.340
		31	0.017	0.001	31.632	0.385
		32	0.081	0.021	33.225	0.359
		33	-0.056	-0.076	33.987	0.372
		34	0.006	0.019	33.996	0.419
		35	0.045	0.034	34.491	0.444
		36	0.083	0.065	36.200	0.412

Table B8. ΔSWAP10Y = ψ^8(C, ΔPDBC30D, ΔCPIYOY, ΔIPYOY, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.086	0.086	1.5034	
		2	0.005	-0.002	1.5089	0.219
		3	0.022	0.022	1.6085	0.447
		4	-0.095	-0.099	3.4839	0.323
		5	-0.072	-0.056	4.5615	0.335
		6	-0.009	0.001	4.5788	0.469
		7	-0.089	-0.085	6.2381	0.397
		8	-0.061	-0.054	7.0232	0.426
		9	-0.015	-0.018	7.0704	0.529
		10	-0.036	-0.035	7.3466	0.601
		11	0.045	0.038	7.7848	0.650
		12	0.058	0.031	8.5100	0.667
		13	0.024	0.009	8.6381	0.733
		14	-0.013	-0.033	8.6735	0.797
		15	0.047	0.044	9.1565	0.821
		16	-0.016	-0.017	9.2147	0.866
		17	-0.104	-0.103	11.628	0.769
		18	0.028	0.044	11.799	0.812
		19	-0.084	-0.079	13.406	0.767
		20	-0.020	0.007	13.494	0.812
		21	0.034	0.016	13.762	0.842
		22	-0.131	-0.140	17.698	0.668
		23	0.089	0.111	19.539	0.612
		24	-0.041	-0.103	19.928	0.646
		25	-0.137	-0.127	24.300	0.445
		26	0.024	0.016	24.440	0.494
		27	-0.063	-0.104	25.389	0.497
		28	-0.099	-0.074	27.689	0.427
		29	0.043	0.009	28.131	0.458
		30	0.106	0.095	30.847	0.373
		31	0.011	-0.019	30.878	0.421
		32	0.075	0.031	32.243	0.405
		33	-0.047	-0.078	32.779	0.429
		34	-0.004	-0.001	32.784	0.478
		35	0.046	0.047	33.297	0.502
		36	0.086	0.064	35.131	0.462

Table B9. ΔSWAP10Y = ψ^9(C, ΔPDBC30D, ΔCPIYOY, ΔIPYOY, ΔLNIGPA, ΔLNCLP, AR(1))

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.087	0.087	1.5422	
		2	-0.010	-0.018	1.5630	0.211
		3	0.045	0.048	1.9842	0.371
		4	-0.092	-0.102	3.7640	0.288
		5	-0.052	-0.033	4.3254	0.364
		6	-0.008	-0.006	4.3382	0.502
		7	-0.053	-0.044	4.9221	0.554
		8	-0.038	-0.035	5.2317	0.632
		9	-0.006	-0.009	5.2401	0.732
		10	-0.038	-0.037	5.5538	0.784
		11	0.006	0.007	5.5619	0.851
		12	0.006	-0.008	5.5686	0.901
		13	0.046	0.046	6.0270	0.915
		14	-0.027	-0.047	6.1867	0.939
		15	0.018	0.022	6.2571	0.960
		16	-0.031	-0.044	6.4704	0.971
		17	-0.109	-0.096	9.1136	0.909
		18	-0.011	-0.002	9.1411	0.936
		19	-0.060	-0.061	9.9406	0.934
		20	0.000	0.018	9.9406	0.954
		21	0.043	0.018	10.366	0.961
		22	-0.109	-0.125	13.073	0.906
		23	0.073	0.089	14.291	0.891
		24	-0.040	-0.090	14.661	0.906
		25	-0.148	-0.130	19.744	0.711
		26	0.031	0.019	19.965	0.749
		27	-0.037	-0.058	20.285	0.778
		28	-0.106	-0.098	22.925	0.689
		29	0.036	0.011	23.228	0.722
		30	0.064	0.055	24.216	0.718
		31	0.021	0.004	24.325	0.757
		32	0.061	0.018	25.235	0.757
		33	-0.041	-0.077	25.639	0.779
		34	0.017	0.015	25.711	0.813
		35	0.047	0.034	26.250	0.826
		36	0.057	0.028	27.069	0.829

APPENDIX C: ADDITIONAL GARCH(1,1) MODELS

Table C1. GARCH (1,1) Model (with ΔPDBC90D and ΔCOREYOY)

	ΔSWAP2Y	ΔSWAP2Y	ΔSWAP5Y	ΔSWAP5Y	ΔSWAP10Y	ΔSWAP10Y
Mean Equation						
Intercept	–0.01 (0.77)	–0.01 (0.60)	–0.01 (0.59)	–0.02 (0.54)	–0.01 (0.62)	–0.02 (0.36)
ΔPDBC90D	0.28 (0.00)	0.29 (0.00)	0.10 (0.02)	0.12 (0.00)	0.004 (0.94)	0.02 (0.75)
ΔCOREYOY	–0.02 (0.60)	–0.02 (0.74)	–0.03 (0.53)	–0.06 (0.26)	–0.06 (0.19)	–0.08 (0.07)
ΔIPYOY	0.003 (0.30)	0.002 (0.39)	0.004 (0.08)	0.002 (0.17)	0.003 (0.14)	0.002 (0.17)
ΔLNIGPA		0.90 (0.01)		0.85 (0.03)		0.58 (0.18)
ΔLNCLP		0.80 (0.39)		2.33 (0.00)		2.45 (0.00)
AR(1)	0.38 (0.00)	0.36 (0.00)	0.29 (0.00)	0.29 (0.00)	0.27 (0.01)	0.27 (0.00)
Variance Equation						
Intercept	0.01 (0.23)	0.01 (0.19)	0.004 (0.29)	0.004 (0.24)	0.004 (0.19)	0.003 (0.23)
ARCH	0.15 (0.16)	0.19 (0.13)	0.11 (0.10)	0.15 (0.11)	0.13 (0.03)	0.16 (0.04)
GARCH	0.59 (0.04)	0.56 (0.04)	0.79 (0.00)	0.78 (0.00)	0.77 (0.00)	0.78 (0.00)
Model Information						
Obs	142	142	142	142	142	142
Adj R^2	0.30	0.30	0.15	0.18	0.07	0.12
AIC	– 0.23	– 0.24	– 0.34	– 0.39	– 0.47	– 0.53
Diagnostic Tests						
ARCH LM (12 lags)	1.41 (0.17)	1.12 (0.35)	0.93 (0.52)	0.59 (0.84)	0.84 (0.61)	0.67 (0.78)
DW Stat	1.96	1.93	1.87	1.79	1.88	1.80
JQB	24.49 (0.00)	15.43 (0.00)	11.78 (0.00)	9.56 (0.01)	7.96 (0.02)	5.24 (0.07)

Note: All vars are in diff, *p*-values are in parenthesis

Table C2. GARCH (1,1) Model (with ΔPDBC30D and ΔCOREYOY)

	ΔSWAP2Y	ΔSWAP2Y	ΔSWAP5Y	ΔSWAP5Y	ΔSWAP10Y	ΔSWAP10Y
Mean Equation						
Intercept	–0.01 (0.83)	–0.01 (0.58)	–0.01 (0.64)	–0.02 (0.34)	–0.01 (0.63)	–0.02 (0.64)
ΔPDBC30D	0.42 (0.00)	0.44 (0.00)	0.22 (0.00)	0.24 (0.00)	0.14 (0.02)	0.16 (0.00)
ΔCOREYOY	–0.04 (0.53)	–0.03 (0.59)	–0.04 (0.33)	–0.06 (0.15)	–0.05 (0.22)	–0.07 (0.09)
ΔIPYOY	0.003 (0.20)	0.003 (0.24)	0.004 (0.07)	0.003 (0.13)	0.003 (0.16)	0.002 (0.17)
ΔLNIGPA		0.92 (0.01)		0.84 (0.04)		0.54 (0.22)
ΔLNCLP		1.05 (0.20)		2.53 (0.02)		2.60 (0.00)
AR(1)	0.36 (0.00)	0.32 (0.00)	0.31 (0.00)	0.29 (0.00)	0.27 (0.00)	0.26 (0.00)
Variance Equation						
Intercept	0.002 (0.31)	0.003 (0.17)	0.004 (0.46)	0.003 (0.36)	0.004 (0.26)	0.002 (0.26)
ARCH	0.05 (0.22)	0.10 (0.13)	0.09 (0.03)	0.13 (0.18)	0.11 (0.07)	0.14 (0.05)
GARCH	0.89 (0.00)	0.83 (0.00)	0.81 (0.00)	0.81 (0.00)	0.80 (0.00)	0.81 (0.00)
Model Information						
Obs	142	142	142	142	142	142
Adj R^2	0.35	0.36	0.21	0.24	0.13	0.18
AIC	– 0.32	– 0.32	– 0.37	– 0.43	– 0.49	– 0.55
Diagnostic Tests						
ARCH LM (12 lags)	2.25 (0.01)	1.79 (0.06)	0.70 (0.75)	0.59 (0.84)	0.81 (0.64)	0.66 (0.79)
DW Stat	1.90	1.83	1.86	1.73	1.87	1.73
JQB	14.27 (0.00)	5.76 (0.06)	5.38 (0.07)	2.87 (0.24)	4.02 (0.13)	1.85 (0.40)

Note: All vars are in diff, *p*-values are in parenthesis