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Journal of Financial Intermediation ●●● (●●●●) ●●●–●●●

Journal of Financial Intermediation

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What determines market development? Lessons from Latin American derivatives markets with an emphasis on Chile

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Received 1 July 2002; revised 3 March 2003

Abstract

There is considerable heterogeneity in the development of derivatives markets in different countries. The question is: why? This paper addresses this question in the context of major derivatives markets in Latin America. The largest derivatives exchanges in Latin America are located in Argentina, Brazil, and Mexico. In addition, over-the-counter (OTC) markets exist in Chile and Peru. Excluding Peru, Chile's derivatives market is to date the least developed. We show that this is due to regulatory constrains and illiquidity. Domestic transactions are OTC, and consist mostly of exchange rate forwards. Recent changes in the Central Bank of Chile's exchange rate policy have not had a considerable impact on the aggregate trading volume of forwards. However, amendments made to the Law of Capital Markets in 2001 bring the possibility of having a more developed derivatives market in the future.

JEL classification: G1

1. Introduction

Prior to the 1970s, currency and interest rates risk was not generally a concern around the world. It was not until the failure of Bretton Woods that the volatility of the US dollar against the Japanese yen rose dramatically. At the same time, the yields on US long-maturity bonds fluctuated considerably at the end of the 1970s and at the beginning of the 1980s. This highly volatile economic environment was sharpened by the 1973s oil cri-

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1042-9573/03/$ – see front matter
doi:10.1016/S1042-9573(03)00043-3

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sis. These changes underlined the importance of corporate risk management, namely, the strategy of eliminating costly lower-tail outcomes that might cause financial distress or interfere with investment plans (Stulz, 1996).

Specifically, between the mid-1970s and the mid-1980s, the derivatives market flourished. Forwards, futures, and options, began to be actively traded on and outside exchanges in most industrialized countries, with the Black and Scholes (1973) option pricing formula providing an important impetus to the development of these markets. Nowadays, notional amounts—a measure of market size—involved in derivative contracts are sizeable. Information gathered by the Bank for International Settlements (BIS) shows that the notional amount of outstanding positions reached US$99.7 trillion outside exchanges (OTC markets), and US$19.5 trillion on exchanges at the end of June 2001.

Among OTC transactions, positions on interest rates contracts represented 76 percent of the notional amount outstanding, whereas those on foreign exchange and other contracts (equity, commodities, credit and other derivatives) amounted to 20.5 and 3.4 percent, respectively. Among exchange-traded derivatives, interest rate contracts also predominated, reaching 89.9 percent of the notional amount outstanding. Meanwhile, turnover—a measure of market activity—reached US$1342 billion in OTC markets and US$2209 billions on exchanges at the end of June 2001.

Despite this impressive growth in derivatives markets around the world, considerable heterogeneity exists in the degree of development across different countries. For example, in Latin America, derivatives markets in Chile lag far behind those in Brazil and Argentina. What accounts for these differences? The analytical pricing machinery provided by Black and Scholes op cit, as well as the voluminous literature on contingent claims that has developed since,[1] are available freely to all participants, so the answer probably lies in institutional and legal factors. Understanding these factors is important for the broader issue of the design and development of financial markets and institutions, i.e., financial system architecture.[2] The purpose of this paper is to address this question within the context of derivatives markets in Chile, Argentina, Brazil and Mexico. Comparing these Latin American markets provides interesting insights into the impact of institutional and regulatory factors on the development of financial markets.

In Latin America, the largest derivatives exchanges are located in Argentina (MATBA, ROFEX), Brazil (BM&F, BOVESPA), and Mexico (MexDer). In addition, OTC markets exist in Chile and Peru. On the Buenos Aires Futures Market (*Mercado a Termino de Buenos Aires*), MATBA, the largest market of derivatives in agricultural products in Latin America, futures and options on futures on wheat, soybean, sunflower seeds are traded. The Rosario Futures Markets (*Mercado a Termino de Rosario*), ROFEX, offers derivatives on agricultural products (futures and options on soybean, corn, wheat, among others), feeder cattle, and financial products, but it is much smaller in size than the MATBA. For instance, for 1993–2001 the volume in tons of agricultural contracts negotiated on ROFEX amounted to only 11.2 percent of that on the MATBA.

[1] See Hull (2000).

[2] See Allen and Gale (1999) and Boot and Thakor (1997).

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The Brazilian Mercantile & Futures Exchange (BM&F) is the leading futures exchange in Latin America, and it is among the largest exchanges in the world. According to information gathered by the Futures Institute, in 1998 the volume traded (number of contracts) at the BM&F amounted to 8.4 and 7.6 percent of the total volume traded in and outside the United States, respectively. The BM&F offers a rich menu of derivative contracts, which includes futures and options on agricultural commodities (coffee, cotton, and wheat), the BOVESPA (São Paulo Stock Exchange) index, interest rates, foreign exchange rate, gold, among others. The BOVESPA also offers derivatives, but it is small relative to the BM&F. For example, the financial volume traded in 2000 on the BOVESPA only reached 2.7 percent of that on BM&F. The products available on the BOVESPA are options on one-day interbank deposits, the BOVESPA index, US dollar denominated Brazilian equity, among others.

The Mexican market for derivatives (MexDer) began to operate in 1998, and the financial volume negotiated on the exchange has increased over time. However, it is still relatively small when compared with the Mexican Stock Exchange (*Bolsa Mexicana de Valores*). The products currently available on MexDer are futures on US dollars, the Mexican Stock Exchange Index (IPC), interbank and Mexican Treasury notes, three-year government bonds, and futures on individual stocks. Meanwhile, in Chile and Peru domestic transactions of derivatives essentially boil down to OTC exchange rate derivatives. According to information gathered by the BIS, the average daily turnover in OTC markets in April 2001 amounted to US$635 million and US$36 million in Chile and Peru, respectively.

The contracts regularly traded in Chile are US$/Chilean peso and US$/*Unidad de Fomento* (UF) forwards.[3] These financial instruments, which were designed to hedge currency risk, were introduced in the domestic market in 1992 and 1994, respectively. They are primarily traded between financial institutions, and between financial institutions and large firms. Other types of derivatives, such as individual stock options and stock indices options, which were introduced on the Santiago Stock Exchange in 1990, have been barely traded. For example, futures contracts on the Price Index of Selective Stocks (IPSA), which includes the 40 most actively traded stocks on the Santiago Stock Exchange, were only traded between 1990 and 1994. Options on stocks, which were introduced in 1994, were traded only in 1994, 1995, and 1998.

Besides the low frequency of transactions of these financial instruments, the trading volumes were also very small as compared with total trading on the Santiago Stock Exchange. Indeed, the share of futures averaged 0.022 percent in the period 1990–1994, whereas options had a share of almost zero percent in the same period. An explanation for such failure is that pension funds (AFP), the key investors of the Chilean financial market—their total assets reached 53.3 percent of GDP in 2000, are not allowed to enter into futures and options on stocks.

However, there have been additional attempts to expand the type of contracts available domestically. In particular, interest rates derivatives and fixed-income assets derivatives were introduced in 1999 and 2000, respectively. To date, these instruments have been

[3] *Unidad de Fomento* is an inflation-indexed accounting unit, which was introduced in 1977. Its value is daily adjusted according to the previous month inflation, expressed on a daily base.

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traded in OTC markets (typically, between commercial banks), and have taken the form of Forward Rate Agreements (FRAs) and swaps on interest rates denominated in local currency. Although, since 1999, the Central Bank of Chile allows stripping coupons of the long maturity bonds it issues domestically, the spot market of interest rates is probably not liquid enough to ensure transactions of these instruments on exchanges.[4]

On the other hand, in order to increase the liquidity of the domestic stock market, the Superintendence of Securities and Insurance (*Superintendencia de Valores y Seguros*) authorized stock short-selling in 1999. Unfortunately, this type of transaction was infrequent for two reasons. First, stock short-selling was not tax free until November 2001. Second, until today, AFP are not authorized to short stocks, even though they could be the main stocks lender. To illustrate, as of December 2001, stocks of private companies and financial institutions reached 10.61 percent of AFP total assets, that is to say, approximately US$3681.4 million.

From the above discussion, Chile's derivatives market does not show significant growth potential. However, a package of amendments to the Law of Capital Markets, which was passed by the Chilean Congress in November 2001, might change this scenario. This consists of 15 reforms aimed at providing alternative funding to emerging companies, and to firms with growth potential, but no credit record; increasing the liquidity of the domestic capital market by enhancing the participation of new investors; offering a wider range of alternatives to investors, in terms of risk/return profiles; eliminating the remaining financial flows restrictions; and, finally, boosting long-term domestic savings.

The specific questions raised by this discussion that are addressed in this paper are: What is the institutional framework of the Chilean derivatives market and how has it contributed to the relative lack of development of this market? What is the impact of recent changes in the Chilean Central Bank's exchange rate policy on the domestic market of exchange rate forwards? And, finally, how have the derivatives markets evolved in other Latin America countries, like Argentina, Brazil and Mexico?

Our results show that stringent regulation has dampened the development of the Chilean financial market, which has lagged behind those in the main Latin American economies. As mentioned earlier, the domestic market for derivatives essentially consists of OTC exchange rate forwards. Contrary to what was expected, changes in Chilean exchange rate policy, introduced by the Central Bank of Chile in 1999, have not had a noticeable impact on the aggregate trading volume of exchange rate forwards. By contrast, both Argentina and Brazil have had exchange-traded derivatives for almost a century, while Mexico has experienced a fast development of its derivatives markets since the mid-1990s.

What we pursue in this paper is sharply delineated from previous research. Previous studies have focused on the use of derivatives by both financial and non-financial firms in the United States (e.g., Cummins et al., 1997; Guay and Kothari, 2002; Henstchel and Kothari, 2001), and have dealt with the benefits from using options on theoretical grounds (e.g., Neuberger and Hodges, 2002). None of these papers have addressed the development of Latin American derivatives markets.

[4] Currently, there is no public information on trading volumes of interest rates and fixed-income assets derivatives. The Central Bank of Chile is in the process of collecting the relevant data.

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This paper is organized as follows. Section 2 presents an overview of the derivatives market activity in Latin America on and outside exchanges. Section 3 studies the evolution of currency forwards in Chile, and analyzes the impact of recent changes of the exchange rate polity on this market. Finally, Section 4 summarizes the main findings.

2. An overview of the derivatives markets in Latin America

2.1. Latin America

In this section, we look at the main derivatives markets existing in the region. As previously mentioned, Chile has been one of the most successful Latin American economies in the past few years. According to information gathered by the World Bank, between 1990 and 2000, Chile grew at an average rate of 6.8 percent, while Argentina, Mexico and Brazil grew only at 3 percent, approximately. In addition, thanks to the autonomy of the Central Bank, inflation went down from 26 percent in 1990 to 4 percent in 2000. By contrast, at the beginning of the 1990s Argentina and Brazil struggled against inflation rates that reached over 2,000 percent a year. Chile has also presented relatively low ratios of total debt service to exports of goods and services: 26 percent in 2000 as opposed to 71.5, 90.7, and 30 percent of Argentina, Brazil, and Mexico, respectively. In addition, gross capital formation in Chile has been slightly higher (23.4 percent) than the average for Latin American countries in 2000 (19.9 percent).

Despite these good indicators, stringent regulation has dampened the development of the Chilean financial market, and this has lagged behind the main Latin American economies'. As explained in the Introduction, the most important financial investors in the economy are pension funds. However, their investment decisions are subject to several constraints that have hindered market liquidity and the emergence of new financial instruments. Only in 2001 have authorities made important amendments to the Law of Capital Markets that might boost the domestic financial market. This will be discussed in more detail in the later sections.

2.1.1. Chile

Even though institutions, other than banks and large firms, have used derivatives infrequently to date, the regulatory framework for trading these instruments on exchanges and in OTC markets dates back to the mid-1980s and the early 1990s.[5] At present, transactions of derivatives in the domestic market are composed primarily by OTC transactions in US$/peso and US$/UF forwards between banks and between banks and large firms. In 2001, total US$/Chilean peso transactions predominated with 75.4 percent of the market.

[5] Regulation applicable to derivatives contracts is contained in the Law of Banks and Financial Institutions, and in the Law of Capital Markets. Derivatives transactions have also to comply with the Central Bank of Chile's regulations applicable to the exchange rate market and to financial institutions. Taxation relevant to these transactions is described in the Law of Income Tax of the Chilean Internal Revenue Service. Detailed information of the current regulation is available at the web sites of the Central Bank of Chile, www.bcentral.cl, and of the Superintendence of Banks and Financial Institutions, www.sapf.cl.

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The process of declining inflation Chile has gone through since the mid-1990s has reduced the appeal of US$/UF contracts, which are designed to hedge against both inflation and currency risk.[6] (This is studied in more detail in Section 3).

OTC interest rates and fixed-income assets derivatives began to be traded in recent years, but their share is still relatively small. Regarding exchange-traded derivatives, there is not an active market for them at present. As Table 1 shows, futures contracts on the Price Index of Selective Stocks (IPSA) and options on stocks were barely traded on the Santiago Stock Exchange in the 1990s.

Domestic banks were first allowed to enter into derivatives contracts in the mid-1980s. At the beginning transactions were limited in number, primarily due to rigid controls. It was not until 1992, after the Central Bank of Chile amended the prevailing regulation, that financial volume grew substantially. To illustrate, transactions in foreign currency and interest rates derivatives carried out in the domestic and foreign markets reached US$1766.2 million and US$215.2 million in 1993, respectively, while they jumped up to US$7293.2 million and US$2431.6 million in 1994, respectively.

At present, domestic banks and financial institutions are allowed to write futures, forwards, swaps, and combinations of these instruments on the Chilean peso, indices linked to past inflation (i.e., *Unidad de Fomento*, UF), domestic interest rates, domestic fixed-income assets, foreign currency, and foreign interest rates. The counterpart must be either another bank or financial institution, or a third party residing in Chile.

Nevertheless, commercial banks are not constrained to domestic derivatives. They can also take long and short positions in futures on foreign currency and interest rates, and take long positions in calls and puts on foreign currency and interest rates futures on official exchanges. In addition, banks can engaged in OTC transactions involving foreign currency forwards, interest rates swaps, puts and calls on futures on foreign currency, among others. Figure 1 shows that, since approximately June 2001, banks have started to take long positions in foreign currency derivatives primarily in foreign markets. The Argentinean crisis and a volatile Brazilian financial market are most likely to have triggered this shift.

Figure 2(a) shows the evolution of the monthly net overall position on derivatives subscribed by commercial banks both at home and abroad, for the period January 1997–October 2001. The net position is defined as assets (long positions) minus liabilities (short positions) on derivatives in a given month. As panel (a) depicts, the net position shows a negative trend since May 2000, approximately. This is better understood by looking at panel (b), which shows that the ratio of short positions to total liabilities (excluding capital) has steadily increased since January 1999, whereas long positions to assets have fell behind. This pattern suggests a pro-cyclical behavior of the net position.[7]

The Law of Capital Markets of 1994 allowed pension funds (AFP) to take positions in currency forwards in the domestic market, and positions in options and forwards on foreign interest rates, foreign interest rate indices, and foreign currency in foreign markets.

[6] The average annual inflation over 1990–1994 was 13.2 percent, whereas over 1995–2001 it reached only 4.7 percent (source: Central Bank of Chile).

[7] In 1997 and 1998, Chile's GDP grew by 7.4 and 3.9 percent, respectively, whereas in 1999 GDP fell by 0.8 percent. Pessimistic expectations about future growth might explain the negative balance in 2000 and 2001, despite positive GDP growth rates (5.3 and 2.8 percent in 2000 and 2001, respectively).

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Table 1
Derivatives trading on the Santiago Stock Exchange, Chile, 1990–2000 (figures in thousand US dollars of December 2000)

Time period	Stocks	Traded assets					Options	Total
		IIF	IRF	Metals	Futures	CFI		
Decade 1960	29,208.7	0.0	1,805.5	2,042.7	0.0	0.0	0.0	33,056.9
Decade 1970	67,342.1	49,263.6	21,916.7	6,534.4	0.0	0.0	0.0	145,056.8
Decade 1980	463,516.4	5,000,321.2	5,290,426.7	17,534.2	0.0	0.0	0.0	10,771,798.6
Decade 1990	4,723,486.8	65,691,662.9	46,988,564.7	14,590,545.8	602,181.7	55,797.7	445.4	132,652,684.9
Decade 2000	5,882,781.6	126,536,927.8	42,527,412.0	46,103,278.7	0.0	32,210.4	0.0	221,082,610.6
1990	1,005,475.4	6,952,874.7	18,328,212.9	332,532.1	9,048.1	0.0	0.0	26,628,143.3
1991	2,305,535.2	11,225,776.8	14,829,065.1	4,444,048.2	27,830.2	6,551.1	0.0	32,838,806.7
1992	2,254,963.7	18,266,751.8	24,839,673.5	3,883,646.9	16,481.5	25,581.0	0.0	49,287,098.4
1993	3,037,499.3	30,510,929.3	28,350,584.4	4,277,098.5	7,432.1	27,544.5	0.0	66,211,088.2
1994	5,324,445.5	33,485,494.4	47,062,740.8	5,058,723.7	75.3	72,970.7	406.1	91,004,856.4
1995	9,800,121.2	53,184,056.7	71,914,005.2	9,764,654.2	0.0	285,162.9	39.2	144,948,039.4
1996	7,301,071.5	95,934,447.7	68,225,750.2	10,753,998.4	0.0	67,352.9	0.0	182,282,620.6
1997	6,140,360.1	116,967,083.9	73,212,728.4	17,367,692.5	0.0	63,342.4	0.0	213,751,207.4
1998	3,814,188.1	167,952,348.6	78,310,946.8	42,913,713.6	0.0	8,466.1	0.1	292,999,663.3
1999	6,251,208.3	122,436,864.6	44,811,939.2	47,109,349.9	0.0	1,005.1	0.0	220,610,367.1
2000	5,882,781.6	126,536,927.8	42,527,412.0	46,103,278.7	0.0	32,210.4	0.0	221,082,610.6
Average 1990–2000	4,828,877	71,223,051	46,583,005	17,455,340	5533	53,653	40	140,149,500
Percentage	3.45	50.82	33.24	12.45	0.00	0.04	0.00	100.00
Ave. 1990–2000/GDP, %	8.78	129.47	84.68	31.73	0.01	0.10	0.00	254.76

Notes. IIF: fixed-income instruments whose maturity is less than a year; IRF: fixed-income instruments, such as mortgage securities, Treasury and Central Bank bonds, commercial banks and firms bonds; Metals: gold and coined silver, and US dollars; CFI: shares of investment funds. Ave. 1990–2000/GDP is calculated as the 1990–2000 average for each category over the 1990–2000 average Chilean GDP.
Source: Santiago Stock Exchange and the Central Bank of Chile.

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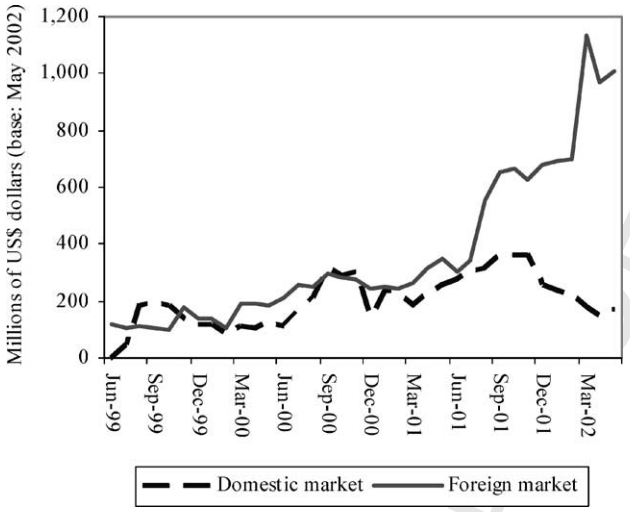

Fig. 1. Long position in foreign currency derivatives held by commercial banks in Chile: May 1999–May 2002. *Source*: Author's elaboration based upon data gathered by the Superintendence of Banks and Financial Institutions.

In practice, however, derivatives contracts have had a negligible share of their total assets, as opposed to public sector bonds and securities issued by the domestic financial sector (about 70 percent of total assets). Until recently, AFP were constrained to meet a target annual rate of return. As a result, all of them invested on similar and low risk portfolios.[8] (This pattern is known as the 'flock effect.')

Transactions in derivatives by non-financial firms are regulated by the Compendium of Foreign Exchange Regulations of the Central Bank of Chile. Figure 3 shows data on derivatives contracts on foreign interest rates entered into by domestic banks and non-financial firms with foreign counterparts for the period January 1998–December 2001. The dollar amount outstanding in fixed-rate contracts has predominated over the whole sample period, and the share of floating-rate contracts was always below 6 percent until September 1999. From November 1999 onwards, however, this situation reverted, and the amount outstanding of floating-rate contracts reached about one fifth of the total. Interestingly, this break in trend coincided with the liberalization of the nominal exchange rate by the Central Bank of Chile in September 1999. Indeed, as currency risk has gone up, banks and firms seemed to have found it more desirable to increase their shares of floating-rate contracts in their portfolios.

2.1.2. Argentina

Trading of forwards on agricultural commodities in Argentina dates back to the beginning of the 20th century. Forwards have been traded on The Buenos Aires Fu-

[8] Until 2001, the rate of return in a 12-month period on any pension fund could not be lower than the minimum between the average rate of return on all pension funds minus 2 percent points, and half the average rate of return on all pensions funds.

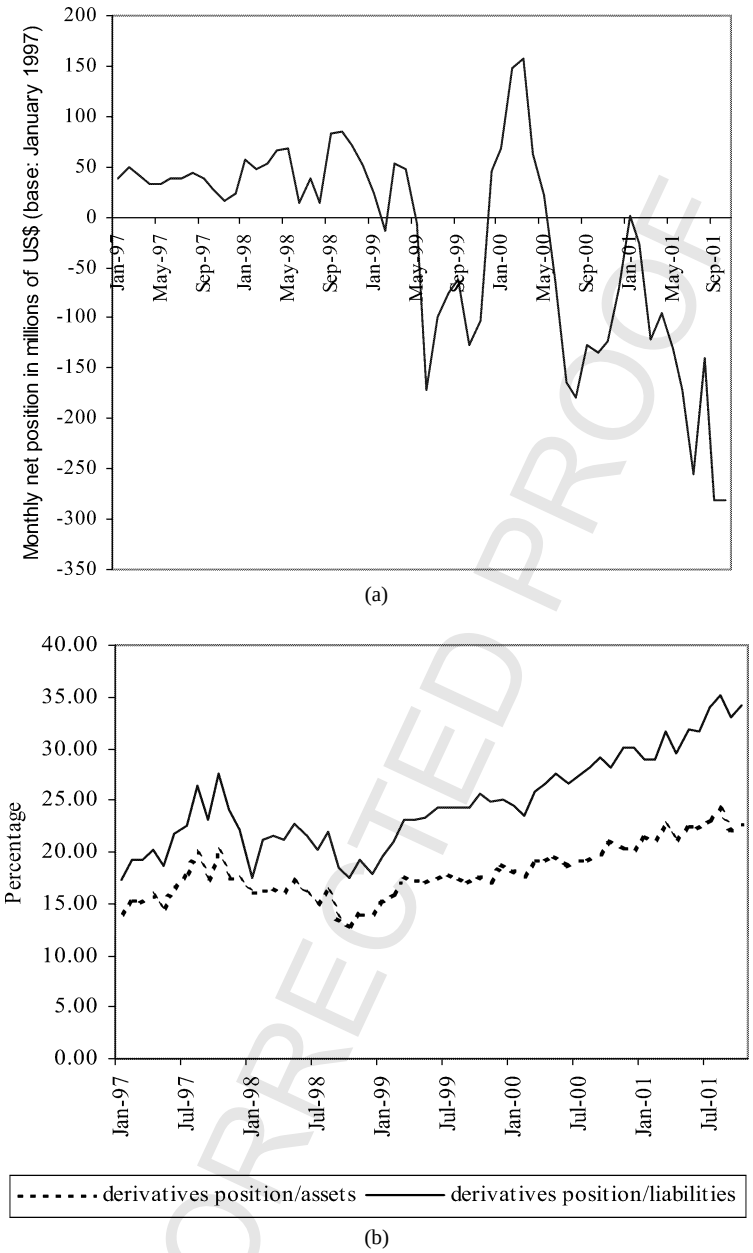

Fig. 2. Derivatives positions of Chilean commercial banks: January 1997–October 2001: (a) monthly net position; (b) derivatives positions as shares of assets and liabilities. *Source*: Author's elaboration based upon information in monthly bulletins of the Superintendence of Banks and Financial Institutions. The next position is defined as the difference between long and short positions on derivatives.

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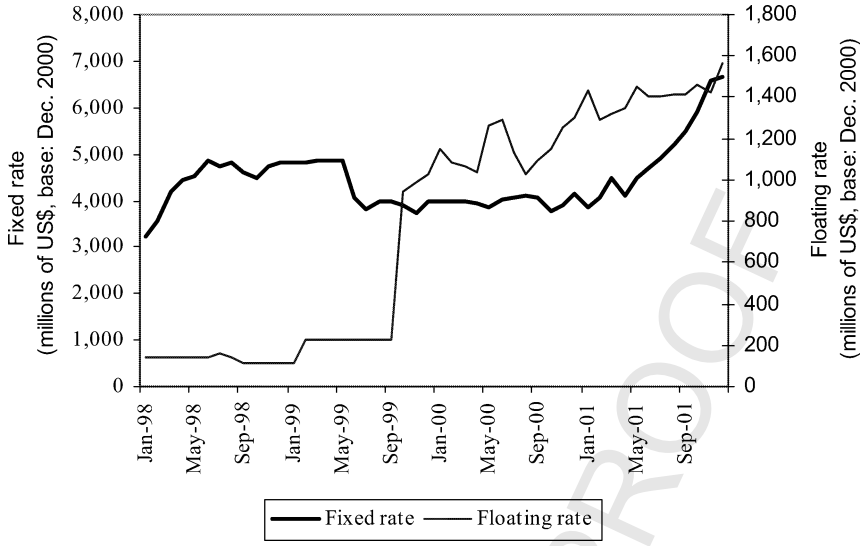

Fig. 3. National amount outstanding in derivatives on fixed and floating interest rates held by commercial banks and firms operating in Chile. *Source*: Author's elaboration based upon information provided by the Central Bank of Chile.

tures Market—MATBA (*Mercado a Termino de Buenos Aires*)—since the exchange was founded in October 1907. Similarly, trading has taken place at the Futures Market of Rosario (Argentina's second largest city), ROFEX (*Mercado a Termino de Rosario*), since 1909. The most actively traded futures contracts are those on agricultural and livestock products, which include grains, oilseeds, cattle and hogs. Meanwhile call options on individual stocks are traded at The Buenos Stock Exchange. Trading volumes, however, are relatively small. For example, for the time period 1990–2001 the share of options averaged only 1.1 percent of all transactions.

Panel (a) of Table 2 shows a world ranking in 2001 of exchanges that trade agricultural products available on the MATBA. Even though the MATBA is the most important agricultural exchange in Latin America, its trading volume reached only 0.24 percent of the total traded by the exchanges under consideration. The top three agricultural exchanges in 2001 were the CBOT (74.3 percent), the Tokyo Grain Exchange (14.6 percent), and the Kansas City Board of Exchange Trade (4.35 percent). In turn, panel (b) of Table 2 shows the evolution of the trading volume (number of contracts) on the MATBA from 1993 to 2001. For this time period, futures on wheat, corn and soybean were the most actively traded, with corresponding average shares of 25, 20.3, and 17 percent. The greatest annual decrease in volume took place in 2001, with a 20 percent drop with respect to 2000. In general, lower trading was observed throughout 2001, and December had no trading at all, as a consequence of the late Argentinean crisis.

The contracts actively traded on ROFEX are futures and options on sunflower, sorghum, wheat, corn, *Rosafe* Soybean Index (RSI), and the Argentine Live Cattle Index. Other contracts involve financial products, such as Argentine T-note options on futures, Argentine T-note futures, and options and futures on short, medium and long-maturity bonds (global

Table 2
Derivatives markets in Argentina
(a) 2001 world ranking of trading volume of options and futures on agricultural products (figures in tons)

Exchange	Wheat	Corn	Soybean	Sunflower seed	Total exch.	Share exch., %
CBOT	1,158,791,883	2,742,467,485	2,174,488,669		6,075,748,037	74.271
Tokyo Grain Exchange		1,039,390,900	153,065,850		1,192,456,750	14.577
Kansas City Board of Trade	353,848,265				353,848,265	4.326
Fukuoka Futures Exch.		201,696,800	48,014,970		249,711,770	3.053
Minneapolis Grain Exchange	135,681,513				135,681,513	1.659
South African Futures Exch.	1,199,600	64,144,300		1,262,450	66,606,350	0.814
Kansai Agricultural Com. Exch.			43,111,110		43,111,110	0.527
MATBA	6,002,800	4,389,400	7,009,600	1,453,500	18,855,300	0.230
MidAmerica Commodity Exch.	1,434,159	3,102,966	7,737,309		12,274,434	0.150
LIFFE	10,836,900				10,836,900	0.132
ROFEX	961,100	116,350	5,046,550		6,124,000	0.075
Matif/Euronext París	2,857,950	2,883,200			5,741,150	0.070
Budapest Commodity Exch.	1,739,000	1,573,300	3900	110,100	3,379,800	0.042
Winnipeg Commodity Exch.	3,228,300				3,228,300	0.039
Central Japan Comm. Exch.			2,496,900		2,496,900	0.031
Sydney Futures Exchange	202,500				202,500	0.002
BM&F		123,876	2241		126,117	0.002
Total product	1,677,301,970	4,059,957,077	2,441,597,499	2,392,950	8,181,202,996	100

Note. The world ranking only considers those products traded on MATBA, namely, wheat, corn, soybean, and sunflower seed.
Source: Buenos Aires Futures Market (MATBA).

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Table 2 (*continued*)

(b) Trading volume (in tons) on MATBA in 1993–2001 by product and contract type

Time period	Wheat		Corn		Sunflower seed		Soybean		Total annual
	Futures	Options	Futures	Options	Futures	Options	Futures	Options	
1993	2,455,800	436,800	2,053,600	232,000	772,600	89,300	984,600	106,900	7,131,600
1994	1,963,100	490,600	1,818,300	392,200	865,600	181,400	885,300	153,900	6,750,400
1995	2,084,000	1,354,400	1,634,300	1,130,200	977,000	391,900	837,900	191,100	8,600,800
1996	4,847,300	2,429,000	2,780,100	1,655,500	1,172,700	751,500	936,800	563,800	15,136,700
1997	4,949,200	2,449,000	4,368,900	2,067,900	1,863,400	980,500	2,604,500	990,500	20,273,900
1998	4,855,800	2,056,700	4,248,600	1,504,500	2,354,000	995,700	2,906,900	1,092,000	20,014,200
1999	5,427,100	2,693,000	3,947,500	978,900	3,394,000	610,200	4,388,200	1,773,600	23,212,500
2000	5,229,300	1,823,900	4,667,200	899,300	2,690,750	180,700	5,367,200	2,747,500	23,605,850
2001	4,108,000	1,894,800	3,588,900	800,500	1,176,700	276,800	5,462,300	1,547,300	18,855,300
Total 1993–2001	35,919,600	15,628,200	29,107,400	9,661,000	15,266,750	4,458,000	24,373,700	9,166,600	143,581,250
Share 1993–2001	25.02%	10.88%	20.27%	6.73%	10.63%	3.10%	16.98%	6.38%	100.00%

Source: MATBA.

(c) Trading volume (in contracts) on Rosario Futures Market (ROFEX), Argentina, 1993–2001

Year	RSI		Wheat		Corn		Other	Total ROFEX	
Futures	Futures	Options	Futures	Options	Futures	Options	(futures/options)	No. contracts	Tons
1993	1297	0	168	0	85	0	754	2304	63,925
1994	4109	0	129	0	131	0	61	4430	117,250
1995	7109	0	961	0	1370	0	606	10,046	315,375
1996	6249	4919	2004	1353	1045	1134	707	17,411	580,175
1997	26,463	3256	2336	1061	1841	624	151	35,732	1,039,850
1998	49,790	9442	4017	1038	2726	515	698	68,226	1,913,600
1999	69,938	22,994	4440	353	862	32	2994	101,613	2,635,280
2000	98,132	32,347	5814	1633	650	4	1517	140,097	3,685,170
2001	142,039	54,118	8956	6108	218	0	3172	214,611	5,792,675
Total 1993–2001	405,126	127,076	28,825	11,546	8928	2309	10,660	594,470	16,143,300
Share 1993–2001	68.15%	21.38%	4.85%	1.94%	1.50%	0.39%	1.79%		

Notes. RSI: *Rosafe* Soybean Index. The category "Other" includes sorghum, sunflower seed, INA (Argentinean feeder cattle index), IMR (Rosafe corn index), and BGC (short-term global bonds).

Source: Author's elaboration based upon information from ROFEX and MATBA.

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bonds). Panel (c) of Table 2 shows the share of these different products in total trading for the time period 1993–2001. As we see, the most actively traded contracts were futures and options on the RSI, with corresponding shares of 68.2 and 21.4 percent of total volume. Futures and options on wheat and corn by contrast lagged behind with an aggregate share of only 8.7 percent.

From the above figures, one can conclude that ROFEX is a relatively small exchange. Indeed, the total volume traded on MATBA in the period 1993–2001 amounted to 143.6 million tons, whereas the volume on ROFEX only reached 16.1 million in the same time period. On the other hand, when compared with other exchanges that traded derivatives on agricultural commodities worldwide in 2001, ROFEX's share only amounted to 0.08 percent.

2.1.3. Mexico

In 1994, the Mexican Stock Exchange (*Bolsa Mexicana de Valores*, BMV) and the Mexican Central Securities Depository (*SD Indeval*) committed to create The Mexican Exchange of Derivatives (MexDer). However, it was not until December 1998 that trading began on MexDer. The contracts currently traded are futures on the exchange rate (US dollar against Mexican peso), the stock index of the Mexican Stock Exchange (IPC), the 28-day interbank interest rate of equilibrium (TIIE 28), Certificates of the Treasury Mexican Confederation (CETES), three-year government bonds (M3), and individual stocks. Table 3(a) gives a detailed description of these contracts.

In May 2001, a significant step to providing more liquidity to MexDer was taken by introducing market makers. So far they are only applicable to futures on TIIE 28, the most actively traded contracts on MexDer, as Table 3(b) shows. The goals of market makers are to provide, among other things, a minimum monthly volume and to offer prices to create liquidity (see Sanchez-Arriola, 2001). The existence of market markets might explain why the daily average financial volume increased from US$1155 million in August–December 2000 to US$11,867 million in January–August 2001. In fact, the average daily volume jumped from US$1733 million in April 2001 to US$13,548 million in May 2001, and kept growing thereafter.

Table 3(c) shows that MexDer is still relatively small as compared with the Mexican Stock Exchange. For instance, in 2001 estimates of the financial volumes over GDP are 33.4 percent for MexDer, and 727.4 percent for BMV. However, MexDer continues to grow. In particular, in January 2002 the number of contracts traded reached 33 percent of all contracts traded in 2001.

2.1.4. Brazil

The first Brazilian institution to offer forward transactions was the São Paulo Commodities Exchange (BMSP), which was founded in 1917. As time went by, BMSP established a rich tradition in the trade of agricultural commodities, especially coffee, live cattle, and cotton. In turn the Brazilian Mercantile & Futures Exchange, BM&F (*Mercado do Futuros & Mercadorias*) was founded in 1985, and within a short time it became one of the world's major futures exchanges.

In 1991, BMSP and BM&F merged, giving rise to the Brazilian Mercantile & Futures Exchange (*Bolsa do Mercadorias & Futuros*), which kept the name BM&F. In 1997 an-

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Table 3
The Mexican market of derivatives (MexDer)
(a) Futures contracts available at MexDer

	Exchange rate	Stock index	Fixed-income[a]	Fixed-income	Stocks
Contract type	US dollar	Stock Index of the Mexican Stock Exchange	28-day interbank interest rate of equilibrium (TIIE)	91-day certificates of the Treasury Confederation (CETES)	CMX, FEMD, GCAA, GFBO, TMXL
	DEUA	IPC	TE28	CE91	
Contract size	US$10,000	Mx$10.00 times the value of IPC	Mx$100,000	10,000 Cetes (= Mx$100,000)	1000 stock
Delivery date	Monthly cycles up to 3 years	Quarterly cycles: March, June, September, December, up to 1 year	Monthly cycles: up to 30 and 6 months	Monthly cycles: up to 30 and 6 months	Quarterly cycles: March, June, September, December

Note. Individual stocks include *Cementos Mexicanos* (CMX), *Fomento Económico Mexicano*, S.A. de C.V. (FEMD), *Grupo Carso*, S.A. de C.V. (GCAA), *Grupo Financiero* BBVA Bancomer, S.A. de C.V. (GFBO), and *Teléfonos de México*, S.A. de C.V. (TMXL).
Source: MexDer.
[a] MexDer also offers futures on 3-year bonds of development of the Federal Government (M3).

(b) Daily averages for January–August 2001

Underlying asset	Volume (no. of contracts)	Share volume (%)	Financial volume (millions US$)	Share financial volume (%)
DEUA	922	1.79	10.0	1.79
IPC	136	0.26	1.0	0.17
CE91	0	0.00	0.0	0.00
TE28	50,521	97.93	550.7	98.03
CMX	12	0.02	0.1	0.01
FEMD	0	0.00	0.0	0.00
GCAA	0	0.00	0.0	0.00
GFBO	0	0.00	0.0	0.00
TLMX	0	0.00	0.0	0.00
Total	51,591	100	561.7	100

(c) Size of MEXDER relative to the Mexican Stock Exchange

	Mexican Stock Exchange (daily averages in millions US$)				
Year	Stock market	Fixed income	Capital market	Money market	Total
1998	122	4	137	5074	5336
1999	139	2	154	8770	9064
2000	165	2	169	16,330	16,666

Financial Volume over GDP in 2001 (estimates): Mexican Stock Exchange 727.4%; MEXDER 33.4%.
Sources (b) *and* (c): MexDer and the World Bank.

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other merger took place, this time with the Brazilian Futures Exchange (BBF) of Rio de Janeiro, which was founded in 1983. The purpose of this merger was to strengthen the domestic commodity market and consolidate BM&F as the major derivatives trading center in Mercosur.

In January 2000, BM&F took a significant step to global trading by joining GLOBEX, an alliance made up by the Chicago Mercantile Exchange, the Euronext NV, the Singapore Exchange-Derivatives Trading, the Spanish Financial Futures and Options Exchange, and the Montreal Exchange. Table 4 shows some derivatives traded on BM&F. Financial volumes are sizeable in absolute terms and relative to Brazilian GDP. In 2001 the daily financial volume reached approximately US$16,550 million, that is, sixty times the daily production of Chile in 1999 (source: United Nations).[9] At the same time, in 2001 the financial volume of BM&F over GDP reached 639.51 percent, which is about thirty seven times that of the São Paulo Stock Exchange (BOVESPA).

Founded in 1890, BOVESPA is the major stock trading center in Latin America. The most actively traded contracts on BOVESPA are listed company stocks, stock options, rights and stock dividends, subscription warrants and investment funds quotas. BOVESPA also trades depository receipts of stocks issued by companies from Mercosur member countries. Table 4(b) shows the total annual financial volume for 1999–2001, classified by financial instrument. The figures show that the cash market (cash sales and purchases of stocks listed on BOVESPA) accounted for over 80 percent of total trading from 1999 to 2001. Options and forwards, the next two most actively traded contracts, had shares of 8.8 and 4.5 percent, respectively, in 2001.

2.2. OTC figures for Latin America

The Bank of International Settlements (BIS) collects data of OTC and traditional foreign exchange markets around the world in its triennial 'Central Bank Survey of Foreign Exchange and Derivatives Market Activity'. Table 5 shows figures of daily turnover in OTC markets by continent, for April 1998 and 2001. The two major OTC markets worldwide were London (England) and New York (United States), with shares of 39.6 and 17.9 percent, respectively, in April 2001. In both years, Europe concentrated over 70 percent of the worldwide OTC turnover. In order to account for the fact that countries differ in the size of their economies, we constructed an indicator of daily turnover over (average) daily production in US dollars. According to it, the most active OTC markets were those in Singapore, United Kingdom, and Hong Kong.

Among Latin American countries, Mexico showed the most active trading on OTC derivatives in April 2001, with a daily average turnover of US$4.6 billion. Out of this amount, US$4.2 billion were on foreign exchange derivatives (Mexican peso against US dollar), and the remaining US$0.4 billion on interest rates derivatives. The second and the third most active OTC markets in 2001 were Brazil and Chile, with corresponding daily turnovers of US$2.1 billion and US$0.6 billion. (When accounting for economy size, Chile had the greatest OTC market in Latin America as of April 2001.)

[9] And, it is equivalent to 1.7 percent of the aggregate daily volume traded on the main exchanges in the United States (NYSE, CME, NYME, CBOE, IMM, and NYFE) in 1995 (source: Martinez, 1999).

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Table 4
Brazilian derivatives markets trading volumes

(a) Brazilian Mercantile & Futures Exchange (BM&F)

Floor trading	2000 Financial volume (millions US$)	2000 Share of total trading (%)	2001 Financial volume (millions US$)	2001 Share of total trading (%)
Gold spot (250g)	217.1	0.01	79.2	0.00
Total gold	340.8	0.01	110.2	0.00
Bovespa Index futures	188,525.4	4.95	91,494.8	2.21
Total Bovespa stock index	188,610.6	4.95	91,831.4	2.22
Interbank deposits (ID) futures	1,896,412.5	49.80	1,761,528.0	42.58
ID × US dollar spread futures	230,638.9	6.06	61,814.7	1.49
ID forward with reset	167,885.0	4.41	228,494.4	5.52
Total Interest rates	2,303,059.7	60.47	2,051,950.6	49.60
US dollar futures	1,007,840.1	26.46	885,639.7	21.41
Total foreign currencies	1,012,123.0	26.58	893,183.4	21.59
C-bond futures	73.7	0.00	115.4	0.00
EI-bond futures	72.8	0.00	15.3	0.00
Total sovereign debt instruments	146.5	0.00	130.8	0.00
Live cattle futures	1102.3	0.03	360.7	0.01
Arabica coffee futures	3933.9	0.10	2757.1	0.07
Anhydrous fuel alcohol futures	550.0	0.01	382.1	0.01
Total agricultural products	5792.8	0.15	3673.7	0.09
Total floor trading	3,510,073.4	92.17	3,833,496.9	92.65
Total electronic system (GTS)	23,516.7	0.62	411,811.7	9.95
Total OTC market	274,695.2	9.21	131,043.1	3.17
Total all markets	3,808,285.3	100	4,137,406.4	100

Note. Only those derivatives contracts with greatest shares within each category are shown in the table, although total figures include all traded categories.
Source: Author's elaboration based upon information from the Brazilian Mercantile & Futures Exchange (BM&F).

(b) São Paulo Stock Exchange (BOVESPA)

Market	Total annual financial volume: 1999–2001					
	1999		2000		2001	
	(mil US$)	(%)	(mil US$)	(%)	(mil US$)	(%)
Cash[a]	70,635.0	82.6	85,555.8	84.1	54,196.1	83.2
Forward	1057.9	1.2	3979.2	3.9	2829.2	4.4
Options	8992.3	10.5	7080.9	7.0	5742.1	8.8
Futures	0.0	0.0	0.0	0.0	0.4	0.00
Others	4814.4	5.6	5,113.9	5.0	2339.4	3.6
Total	85,499.8	100	101,729.8	100	65,107.3	100

[a] Cash purchase or sale of a given number of shares, at a price set on trading floor sessions.

(c) Relative size of BM&F and BOVESPA in 2000

Exchange	Financial volume (mil US$)	Share of GDP (%)
BOVESPA	101,729.8	17.1
BM&F	3,808,285	639.5

Sources (b) *and* (c): BOVESPA and the World Bank.

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Table 5
OTC derivatives market activity in Latin America and elsewhere (average daily turnover in billions US$)

Continent	Total	%Share	Total	%Share	Foreign exchange[d]		Interest rates[e]		Total/daily GDP[f]	
	Apr-98	Apr-98	Apr-01	Apr-01	Apr-98	Apr-01	Apr-98	Apr-01	Apr-98	Apr-01
America	330.6	23.48	335.4	21.12	265.6	209.2	65	126.2	9.33	6.82
Argentina	0.1	0.01	–	–	0.1	–	–	–	0.09	–
Brazil	–	–	2.1	0.13	–	1.9	–	0.3	–	0.88
Canada	33.6	2.39	43.3	2.73	27.2	33.4	6.4	9.9	13.32	16.76
Chile	0.5	0.04	0.6	0.04	0.5	0.6	–	–	1.85	2.29
Mexico	2.6	0.18	4.6	0.29	2.4	4.2	0.2	0.4	1.32	2.25
Peru	–	–	0.04	0.00	–	0.04	–	–	–	0.17
United States	293.8	20.86	284.7	17.93	235.4	169.1	58.4	115.7	8.03	7.60
Asia[a]	276.3	19.62	267.1	16.82	236.2	244.8	39.8	22.3	11.62	10.96
Hong Kong	51.4	3.65	52.0	3.28	48.9	49.4	2.4	2.6	80.20	79.26
Japan	123.3	8.76	131.7	8.29	91.7	115.9	31.6	15.8	7.23	7.54
Malaysia	0.8	0.06	0.9	0.06	0.8	0.9	0	0.0	2.51	2.83
Saudi Arabia	1.4	0.10	1.0	0.06	1.1	0.9	0.2	0.1	2.40	1.65
Singapore	90.7	6.44	69.5	4.37	85.4	66.3	5.3	3.2	256.15	191.49
Taiwan	1.6	0.11	1.8	0.11	1.5	1.7	0.1	0.1	n.a	n.a
Thailand	2.2	0.16	1.3	0.08	2.2	1.3	–	0.0	4.43	2.60
Europe[b]	1034.5	73.47	1193.0	75.11	800	676.1	234.7	516.9	28.27	31.82
Belgium	24.9	1.77	21.8	1.38	20.1	7.8	4.9	14.1	25.59	21.92
Denmark	25.9	1.84	25.3	1.59	21.7	19.5	4.2	5.8	37.86	36.13
France	98.5	7.00	106.0	6.68	57.9	40.9	40.6	65.1	17.48	18.37
Germany	86.7	6.16	159.2	10.03	57.6	65.2	29.1	94.0	10.51	18.85
Italy	21.2	1.51	36.1	2.27	17.1	12.4	4.1	23.7	4.64	7.71
Netherlands	31	2.20	49.4	3.11	27.5	25.2	3.5	24.2	19.99	31.11
Spain	16.6	1.18	25.9	1.63	13.7	5.5	2.9	20.5	7.13	10.87
Sweden	14.8	1.05	22.3	1.40	11.2	19.1	3.6	3.2	15.91	23.38
Switzerland	63	4.47	62.6	3.94	57.2	53.0	5.9	9.6	62.45	60.54
United Kingdom	591.2	41.99	628.1	39.55	468.3	390.3	122.9	237.8	104.54	108.42
Africa/Oceania[c]	43.0	3.05	60.04	3.78	39.0	51.77	4.0	10.7	18.27	23.38

Notes. The figures were adjusted by local double-counting. The estimated coverage of derivatives markets in individual countries ranged between 73 and 100%. The ratio gives an idea of how active is the OTC market with respect to the size of each economy.

Source: Author's elaboration based upon information provided by the BIS, Triennial Central Bank Survey of Foreign Exchange and derivatives Market Activity in 1998 and 2001, and the United Nations.

[a] Included in the computations but not shown: Bahrain, India, Indonesia, Philippines, South Korea.

[b] Included in the computations but not shown: Austria, Czech Republic, Finland, Greece, Hungary, Ireland, Luxembourg, Norway, Poland, Portugal, Russia, Slovenia, and Slovakia.

[c] Includes South Africa, Australia, and New Zealand.

[d] Forwards, swaps, and options.

[e] Single-currency contracts only.

[f] Total/daily GDP is the ratio of total turnover of the month of April over an estimate of daily economic activity, namely, annual GDP (in current dollars) divided by the number of business days in a year (approximately 250).

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3. A closer look at the derivatives market in Chile

In this section, we study in more detail the evolution of the derivatives market in Chile in the most recent years. As mentioned earlier, the derivatives regularly traded in Chile are US$/Chilean peso and US$/UF forwards. These types of contracts were introduced in the domestic market in 1992 and 1994, respectively.

3.1. Exchange rate derivatives

When derivatives were introduced in the early 1990s their market turnover only ranged between 10 and 20 percent of the total amount traded in the spot exchange rate market. However, as Table 6 shows, in the past few years market activity has jumped to over 50 percent of the spot market. Transactions in forwards contracts are carried out by two different ways: trading and position. Trading focuses on speculative transactions, whereas position involves hedging market risk. The market for forwards is driven by the needs of exporters and importers, and consists primarily of commercial banks and investment-bankers engaged in money-market investments. Medium and small-size firms do not generally enter into derivatives contracts because of stringent guarantees. The minimum amount per contract is US$1 million. However, it is possible to take a position for US$50,000 or less through bank branches.

Maturities of US$/Chilean peso forwards range from 1 to 7 days, 8 to 30 days, 31 to 42 days, and more than 42 days. The forward prices for long and short positions are calculated from the spot exchange rate and the interest rates for borrowing and lending in Chilean pesos and US dollars.[10] In turn the maturities of US$/UF forwards range from

Table 6
Chile's domestic transactions in the Foreign Exchange rate market (millions of USD per working day)

	2000		2001	
	July	October	January	April
Total (net)[a]	1603	1962	2125	2329
By instrument				
Spot	1058	1321	1565	1694
Forwards and swaps[b]	545	941	560	635
By currency, Chilean peso against:				
USD	1578	1934	2080	2283
DM, Japanese yen	1578	1934	2080	2283
Non-local currency[c]	25	28	45	46

Source: Central Bank of Chile.
[a] Adjusted for inter-bank double counting.
[b] Derivatives are OTC instruments.
[c] DM/USD, Yen/USD, others.

[10] For example,

$$\text{Bid} = \text{Bid spot exchange rate} * \left(\frac{1 + \text{lending rate in Ch\$} * \text{maturity}/30}{1 + \text{borrowing rate in US\$} * \text{maturity}/360} \right).$$

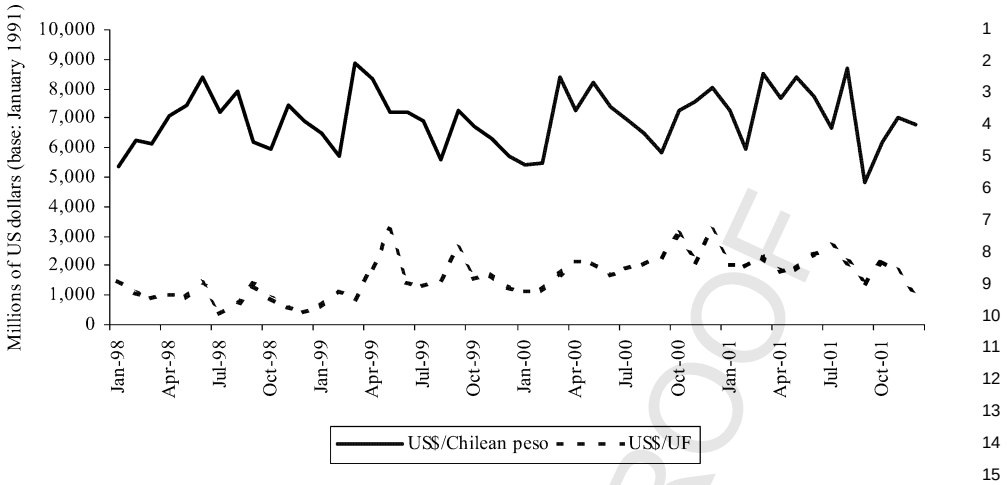

Fig. 4. Monthly turnover of currency forwards subscribed in the Chilean formal exchange rate market: January 1998–December 2001. *Source*: Based upon information provided by the Central Bank of Chile. Figures were deflated by the percent variation in the US Consumer Price Index (CPI). The formal exchange rate market is composed of commercial banks and money exchanges authorized by the Central Bank of Chile.

1 to 90 days, 91 to 180 days, and 181 to 360 days. The forward price (rate) is quoted as a premium (either positive or negative) over the percent variation in the UF.[11]

Figure 4 shows the evolution of the aggregate turnover of US$/Chilean peso and US$/UF forward contracts for the time period January 1998–December 2001. It is evident that the trading volume of US$/Chilean peso forwards was much greater than that of US$/UF forwards. As mentioned in Section 2.1.1, Chile's declining inflation rate has made the simultaneous hedging of currency and inflation risk no longer as urgent. On the other hand, the shorter maturity of US$/Chilean peso forwards (between 7 and 42 days) might be more suitable to hedge currency risk than inflation-linked contracts, especially to importers and exporters. The forwards market activity shows a seasonal behavior, in which turnover peaks generally take place around those months in which international trade is more active, namely, March, April, September, and October.

(Short interest rates in pesos are always quoted on a monthly base, whereas interest rates in US dollars are quoted on an annual base.)

[11] For instance, if the currency purchased on a future date is the US dollar, the ask forward price is given by

$$\text{Fwd price} = \frac{\text{Ask spot exchange rate}}{\text{UF value}}\left(\frac{1+\text{borrowing in UF} * \text{maturity}/360}{1+\text{lending rate in US\$} * \text{maturity}/360}\right).$$

The forward rate solves the equation

$$\text{Fwd price} = \left(1+\frac{\text{Fwd rate} * \text{maturity}}{360}\right) * \frac{\text{Observed exchange rate}}{\text{UF}},$$

where the observed market exchange rate is the average value of the exchange rate for purchases and sales made by banks and money exchanges with third parties over the previous business day.

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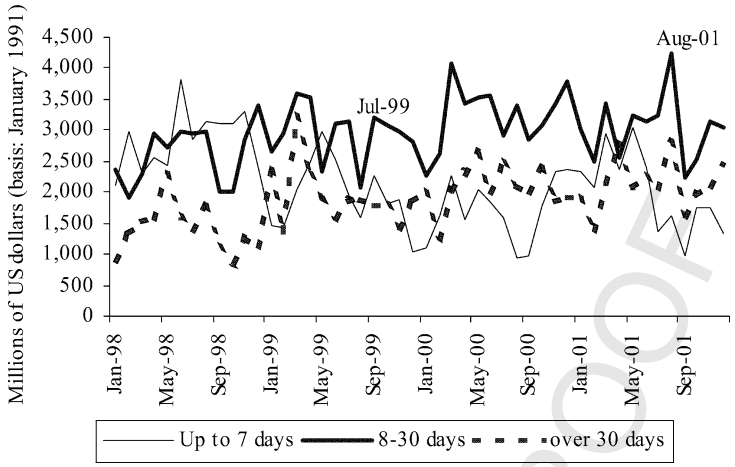

Fig. 5. Monthly turnover of US dollar/Chilean peso forwards subscribed in the Chilean formal exchange rate market: January 1998–December 2001. *Source*: Based upon information provided by the Central Bank of Chile. Figures were deflated by the percent variation in the US Consumer Price Index (CPI). The formal exchange rate market is composed of commercial banks and money exchanges by the Central Bank of Chile.

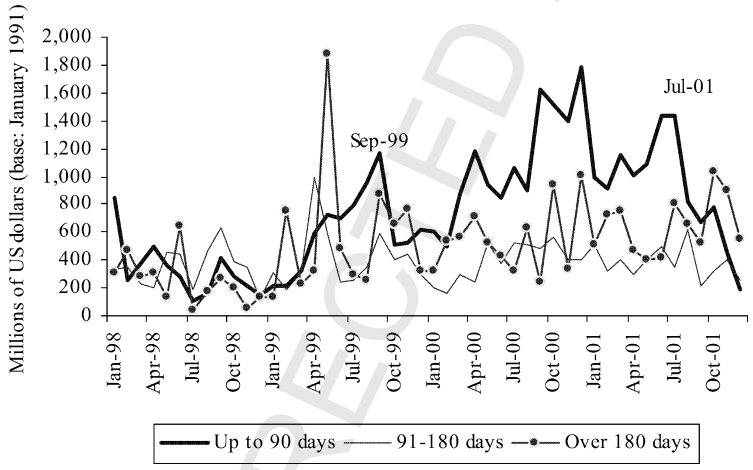

Fig. 6. Monthly turnover of US dollar/UF forwards subscribed in the Chilean formal exchange rate market: January 1998–December 2001. *Source*: Based upon information provided by the Central Bank of Chile. Figures were deflated by the percent variation in the US Consumer Price Index (CPI). The formal exchange rate market is composed of commercial banks and money exchanges authorized by the Central Bank of Chile.

Figures 5 and 6 show the turnover of US$/Chilean peso and US$/UF forward contracts disaggregated by maturity. Among US$/Chilean peso forwards, the most actively traded contracts in the time period January 1998–December 2001 were those whose maturity was less than or equal to 7 days, and between 8 and 30 days. In particular, the latter dominated turnover approximately from June 1999 onwards. For US$/UF forwards, the most actively traded contracts were those whose maturity was less than or equal to 90 days, and between

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91 and 180 days. It is interesting to notice that contracts with maturity less than or equal to 90 days became the most actively traded around June 1999. As explained below, this fact appears to be a consequence of the change in the exchange rate policy of the Central Bank of Chile.

From August 1984 to September 1999, the exchange rate policy in Chile consisted of a floating band, whose center was the so-called reference exchange rate (*dolar acuerdo*). The value of the reference exchange rate was recalculated daily according to the fluctuations in the parities of a currency reference basket—comprised by the US dollar, the Japanese yen, and the Deutsche mark, and adjusted by the difference between domestic and foreign inflation. Even though the dirty float[12] lasted for 15 years, the level and the rule for adjusting the reference exchange rate, as well as the width of the floating band, experienced many changes over time. The floating band was finally eliminated on September 2, 1999.[13]

The exchange rate essentially floated between September 1999 and July 2001. From July 2001 onwards, the Central Bank of Chile has either actively traded in the exchange rate spot market or has issued US dollar-denominated bonds to smooth out fluctuations in the spot rate caused by economic turbulence in neighboring countries, such as Argentina and Brazil. Interestingly, the derivatives market did not become more active as a consequence of the liberalization of the exchange rate, but as a consequence of external events. Figure 7(a) shows that the forwards market, as a share of the spot market, became noticeably more active at the burst of the Asian crisis at the beginning of 1998. Thereafter and until 2000, the market share of forwards was around 50 percent of the spot market, to reach 40 percent in 2001. Figure 7(b) shows an interesting phenomenon: after the beginning of the Asian crisis, transactions between banks and third parties predominated over those between banks. This means that turbulence made economic agents more aware of currency risk.

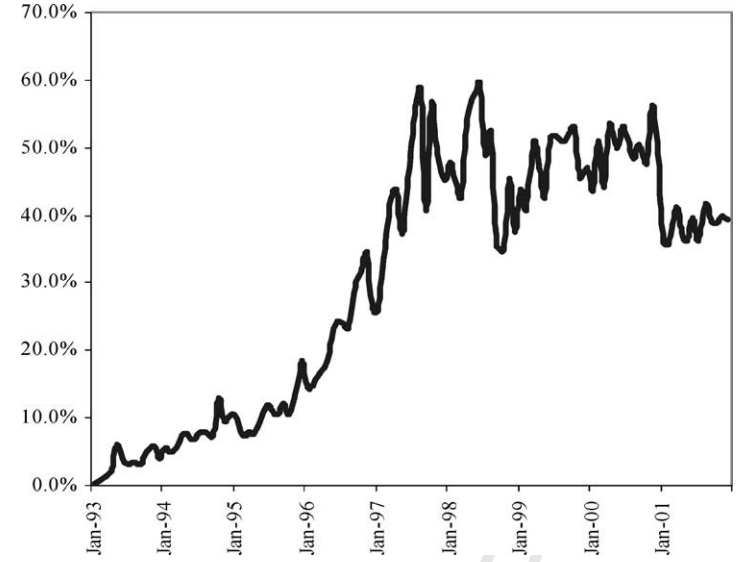
But why did the free float itself not lead to a more active market for derivatives? In fact, economic agents conjectured that the volatility of the nominal exchange rate might dramatically increase after eliminating the floating band. Why? Because during the dirty float, the Central Bank of Chile engaged in active trading in the exchange rate market whenever the spot rate either approached the bottom or the upper bound of the band. Therefore, such policy implicitly provided insurance against currency risk. Then the key question is: how much more volatile did the exchange rate become over the free float period (September 1999–July 2001)?

Figure 8 shows three different estimates of the daily volatility of the 'real' exchange rate (S_t) for the time period January 1993–September 2001. This series is obtained by deflating the nominal exchange rate by a proxy of daily inflation (UF). The exponentially weighted moving average (EWMA) estimator is given by

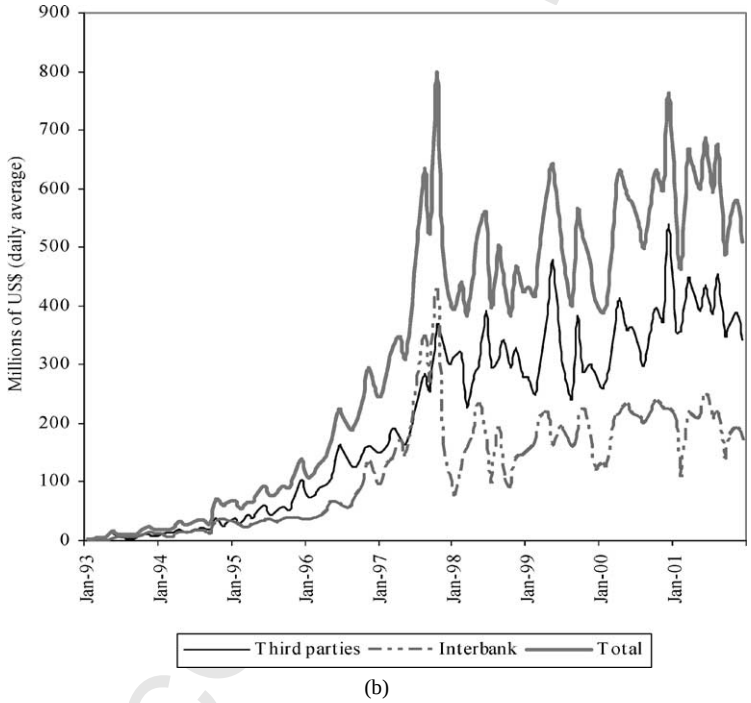
$$\sigma_{\mathrm{EWMA}} = \sqrt{\sum_{t=1}^{T} \frac{\lambda^{t-1}}{\sum_{j=1}^{T} \lambda^{j-1}} \left(S_t - \overline{S}\right)^2}, \tag{1}$$

[12] A dirty float is a type of floating exchange rate that is not completely free because Central Banks interfere occasionally to alter the rate from its free-market level.

[13] For a complete analysis of the evolution of the nominal exchange rate during the dirty float, see Lefort and Walker (1999).



(a)



(b)

Fig. 7. Chile's forward and spot markets: January 1993–December 2001: (a) forwards market as a share of the spot; (b) average daily turnover of forward contracts between commercial banks and between commercial banks and third parties. *Source*: Central Bank of Chile.

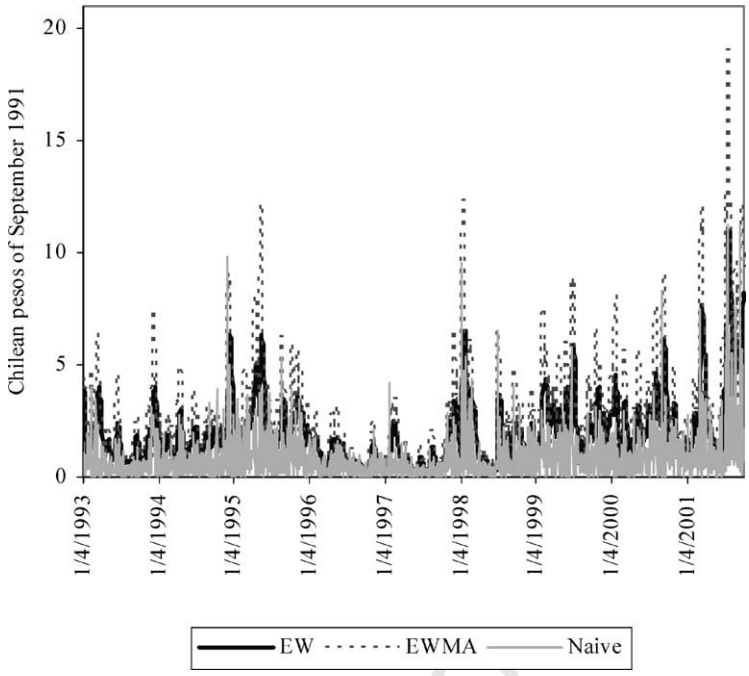


Fig. 8. Estimates of Chile's nominal exchange rate volatility: January 1993–September 2001. *Source*: Based upon on daily data of the observed market exchange rate, provided by the Central Bank of Chile. The observed exchange rate series was deflated by the daily percent variation of the *Unidad de Fomento* (base = 1, September 1, 1991). EW stands for exponentially weighted and EWMA for exponentially weighted moving average.

where λ is obtained by minimizing the (daily) root mean squared prediction error ($\mathrm{RMSE_v}$):

$$\mathrm{RMSE_v} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(S_{t+1} - \widehat{S}_{t+1|t}(\lambda)\right)^2} \tag{2}$$

(see, for example, Harvey, 1989).

The one-day real exchange rate forecast, given the data available at time t (that is, one day earlier), is given by[14]

$$\widehat{S}_{t+1|t} = \lambda \widehat{S}_{t|t-1} + (1-\lambda) S_t, \tag{3}$$

with the initial condition $\widehat{S}_{2|1} = S_1$.

[14] In order to estimate the optimal λ, we carried out a grid search over the interval [0.01, 0.99], with a step of 0.01. By using the data from the whole sample period, we found an estimate of λ equal to 0.51. The volatility series was constructed from Eq. (1) by taking $T = 20$ (the average number of business days in a month), and plugging in the estimate of λ. $\overline{S}$ is the sample mean of the 20 observations taken each time.

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The equally weighted (EW) estimate of volatility is calculated from Eq. (1) by setting $\lambda = 1$. That is to say,

$$\sigma_{\mathrm{EW}} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(S_t - \overline{S}\right)^2}. \tag{4}$$

Finally, the naïve estimate is calculated as the absolute value of the daily change in the real exchange rate:

$$\sigma_{\text{naïve}} = |S_t - S_{t-1}|. \tag{5}$$

In order to address the question on how volatility changed after eliminating the floating band, we divided the sample into two groups of a two-year length each. The time period pre-change goes from May 1997 to May 1999, whereas the post-period covers June 1999 to June 2001. The floating band was dropped in September 1999, so the second time period is essentially free from any intervention from the Central Bank to stabilize the nominal exchange rate.

Tables 7(a)–(c) show descriptive statistics of the three volatility estimates for the pre-free-float and post-free-float periods. In all cases, increases in mean and standard deviation of volatility are observed in the post-free-float period. In addition, the frequency of higher volatility episodes is higher. Table 7(d) shows further evidence of a structural break in the probability distribution of volatility. A Kolmogorov–Smirnov test rejects the null hypothesis of equal cumulative distribution functions (pointwise) for the pre and post free float. In addition, a Welch two-sample t-test suggests that the mean of volatility actually increased over June 1999–July 2001. The Wilcoxon/Mann–Whitney and Barlett tests in turn suggest that higher moments of volatility also changed after dropping the floating band.

We also carried out a more rigorous test to detect breaks in volatility. Figure 9 shows daily changes of the (deflated) nominal exchange rate for January 1993–September 2001. Sudden changes in volatility are detected by the Inclan and Tiao's (1994) Iterative Cumulative Sums of Squares (ICSS) algorithm, which is implemented in the TSM GAUSS module. The three episodes of greatest volatility over the sample period were November 1994 (10 percent nominal revaluation of the exchange rate), January 1998 (liquidity crisis of the domestic banking system due to the Asian crisis), and July 2001 (outbreak of the Argentinean crisis).

The analysis behind the ICSS algorithm is that the time series of interest has a stationary unconditional variance over an initial time period until a sudden break takes place, possibly motivated by some special event in financial markets. The unconditional variance is then stationary until the next sudden change occurs. This process repeats through time, giving a time series of observations with a number of M breakpoints in the unconditional variance in T observations:

$$\sigma_t^2 = \begin{cases} \tau_0^2 & 1 < t < \iota_1, \\ \tau_1^2 & \iota_1 < t < \iota_2, \\ & \cdots \\ \tau_M^2 & \iota_M < t < T. \end{cases} \tag{6}$$

In order to estimate the number of changes and the point in time of variance shifts, a cumulative sum of squares residuals is used, $C_K = \sum_{t=1}^{k} \varepsilon_t^2$, $k = 1, 2, \ldots, T$, where $\{\varepsilon_t\}$ is

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Table 7
Statistics by classification of volatility estimates: pre and post change of the nominal exchange rate policy in Chile (1999)

Interval (Ch$)	Mean		Max		Min		Std. dev.		Percent	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
(a) Exponentially weighted moving average										
[0, 5)	1.595	2.361	4.920	4.990	0.100	0.220	1.207	1.215	91.57	88.39
[5, 10)	5.879	6.768	8.390	9.980	5.010	5.020	0.821	1.270	7.68	10.49
[10, 15)	11.278	11.373	12.420	12.110	10.400	10.480	0.855	0.634	0.75	1.12
All	1.996	2.924	12.420	12.110	0.100	0.220	1.828	2.028	100	100
(b) Equally weighted moving average										
[0, 2)	0.909	1.464	1.990	1.990	0.160	0.690	0.516	0.319	61.99	44.0
[2, 4)	2.770	2.736	3.990	3.990	2.010	2.000	0.546	0.520	32.96	44.38
[4, 6)	4.512	4.836	5.900	5.940	4.000	4.020	0.615	0.639	3.37	9.18
[6, 8)	6.366	6.812	6.550	7.670	6.060	6.070	0.181	0.587	1.69	2.43
All	1.736	2.468	6.550	7.670	0.160	0.690	1.294	1.289	100	100
(c) Naive										
[0, 2)	0.552	0.733	1.990	1.960	0.000	0.000	0.504	0.513	91.95	88.76
[2, 4)	2.469	2.618	3.480	3.820	2.010	2.000	0.377	0.534	6.93	10.49
[4, 6)	4.638	5.125	5.370	5.810	4.110	4.440	0.545	0.969	0.75	0.37
[6, 8)	6.510	7.480	6.510	7.480	6.510	7.480	–	–	0.19	0.19
[8, 10)	9.540	8.320	9.540	8.320	9.540	8.320	–	–	0.19	0.19
All	0.743	0.974	9.540	8.320	0.000	0.000	0.898	0.919	100	100

(d) Comparison of pre and post distributions

Test	Exp. weighted	Equally weighted	Naive
Kolmogororv–Smirnov[a]	0.273	0.380	0.210
	(0.000)	(0.000)	(0.000)
Welch two-sample t-test[b]	7.854	9.257	4.151
	(0.000)	(0.000)	(0.000)
Wilcoxon/Mann–Whitney[c]	9.488	10.080	6.165
	(0.000)	(0.000)	(0.000)
Bartlett[d]	5.689	0.007	0.291
	(0.017)	(0.931)	(0.589)

Notes. P-values between parenthesis. The time period pre-change goes from May 1997 to May 1999, whereas the post-period covers June 1999 to June 2001.
Source: Author's elaboration.

[a] The two-sample Kolmogorov–Smirnov goodness of fit test is used to test whether two sets of observations could reasonably have come from the same distribution. Under the alternative hypothesis the cumulative distribution function (cdf) of x (post) does not equal the cdf of y (pre) for at least one sample point.

[b] Under the Welch modified two-sample t-test the null hypothesis is that the population mean for x less that for y is zero. The alternative hypothesis is that the difference of means for x and y is greater than zero.

[c] The Wilcoxon rank sum test is used to test whether two sets of observations come from the same distribution. The alternative hypothesis is that the observations come from distributions with identical shape but different locations. Unlike the two-sampled t-test, this test does not assume that the observations come from normal distributions. This test is equivalent to the Mann–Whitney test.

[d] The Bartlett test compares the logarithm of the weighted average variance with the weighted sum of the logarithms of the variances. Under the joint null hypothesis the subgroup variances are equal.

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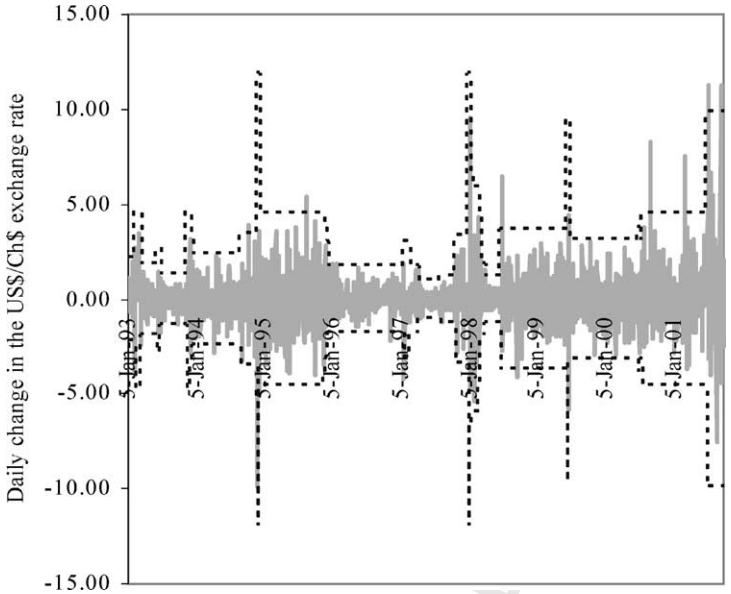

Fig. 9. Daily changes of Chile's US$/Ch$ exchange rate: January 1993–September 2001. *Source*: Author's elaboration. The US$/Ch$ rate was previously deflated by the UF. Change points were estimated by the ICSS algorithm; the dotted lines represent ±3 standard deviations.

a series of uncorrelated random variables with zero mean and unconditional variance σ_t^2, as in (6). Inclan and Tiao define the statistic:

$$D_k = \frac{C_k}{C_T} - \frac{k}{T}, \quad k = 1, 2, \ldots, T, \qquad D_0 = D_T = 0.$$

If there are no changes in variance over the whole sample period, D_k will oscillate around zero. In contrast, if there are one or more shifts in variance, D_k departures from zero. The ICSS algorithm systematically looks for breaks in variance at different points in the series.

Table 8 shows the shifts in variance over January 1993–September 2001 for daily frequency data. Out of the 29 shifts in variance, about 17 percent of them took place during the free float. That is to say, about three breaks in variance per year. Meanwhile, between January 1993 and August 1999, twenty four changes in variance took place, which amounted to approximately 4 breaks per year. On the other hand, except for June 1999 and September 2001, the unconditional standard deviation of the exchange rate over the free float shows a similar pattern to that of low volatility periods over the dirty float.

We also investigated whether the volatility of the Ch$/US$ exchange rate was high or not during the free float, when compared with currencies of other countries with free/dirty float regimes. Table 9 shows evidence about volatility of exchange rates for 12 countries, including Chile, for the period 1998–2001. We divided the sample into two groups: 1998–August 1999 (floating band) and September 1999–2001 (free float with occasional intervention of the Central Bank of Chile). As previously discussed, the Ch$/US$ exchange rate shows a similar pattern between the two periods. The standard deviation and

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Table 8
Chile's average volatility of the exchange rate computed between shifts dates (January 1993–September 2001)

Time period	Average volatility per day (Ch$ of September 1991)	Time period	Average volatility per day (Ch$ of September 1991)
4 Jan 93−3 Feb 93	0.74	31 Jul 97−21 Oct 97	0.42
4 Feb 93−9 Mar 93	1.56	22 Oct 97−2 Jan 98	1.12
10 Mar 93−2 Jun 93	0.62	3 Jan 98−11 Jan 98	3.97
3 Jun 93−24 Jun 93	0.91	12 Jan 98−25 Jan 98	2.17
25 Jun 93−11 Nov 93	0.46	26 Jan 98−25 Feb 98	1.99
12 Nov 93−12 Dec 93	1.55	26 Feb 98−2 Mar 98	1.55
13 Dec 93−29 Aug 94	0.79	3 Mar 98−29 Mar 98	0.63
29 Aug 94−27 Nov 94	1.15	30 Mar 98−23 Jun 98	0.42
28 Nov 94−5 Dec 94	3.96	24 Jun 98−13 Jun 99	1.25
6 Dec 94−22 Nov 95	1.50	14 Jun 99−23 Jun 99	3.17
23 Nov 95−5 Dec 95	1.37	24 Jun 99−28 Jun 00	1.05
6 Dec 95−14 Jan 97	0.59	29 Jun 00−10 Jul 00	1.27
15 Jan 97−18 Feb 97	1.02	11 Jul 00−19 Jul 00	1.06
19 Feb 97−10 Apr 97	0.60	20 Jul 00−2 Jul 01	1.52
11 Apr 97−30 Jul 97	0.35	3 Jul 01−28 Sep 01	3.30

Source: Own elaboration based on sudden breaks in volatility detected by the ICSS algorithm.

the interquartile change of daily returns slightly increase over the second period. Now, when compared with other economies, Chile was not the most volatile. For example, the currencies of Australia, New Zealand and Brazil had a higher standard deviation and interquartile range over September 1999–2001. It is interesting to notice that, out of the twelve countries, only Canada and Peru had less volatile exchange rates than Chile over the two time periods.

We conclude therefore that the change in volatility of the Ch/US exchange rate was not sharp enough to noticeably alter the aggregate trading volume of forwards contracts, as Fig. 4 shows. What is interesting is that the composition of the forward contracts changed. Currently, the most actively traded contracts are those whose maturity ranges between 8 and 30 days, in the case of US$/Chilean peso forwards, and those whose maturity is less than or equal to 90 days, in the case of US$/UF forwards.

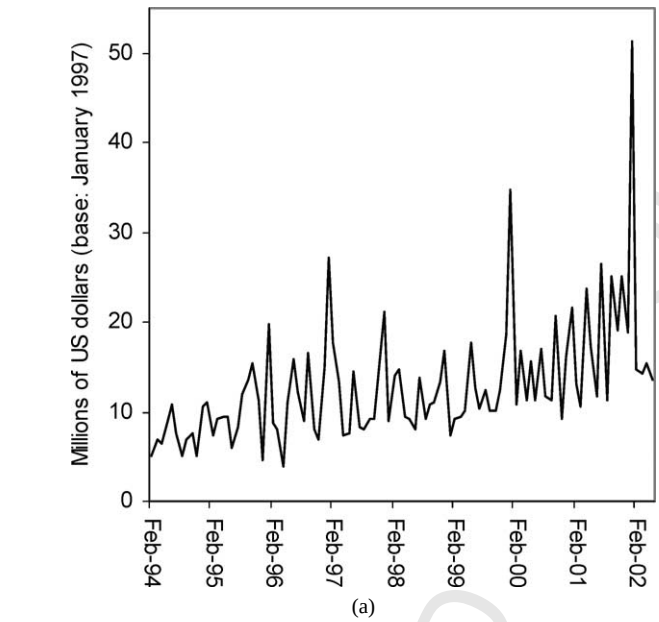
For US$/Chilean peso forwards, whose maturity is between 8 and 30 days, we observe an upward trend in their turnover since the end of 1998. However, its predominance became evident only approximately since June 1999. Prior to June 1999, 91–180 day contracts represented a high share of the total turnover of US$/UF forwards. However, they later lost ground to shorter maturity contracts. An explanation for these phenomena might be the following. Even though the exchange rate has not exhibited a sharp increase in its volatility, eliminating the floating band has led to higher currency risk. Indeed, as the exchange rate insurance provided by the floating band was no longer available, economic agents found that a better way to hedge currency risk was by entering into shorter maturity contracts.

In previous sections, we have argued that regulatory constraints faced by pension funds (AFP), and low market liquidity might be two factors that have slowed down the development of derivatives markets in Chile. Panels (a) and (b) of Fig. 10 show estimates of market liquidity on a monthly and daily basis, respectively. Panel (a), in particular, shows that the average of liquidity—which is defined as the difference between actual and required bank

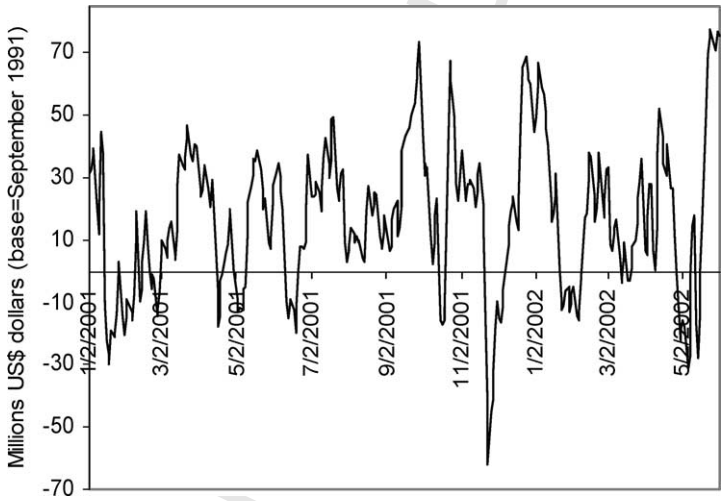
Table 9
Daily variations of different currencies under free/dirty float

	Australia	Brazil	Canada	Chile	Indonesia	Japan	South Korea	Mexico	New Zealand	Peru	Turkey	Thailand
					1998–August 1999							
Mean (%)	0.004	0.128	0.011	0.038	−0.069	−0.047	−0.087	0.036	0.029	0.051	0.218	−0.055
Maximum (%)	2.625	12.913	1.434	3.922	19.019	3.788	4.960	3.980	2.953	1.700	29.314	4.669
Minimum (%)	−4.864	−9.033	−1.635	−1.834	−21.078	−5.855	−9.857	−2.646	−4.155	−1.873	−22.916	−6.000
Standard dev.(%)	0.804	1.507	0.390	0.530	3.476	1.058	1.261	0.732	0.845	0.423	3.506	1.165
IQ range[a]	0.995	0.493	0.428	0.537	2.540	1.138	0.833	0.712	0.964	0.442	0.447	0.823
Asymmetry	−0.650	1.893	−0.239	0.968	0.113	−0.564	−1.513	0.966	−0.510	0.155	2.370	−0.997
Kurtosis	6.670	26.053	4.777	10.653	12.656	6.591	16.036	7.668	6.132	5.207	43.824	10.210
					September 1999–2001							
Mean (%)	0.038	0.032	0.011	0.040	0.054	0.031	0.018	−0.004	0.035	0.003	0.189	0.025
Maximum (%)	3.964	3.594	0.851	3.644	5.592	2.268	1.897	1.707	3.852	0.942	22.879	1.762
Minimum (%)	−2.231	−4.013	−1.054	−2.116	−8.831	−3.054	−1.890	−3.577	−3.300	−1.841	−16.002	−3.316
Standard dev. (%)	0.741	0.868	0.330	0.558	1.385	0.689	0.505	0.516	0.812	0.319	2.081	0.484
IQ range	0.890	0.934	0.436	0.604	1.278	0.833	0.550	0.624	0.953	0.370	0.947	0.543
Asymmetry	0.263	−0.363	−0.002	0.721	−0.676	−0.447	0.349	−0.425	0.104	−0.241	3.059	−0.363
Kurtosis	4.382	5.762	2.837	8.579	9.166	4.885	4.565	7.207	4.799	5.302	48.839	7.694

Note. The data analyzed are daily returns of the different currencies against the US dollar.
Source: Author's elaboration based upon data from the Bank of Canada.
[a] IQ range stands for interquartile range, and it is computed as $Q_{3t} - Q_{1t}$, where Q_{3t} and Q_{1t} are the third and first quartile of the sample period, respectively.



(a)



(b)

Fig. 10. Liquidity of the Chilean financial system: (a) monthly averages, February 1994–May 2002, have been adjusted by inflation; (b) daily liquidity, January 2001–May 2002, each data point represents a moving average of liquidity on the preceding 30 days; figures have been adjusted by the daily variation of the *Unidad de Fomento* (UF). *Source*: Author's elaboration based upon information collected by the Central Bank of Chile. Liquidity is defined as the difference between actual and required reserves.

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reserves—in any given month has been relative low for the period February 1994–May 2002. Indeed, the average for the whole time period was only US$12.9 million, and higher liquidity is observed only from 2000 onwards. Panel (b) shows liquidity on a daily basis from January 2001 to May 2002, where each data point is a 30-day moving average. These figures show more clearly how liquidity fluctuates, and how sharply negative it can get over some time periods.

But what about the future of derivatives markets in Chile? As previously mentioned, a package of amendments to the Law of Capital Markets was passed by the Chilean Congress in November 2001. The main innovations can be summarized as follows. First, short-selling of frequently-traded stocks and bonds will be exempted from the capital gains tax (15 percent). This will also apply to the sale of bonds traded on stock exchanges. Second, the capital gains tax will be eliminated from the sale of frequently-traded stocks, which were purchased after April 19, 2001. Third, an emerging stock exchange will be created in order to provide an alternative source of funding for medium-sized companies. Capital gains of stocks traded on this exchange will be exempted from the capital gains tax for three years. Fourth, multiple pension funds (AFP) will be available. AFP will now not only offer one single fund but five different alternative investment portfolios to their affiliates, according to their tastes for risk and return.[15] Fifth, there will be more investments choices for savings in excess of the mandatory 10 percent of monthly gross income, which is currently managed by pension funds. Voluntary savings will be managed not only by pension funds, as has been until now, but by mutual funds, investment funds, banks, and life insurance companies.

In principle, the elimination of the capital gains on short-selling of stocks, the creation of an emerging stock exchange, and the multi-fund AFP might have the greatest impact on the Chilean derivatives market by providing additional liquidity to the spot markets, and by offering new financial instruments. In particular, the existence of multi-fund AFP might reduce the flock effect referred to in Section 2.1.1. However, we will have to wait for the next few years to see the effect of these amendments. Meanwhile, the OTC market of currency forwards continues to be the most active.

4. Conclusions

Derivatives began to be actively traded between the mid-1970s and the mid-1980s on and outside exchanges in most industrialized countries. According to information gathered by The Bank of International Settlements, at the end of April 2001 the value of OTC positions outstanding was over US$99 trillion, while the value of positions outstanding in organized exchanges was approximately US$20 trillion. In Latin America, the largest derivatives exchanges are located in Argentina (MATBA, ROFEX), Brazil (BM&F, BOVESPA), and Mexico (MexDer). In addition, OTC markets exist in Chile and Peru.

[15] In particular, there will be three age brackets (less than 40, 41–55, and over 55 years old), and a default fund for each bracket. Riskier portfolios will be made available only to younger affiliates in order to reduce excessive market risk as their retirement approaches.

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The contracts regularly traded in Chile are US$/Chilean peso and US$/*Unidad de Fomento* (UF) forwards. Other types of derivatives, such as individual stock options and stock indices options have been barely traded. In the case of Chile, the causes appear to be low market liquidity and regulatory constraints faced by institutional investors. However, recent amendments to the Law of Capital Markets—which involve the creation of an exchange for emerging firms, and the existence of multi-fund AFPs, among others—might boost the derivatives market. Meanwhile, foreign exchange rate derivatives continue to be the most actively traded.

In our analysis, we examined the effect of the elimination of the floating band of the US dollar against the Chilean peso in 1999 on forwards turnover. The figures showed us that, at least until December 2001, the exchange rate had not been significantly more volatile. And, therefore, the forwards market has not become noticeably more active. However, economic agents have now switched to shorter-maturity contracts as the exchange rate insurance provided by the floating band is no longer available.

A subject for future research is to analyze the impact that the amendments made to the Chilean Law of Capital Markets might have on the domestic derivatives market. Until now, OTC markets for derivatives on foreign exchange and, more recently, on interest rates continue to be the only ones in existence. Exchange trading of derivatives has not resumed yet, and the big question is if it ever will.

Acknowledgments

The author wishes to thank the valuable comments of participants at the 2002 Midwest Finance Association Meeting, held in Chicago, USA, March 2002, and at a seminar held in the Central Bank of Chile in July 2001. Funds provided by Grant DID No. Soc-01/19-2 (Department of Research and Development of the University of Chile), and by an institutional grant of the Hewlett Foundation are greatly acknowledged. All remaining errors are the author's.

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