THE CHILEAN EXPERIENCE REGARDING COMPLETING MARKETS WITH FINANCIAL INDEXATION

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Resumen

Se evalúa desde variadas perspectivas la hipotesis de que la indexación de instrumentos financieros al IPC ha sido un factor determinante en el desarrollo del mercado de capitales chileno. El acortamiento efectivo de la madurez de los bonos nominales, la probable dolarización de la deuda de largo plazo y la reducción de las madureces medias, implican mercados más pequeños o mayores costos experados de quiebra como una consecuencia directa de no tener indización eb paises de inflaciones relativamente altas y variables. El mercado chileno aparece comoun caso exitoso de indización financiera, con un gran porcentaje de activos indizados mantenidos en manos de los inversionistas (entre 63% y 99% - excluyendo bancos e inversiones en acciones en la segunda medida). El desarrollo de un mercado indexado de renta fija ha impacado directamente en el desarrollo de otros, incluyendo la bolsa. La distorción en retornos relativos a la deuda y al capital también ha contribuido al desarrollo de dichos mercados.

Los bonos indexados de corto y de largo plazo proveen patrones de retornos diferentes, unicos y relevantes que no pueden ser replicados por mercados internacionales. Ello es relevante debido a que retornos inesperados a los bonos indexados representan "cambios en variables de estado" que impactan significativamente en los precios de los activos, ademas debido a que los diferentes sectores económicos encontrarían diferentes estructuras "óptimas" de deuda (o portfolios de margen), en términos de su denominación (UF-USD) y madurez. Asimismo encontramos evidencia de que: i) la composición de activos del Banco Central de Chile debiera incluir una pequeña proporción de deuda de largo plazo de los Estados Unidos y acciones de mercados emergentes; ii) hace poco sentido para inversionistas locales el invertir en renta fija extranjera como una estrategia de largo plazo.

Abstract

The general hypothesis that financial indexation to the CPI has been important for the development of the Chilean capital markets is analyzed from several perspectives. The effective maturity shortening of nominal bonds, the likely dollarization of longer term debt and the reduction of average maturities, imply smaller markets or higher expected bankruptcy costs as a direct consequence of not having indexation in countries with moderately high and variable inflation rates. The Chilean market appears as a successful example of financial indexation, with a very large percentage of indexed assets held by investors (between 63% and 99% - excluding banks and equity investment in the latter measure). The development of an indexed fixed-income market has indirectly impacted the development of others, including the equity market. The distortion in relative returns to debt and equity has also contributed to the development of these markets.

Short- and long-term indexed bonds provide distinct, unique and relevant patterns of returns that cannot be replicated in the international markets. This uniqueness is relevant since unexpected indexed bond returns represent "changes in state variables" that significantly impact asset prices, and also since diverse economic sectors would find different "optimal" debt structures (or hedge portfolios), in terms of their relative currency denomination (UF-USD) and maturity. We also find evidence that: i) the Central Bank of Chile's asset composition should include and a small proportion of long-term US government debt and also emerging market equity; ii) it makes little sense for local investors to invest in foreign fixed income as a long-term strategy.

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I INTRODUCTION

For a Chilean capital market participant, it may be hard to imagine a world *without* our indexation unit, the Unidad de Fomento (UF). In fact, most market participants would probably agree that the UF has played a "central role" in the creation of a local capital market, and also that it has had a "positive impact on growth and welfare". Of course, the trouble is proving it, and in a very limited sense, we try to do so.

From an investor's perspective, financial indexation may have quite a different role than the one presumably assigned to it by the economic authorities. From the latter perspective, indexation may be an efficient mechanism to signal the market a commitment to keep inflation under control. This in turn has to be weighted against the possibility of smoothing taxes, by letting inflation dilute the value of the outstanding nominal government debt if it is necessary, although this creates certain "time-inconsistencies" that have to be dealt with.[1]

It is thus seen that, from the above perspective, the idea of completing the financial market is not directly relevant, even though it may be important for determining the financial costs of government debt. The optimal government debt structure could take into account its implications on welfare, efficiency and completeness of the financial markets.

The idea of market completeness comes from an Arrow-Debreu economy. They analyze a case where a finite number of possible future "states of the world" exists (i.e. peace, war, recession, prosperity). Completing the market consists in generating patterns of payments in the different states that did not previously exist, such that investors can either hedge against or bet on the occurence of certain states, in a way that could not be achieved before. In practice, we can say that a given financial instrument "completes the market" if it generates ***relevant*** patterns of returns that cannot be replicated by the existing securities in the national or international financial markets.[2] In addition, if given markets/instruments are developed as a byproduct of a certain financial innovation, we may say that such innovation has helped to complete the markets.

On the other hand, indexation may have the perverse effect of allowing market participants to "feel comfortable" with certain "reasonable levels of inflation", and this may eventually make it harder to

[1] See, for example, Landerretche et.al. (1997).
[2] It has to be relevant in the sense that, in "equilibrium", it is not a pattern that would be diversified away. For instance, in a CAPM world, we only need one risky mutual fund, and no particular "premium" would be paid for new patterns.

reduce it from the perspective of an economic policymaker. Perhaps "private discomfort" with inflation facilitates the implementation of policies to reduce inflation, but in any case, other than sending letters to the newspapers, the role of the private sector in reducing endemic inflation rates is not clear.

We argue that indexation in Chile (jointly with several other structural reforms that have taken place) has helped to complete and develop the financial markets at least in the following senses:

- It has allowed the existence of a medium- and long-term bond (and loan) market that otherwise would not exist
- Long term UF indexed bonds create relevant patterns of returns that are not available either internationally or locally, via short-term nominal or indexed bonds, or dollar-denominated bonds
- Long-term UF indexed bonds generate ***relevant*** patterns: they are useful for hedging against adverse changes in capital goods prices

We also argue that, had it not been for the rules that made the Chilean index unit mandatory in many financial transactions, and for the UF-denominated government (Central Bank) debt, the fixed income market would have developed toward shorter-term dollar-denominated securities, as the international evidence for other developing countries suggests. This in turn would have had a significant impact on the potential bankruptcy costs of the Chilean economy.

II CAPITAL MARKETS AND INFLATION

The problem of how to develop a capital market under high and volatile inflation rates has been a subject of analysis for quite some time.[3] In this context, Chile is an interesting case study.

A. A Brief History

Before 1974, upper limits on interest rates and credit rationing coexisted. During 1974 and later, nominal and real (UF-based) interest rates became progressively liberalized and quantitative restrictions on credit started to disappear. In 1974 a new tax law introduced "Monetary Correction" mechanisms, with the idea of neutralizing the impact of inflation on the balance sheets and also on

[3] See, for example, Arnella, Dornbusch and Obstfeld (1983).

the tax obligations by firms and individuals. Nevertheless, as documented in Valdés (1988), the monitoring of asset and liability structures of financial intermediaries probably failed, first with the SINAP (national system of savings an loans), then with the "Financieras", and later with other episodes.[4]

This early experience with the liberalization of financial markets ended with the devaluation of the local currency and the well-studied debt crisis of 1982 (for example, see Mizala, 1991, and the references therein), with most of the financial sector back in the hands of the State. At least in part, this crisis may be attributed to "poor practices regarding risk management of the bank's assets"[5] that partly correspond to a "mismatching" problem. Indeed, dollar denominated debt was predominant over other kinds of debt, because of its apparently lower cost at the time, but it usually did not have dollar denominated assets as a counterpart. It is reasonable to expect that this lack of matching increases expected bankruptcy costs after a devaluation.[6]

In any case, from the above discussion, it is clear that indexation is not a sufficient condition to create a successful and stable capital market. Nevertheless, it does seem useful and probably even necessary in a context of moderately high and volatile inflation rates, especially considering that these variables usually are linked to other unstable macroeconomic indicators.

The Chilean experience suggests that the following steps are necessary for a capital market to develop in an inflationary context. End the financial repression by deregulating institutions and liberalizing interest rates; create an index unit and allow for indexed financial instruments;[7] reform the tax code in order to achieve inflation neutrality; create regulatory institutions to monitor, among other things, the "matching" of the asset and liability structure of financial intermediaries. The first three conclusions are present, for example, in De Pablo, Mancera and Henrique (1983).[8] The last conclusion arises from the Chilean experience and also from the application of well-known principles in asset and liability management.

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[4] See Valdés (1988) for a good description of the liberalization process and several bankruptcy cases.

[5] See Mendoza, op.cit.

[6] Speculating, the debt crisis would have had a smaller impact on the real economy if, instead of dollar denominated debt, banks had issued indexed debt. There are two simple reasons for this. First, UF based loans seemed more expensive - total debt levels presumably would have been smaller. Second, the inflation-adjusted value of the exchange rate increased 60% between June and December of 1982 and 53% toward the end of 1983. Thus, indexed debt levels would have been much lower.

[7] The Unidad de Fomento (UF) was introduced in Chile in 1967, although daily adjustments to its value only began in 1977. For example, see Mendoza (1991).

B. A Market for Indexed Securities

One of the important questions that need to be answered is the following. What are the necessary conditions for a market of indexed financial instruments to be successful? Naturally, we have to explain what is meant by "successful", and we intend to do so in the section D, where some empirical evidence for Chile is presented. Nevertheless, some thoughts follow.

The widespread acceptance of the UF as the *de facto* local currency unit in most financial transactions, is probably attributable to: i) the unit has credibility, in the sense that it will not be manipulated by the authorities, and is based on the CPI, that is computed by an independent entity, the National Institute of Statistics (INE);[9] ii) the laws themselves accept it as a valid alternative currency unit. For example, most loans and time deposits are required to be indexed, or, in the case of life insurance companies, assets and liabilities are measured in UFs; iii) there exists a deep, liquid market for Central Bank indexed bonds. This gives a risk-free real interest rate, for many different maturities, as a reference for private transactions; iv) the tax regulations are consistent with a generalized indexation of the economy.

To the above, we should add that the UF significantly reduces the costs of recontracting and allows to do so almost instantaneously in an inflationary environment.

It is likely for these conditions to be necessary and even sufficient for having a successful indexed bond market. The last three deserve special attention. If the laws do not explicitly consider the index as a valid currency unit, it is less likely that private contracts will generally use it. For example, if life insurance companies do not issue indexed contracts, then buying indexed assets may not be suitable for the purposes of matching assets and liabilities. A bank would probably not be as willing to produce loans linked to the CPI if it can not raise funds in the same unit.

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[8] See also El Ladrillo (1992), p.112-113.

[9] By contrast, the "dólar acuerdo" has no credibility. The Central Bank has outstanding debt denominated in that unit and its value is supposedly determined by following a "crawling peg" rule. Nevertheless, in at least three opportunities it has "revalued" the "dólar acuerdo" or changed the rule, automatically reducing the market value of the outstanding debt.

The point of having traded indexed government paper is also important, since it reduces the uncertainty surrounding the expected costs and benefits of buying or selling indexed securities. On the other hand, the costs of creating a new market and informing investors may be large enough as to inhibit the spontaneous creation of indexed securities by the private investors.[10]

Finally, the tax considerations are also important. If unexpected inflation is neutral in terms of its tax consequences, it is likely that there would be more issuers and investors interested in such instruments. Since we are interested in the market for fixed-real-income bonds, the tax advantages of debt are important too. In Chile, between 1974 and 1984, a considerable tax advantage to the use of debt existed, that later disappeared with the 1984 tax reform.[11] Among other factors, this would give as a reason to expect debt levels (indexed or otherwise) to be lower in Chile than in other countries.

In January 1997 the United States Treasury issued TIPs (Treasury Inflation Protected bonds). This is an interesting case study. Soon after the the issue of these 10-year bonds, the Federal Home Loan Bank and the Tennessee Valley Authorities announced that they would do the same.[12] With a current 3.3% rate of inflation, the resulting 3.45% real interest rate, compared with the 6.4% rate on the equivalent nominal bond is debatably "large". This may be due to the illiquidity of this new instrument, and also to the uncertainty over the status of the current CPI index, that is said to overstate inflation.[13] Shortly after the introduction of this new security, the pension fund manager TIAA-CREF created a new inflation protected account, considered to be a long-term, low-to-medium volatility alternative. Nevertheless, the tax treatment of this security may also explain in part the relatively large yield. In fact, Cohen, Hasset and Hubbard (1997) argue that inflation is still relevant for the determination of the user cost of capital. The use of debt still has a tax advantage but, in the particular case of indexed bonds, both the real component and the nominal adjustment to the value of the bond (the nominal capital gain) are taxed. This means that for high enough levels of inflation, the cash flows paid by the bonds could become insufficient to pay the tax liability they create.[14]

In this discussion, the four elements considered necessary for a successful indexed market are present. Credibility of the unit; its validity as an alternative currency unit for certain financial products; the tax considerations; and a central authority taking the first step to create the new

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[10] Campbell and Shiller (1996) also present the "money illusion" and "balkanization" arguments.
[11] This may be an additional explanation for the debt crisis. See Hernández and Walker (1993) or Walker and Hernández (1992) for the english working paper version.
[12] See for example http://www.morevalue.com/themes/i-bond2.html
[13] For a simple discussion see the Financial Pipeline, http://www.finpipe.com/tips.htm

instrument and provide liquidity to it. After this, the private sector may continue to develop this market.

Nevertheless, we must not ignore other important reforms that have directly or indirectly contributed to deepen the Chilean financial markets, notably the pension fund reform and the privatizations. In their beginnings, pension funds invested only in indexed fixed income, and still invest a large fraction of their portfolios that way. On the other hand, privatized firms have frequently used the capital markets to finance their operations. In the end, it is not possible to isolate the effects of the UF on the development of the local capital markets.

III INDEXATION AND LONG TERM FIXED INCOME MARKETS

In this section we present arguments that justify the idea that generalized indexation contributes to the existence of a long-term capital market in countries with a history of high and volatile inflation rates.

A. Inflation and the shortening of effective maturity

It is a well-known fact that higher interest rates imply a shortening of the effective maturity (or duration) of a fixed income security. Naturally, for a given real interest rate, higher expected inflation rates imply that a larger fraction of the value of a given fixed-income (nominal) security has to be paid at the beginning of its life. The Figures 1 and 2 illustrate this.

Figure 1 shows the percentage of the total present value of a 20-year annuity bond that is paid during the first and following semesters. For example, with a 30% annual inflation rate, 80% of the real value of the loan is paid after the 10^{th} semester. With a 0% inflation rate, the same 80% is paid after 27 semesters.

Another way to look at this is through the Macaulay Duration that corresponds to the price-elasticity of the bond to changes in its discount rate. It is important to keep in mind as a reference that a pure-discount bond has a Duration equal to its maturity. Figure 2 shows a convex function that relates the duration of the annuity bond to the rate of inflation, for a fixed real interest level. Increasing the

[14] This and other potential problems are noticed by Campbell and Shiller op.cit..

inflation rate from 0% to 15% reduces the Duration of the bond from 8.5 to 5 years, approximately. With 30% inflation the number drops to slightly above 3 years.

Therefore, we can conclude that high levels of expected inflation concentrate the inflation-adjusted (real) payments in the first few years of the life of the bond, and thus little incentives remain to extend the maturity of the bonds from the perspective of either borrowers or lenders. For example, under the same assumptions, extending the life of a loan from 10 to 15 years increases its present value by 32% under zero inflation, but only 10% under a 15% inflation rate.

Of course, the problem is that under high inflation nominal payments that are far away have little real value. To keep the real value of payments relatively constant, it would be necessary to have nominally increasing payments. This is exactly what indexation does (in addition to its more important feature, that is providing protection for unexpected changes in the inflation rate) and the above arguments clearly make a case for it.

We conclude that, without some kind of indexation, high inflation rates makes long term markets disappear.

B. A discussion about the nature of the inflation risk premium in nominal rates

Campbell and Shiller (1996) estimate the inflation risk premium for a 5 year US pure discount bond in the neighborhood of 50 to 100 basis points. To estimate it, among other methodologies, they use sample averages and covariance with consumption growth and the returns of a stock index (C-CAPM and CAPM). They also quote evidence from Siegel (1994) for the UK of an average premium of only 0,5%.

The actual risk premium could be even lower if the nature of the inflation risk premium resembled more to that of a "sleeping monster".[15] In this case, the normal covariance and other sample statistics would not reflect the "true" risk premium, unless the number and magnitude of the high inflation episodes in the sample coincides with what was expected, on average, by the market participants.[16]

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[15] Haugen (1995) explains that if the higher expected returns of "value stocks" is due to risk, it must be a "sleeping monster" kind of risk.

[16] This is a "peso problem" argument that has also been used to explain the equity premium puzzle (Goetzmann and Jorion, 1997). It is the kind of risk reflected in the increase in value of out-of-the-money puts after the stock market crash of 1987 (Bates, 1997).

Figure 3 shows long term US Government Yields and trailing 12-month inflation rates. Judging from valley-to-valley, four "high inflation" episodes seem to appear. Comparing the left and right extremes of the graph gives the impression of higher real yields towards the end, closer to a 4% "real" rate of return (at the beginning of the period it is closer to 2%). Comparing that with the 3.5% of the TIPs gives a 0.5% premium, assuming that the term structure for real rates is flat.[17]

In the case of a country like Chile, where the inflation episodes have been significantly more acute, it is only possible to speculate on how large the premia on long-term nominal bonds would have to be in order to induce investors to buy them. Mendoza (op.cit.) finds evidence of a "liquidity premium" (a higher return) for 90 day UF-denominated over nominal 30 day deposits. This is like a negative inflation premium. But since these are very short-term instruments, it is not possible to extend the conclusions to longer-term paper. We expect both, the large historical levels and high volatility of the inflation rate, to imply that the inflation premium should be larger than in the US. Nevertheless, the exercise presented in the Appendix shows that large inflation volatility might have counter-intuitive implications. In fact, given a credible inflation target, a *higher* historical volatility would imply (ceteris paribus) *lower* nominal rates on long-term bonds by a "convexity effect": The present value is a convex function of its discount rate. Therefore, for a given a long-term expected value, higher volatility in the inflation rates implies *lower* nominal rates. Naturally, this effect may be more than compensated by a higher required risk premium due precisely to the high volatility. Nevertheless, the point is that using the Fisher equation to estimate the inflation risk premium may lead to underestimate it.

We simply conclude that it may be difficult to estimate the inflation premium, because of its eventual "sleeping monster" nature and the impact that its volatility has on the implementation of the Fisher equation.

A simple attempt to estimate what the long-term nominal rates would look like in Chile follows. We consider twice the inflation risk premium of the US. We take the rates for the PRC 20 of the end of July 1997 (6.5%), use the Vasicek model and assume a 4% long term expected inflation rate. This gives a nominal yield for the equivalent (annuity) nominal bond between 11% and 12% (using inflation risk premia of 1% and 2%, respectively) and a duration of 7 years (about 1 year less than that of the corresponding UF bond).

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[17] See Barro (1995).

C. Implications of not having a UF

In the particular case of Chile, given that most financial transactions use the UF as a reference, and that most financial instruments are expressed in this unit,[18] a forced elimination of the UF is likely to have large negative social costs, apart from welfare redistribution effects. Any manipulation of the UF is likely to have a considerable negative impact, because a widely accepted unit would lose its credibility, casting doubts on the true value of a very large fraction of the financial assets held by investors. Affiliates to the pension fund system would be especially affected.

In the case of other countries, with a history of large and volatile inflation rates, we hypothesize that the lack of a widely accepted indexed monetary unit has two implications. First, the capital markets will use a different inflation protection unit, such as a foreign currency, especially the US dollar, given its widespread acceptance.[19] Second, the maturities of most financial instruments (in local nominal currency or denominated in dollars) will be relatively short.

The reasons to expect a relatively short-term market in local nominal currency were given above, and have to do with the shortening of the effective maturities of the fixed income nominal securities.

On the other hand, the purchase or sale of dollar denominated instruments usually entails important risks. From an investor's perspective, the principal risk of investing in a foreign currency denominated asset is an unexpected appreciation of the local currency. This happened, for example, in 1994, when a few Chilean pension funds had investments abroad, and the UF appreciated 12.5% against the dollar. Given the arbitrage that exists between short-term UF and peso-denominated deposits,[20] this means that the latter also had an additional real return of approximately 12.5% than its counterpart in dollars. It is perhaps because of these risks and also due to the relatively high local interest rates that a very small percentage of the institutional investments are denominated in dollars (see sections D and E below). Investors should trade-off this currency risk against interest rate risks. If only foreign currency denominated bonds were available for longer term investing, it may be convenient to invest a certain fraction of the portfolio in them.

From the perspective of a productive firm, issuing US dollar-denominated debt has different degrees of risk, depending on the nature of its activities. A firm in the tradable productive sector should

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[18] See section II.D below.
[19] In addition, the inflation tax becomes smaller because the demand for local money balances decreases.
[20] Mendoza, op.cit.

probably issue long-term dollar-denominated debt to match the currency denomination of assets and liabilities and reduce bankruptcy risks. . We understand bankruptcy risk as a "second moment risk", that has to do with the residual variance of net income, that depends on the covariance between income and expense flows. We need to measure it *ex ante*, before knowing the trajectory of the exchange rate, for example. In this sense, firms in the non-tradable sector would increase their bankruptcy risks by issuing dollar-denominated debt. If this is the only way to obtain longer term financing, there will be a trade-off between the possibilities of matching the currency and the maturity structures of assets and liabilities. Compared to the alternative of issuing long-term indexed debt, firms would probably end up with a larger than optimal fraction of dollar denominated debt and with a shorter than optimal maturity for it. This allows us to conclude that there is room for some foreign currency denominated debt, but given that there is going to be a degree of mismatching in the asset and liability structure, the maturities will be generally shorter than with matching debt.

Altogether, both effects imply that in fact a long-term fixed-income market would probably be less developed than in an indexed market. By the same token, if under high inflation rates the local currency is replaced by a foreign one as the preferred denomination for the local securities, the economy is likely to face higher potential bankruptcy costs than in the case of a generalized use of indexed debt. For the firms in the tradable sector, with or without indexing their debt structure should be similar, whereas for the firms in the non-tradable sector, dollar denominated debt instead of indexed debt increases the potential for bankruptcy.

Table 1 presents international evidence for several countries with respect to what securities are more frequently traded. Confirming our intuition, it is seen that most of the fixed income traded is short-term, but we could not gather much evidence of dollar denominated bonds. The relative composition of short and long-term bond trading volumes is heavily biased toward the short term in all cases, notably more than in the case of Chile (Table 2). Nonetheless, a large fraction of what appears as long-term fixed-income in local currency actually corresponds to floating rate notes. For example, in the case of Mexico nearly all of it has such characteristics. Thus, these would also be short term. The relative sizes with respect to the Chilean market are also interesting. The Mexican economy is roughly 6 times the Chilean one, but the so-called "fixed income" is even smaller than the mortgage bond subsector for the Chilean case.

D. **The Chilean fixed-income market**

Table 2, Panels A and B, show the trading volume in the Santiago Stock Exchange. It corresponds to the principal trading center in the country. In 1996, the total amount traded was roughly 3 times the Chilean GPD, and in this sense it is relatively large. The largest fraction of the total amount traded in 1996 corresponds to "financial intermediation" (53% of the total), that actually corresponds to a market that provides short-term liquidity, where very short-term paper are traded, such as time deposits and the like. The longer-term fixed-income market is smaller, but still represents a large volume relative to GDP. Such instruments totaled USD 79 billion, most of which (nearly USD 59 billion) corresponds to paper issued by the Central Bank and the government. The bonds issued by the private sector represent USD 20 billion, and more than half of it corresponds to mortgage bonds, being by far the most important privately issued fixed-income security.

Panel B tries to decompose the volumes traded in 1996. Both for short and long-term securities, the most important denomination are the UF (and other very similar units). The dollar-denominated short-term securities traded are not really financial instruments; it corresponds more properly to a foreign exchange market. We see that the vast majority of the securities issued by the private and public sectors are denominated in indexed units.

Dollar-denominated bonds are rather scarce. As of December, 1996, the firms that had outstanding debt in dollars actually did belong to the tradable sector,[21] with the exception of CTC, the largest local telephone company, but in this case a large fraction of its costs are dollar denominated. Of its total outstanding debt (estimated in USD564 million)[22] 36% had this denomination.

There have been other recent dollar denominated bond issues, not registered with the Superintendence, that have been sold abroad, but they have corresponded to firms that do business overseas.

The previous analysis was about "flows". Now we look at "stocks". Table 3 shows the asset holdings of the principal institutional investors in Chile. We can see again that, after the bank loans, the major holdings correspond to Central Bank and Government debt (USD 20.5 bn) and mortgage bonds (USD 8 bn). Looking at the totals, the first three columns are practically entirely indexed and long term. It is difficult to decompose the column "Deposits and Bank Bonds", but if we do so following

[21] These are Soquimich (mining); Celarauco (pulp); Cocar (coal); CTC (telephone); Viña Santa Rita (wine); Industrias Tricolor (paints). See note (1) on Table 3.

the composition of the pension funds' assets, we get that 93% of it is indexed, 27% is truly long term (bank bonds) and 8% are indexed deposits with more than 1 year maturity. Finally, the bank loans can be decomposed as 15% USD, 37% peso and 48% indexed. The final result is that, out of the USD 82bn represented in Table 3, USD 51.6 bn (63% is indexed).

We believe that the overall evidence shows a successful indexed market. In addition, most productive and financial firms have chosen UF-denominated debt. This proves that, for the purposes of matching assets and liabilities, it dominates other feasible alternatives, such as dollar-denominated debt, giving credibility to our hypothesis that, without the UF, the overall bankruptcy risks of the economy would increase. The relatively large mortgage bond market can also be interpreted as evidence of success and in this case it implies lower expected distress costs for individuals and firms that have purchased real estate property with indexed loans, compared with the alternatives of either short-term nominal or long term dollar debt.

E. Possible Links Between Markets

Tables 2 and 3 show that the most important long-term bond issues are mortgages. Most of the outstanding stock issued is in the hands of the pension funds and the life insurance companies. The longer maturity of these instruments gives these investors the possibility of matching their assets and (defined or undefined) liabilities. They have thus been useful for the development of these two industries. At the same time, the funds raised in this manner are essentially used in the construction sector, allowing its development, particularly in the medium- to high-income residential sector.

On the other hand, the lack of indexed bonds issued by non-financial firms could be used as an argument against their attractiveness or even their usefulness from a social welfare perspective. We argue below that there are other reasons that explain the relatively low volumes issued.

Figure 4 shows the bond issues registered with the SVS. Notice that registration represents the purpose of issuing and selling a bond, but it is possible for a bond issue to fail. The amounts represent the aggregate face value of debt, and for this reason the ex-post proceeds from bond sales may be different. But it still represents what the intentions were ex-ante. The figure shows that with the exception of 1994 (where Pangue, a failed issue, represents 25% of the total), there seems to be a downward trend. We can also see an inverse relationship between the levels of interest rates

[22] Boletín Mensual, SVS, Diciembre.

of a particular year and the amount registered. In addition, the year with the highest dollar issues, was 1993, when UF based interest rates were high. Therefore, we can hipothesize that one of the reasons for the small amount of bonds issued by nonfinancial firms is that, on average, UF-based interest rates have been high. Recall that the Central Bank has kept local interest rates high by means of a special reserve requirement to the foreign capital flows into Chile. Thus, the fixed-income market is ***segmented*** from the rest of the world. A simple excercise that illustrates the extent to wich local UF rates are higher than their equilibrium levels follows:

US real interest rate (TIPs)	3.5%
Country dollar risk premium[23]	1.1%
PPP rule followed by the Central Bank for the "dólar acuerdo" (Expected depreciation of the UF)	-4%
UF/USD currency risk premium	X
Theoretical rate	X+0.6%
PRC 10 rate (july 22, 1997)	6.7%

This exercise shows a very large spread that may explain why issuing UF-bonds may not be attractive. The currency risk-premium would have to be extremely large in order to make the current rate an "equilibrium" one.

A second reason as to why bond issues are scarce relative to other countries is the Chilean tax structure, that is virtually neutral with respect to the incentives for the use of debt or equity.[24]

Thirdly, although the fixed income market may be segmented, the stock market is likely to be *integrated* to the rest of the world for two reasons: the foreign investors that operate in Chile, and the massive use of ADRs by the largest firms. Figure 5 shows the intentions of issuing stock, valued at subscription prices (which are likely to differ from the final prices obtained). The same figure shows the ratio of market-to-book for the aggregate stock market. Excluding 1987 and 1988 (years of important privatizations) there is an upward trend. At the same time, due to the "alignment" process of the local stock market with the rest of the world,[25] the market-to-book ratios increased considerably (they have triplicated since 1990). We thus find that, relative to presumable "equilibrium levels", debt financing may be expensive relative to equity financing, and this may have tilted the financial structure toward the use of equity.

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[23] Estimated by CB Capitales, as the difference between the dollar rates obtained by local companies abroad and the corresponding US Treasury Rate. ***Informe Económico 6***, mayo 1997. For Mexico, Domowitz et.al. (1996) find an equivalent premium of 2-2.7%.

[24] See Hernández and Walker, op.cit.

[25] Walker (1997) estimates a 6% drop in the real discount rate for stocks after 1991.

Finally, we propose the idea that the early bond issues may have contributed to the development of the stock market as well. We base this reasoning on Myers' (1984) *pecking-order theory*, in that due to information asymmetry and the costs of dealing with it, there would be a sequence of preferred financing sources. First, retained earnings, followed by debt (presumably supplier's credit, then banks and last with the public) and finally, new equity. The idea of a sequence can be interpreted either as a list of preferred financing sources (given a certain level of information asymmetry between a firm and its stakeholders) or as a chronological sequence, as a function of the accumulation of information by investors about firms' activities. Figures 4 and 5 show evidence that is roughly consistent with the latter vision. Up to 1991, Figure 4 shows a relatively large issues of debt with public. Hernández and Walker op.cit. conclude that during the same period the use of bank debt was significantly reduced. This would also be consistent with a new step in the *pecking-order* theory, in the sense that, as potential investors become informed about the nature of traded firms and their businesses, it is less costly to issue traded securities, since the information asymmetry is smaller. These new bond issues required firms to orderly provide information to the Superintendence and notably also to the official Risk Rating Committee. Issuing firms later used the same institutional arrangements to get approval for selling new stock issues to the pension funds.

We can thus conclude that the long term indexed bond market has been important for the development of the entire capital market.

IV THE UNIQUE RETURN PATTERNS OF INDEXED BONDS FROM A LOCAL PERSPECTIVE

The idea of completing a market with financial indexation form the perspective of a local investor is rather intuitive: in the absence of indexation, unexpected inflation risks are essentially non-diversifiable. But, with the aid of indexation, this risk is totally eliminated. For example, a long-term investor that holds an indexed annuity bond for the purposes of his pension is essentially holding a riskless security. On the other hand, a firm whose income and expense streams are tied to the price index would view moderate levels of indexed debt as riskless. Thus, indexation would be a welfare-improving device that completes the market.

With the above in mind, we could go further and measure all security returns in terms of index units (as is usually done in Chile). We could then define a riskless asset as the one with zero variance

measured in this unit. In this context, by definition, an indexed bond issued by the government would be riskless (for a matched investment horizon). Therefore, analyzing whether other assets exist, apart from indexed bonds, whose combinations would provide us with a riskless portfolio, amounts to finding two perfectly negatively correlated assets. It is hard to imagine two of such assets. As a consequence, trying to identify the degree of uniqueness of indexed bonds against other local assets, e.g. how successfully they can be replicated, makes little sense from this perspective. We would not expect a combination of stocks, cash, and real estate, for example, to provide a riskless indexed return. We thus analyze the return patterns of indexed bonds by themselves.

Figure 6 and Table 4 both present results for Chilean indexed bonds. The indices are the following:

a) **INPRC10**. The PRC 10 is a Central Bank UF denominated bond, with semiannual constant coupons during 10 years. The index assumes a simple trading strategy. It consists in buying a newly issued PRC 10 at the end of each month, with the proceeds of the sale of the previous one. The interest rate used for the calculations corresponds to the yield of the bond on the last day of each month. In the early years, before the existence of the PRC, the equivalent PDP series was used. Sources: calculated here based on data provided by AFP Habitat and Bolsa de Comercio de Santiago.
b) **INU12**: it corresponds to a 12 year mortgage bond issued by the Banco del Estado de Chile. This bond has a different indexation unit,[26] that may make it behave slightly different. We calculate it using the same methodology, and the same data sources as above.
c) **INUF90**: corresponds to the 90-day deposit rate in UF, offered by prime banks to a large pendion fund. Same methodology, same sources as above.
d) **CB YIELD**: corresponds to a fixed-income UF-based long-term government bond index calculated by CB Capitales. Source: CB Capitales.

The U12 and the CB Yield are only used for control purposes, given that the longest series correspond to the other two. The correlations between INPRC10 returns and the returns of INU12 and CB Yield are quite high, and in this sense the PRC 10 may be representative. It is also interesting to notice that in the common period, the observed returns are very similar between the longer term indices and also with the short term deposit, although there would seem to be a premium between 6 and 10 basis points per month in the PRC 10 returns. Not surprisingly, the short term paper has the lowest volatility, followed by the CB Yield (a portfolio), PRC 10 and U12. Since U12 has a longer duration, the results can be expected. The small differences between the different

[26] IVP, that is similar to a lagged UF.

volatilities and correlations suggest that there is little room for diversification in the fixed income markets. This, in addition to the similarity of the observed returns gives credibility to the idea of a well-arbitraged market.

The numbers and also Figure 6 show a very similar behavior for the long-term indices, but the behavior of the short-term index is obviously different, significantly smoother, given its short maturity. It is precisely the volatility of the longer-term indices what gives protection to the long-term investors, jointly with its long-term negative serial correlation, which is apparent in the graph.[27] This is due to the effects of a mean-reverting changing yield through time. We see that short- and long-term UF investing indeed provides very different patterns of returns that are not equivalent from the perspective of a local investor.

V THE UNIQUE RETURN PATTERNS OF INDEXED BONDS: AN INTERNATIONAL PERSPECTIVE

The idea of completing the market with indexed bonds is analyzed here from the perspective of an investor that looks into the world markets for alternatives that are similar to indexed Chilean fixed income securities. We show that replicating portfolios of foreign securities in general will not do a very good job. These findings can be useful in several ways: 1) for the Chilean Central Bank. It has to invest in foreign assets and has UF-denominated short- and long-term liabilities. It is interesting to see the kind of portfolios that minimize the "tracking variance" with respect to its liabilities; this is, the kind of portfolios that minimize the variability of the difference between asset and liability returns; 2) for Chilean investors that wish to invest abroad. For long-term local investors, a riskless investment opportunity is represented by a long term UF denominated bond; for short-term local investors, the riskless asset would be a UF short-term instrument. In both cases the results indicate what would be the foreign portfolio that most closely resembles the local riskless asset. Results give us indications as to why so little has been invested in foreign securities by pension funds and insurance companies; 3) for government authorities, to understand better why foreign investors seem interested in investing in local fixed income securities, despite the reserve requirements.

[27] For overlapping annual returns of the PRC 10, the 1-year serial correlation is -0.42. For non-overlapping yearly returns it is -0.82 (with only 6 data points).

The analysis is developed based on software and data from Ibbotson Associates,[28] and treats two fixed income UF-based wealth indices as if they were two separate fund managers. We do a "performance attribution analysis"[29] on them and also analyze the out-of-sample rolling-portfolios that would have resembeled most closely our indices. The algorithm implements a Markowitz-style optimization model, searching for the nonnegative portfolio weights that minimize both the tracking variance ($\mathrm{var}(r_I - r_R)$ where in this case *I* and *R* represent the replicated index and the replicating portfolio, respectively) for the entire period and also the series of weights that would minimize it on a 36-month moving-average basis. The latter are used to calculate out-of-sample replicating portfolio returns.

In order to find foreign replicating portfolios, INPRC10 and INUF90 were transformed into dollars, at the observed exchange rate and the corresponding value in pesos for the UF (Source: Central Bank of Chile).

All the international data used has the same source: Ibbotson Associates. The data indices chosen are: i) Salomon Brothers (SB) US 3 month T Bill index; ii) U.S. Intermediate-Term Government Bond; iii) U.S. Long-Term Government Bond; iv) U.S. Long-Term Corporate Bond; v) Salomon Brothers (SB) Broad Investment-Grade (BIG) Bond Index; vi) S&P 500; vii) Morgan Stanley Capital International EAFE; viii) Morgan Stanley Capital International Latin America Free Index; ix) International Financial Corporation, IFCI emerging composite index.

The criterion employed was to try to have world coverage with bond and stock portfolios, giving additional emphasis to US indices.

Figure 7 shows the cummulative dollar return for the indices and their overall replicating portfolios. We only show the in-sample results (e.g. when a single set of portfolio weights is used for the entire period) because the out-of-sample results were similar. The replicating portfolio barely obtains half of the wealth accumulated by the local indices. The high local interest rates and the UF/dollar appreciation have caused this.

The time-varying portfolio weights are shown in Figures 8 and 9. Results are also presented in Table 5. Panel A only presents the asset class weights that turned out to be different from zero. We also

[28] By permission. The software is called "ENCORR ATTRIBUTION".
[29] See Sharpe (1992).

present the parameters of a simple one-variable linear regression (Panel B), that correlates the index returns with their corresponding replicating portfolios.

The portfolio weights are heavily concentrated in the short-term T-Bill. The reason for this is that if no single asset class has a significant correlation with the indices, then the tracking variance is minimized with the smallest variance asset. Nonetheless, there are differences between the replicating portfolios of the two indices. The longer-term index includes long-term US Government bonds (the short-term index does not) and also larger percentages in emerging markets. Panel B statistics indicate that the out-of-sample methodology provides insignificant results, except for the constant (alpha). This contrasts somehow with the overall period results that appear statistically significant, despite their low explanatory power. The implication of this is that the optimal portfolio weights may not be stable through time (and this is confirmed by Figures 8 and 9). The serial correlation of the rolling portfolio implies that it may be possible to use this information to better calculate portfolio weights.

We can thus conclude that both UF indices provide patterns of return that are not available in the international markets. This is true in the following two senses: First, the large alphas indicate that, with respect to their replicating portfolios, the UF based indices have provided additional dollar returns between 0.7% and 1% *per month*. Second, the low correlations indicate that the alternatives have a very different behavior through time, and do not have the hedging properties that may be required by a local investor.

Other lessons that can be drawn from this exercise are that the Central Bank should consider, for hedging purposes, including long-term US bonds and also a small proportion of its portfolio in emerging market equity. Finally, from the perspective of a Chilean investor whose investment horizons are represented by either index, investing in foreign fixed-income seems to make little sense, given that local indexed bonds dominate them.

VI RELEVANCE OF THE RETURN PATTERNS PROVIDED BY UF BONDS

The results of the previous section allow us to conclude that UF short- and long-term bonds provide patterns of returns that are not available in the international markets. The point now is to assess whether these patterns are relevant and if so, in what sense.

We analyze this in three different perspectives. In the state-variable perspective we analyze the idea that the short and long UF indices may represent relevant "states of nature". From the perspective of an "optimal leverage composition" (or hedging against changes in capital asset prices), where we indirectly analyze if firms that belong to the non-tradable sector would find it convenient to use more UF denominated debt. Finally, we see if UF denominated bonds provide useful protection against adverse changes in non-tradable goods prices.

A. The states of nature perspective

If short and long UF bonds indeed are useful indicators of the state of the economy, news about them should have significant impacts on the prices of financial instruments. In particular, investors might want to either hedge against or bet on the movements of these variables, and this risk should be priced. Therefore, if we correlate the returns of these bonds with those of the stock market, for example, significant relationships should emerge. [30]

To test this simple idea, we perform a regression analysis with the four industry stock market indices of the Bolsa Electrónica de Santiago. These are value-weighted indices that represent buy-and-hold strategies. The four sectors represented here are electricity, services, manufacturing and natural resources. The returns on these indices are first expressed in dollars and calculated in excess of the 90 day US T-bill's. This is also done for the explanatory variables: the excess dollar return of the short and long UF indices and also of the US long-term government bond index.[31] Although the reason for working with excess returns will become apparent in the next section, it is interesting to notice that the resulting numbers are almost unit-free, since we implicitly subtract on both sides the variation of the dollar exchange rate.

Table 6 shows the results. A seemingly unrelated regression analysis (SUR) was performed, including in addition equations for the short- and long-term index excess returns. Panel A shows the results of estimating an auto regressive equation for the short-term index return. Panel B shows the results for the long-term bond and stock indices.

In Panel A the lags were set ex-post to 3, with the purpose of minimizing the number of degrees of freedom lost in the SUR analysis for the rest of the equations, given that higher lags were not significant. Results show a relatively weak positive AR1 behavior.

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[30] Strictly speaking, to test this we should first estimate the sensitivity of different asset prices to these state variables and then verify in a cross-section if this risk is priced.

Panel B starts with an analysis or the long UF index in the first column of numbers. We find a very well behaved equation where the only significant explanatory variable is the excess return on the short term UF bond. In the other equations, we find that the coefficient on the short term bond is negative and insignificant, and in three out of the four equations the long-term bond very significant. We can reject the joint hypothesis that the coefficients on the UF bonds are zero at any significance level.

We thus conclude that the UF bonds are useful indicators of the state of the economy and perhaps more so the long-term bond, even though it is greatly influenced by the short-term rate.

B. The "optimal debt composition" or "hedging against capital asset price changes" perspective

All regressions in Panel B exclude a constant and are expressed as returns in excess of the T-bill's because one minus the sum of the regression coefficients represents what should be invested in the T-bill. To see this, assume 3 assets (A, B and C) an suppose that we want to find the unrestricted portfolio composed of B and C that best replicates A. If we run the regression:

$$r_A - r_B = b(r_C - r_B) + v \qquad (2)$$

estimated *b* will represent the fraction of the portfolio invested in *C* and 1-*b* the one invested in *B*. The regression analysis finds the portfolio weights that minimize the tracking variance.

Given this, the coefficients of the regressions without constants can be interpreted as the portfolio weights of the short term UF bond, the long term UF bond, the US long term government bond and the T-Bill (computed as 1 minus the sum of the other coefficients).

The results obtained have two alternative (but complementary) interpretations: 1) Hedging portfolios: we find the low risk fixed-income portfolios that most closely resemble the returns of the industry portfolio. The idea is that if we could not invest directly in a given industry, what portfolio should be used. For example, we could ask ourselves what portfolio allows us to hedge best against adverse price changes in housing (non-tradable sector). 2) "Optimal leverage composition": we assume that

[31] Same sources as before.

the evolution of the industry portfolios represents those of the firms that compose them. They would reflect the market's assessment of changes in the value of assets. In this case it makes sense to look for the composition of the total liability (represented by government bonds),[32] in terms of maturity and currency denomination, that most closely follows the market value of assets, because in this way we minimize bankruptcy risks.

The hypothesis that can be tested (that is consistent with both of the above perspectives) is that the "non-tradable sectors" (electricity and services) should have a higher "optimal" percentage of the total composition (either as a hedging portfolio or as a liability) in UF denominated bonds. The opposite should be true for the tradable sector (manufacturing and natural resources). We should also verify if the former is greater than the latter, as expected. Notice that in this case, since we are not dealing with the market value of assets but with that of equity, results are likely to be biased against our hypothesis. For example, if a firm already has a debt composition that is optimal, the value of equity would be less affected by adverse changes in the exchange or interest rates.

Results in Panel B can now be reinterpreted. First, the replicating portfolio of the long indexed bond consists of a long position in the short-term UF bond (1.16) a long but insignificant position in the long-term US bond (0.05) and a short position in the T-Bill (-0.21). This means that historically the UF bond has provided a pattern of returns that is similar to buying a short term indexed bond with dollar debt.

The last four columns in Panel B show the results for the stock portfolios. In general, these are well-behaved regressions, and considering the usual explanatory power for stock portfolio returns based on a few explanatory variables, results are in line with what can be expected. Moreover, results are overall significant, although the coefficients could be biased if the omitted variables are correlated with the regressors. Nonetheless, the portfolio perspective given above is still valid.

To interpret the results for the stock portfolios, notice that we are interested in testing whether the total amount in UF denominated bonds (the sum of the first two coefficients) is greater than the amount in dollar denominated bonds. In other words, it is sufficient to test if the sum of the first two coefficients is greater than 0.5. The role of separate coefficients for the short and long bonds (in UF and USD) is to allow for the adjustment of the portfolio duration. Results indicate that, for the electrical and services portfolios (in the non-tradable sector) the UF coefficients indeed are larger

[32] It is natural to assume that from the perspective of an issuing firm, the bond issued is free of default risk.

than those for USD at significance levels of 1% and 10%, respectively. For the other two (tradable sector) they are not. This is consistent with what is expected. On the other hand, only the electrical sector gives some indication of having coefficients that are larger to those of the industries in the tradable sector.

We conclude that the evidence is mixed, and gives us only partial support to our hypothesis that the "optimal composition" is biased toward the indexed unit.

C. Indexed bonds and goods prices

Table 7 presents the results of performing simple bivariate Granger causality tests between tradable and non-tradable goods price returns and our short and long indexed bond returns. The idea is to verify to what extent investing in these assets would provide protection to an investor that wishes to hedge against adverse changes in goods prices. We need a measurement unit for returns and price changes, and since the US Dollar has had a significant downward trend, we decided to measure everything in units of the tradable good. Therefore, the price returns would actually correspond to the change in the relative prices of the tradable and non-tradable goods. Also, the index returns are measured in terms of the tradable good.

Results show that the correlation between lagged price returns and bond returns are positive, but not significant. We therefore do not find direct evidence that UF investing by itself provides a good hedge against increases in the relative prices of non-tradable goods. Maybe more importantly, we find no feedback of indexed bond returns into prices, and this helps to mitigate the eventual concern of the economic authorities that financial indexation perpetuates inflation.

VII CONCLUSIONS AND FINAL COMMENTS

We believe to have provided enough evidence as to prove that financial indexation has been important in the process of developing the Chilean capital market. This, by means of a better resource allocation, is likely to have had a positive impact on welfare and growth.

The issue had to be analyzed from several perspectives in order to justify the conclusion.

The Chilean experience with the liberalization of financial markets leads us to conclude that, in addition to liberalizing interest rates and credit restrictions, and also to having an inflation-neutral tax system, the UF is a central piece of the "technology" developed for protecting capital market participants from inflation. This technology also includes credibility of the unit; compatible laws; and the precedent established by the central authorities, issuing indexed bonds.

We show that without an inflation protection unit, high-expected inflation rates and nominal financial instruments imply that the effective maturity of a long-term nominal bond is short. The implications of not having an index unit are that longer-term debt is likely to be issued in a foreign currency (such as the US dollar) and that the overall size and average maturity of the fixed-income markets are likely to be reduced. This in turn implies a larger degree of "mismatching" in the asset-liability structures for firms, increasing the expected bankruptcy costs.

We present the Chilean fixed-income market, and its generalized indexation, as a successful one. We estimate that 63% of the assets held by institutional investors (USD 82bn, including banks, pension funds, life insurance companies and mutual funds) are indexed. If we exclude banks, the number increases to 80%. Excluding also the investment in equity increases the percentage to 99%.

We also try to show links with other markets, especially the equity market, and conclude that the development of a fixed-income-indexed market was a necessary step toward the development of the former. Similar arguments apply in the financial sector to the development of mortgages, pension funds and life insurance companies. In the real sector, the development of the construction sector probably is one of the greater beneficiaries of indexation, through the market for mortgages. On the other hand, non-financial firms have issued small amounts of debt. We show evidence that this is in part due to the distortion between the required returns on debt and equity, being too high for the former.

We find that it is not possible to successfully replicate the short and long indexed bond return patterns in the international markets, and in this sense they are unique. This uniqueness is relevant for local investors, considering the following evidence. i) Short- and long-term indexed bonds represent states of nature that significantly impact asset prices; and ii) different debt structures (hedge portfolios) would be optimal for firms in the tradable and non-tradable sectors, with the latter being tilted toward UF-denominated securities. As an aside, these results also indicate that the Central Bank's optimal asset composition should include long-term US government bonds and a small fraction of emerging market equity. Finally, from the perspective of local investors, investing in

foreign fixed-income seems to make little sense, and this may explain why this process has been so slow.

There has probably been an important role for the economic authorities in the development of the local capital market. In addition to the set of regulations, the issuance of indexed bonds with diverse maturities has been important. The liquidity and benchmarking that these bonds provide are necessary signals for the private sector. In this sense, it is likely that other government initiatives, such as issuing, in addition to indexed bonds, nominal and dollar denominated long-term bonds would help to continue completing the financial markets. For example, long-term nominal bonds could have a social role not only in terms of allowing private sector expectations about future inflation rates to become known, but also in terms of modifying or creating certain forms of industrial organization. With clear reference rates provided by these instruments, and minor law changes, it is likely to observe increased competition in the market for nominal funds, and this could lower nominal interest rates on consumption loans, for example.

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APPENDIX: THE CONVEXITY EFFECT

Consider the Vasicek (1977) model for the term structure of interest rates. It assumes that the changes in the nominal interest rates follow a mean-reverting diffussion process with constant parameters of the following type:

$$dr = a(b - r)dt + \sigma dz \qquad (2)$$

where *a* is the "pull", *b* the level towards which the rates revert, σ the volatility parameter, and *dz* the Wiener process. This equation has a closed form solution that depends on the above parameters an also on the current level of the short rates.

In order to study the impact of the volatility of the inflation rate, we assume for the US, that the real rates are constant, and that the current and "equilibrium" rates corresponds to that of TIPs plus a 3% long term inflation rate (which gives a log nominal rate of 6.396%). We estimate the parameters *a* and σ from a simple regression of changes in the annual inflation rate against the lagged value for it from 1960 on. This yields the corresponding estimates of 0.26 and 2.15%, respectively. If we use these parameters in the Vasicek formula, we obtain a downward sloping nominal yield curve. Thus, using the Fisher equation to estimate the expected inflation rate (that is assumed constant) would understimate it by 17 bp in the 10 year bond and 25 bp in the 20 year bond. For Chile, if we assume a current and long-term real rate of 6%, a constant expected inflation rate of 4%, a parameter *a* equal to 0.201[33] and twice the volatility of the US (4%), we get that the 10- and 20-year nominal discount bonds would appear to have interest rates that are 78 bp and 130 bp below the value given by the Fisher equation. What may be surprising is that in this case the "inflation risk" works in a way that is opposite to what can be expected. If we increase the inflation volatilities, the resulting nominal rates are lower. The present value is a convex function of its discount rate. Therefore, for a given a long-term expected value, higher volatility in the inflation rates implies *lower* nominal rates.

[33] Corresponds to the coefficient of the error correction model in Table V.10 of Rojas *et.al.* (1995).

Table 1

A. Traded Volumes in Mexico (Bolsa Mexicana de Valores) (USD Millions)

	1993	1994	1995	1996
Equity	83,368	81,345	28,333	41,308
Fixed Income	30,945	10,631	5,676	2,664
Money Market	4,184,416	5,262,548	598,860	869,903
TOTAL	4,298,729	5,354,524	632,869	913,875

SOURCE: Larraín Vial

B. Traded Volumes in Venezuela (Bolsa de Valores de Caracas) (Millions of USD)

	1996
Equity	1,420
Brady Bonds	1,946
Long-term Bolivar denominated bonds	212
Short-term	

SOURCE: Santander Investment; most transactions are OTC.

C. Traded Volumes in Colombia (Millions of USD)

	1996
Equity	1,502
Brady Bonds	1,946
Long-term bonds	13,451
Short-term	20,728

SOURCE: Santander Investment; no USD transactions in the local markets.

Table 2: PANEL A

TRADING VOLUMES IN THE SANTIAGO STOCK EXCHANGE

(Millions of USD; numbers adjusted by CPI to December 1996 and then transformed into dollars at the exchange rate $424.75 / USD)

	Instruments	1994	1995	1996
A.	Dollars (bills and checks)	***5868***	***11330***	***12478***
B.	**Government, State Owned Firms, and Central Bank Bonds**			
B.1	Bono Reconocimiento (BR)	902	1055	1107
B.2	Pagares Compra Cartera (PCC)	1963	1304	236
B.3	Pagares Capítulo XVIII-XIX (PCD)	2239	2906	3242
B.4	Pagares Dolar Preferencial (PDP)	3417	2087	81
B.5	PRC C/Cupones (PRC)	35364	59713	54228
B.6	Pagares Reajustables Tesorería (PRT)	31	4	0
B.7	Pagares Tasa Flotante (PTF)	165	15	0
B.8	Pagare Portador Banco Central (PPBC)	283	298	10
B.9	State owned firms	0	0	0
B.10	Bonos Cora (COR)	0	4	0
	Subtotal	***44364***	***67387***	***58903***
C.	**Private Fixed Income**			
C.1	Mortgage bonds	5612	11278	12942
C.2	Leasing Bonds	764	976	2587
C.3	Bank Bonds	2930	2419	2626
C.4	Bonds issued by non-financial firms	945	1394	2321
	Subtotal	***10251***	***16067***	***20476***
B+C	***Subtotal Fixed Income***	***54614***	***83454***	***79380***
D.	**Short term financial intermediation**			
D.1	Non indexed IOUs	16218	21204	28004
D.2	Indexed IOUs	22642	40515	83324
	Subtotal	***38861***	***61718***	***111329***
E.	Stocks	6179	11371	8472
F.	Total Investment Funds Shares	85	331	78
	GRAND TOTAL	***105606***	***168204***	***211736***

SOURCE: Memoria Anual, Bolsa de Comercio de Santiago, 1994-1996.

Table 2: PANEL B

ESTIMATED DECOMPOSITION OF 1996 TRANSACTIONS (USD Millions)

		Short Term		Long Term		Total
A.	***Peso denominated***	***28004***		***0***		***28004***
	Private sector	28004	(D.1)	0		28004
	Public sector	0		0		0
B.	***Dollar denominated***	***12478***		***3544***		***16021***
	Private sector	12478	(A)	302	(1)	12779
	Public sector			3242	(2)	3242
C.	***Indexed***	***83324***		***75836***		***159160***
	Private sector	83324	(D.2)	20175	(3)	103499
	Public sector	0		55661	(4)	55661
	Total	***123806***		***79380***		***203186***

(1) Assumes that 13% of the amount traded bonds issued by non financial firms corresponds to US$, same proportion of their outstanding debt, an estimated 2.3 US Billion. Source: SVS.
(2) PCD
(3) Subtotal (C) minus (1)
(4) Subtotal (B) minus (2)

Table 3 *- Asset Classes Held by Major Institutional Investors (Millions of USD)*

	Central Bank and Govt.	Mortgage bonds	Nonfin. bonds	Deposits and Bank Bonds	Stocks	Inv. Fund Shares	Inv. Abroad	Other	TOTAL
Pension Funds	11591	4919	1285	1591	7159	834	149		27527
Life Insurance Companies	2605	2957 a.	na	na	577	na	na	1053 b.	7192
Mutual Funds	604	212	65	1721	198			11	2810
ST Fixed income	*484*	*31*	*1*	*1347*				*3 c.*	*1866*
LT Fixed Income	*97*	*169*	*63*	*329*				*1 c.*	*658*
Equity	*24*	*13*	*1*	*45*	*198*		*na*	*7 c.*	*287*
Banks	5785						1,2	38585 d.	44371
TOTAL	20584	8088	1350	3312	7934	834	149	39649	81900

a. Assumes that all privately issued bonds held are mortgage bonds. It also includes bonds issued by banks.

b. Corresponds to other real-estate investments. Includes Mutuos Hipotecarios, another kind of mortgage bonds

c. Cash+others

d. Excludes mortgage loans; includes rest of the loans and cash, principally "colocaciones efectivas"

SOURCES: AFP Habitat (from official sources, SAFP); Boletín SBIF, Dic, 1996; Boletín Mensual SVS Dic. 1996; Duff and Phelps report for life insurance companies.

TABLE 4 *- Representative Fixed-Income Indices*

UF BASED STATISTICS

	INPRC10	INU12	INUF90	CB YIELD
Period covered	Jan-90 to Mar-97	Jan-90 to Mar-96	Jan-90 to Mar-97	Jan-93 to Feb-97
Average monthly return	0.63%	0.63%	0.57%	0.63%
Monthly Standard Deviation	1.47%	1.59%	0.18%	0.78%
Common Period (Jan-93 to Mar-96)				
Average monthly return	0.64%	0.59%	0.54%	0.62%
Monthly Standard Deviation	0.90%	1.28%	0.07%	0.86%
Correlations				
INPRC10	1	0.6360	0.5153	0.7828
INU12		1	0.1545	0.4342
INUF90			1	0.4667

TABLE 5 *- Replicating portfolio results (Jan 1990-Mar 1997)*

PANEL A.	AVERAGE COMPOSITION	
	INPRC10	INUF90
SB U.S. 3 Mo TBill TR	78.43	90.75
U.S. LT Gvt TR	8.09	0.00
IFCI Emerging Composite TR	12.23	7.32
MSCI EM Latin America Free TR	1.25	1.92

PANEL B.	OVERALL		ROLLING	
	INPRC10	INUF90	INPRC10	INUF90
Alpha	0.0072	0.0069	0.0104	0.0103
Alpha T Statistic	2.4035	2.3864	3.3677	3.7981
Beta	1.0737	1.1254	0.1628	0.0269
Beta T Statistic	3.5094	2.907	0.6166	0.0886
R Squared	0.1266	0.0904	0.0077	0.0002
F Statistic	12.3159	8.4507	0.3802	0.0078
Number of Observations	87	87	51	51
Serial Correlation	0.0991	0.1069	0.2682	0.314

SOURCE: calculated here based on Ibboston Associates' international data and software.

TABLE 6 *- Influence of UF Indices on Stock Returns*

PANEL A*: The state variable*

Dependent Variable:	**EINUF90**	
Nº Obs.		60
Degrees of Freedom		56
R Bar Squared		0.0339
SSR		0.0126
DW		1.9677
Explanatory Variables:	Value	*t-test*
Constant	0.0061	*2.7731*
EINUF90(t-1)	0.2650	*2.0925*
EINUF90(t-2)	-0.0500	*-0.3823*
EINUF90(t-3)	-0.1350	-1.1896

PANEL B*: Stock, UF and USD portfolio returns*

Dependent Variable:	**EINPRC10**	**ERELECT**	**ERSERVI**	**ERINDUS**	**ERRNATU**
N. Obs.	60	60	60	60	60
Degrees of Freedom	58	57	57	57	57
R Bar Squared	0.8222	0.2447	0.2400	0.1909	0.1916
SSR	0.0042	0.2636	0.2845	0.2692	0.2854
DW (*)	1.9681	1.8903	1.7390	1.7716	1.7715
Explanatory Variables:					
EINUF90	1.1571	-0.3356	-1.0352	-0.4501	-1.6159
t-test	*17.6062*	*-0.2564*	*-0.7610*	*-0.3409*	*-1.1868*
EINPRC10		2.2766	2.4900	1.5870	2.7715
t-test		*2.2227*	*2.3385*	*1.5356*	*2.6006*
EUSLTGVT	0.0490	-0.0838	0.7331	0.7990	0.0379
t-test	*1.1169*	*-0.2384*	*2.0065*	*2.2534*	*0.1038*
Hypothesis:					
UF coefficients>USD (p-values)		0.0089	0.0952	0.2516	0.2524
Equal UF Coefficients (p-values)					
0.0973		x		x	
0.1376		x			x
0.4076			x	x	
0.5880			x		x

NOTES: All dependent and explanatory variables are measured in dollar excess returns above the 90 day T bill monthly return. EINUF90 corresponds to the 90 day UF based index excess returns; EINPRC10, the 10 year UF bond excess returns; EUSLTGVT corresponds to the long-term government bond excess returns; ERELECT, ERSERVI, ERINDUS, ERRNATU correspond to the four industry indices calculated by Bolsa Electrónica, and respectively represent the electrical, services, manufacturing and natural resources sectors.

(*) The DW statistics do not change if we include a constant in the equations.

TABLE 7 *- Bivariate Granger Tests of Causality*

Variables measured in terms of tradable goods units (1992:1 - 1997:3)

	Adjusted R**2	Observed Significance for first-order autocorrelation test (a)	Tested 12 lags of:	Sum of coefficients	t-test
NT "causes" UF90	0.1652	0.4787	CPI_NT	1.0951	1.3917
UF90 "causes" NT	0.0694	0.7515	INUF90	-1.0385	-0.7721
NT "causes" PRC10 (b)	0.2612	0.1644	CPI_NT	0.5501	0.7264
PRC10 "causes" NT (b)	0.2552	0.0881	INPRC10	0.0034	0.0186

(a) Test suggested by Godfrey (1978) and Breusch (1978)

(b) Modelled with an AR1 error

Notes: "NT" means non-tradable; CPI_NT corresponds to the consumer price index of the non-tradable sectors (SOURCE: INE). As before, INUF90 and INPRC10 correspond to the 90-day and 10 year indexed bond returns.

Figure 1

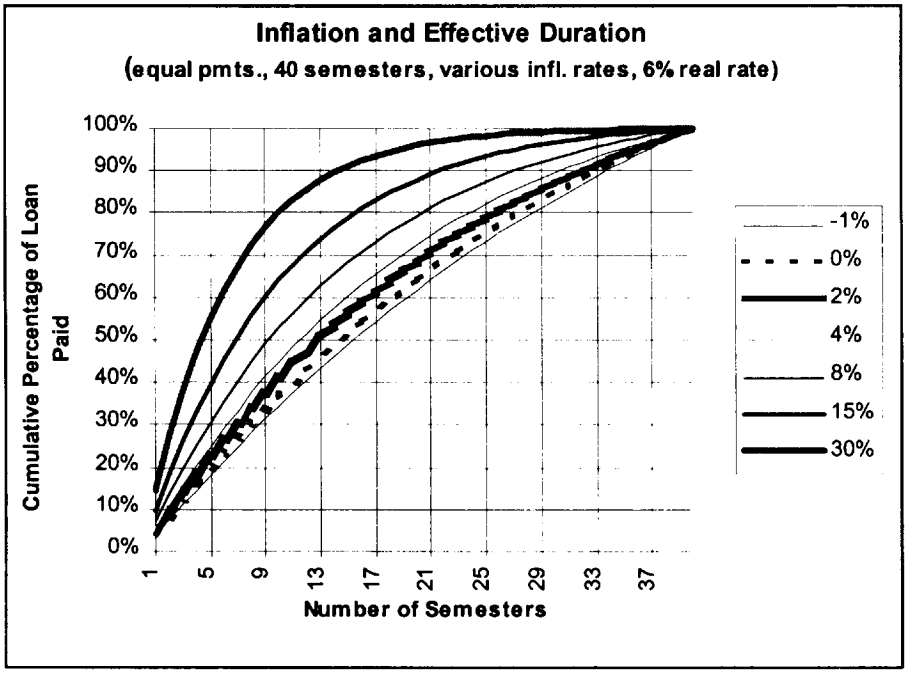


Figure 2

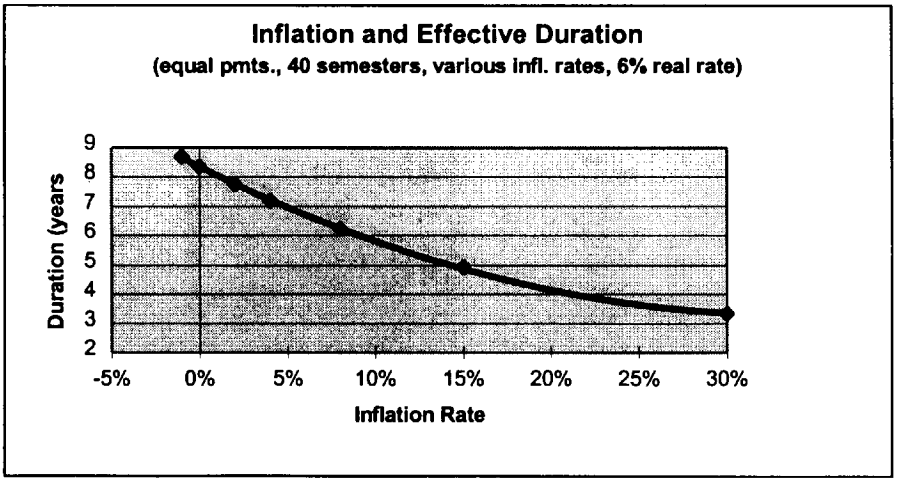
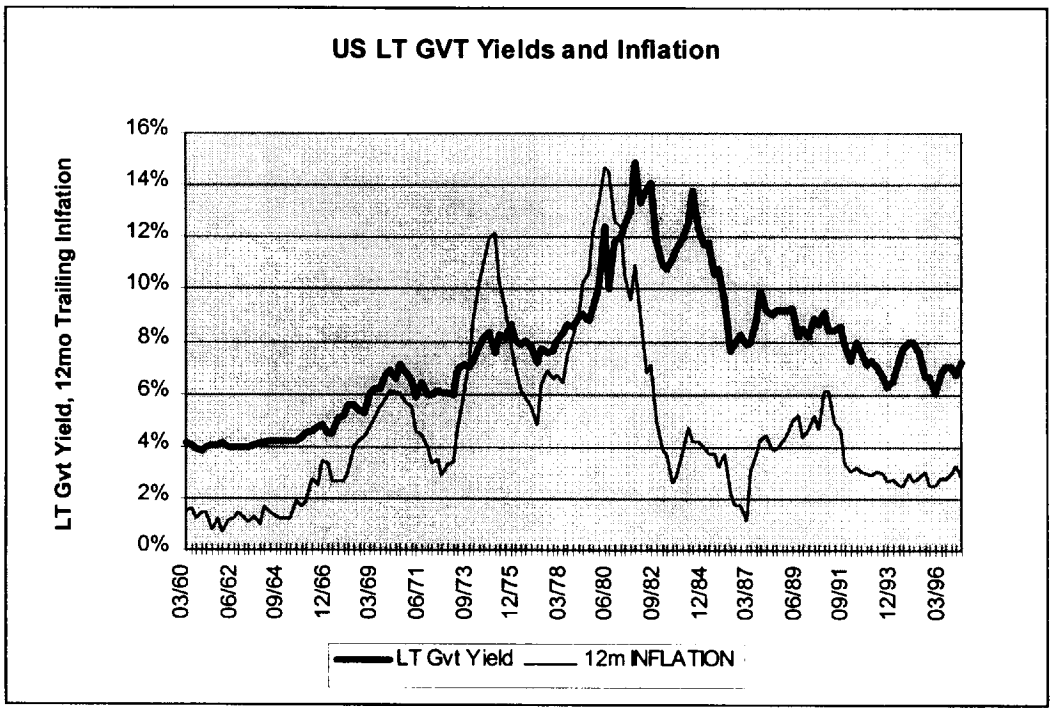
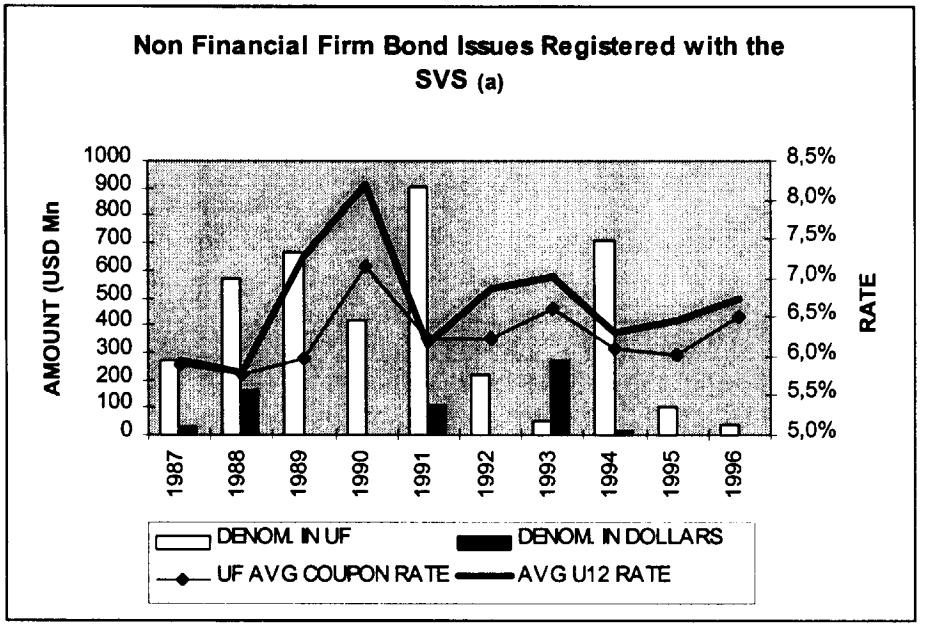


Figure 3



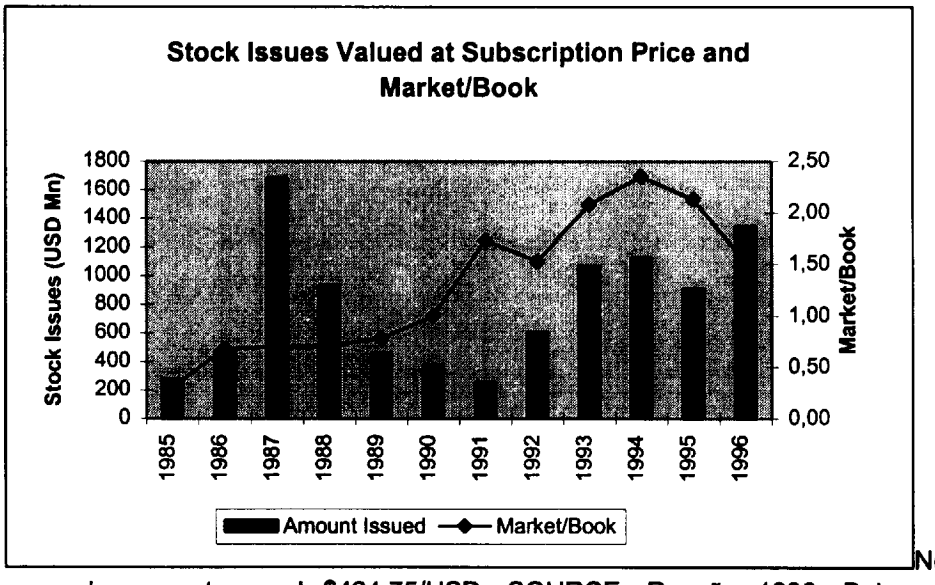
SOURCE: Ibbotson Associates.

Figure 4



(a) Numbers in UF transformed into dollars at the December 1996 UF/USD = 31.27. Avg U12 rate corresponds to a market determined interest rate offered by Banco del Estado mortgage bonds. SOURCE: Boletín Mensual SVS, Dic. 1996 and other numbers

Figure 5



Note: exchange rate used $424.75/USD. SOURCE: Reseña 1996, Bolsa de Comercio de Santiago.

Figure 6

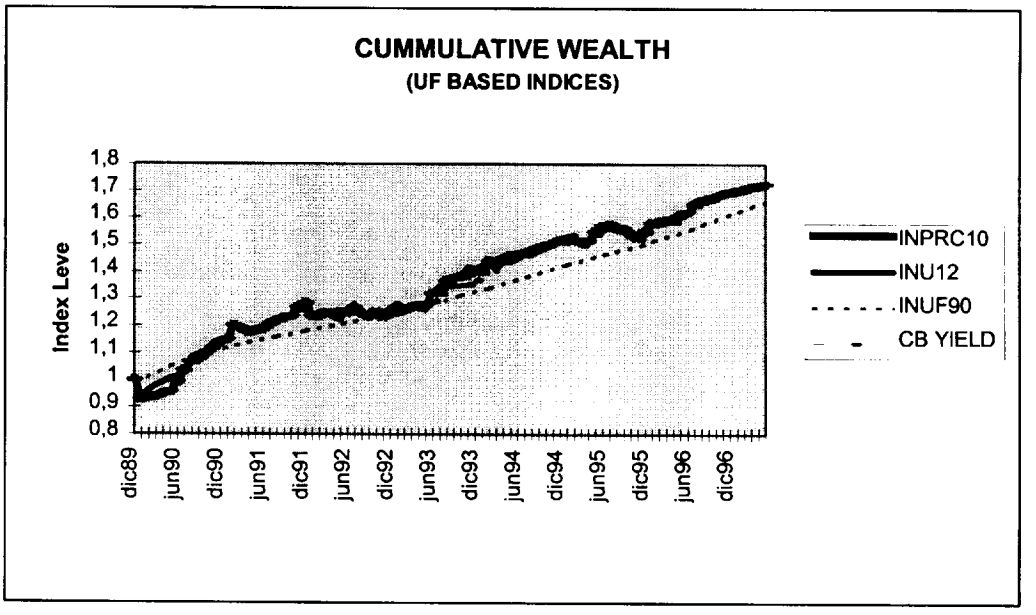
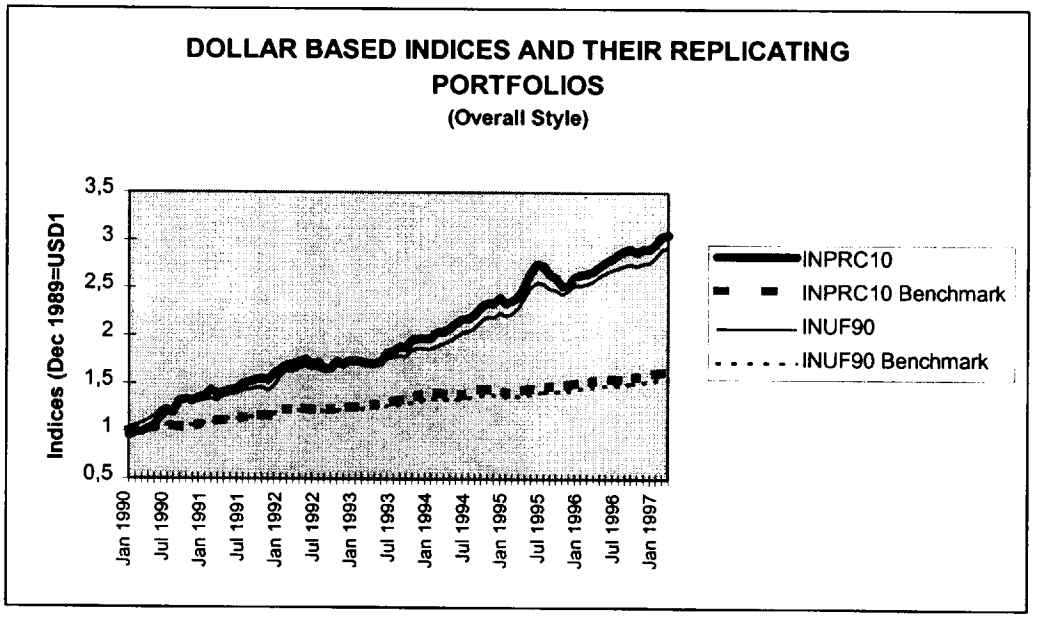


Figure 7



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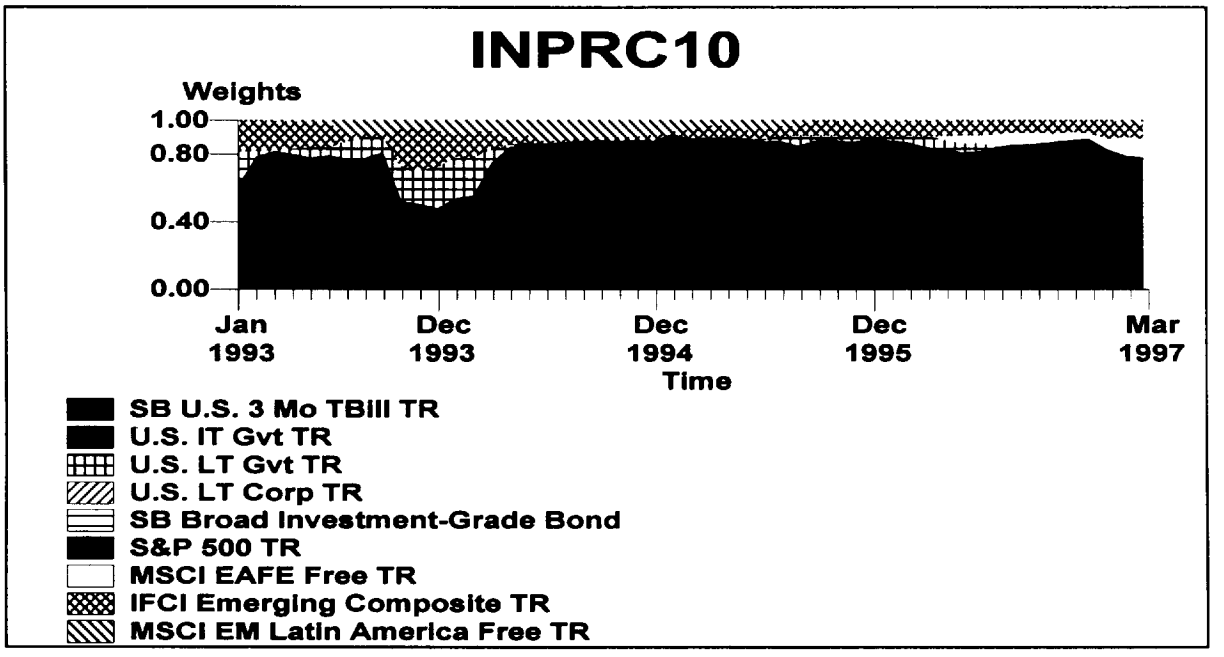
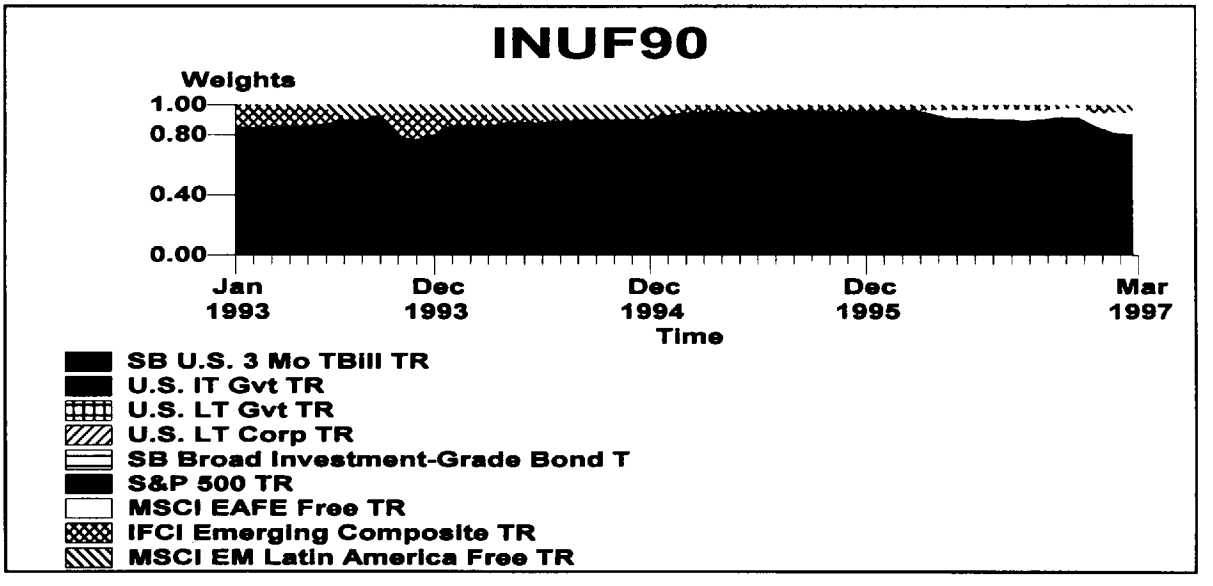


SOURCE: calculated here based on Ibbotson Associates' software and international data.

Figure 9



SOURCE: calculated here based on Ibbotson Associates' software and international data.