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FOREIGN SHOCKS ON CHILEAN FINANCIAL MARKETS: SPILLOVERS AND COMOVEMENTS BETWEEN BONDS AND EQUITY MARKETS*

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Abstract
The domestic impact of external shocks will depend on the degree of coupling of domestic assets to foreign markets, but also on the spillovers among assets. The covariance between different types of assets could be affected by the new information. Changes in the covariance could come from a stronger rebalancing between stocks and bonds. Therefore, we will analyze four different assets – government bonds, corporate bonds, money market instruments and equity – and study the conditional correlation between them. We find that the corporate bond market tends to increase coupling in turbulent times, while money market decreases. We propose to test international spillovers taking into account a methodology for estimating the conditional mean, variance and covariance on domestic bond and equity markets, while considering that shocks may have asymmetric effects depending if the news are good or bad.

Resumen
El impacto doméstico de los shocks externos dependerá no solo del grado de acoplamiento de los activos nacionales a los mercados extranjeros, sino también de los efectos secundarios entre los activos. La covarianza entre los diferentes tipos de activos podría verse afectada por la nueva información. Los cambios en la covarianza podrían provenir de un reequilibrio más fuerte entre acciones y bonos. Por lo tanto, analizamos cuatro diferentes activos - bonos del Estado, bonos corporativos, instrumentos del mercado monetario y de renta variable - y estudiamos la correlación condicional entre ellos. Encontramos que el mercado de renta fija privada tiende a acoplarse más en épocas turbulentas, mientras que el mercado monetario se acopla menos. Proponemos testear el contagio internacional toman en cuenta una metodología para la estimación de la media condicional, varianza y covarianza en los mercados de renta fija y de renta variable nacional, teniendo en cuenta que los shocks pueden tener efectos asimétricos dependiendo si las noticias son buenas o malas.

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1. Introduction

The correlation between financial assets returns has increased significantly since the subprime crisis began. The high correlation has been observed not only among different asset classes within a country, but also across border (IMF, 2012). The latter is in part explained by domestic markets being increasingly more integrated to global markets, and therefore external shocks affect both international and domestic assets. From a financial stability point of view it is important to understand the channel of transmission of these shocks, and to identify how different this channel is depending on whether the shock is financial or real in its origin. The geographical region in which these shocks originate seems to be relevant as well depending on the particular interconnectedness that a country might have with the region where the shock was originated. In addition, distinguishing among asset classes and quantifying not only the direct impact of external shocks on each one but also the spillovers among them is a further question that we address in the paper.

The related literature has been mostly concentrated on studying the impact of financial shocks on mean asset returns only (Bomfim, 2003; Chen et al., 1986). Research that also includes volatility (Jones, 1998) and correlations (Brenner et al.,2009; Chancharoenchai and Dibooglu, 2006; Choudhry, 2004), and in some cases considered macroeconomic shocks (Balduzzi et al.,2001; Andersen et al. (2003, 2007)), has been circumscribed to studying the impact of domestic shocks on domestic assets. We extend the previous literature to take into account cross-border effects, by estimating the conditional mean, variance and covariance from foreign shocks on domestic bonds and equity markets, after controlling for the effects of domestic shocks not necessarily related to external conditions. Our work is closer to Brenner et al. (2009) in terms of the estimation technique and the fact

that correlations among assets are considered, and to Melendez et al. (2011) in that the main country of interest is Chile.

Understanding how foreign shocks impact domestic assets, and in particular, how macroeconomic shocks in the developed world affect financial asset returns in the domestic economy is important in the current situation. High global liquidity – as a result of the quantitative easing programs in the developed world (U.S., most importantly, but also in U.K. and Japan) – has depressed yields across all types of assets motivating investors to search for better investment opportunities in the emerging economies. The latter have also benefited from lower spreads, but still offer a premium with respect to developed markets. The end of these liquidity packages is therefore a much expected event in that the consequences are extremely difficult to forecast. It could greatly impact domestic yields if it occurs in a disorderly way or if risk aversion increases dramatically. Recent market reaction to FED's Chairman, Ben Bernanke, only announcing the possibility of ending the program caused a reaction in bond rates and equity markets that was very much spread into international markets. In order to improve information and transparency the FED has explicitly tightened the exit strategy to macroeconomic data, in particular, it has been announced that unless the labor market shows clear signs of recovery (6.7% unemployment rate) the quantitative easing program will not end.

The high global liquidity poses other questions as well because relatively less liquid markets may price information in a less efficient manner and prices could not reflect immediately the news. Search for yield during crises can induce negative correlation between liquid versus illiquid markets as investors increase their preference for liquidity during such episodes. Additionally, a shock that increases market liquidity could result in a greater demand for such assets having a positive impact on returns.

The domestic impact of external shocks will depend on the degree of coupling of domestic assets to foreign markets, but also on the spillovers among assets. The covariance between different types of assets could be affected by the new information. Changes in the covariance could come from a stronger rebalancing between stocks and bonds. Therefore, we will analyze four different assets – government bonds, corporate bonds, money market instruments and stocks – and study the conditional correlation between them. We find that the corporate bond market tends to increase coupling in turbulent times, while money market decreases.

As will be discussed in detail in the next sections, the estimation technique is crucial in this type of work, as well as the span and frequency of the data used. As such, we propose to test international spillovers taking into account a methodology for estimating the conditional mean, variance and covariance on domestic bond and equity markets, while considering that shocks may have asymmetric effects depending if the news are good or bad (Glosten et al.,1993; Melendez et al., 2011).

2. Econometric Methodology

2.1 Foreign Shocks and Return Spillovers

To capture the dynamic relationship between the returns from different bond and equity markets a VAR (p) is estimated. In addition, we included variables representing exogenous shocks from abroad (as well as domestic shocks) and the asymmetric effect from "bad news" associated with the corresponding shocks, as follows:

$R_t = A_0 + \sum_{k=1}^{p} A_k R_{t-k} + \beta x_t + \theta I_t x_t + \varepsilon_t$, where (1)

$I_t = 1(x_t \Rightarrow bad\ news)$.

The spillovers from other domestic markets are captured by the non-diagonal coefficients of the matrix A_k, while the effects of external shocks are reflected in β and θ.

2.2 Foreign Shocks and Volatility Spillovers

In order to analyze possible volatility spillovers from other markets and asymmetric effects of positive versus negative shocks, we estimate a multivariate version of the GARCHX(1,1) model:

$$h_{it} = w_i + \alpha_i \varepsilon_{it-1}^2 + \sum_j \alpha_j \varepsilon_{jt-1}^2 + \gamma x_t + \delta I_t x_t. \quad (2)$$

The interesting thing about this specification is that simultaneously captures spillovers from other domestic markets (α_j), and the effects of external and domestic shocks (γ and δ).

The model described above, in principle, requires the simultaneous estimation of the parameters for the conditional return and variance equations. However, in this case it is possible to consistently estimate the coefficients α_j of the equation (2) by a sequential method in which instead of ε_{jt} the residuals from the VAR estimated in equation (1) are used. That is, it could consistently estimate the coefficients of the equation (2) using a standardized software for GARCH models, in which the variables ε_{jt-1}^2 are incorporated exogenously to the conditional variance model. This two-step method significantly simplifies the estimation of the multivariate model, as well as being in line with the idea of Dynamic Conditional Correlation model presented below.

2.3 Dynamic Conditional Correlation

Following the scalar Dynamic Conditional Correlation model (DCC) proposed by Engle (2002), we have that the conditional correlation is given by

$\rho_{ijt} = \frac{q_{ijt}}{\sqrt{q_{iit} q_{jjt}}}$,

with $q_{ijt} = (1 - a - b)\rho_{ijt} + a z_{it-1} z_{jt-1} + b q_{ijt-1}$, (3)

where $z_{it} = \varepsilon_{it} / h_{it}$, and

$\rho_{ij} = T^{-1} \sum_{t=1}^{T} z_{it} z_{jt}$.

To estimate the coefficients of equation (3) it is possible to use a version ARMA (1,1) of the same equation, which takes the form:

$e_{ijt} = (1 - a - b)\rho_{ij} + (a + b) e_{ijt-1} - b\left(e_{ijt-1} - q_{ijt-1}\right) + \left(e_{ijt} - q_{ijt}\right)$, (3')

where $e_{ijt} = z_{it} z_{jt}$.

Note that the estimated coefficients a and b requires restricting the constant in the equation above to take the value $(1 - a - b)\rho_{ij}$.

2.4 Asymmetry

To estimate correlations varying over time, while allowing asymmetric effects from common negative shocks in both markets, the following scalar Asymmetric Dynamic Conditional Correlation model (A-DCC) is estimated as follows:

$q_{ijt} = (1 - a - b)\rho_{ijt} + a z_{it-1} z_{jt-1} + b q_{ijt-1} + g n_{it-1} n_{jt-1}$, (4)

where $n_{it} = 1(z_{it-1} < 0) z_{it-1}$.

2.5 Structural break

Now, if we also consider the possibility of a change of regime in the unconditional correlation, we estimate the following scalar A-DCC model with Structural Break:

$q_{ijt} = \left[(1 - a - b)\rho_{ij1} + g n_{ij1}\right](1 - d_t) + \left[(1 - a - b)\rho_{ij2} + g n_{ij2}\right] d_t + a z_{it-1} z_{jt-1} + b q_{ijt-1} + g n_{it-1} n_{jt-1}$, (5)

where

$d_t = I(t \leq t_{break})$,

$\rho_{ij1} = T^{-1} \sum_{t=1}^{t_{break}} z_{it} z_{jt}$, $\rho_{ij2} = T^{-1} \sum_{t=t_{break}+1}^{T} z_{it} z_{jt}$, and

$n_{ij1} = T^{-1} \sum_{t=1}^{t_{break}} n_{it} n_{jt}$, $n_{ij2} = T^{-1} \sum_{t=t_{break}+1}^{T} n_{it} n_{jt}$.

3. Estimation Results

3.1 Database

The dataset used in this paper includes information of four financial assets: stocks, long-term government bond, long-term AAA corporate bond, and short-term (one year) deposit rate. For stocks we use the IPSA Index, which includes the 40 most traded stocks in the Chilean market. For the long-term government bond, we use a benchmark with indexed bonds[1], whose duration is between 7.155 and 9.061 years. The deposit rate is obtained through a daily survey, and represents the rate that institutional investor access for a one-year maturity bank deposit. These securities can also be traded in the secondary market. The long-term AAA corporate bond comes from a benchmark, which includes securities with duration over nine years.

The stock market return is calculated using the difference in logs between the current closing market price, and the previous one. For fixed income assets we calculate the holding period return, assuming that the investor buys the security and sells it the next day. We utilize the first order approximation for the price of the bond, in order to compute the daily return, employing the average duration of the benchmark in the previous day in case

[1] The market for indexed bonds is more liquid than the one for nominal bonds. Therefore, we use this asset to measure the long-term fixed income market.

of the long-term bonds (government and corporate), and a duration of one year for deposits[2]. This allows us to compare daily stock returns with fixed income returns.

Stock closing market price is obtained from Bloomberg, while the information of yields and duration of government bonds and deposit is obtained from the Central Bank of Chile. The yield and duration data of corporate bonds is obtained from LVA Indices. The sample covers a period from May 7, 2004 (the first day the deposit rate is available), until June 19, 2012. There are approximately two thousand observations for each asset. Summary statistics are presented in Table 1. Returns are in percentage, in a daily basis. The return of the Chilean stock market is the largest among the four assets, but also the standard deviation is the largest. The long-term government bond has the second higher average return, and also the second higher standard deviation. The deposit rate has the lowest standard deviation. This is coherent with the fact that it has the shorter duration; therefore for the same variation in yields, the return changes less. The corporate long-term bond shows a negative average daily return, which could be related to a less liquidity, or to a hold-to-maturity strategy, by investors who usually hold these kinds of securities, like institutional investors.

Table 1. Descriptive statistics: Daily asset returns
(percentage)

	BCU 10	AAA	PRIME	RIPSA
Mean	0.0035	-0.0065	0.0019	0.0547
Standard deviation	0.3672	0.3167	0.0826	1.1132
Min	-3.1685	-2.7500	-1.3400	-7.1728
Max	1.3775	3.4007	1.9200	11.8034
Skew	-0.8963	1.3728	4.7043	-0.0422
Kurt	6.6563	26.8611	220.8523	10.6775
N	2025	2035	2035	2035

[2] Deposits are like a zero coupon bond, so its maturity is equal to its duration.

The financial shock driven by foreign markets is incorporated using stock returns from several geographic areas, including developed and emerging markets. This is consistent with the fact that shocks from different locations may affect differently the Chilean market. Therefore, we use MSCI index for five regions: MSCI Emerging Markets Latin America, MSCI America, MSCI Europe, MSCI Emerging Markets Europe, and MSCI Emerging Market Asia. Returns for those markets are computed using the difference in logs between the current and the previous closed market price. Also, in order to explore the asymmetric effect on bad news, we assume that any negative return in those markets is a bad news. In Table 2 some summary statistics are given. It can be seen that developed markets have a lower average daily return than emerging markets. MSCI Latin America has the highest daily average return, but also it has one of the largest standard deviation, only exceeded by MSCI Emerging Markets Europe. MSCI Asia, on the other hand, has the second largest average return, and the second lowest standard deviation. Regarding the bad news, all the areas have around 45% of daily returns lower than zero, except Europe which has almost 48% of bad news. The closed market values of the indices were obtained from Bloomberg.

Table 2. Descriptive statistics: Foreign markets financial shocks
(daily return, percentage)

	MSCI_LATAM	MSCI_NAMERICA	MSCI_EUROPE	MSCI_ASIA
Mean	0.0609	0.0117	0.0029	0.0319
Standard deviation	2.0758	1.3666	1.6122	1.5684
Min	-15.0600	-9.5050	-10.1783	-8.6225
Max	15.3531	10.4276	10.6981	12.6541
Skew	-0.4324	-0.4102	-0.0808	-0.3418
Kurt	8.8990	9.9713	6.9544	5.8689
N	2035	2035	2035	2035
% bad news	44.62	44.91	47.76	45.21

The foreign macroeconomic shocks are computed on a monthly basis. Using data of the expected and observed growth in the Industrial Production Index, the difference between the observed an expected growth is added to the dataset on the release date. This value is then standardized using an estimated standard deviation of the expectations, calculated employing the minimum and maximum expected values. We assume that the distribution of expected values is closed to a normal, therefore we compute the estimated standard deviation of expectations dividing the difference between the maximum and minimum expected value by six[3]. The reason for using this approach is to control for both the amount of the unexpected growth, and the uncertainty at that time. Thus, comparing two times with the same unexpected growth, the one that has the less estimated standard deviation must affect more the Chilean market than the other one.

The economies considered to account for these shocks are United States, Eurozone and Brazil. The reason to choose these countries is the importance in the Chilean economy due to trade, and the proximity as geographic location. The information of observed value, expected average value, minimum and maximum expectations, and the release date, became from Bloomberg. Descriptive statistics of the deviation from the expected value, and the estimated standard deviation are presented in Table 3. On average, analysts for the U.S. and Europe overvalue the industrial production growth in a 0.05%. On the other hand, analysts for Brazil overvalue the industrial production growth in a 0.33%. Also, analysts for the US show more homogenous expectations, while the ones for Brazil show the higher dispersion, on average.

[3] Considering that the length between the 0,1 and 99,9 percentile in a normal distribution is covered by six standard deviations.

Domestics macroeconomic shocks are obtain from several sources. First, the economic growth measured by the Monthly Economic Activity Index (IMACEC) and the monthly growth of prices, measured by the Consumer Price Index (CPI) are contrasted with the Economic Expectations Survey (EEE), conducted by the Central Bank of Chile[4].

Table 3. Descriptive statistics: Foreign macroeconomic shocks
(percentage)

	Deviation from expected value			Standard deviation expected value		
	United States	Eurozone	Brazil	United States	Eurozone	Brazil
Mean	-0.0582	-0.0520	-0.3308	0.1853	0.3185	0.4125
Standard deviation	0.4010	0.5552	1.1513	0.0919	0.1835	0.2721
Min	-1.8700	-1.7000	-6.2100	0.0833	0.0833	0.1167
Max	1.1000	1.9000	1.1900	0.6000	0.9000	1.5600
Skew	-0.8685	-0.0340	-2.2731	2.2557	1.4977	2.5928
Kurt	3.5724	1.3732	8.8513	5.5272	2.1055	7.5603
N	98	98	85	98	98	85

Like foreign macroeconomic shocks, for these data we compute the deviation from the expected value, and also we obtain the estimated standard deviation of expectations. In this case, however, the EEE contains the tenth and ninetieth percentile, so the difference between the maximum and minimum expected value is divided by 2.56. Table 4 summarizes the descriptive statistics.

Table 4. Descriptive statistics: Domestic macroeconomic shocks
(percentage)

	Deviation from expected value		Standard deviation expected value		Unexpected changes MPR	Copper return
	IMACEC	IPC	IMACEC	IPC		
Mean	-0.1220	0.0195	0.7139	0.1246	-0.0179	0.0501
Standard deviation	1.3582	0.3207	0.4158	0.0501	0.4221	2.2235
Min	-3.3000	-1.0000	0.1953	0.0391	-2.5000	-11.7093
Max	4.5000	0.8000	2.6992	0.3828	0.5000	11.6437
Skew	0.1627	-0.0765	2.3777	1.6725	-3.7037	-0.3077
Kurt	0.4135	0.4079	7.4476	6.1490	19.2411	3.2431
N	97	97	97	97	98	2035
% bad news	-	-	-	-	-	46.29

[4] Observed values for the economic growth are obtained from the press releases, and these could differ from the actual serie, due to corrections made to the index by the Central Bank of Chile.

Analysts on average overvalue the economic growth by 0.12%, and undervalue the CPI by almost 0.02%. The standard deviation shows that analysts on average have more uncertainty in the economic growth than in variations in prices.

Unexpected changes in the monetary policy rate (MPR) were assessed using a methodology different from Zettelmeyer (2003), Central Bank of Chile (2003) and Larraín (2007). While the first two use the changes in the yield of short-term government debt before and after the meeting[5], the least uses forward rates to determine the expected and unexpected changes in the MPR. We use a method close to Larraín (2007), but instead of forward rates, in this case we use the difference between the Interbank Rate (IBR) ---which is computed using a weighted average of the rate involved in bank short-term operations--- and the new monetary policy rate. Thus,

$$\Delta MPR_t^{exp} = 0.25\left[round\left((IBR_t - MPR_{t-1})/0.25\right)\right],$$

and then

$$\Delta MPR_t^{unexp} = (MPR_t - MPR_{t-1}) - \Delta MPR_t^{exp}.$$

Therefore, if the IBR, when the monetary policy meeting is carried on, is closer to a new level – considering jumps of 25 basis points –, is estimated that the market expects on average an increase in the MPR at that new level. Then, the unexpected change is the difference between the new MPR (given by the decision on the monetary policy meeting) and that new level. In 47 out of 98 months, an unexpected change was found. The average of the unexpected changes is a decrease in 1.8 basis points. The minimum unexpected

[5] They use this type of security because they use data from 1999 to 2003 and from 2000 to 2003, respectively, and the Central Bank of Chile managed the monetary policy as an indexed base until August 2001, when it changes to a nominalized base (Central Bank of Chile, 2003).

change is a decrease of 2.5 percent points on the MPR, and the maximum is an increase in 0.5 percent points.

Finally, the return of copper price is considered as a domestic shock due to the economic dependence of Chile to this commodity. It has a daily basis, and in this case, as well as in the foreign markets financial shocks, a negative daily return is the condition to consider a bad news. The price is in cents of dollars per pound. The average daily return reaches 0.05%, for the whole sample, and in 46.3% of the sample days the copper return was lower than zero.

3.2 Return and Volatility

BCU10 are Central Bank indexed bonds issued at ten-year maturity in order to manage liquidity in the domestic market at longer maturity. They are also intended to help boost the development of the capital market. As such, these are issued based on a pre-established schedule, which responds to structural factors (Central Bank of Chile, 2012). Banks and pension funds are the main investors, the first being the main ones allowed to participate in the primary market[6]. Banks are also very active in the secondary market both directly or as mandates. By regulatory constraints, pension funds are only allowed to trade through the Santiago Stock Exchange. As a result, one of the characteristics of the fixed income market in Chile is that it is separated into two segments: the interbank (the largest in terms of volume) and the stock exchange. There is a third segment though, mostly retail, where mutual funds and insurance companies are allowed to trade (D'Acuña et al., 2009; Lazen, 2005). Primary and secondary markets are arbitraged, as differences in price and returns are negligible.

[6] Some of the largest Pension Funds, Mutual Funds and Insurance companies are also allowed to participate.

In general the fixed income market in Chile is not very deep, and some instruments (particularly corporate bonds) are not traded on a daily basis, which results in prices not being quoted on a daily basis. Being a safe or very low risk instrument, the BCU10 is highly demanded and thus this issue is less frequent, although 20% of the year they are not traded (Lazen, 2005). The turnover is considerably lower than that of developed economies – approximately 11% of the stock of BCU is traded on a monthly basis – mostly because of the buy-and-hold profile of the main demanders (Central Bank of Chile, 2012). In turn, its return is not expected to (immediately) reflect market conditions, but rather reacts to changes in expected future inflation, expected changes in monetary policy and/or strong portfolio reallocations (if any) of the mentioned institutional investors.

Given the above, as shown in table 5, it is not a surprise that there are no significant variables explaining BCU10 return as all of the capture short-term market developments. On the other hand, table 6 illustrates that volatility does respond to domestic macroeconomic variables, such as the monthly activity index (IMACEC) and copper price return. Again, this result makes sense, as it is uncertainty around fundamentals that may trigger changes in the BCU issuance strategy, and in the management of the monetary policy. On the same line, international volatility (VIX) appears to be significant to explain BCU10 return volatility, which is not the case in the estimates for corporate bonds. One possible explanation is that higher global risk aversion may impact relatively more sovereign rather than corporate returns as the former are refugee or safe havens. Consistently, the positive coefficient shows that an increase in the global uncertainty produces an expansion in the demand of more safety securities, and therefore generating a greater return.

In the case of corporate bonds (AAA) the level of returns is affected by BCU10 returns. This may be a direct and mechanical result given that BCU are the benchmark bond against

which corporate bonds are priced. It may also be explained by the fact that the main institutional investors – pension funds – are by law only allowed to buy the highest rated bonds, and therefore AAA bonds and BCU mostly compose their bond portfolio.

As for the influence of external shocks, only surprises in the U.S. and European industrial production indices appear significant. In both cases the effect on returns is negative. This means that bad news regarding the economic performance in these regions may result in higher demand of local bonds, phenomena that has been observed since mid 2009 and is only recently being reversed.

In terms of volatility, there are no spillovers from other domestic markets. However, in this case shocks in foreign stock exchanges – as well as surprises in U.S. and Brazil industrial production indices- have a significant impact on the volatility of corporate bond returns. We also observe that the price (return) of copper is inversely related with corporate bond volatility. Interestingly, after controlling for macroeconomic surprises, the external volatility index (VIX) does not affect corporate bond volatility.

Movements in the short-term deposit rate of institutional investors reflect an increase or decrease in the liquidity within the money market. A more accurate measure of this liquidity is the prime-swap spread, defined as the spread between the deposit rate of institutional investors, and the floating rate at the same maturity. This is similar to the Libor-OIS spread. Therefore, institutional investors use these deposits as a way to have more flexibility in their allocation movements. Thus, when the demand of deposit increase, the rate falls, generating a more liquidity scenario, and allowing banks to fund at a lower price. The risk of this instrument is very low, and it can be sold in the secondary market.

Table 5. Econometric results for return equations
(p-values under estimated coefficient)

	Return equation:			
	AAA	BCU 10	PRIME	RIPSA
AAA(-1)	0.015109	0.114158	0.008539	-0.000001
	0.813	*0.314*	*0.201*	*0.999*
BCU10(-1)	0.025898	0.088700	-0.000317	0.000306
	0.043	*0.531*	*0.936*	*0.097*
PRIME(-1)	0.070347	-0.334562	0.124637	0.006470
	0.801	*0.571*	*0.012*	*0.044*
RIPSA(-1)	0.432269	-3.149462	0.176408	0.109580
	0.798	*0.573*	*0.437*	*0.000*
VIX	0.002255	0.003333	0.000614	0.000005
	0.293	*0.635*	*0.051*	*0.849*
VIX_AR1*VIX	0.004142	-0.001538	-0.000148	-0.000012
	0.346	*0.952*	*0.789*	*0.769*
MSCI_NAMERICA	-2.384916	-5.082767	-0.778191	0.188763
	0.490	*0.490*	*0.096*	*0.000*
d(1|NA)*MSCI_NAMERICA	3.611891	5.867560	0.492061	-0.032993
	0.492	*0.670*	*0.475*	*0.510*
MSCI_EUROPE	0.232222	-1.578655	0.080448	-0.009618
	0.928	*0.800*	*0.823*	*0.698*
d(1|E)*MSCI_EUROPE	-1.508762	-2.453457	-0.135999	0.082945
	0.703	*0.833*	*0.819*	*0.043*
MSCI_LATAM	1.374391	0.407691	-0.004749	0.193418
	0.527	*0.953*	*0.989*	*0.000*
d(1|LA)*MSCI_LATAM	-0.764605	-0.151190	-0.278845	0.008379
	0.808	*0.988*	*0.588*	*0.811*
MSCI_ASIA	-1.799439	-3.293417	0.166522	-0.004441
	0.392	*0.640*	*0.581*	*0.856*
d(1|A)*MSCI_ASIA	2.396544	6.579793	-0.169748	0.036097
	0.472	*0.549*	*0.718*	*0.341*
PI_US	-0.044593	0.016069	-0.004479	0.000126
	0.059	*0.900*	*0.241*	*0.708*
PI_EU	-0.103806	0.001150	-0.002484	-0.000526
	0.000	*0.994*	*0.575*	*0.094*
PI_BZ	-0.009330	0.003914	-0.007491	-0.000263
	0.733	*0.977*	*0.054*	*0.322*
R_COPPER	-0.882272	0.731922	0.128505	0.001755
	0.560	*0.871*	*0.496*	*0.890*
d(1|RC)*R_COPPER	1.114250	-0.974669	-0.239337	-0.013390
	0.645	*0.899*	*0.453*	*0.523*
IMACEC_EST	0.000509	0.075075	-0.003068	0.000006
	0.993	*0.405*	*0.549*	*0.982*
CPI_EST	-0.010818	-0.058942	-0.004269	-0.000452
	0.863	*0.460*	*0.217*	*0.084*
MPR	-0.125188	-0.374557	-0.237533	-0.000491
	0.529	*0.492*	*0.000*	*0.727*
Constant	-0.027700	-0.018853	-0.018494	0.000904
	0.444	*0.892*	*0.001*	*0.022*
Number of observations	2033	2033	2033	2033
Adjusted R-squared	0.001	-0.007	0.072	0.472
Durbin-Watson stat	2.022	2.141	2.322	1.977
Akaike info criterion	0.666	2.332	-3.104	-7.029
Schwarz criterion	0.796	2.462	-2.974	-6.899
Hannan-Quinn criter.	0.714	2.380	-3.056	-6.982

Given that, results in the return equation indicate that increases in the uncertainty, measured by a positive variation in the VIX, generate a higher demand of these short-term instruments, due to the lower default risk and shorter maturity, and therefore a decrease in the yield producing greater returns. On the other hand, the negative correlation between the stock market returns in North America and the short-term deposit rate returns, shows that when things are going well in the U.S., that generates less risk aversion by investors, and hence the demand in deposits decrease, in order to invest in riskier securities. Coherent to this, when things are worse in the U.S., there are more demand for deposits, generating a higher demand, and therefore positive returns. The asymmetric effect of the negative news in North America does not reflect in this asset.

The effect of foreign macroeconomic shocks is driven only by the Brazilian economy. The negative coefficient expresses that if the observed value was less than the expected one, there is a positive return, because it could be interpreted as negative news, which generates a higher demand of deposits, decreasing the yield. Finally, surprises in the Monetary Policy Rate (MPR) generate an effect in the deposit rate due to its short-term maturity, consistent with Larraín (2007). The negative sign reflects that if there is a positive surprise in the MPR – i.e. the market expectation was to set a lower rate than what was defined by the Central Bank – an increase in the deposit rate is generated, producing a negative return.

The variance equation shows a spillover between the variance of the deposit rate returns, and the conditional variance of the stock market. An increase in the conditional variance of the stock market generates a decrease in the variance of the deposit rate returns. This could be interpreted as a flight-to-quality movement. When there is more uncertainty in the stock market, that volatility generates a more demand for deposits, due to the flight-to-quality, producing more liquidity, and therefore decreasing the volatility in that market. Consistent

with the least, negative returns in Asian stocks produce a decrease in the volatility of the deposit rate returns. On the other hand, negative news in the cooper price generates an increase in the volatility of the deposit rate returns. There is a relation between the cooper price, due to the dependence of that commodity the Chilean economy has, and the performance of the economy. As the deposit rate is correlated with the MPR, which is the instrument that the Central Bank of Chile has to control the economic activity, a negative news in the cooper price is directly interpreted as a lower growth of the economy, therefore increasing the chances to change the MPR, affecting the variance of the deposit returns.

Both the returns of BCU10 and the money-market (PRIME) are significant and affect positively the returns of the stock exchange, but the magnitude of this effect is myriad compared to the size of the autocorrelation coefficient (equity index return from the previous day).

In terms of foreign stock exchange markets, there is a positive estimated relation between the return in the North America stock index and the IPSA. Also, Latin-American stocks are very important for the Chilean stock returns. Not only the coefficient on positive news is highly significant but also the marginal effect is material. Meanwhile, there is a negative estimated effect related to the negative news coming from the European stock exchange.

After controlling for financial shocks, as we interpret foreign exchange shocks, macroeconomic surprises in foreign markets do not appear to be significant, except for the European market. The small estimated effect is negative, which means that if the observed value is lower than expected, it results in a positive return. This could be explained by the role that domestic pension funds play in the market, especially when there is higher volatility or uncertainty in the international markets as they reallocate their portfolios assigned a larger share to domestic assets, and thus liquidating investments abroad.

Table 6. Econometric results for variance equations
(p-values under estimated coefficient)

	Variance equation:			
	AAA	BCU 10	PRIME	RIPSA
RESID(-1)^2	0.037456	0.049239	0.348222	0.124626
	0.000	*0.210*	*0.000*	*0.000*
GARCH(-1)	0.796141	0.686697	0.377413	0.797618
	0.000	*0.000*	*0.000*	*0.000*
E_BCU10(-1)^2	0.000166		-0.000002	0.000000
	0.754		*0.872*	*0.002*
E_PRIME(-1)^2	-0.028574	0.086538		0.000069
	0.448	*0.849*		*0.056*
E_RIPSA(-1)^2	-10.328950	11.586660	-1.290529	
	0.506	*0.947*	*0.001*	
E_AAA(-1)^2		-0.044642	-0.000221	0.000005
		0.415	*0.094*	*0.065*
VIX	-0.000136	0.005995	0.000031	0.000000
	0.661	*0.052*	*0.124*	*0.569*
VIX_AR1*VIX	0.000219	0.009858	-0.000031	0.000000
	0.704	*0.216*	*0.367*	*0.089*
MSCI_NAMERICA	2.123901	-10.688740	0.038346	0.000084
	0.014	*0.127*	*0.358*	*0.721*
d(1|NA)*MSCI_NAMERICA	-3.177553	11.662180	-0.035608	-0.000329
	0.005	*0.257*	*0.554*	*0.295*
MSCI_EUROPE	-1.010546	-2.453260	-0.010468	-0.000084
	0.121	*0.655*	*0.734*	*0.630*
d(1|E)*MSCI_EUROPE	2.278684	6.982846	-0.015808	0.000369
	0.009	*0.368*	*0.748*	*0.139*
MSCI_LATAM	0.318937	-2.401958	0.027086	0.000001
	0.000	*0.592*	*0.310*	*0.992*
d(1|LA)*MSCI_LATAM	0.309318	3.183786	-0.037362	-0.000186
	0.467	*0.616*	*0.360*	*0.355*
MSCI_ASIA	0.396985	3.460531	-0.023265	0.000131
	0.368	*0.492*	*0.268*	*0.394*
d(1|A)*MSCI_ASIA	-1.747899	-4.995297	0.057027	-0.000169
	0.009	*0.527*	*0.034*	*0.473*
PI_US	0.028999	-0.016191	0.000174	0.000000
	0.000	*0.834*	*0.569*	*0.937*
PI_EU	0.006384	0.014705	-0.000136	0.000000
	0.202	*0.842*	*0.719*	*0.903*
PI_BZ	0.013140	0.008788	-0.000107	0.000002
	0.034	*0.885*	*0.764*	*0.201*
R_COPPER	-0.705776	-2.662933	0.021878	-0.000133
	0.001	*0.126*	*0.162*	*0.046*
d(1|RC)*R_COPPER	0.025548	2.284711	-0.050703	-0.000013
	0.932	*0.002*	*0.052*	*0.896*
IMACEC_EST	0.000997	0.121957	-0.000165	0.000003
	0.908	*0.017*	*0.700*	*0.128*
CPI_EST	-0.002993	-0.003388	0.000067	0.000002
	0.636	*0.950*	*0.836*	*0.105*
MPR	-0.060440	0.020769	-0.002614	0.000011
	0.111	*0.965*	*0.108*	*0.271*
Constant	0.030784	0.284030	0.000919	0.000001
	0.000	*0.006*	*0.006*	*0.213*

Finally, among domestic shocks a small effect is estimated on consumer price index expectations, and the sign is negative. That is, when the observed CPI value is lower than expected, it results in a positive return. This makes sense as we interpret it in the following way: lower inflation implies a lower discount rate, and therefore higher value of stocks.

Regarding second moments, it is interesting that there are significant spillovers from the variance of corporate (AAA) and Central Bank bonds (BCU10), as well as money-market returns (PRIME). The signs are nevertheless mixed. While the variance of corporates bonds and prime have a positive relation with that of the equity market index, the variance of the Central Bank bond has a negative relation. Increases in uncertainty, as negative news, generate a higher variance in stocks. Copper price returns have a negative relation.

3.3 Conditional correlations

The average correlation (unconditional or long-term correlation) of BCU10 with corporate bond returns, money market and stocks is close to zero or very low (table 7).

For the corporate bond market, there is, in general, an increase in the coupling (positive correlation) in turbulent periods. This observation alone is based on the positive sign of the coefficient of asymmetry (although not significant to conventional values).

For money-market returns, there is, in general, a decrease in the coupling (negative correlation) in riskier periods. The asymmetry coefficient (g) is negative and significant at 5%. This higher negative correlation could be explained by search for higher liquidity or lower relative risk.

Table 7. Conditional correlations

	Conditional correlations to:					
		BCU 10		AAA		PRIME
	AAA	PRIME	RIPSA	PRIME	RIPSA	RIPSA
a	-0.0167	0.0089	-0.0039	0.0055	-0.0039	-0.0141
	[0.0258]	[0.7531]	[0.5946]	[0.3314]	[0.4092]	[0.5855]
b	0.866	0.2454	-0.4656	0.9519	0.9757	-0.3248
	[0.0000]	[0.3422]	[0.0052]	[0.0000]	[0.0000]	[0.6477]
g	0.0154	-0.0503	0.0086	-0.0045	0.0064	-0.2406
	[0.2059]	[0.0082]	[0.3295]	[0.6050]	[0.4836]	[0.4930]

p-value in parentheses

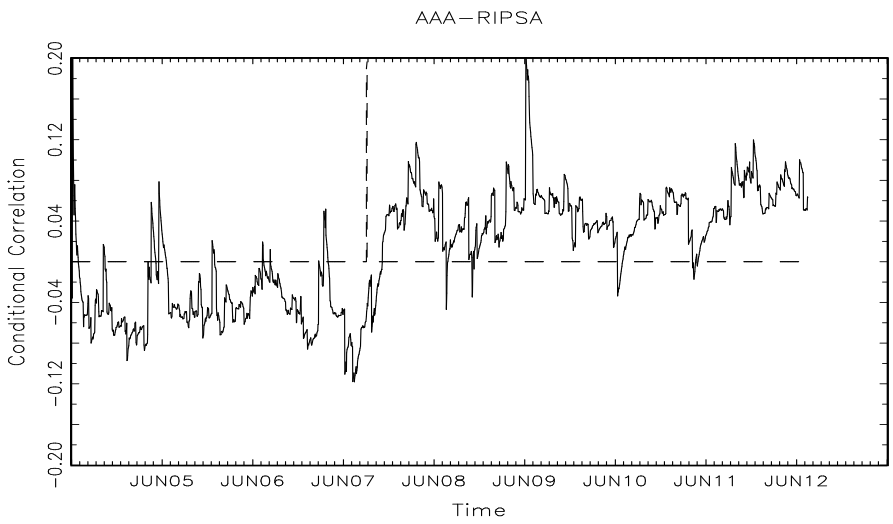
3.4 Structural Break on Unconditional Correlations

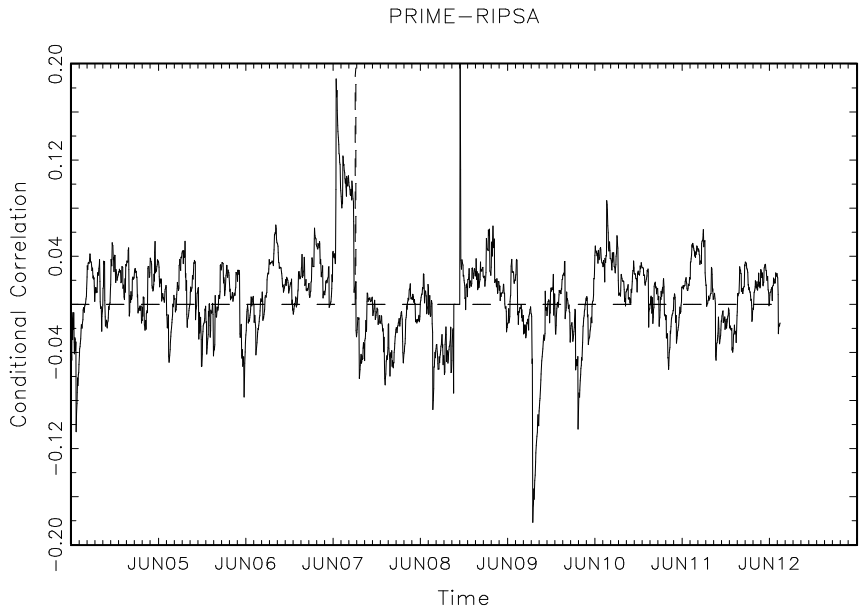
In order to test for a change of regime on long run correlations, we consider two appealing dates during the sample period. The first date is the beginning of the Subprime crisis on August 10, 2007. The second date corresponds to Lehman Brothers collapse on September 15, 2008.

Table 8. Structural break tests

		BCU 10-AAA	BCU 10-PRIME	BCU 10-RIPSA	AAA-PRIME	AAA-RIPSA	PRIME-RIPSA
Aug-2007	LR-test	0.88	1.30	0.01	0.34	4.25	23.40
	p-value	[0.35]	[0.25]	[0.93]	[0.56]	[0.04]	[0.00]
Sep-2008	LR-test	1.98	0.36	0.08	0.77	0.47	1.80
	p-value	[0.16]	[0.55]	[0.77]	[0.38]	[0.49]	[0.18]

As we can see in table 8, only the long run correlation between AAA and money-market return with the Chilean stock returns exhibit significant evidence of structural change by the beginning of the Subprime crisis (at 5% and 1% significance level, respectively). In the first case, the unconditional correlation changes from negative to positive after the break date. In the case of money-market and IPSA returns, the change is from positive to negative.





4. Conclusions

In this paper we use four assets in order to test how different shocks affect the Chilean market. We use the returns of a long-term government bond, of a long-term AAA corporate bond, of a money market deposit rate, and of the stock. Furthermore, we incorporate foreign financial shocks, using stock returns from different geographic areas; foreign macroeconomic shocks, using the expected and observed values of the industrial production growth; and domestic macroeconomic shocks, using the expected and observed values of

the monthly economic activity index, the consumer price index, unexpected changes in the monetary policy rate, and the return in the copper price. We also control for the global uncertainty, measured by the VIX.

We found that returns of the long-term government bond are not significantly affected by any shock, while the variance of these returns react significantly to movements in the VIX, negative news in the copper price, and to the monthly economic activity index. On the other hand, returns in corporate bonds are affected by the long-term government bond returns, and also by the foreign macroeconomic shocks from the Eurozone and US. The volatility of these returns reacts to the foreign financial shocks, to foreign macroeconomic shocks in US and Brazil, and to returns in cooper price. The returns of money market deposits are affected by the VIX, the North America stocks, the macroeconomic shocks in Brazil, and to the unexpected changes in the monetary policy rate. The variance of money market returns is affected by the variance of the corporate bonds, of the stock returns, and of the negative news in both, the Asian stocks and the copper price.

On the other hand, the Chilean stock returns are significantly affected by the previous return of the long-term government bond and to the previous returns of the money market deposits. Furthermore, foreign financial markets play a significant role in the returns of the Chilean stock, being affected by North America stock returns, negative returns of European stocks, and Latin-American stock returns. Also, it is related with the macroeconomic shocks in the U.S., and unexpected growth in the consumer price index. The variance of the stock market is affected by the variance in the corporate bond market, by the government bond market, and by the money market deposit variance. Increases in global uncertainty generate an increase in the volatility of the stocks, and the return in the copper price produces a negative effect into the Chilean stock market volatility.

Finally, we found some statistical evidence in favor of a structural change in the unconditional correlation between returns on the stock exchange index (IPSA) and both, returns on corporate bonds and the money market deposits (PRIME). In both cases, the date of the change seems to be by the beginning of the subprime crises, not after the Lehman Brothers collapse.

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