INDEXED UNITS OF ACCOUNT: THEORY AND ASSESSMENT OF HISTORICAL EXPERIENCE

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An indexed unit of account, such as the *Unidad de Fomento* (UF) in Chile, is a money analogue that can be used to price items for sale or to specify amounts to be repaid in the future. While it is in a sense a sort of money, it is not true money since it is not a medium of exchange and it has no physical embodiment like coins, notes, or reserve balances. An exchange rate between the unit and the true money or legal tender (in Chile, the peso) is defined using an index number (such as the consumer price index), and payments are executed in money. Indexed units of account thus facilitate payments that are tied to the index number, without being a means of payment.

How can the indexed unit of account be called an analogue of money when it does not have any physical embodiment? Money, the textbooks have long said, has three attributes: it is a medium of exchange, a store of value, and a unit of account. As a medium of exchange, it is a physical object or account balance that passes from person to person when items are bought and sold. This role is very important because it eliminates the need for ordinary barter, which is an inefficient means of effecting trade as it requires discovering a double coincidence of wants. The store of value function of money allows people to store purchasing power between transactions, which allows them to transact more efficiently, even though money is not the primary medium for long-term storage of value. This function is central to the cash-in-advance theoretical literature in monetary

economics. The third function, the unit of account, is that prices are quoted in money units.

The use of an indexed unit of account, such as the UF in Chile, separates the first two functions from the third. A distinction can then be made between the unit of account and the currency or legal tender or between the money of account and the money (see Keynes, 1930, p. 3). In Chile, the peso serves as the medium of exchange and the store of value (and also partly fills the unit of account function), while another unit of account, the UF, is fixed in real terms. Prices are often quoted in UFs.

This paper reviews the history of and reasons for the use of an indexed unit of account and then asks why there might be an advantage to separating the three functions of money, allowing a unit of account that is not the same as the currency. I argue not only that the Chilean UF is an excellent idea that should be imitated around the world, but also that another indexed unit of account, defined in terms of nominal incomes rather than the consumer price index, should also be created. Moreover, I consider whether the indexed units of account should be "monetized" by creating institutions to allow transactions to be carried out in reference to the units of account. With automated debit card, credit card, and electronic funds transfer systems, it may be possible to specify all prices in terms of indexed units of account, thus effectively indexing all prices.

CHILE'S *UNIDAD DE FOMENTO*

The *Unidad de Fomento* (UF) was introduced in Chile in January 1967 by the Superintendencia de Bancos e Instituciones Financieras, a government regulatory agency. As far as I have been able to determine, the UF is the world's first successful indexed unit of account. That is, it is the first case of indexation being achieved by quoting prices in a money-like unit, rather than relying on an indexation formula.

Chile had issued an earlier unit of account in 1960, namely, the *Unidad Reajustable* or UR, which was based both on price and wage indexes, but it was not very successful. The UF is an amount of currency related to the *Índice de Precios al Consumidor* (IPC), the Chilean consumer price index. The UF was originally calculated three times a year, and it was calculated monthly between 1975 and 1977, but daily adjustments in the UF have been made

since 1977. The UF is now a lagged daily interpolation of the monthly consumer price index. The formula for computing the UF on day t is

$$UF_t = UF_{t-1} \times \left(1 + \pi\right)^{1/d},$$

where π is either the inflation rate for the calendar month preceding the calendar month in which t falls if t is between day ten and the last day of the month (and d is the number of days in the calendar month in which t falls) or the inflation rate for the second calendar month before the calendar month in which t falls if t is between day one and day nine of the month (and d is the number of days in the calendar month before the calendar month in which t falls). Since the inflation rate for a calendar month is computed using the consumer price index for that month and for the preceding month, the UFs within a given calendar month will depend on the consumer price index for each of the three preceding months. In April, for example, the UFs for April 1 through 9 depend on the consumer price index for January and February and for April 10 through 30 on the consumer price index for February and March.

UFs were not generally used by the public until the early 1980s, about fifteen years after their introduction, though only a few years after the values were produced on a daily basis (Levin, 1995). The UF is now widely used in Chile.

Most bank deposits in Chile are thirty-day nonindexed deposits or ninety-day indexed deposits whose rates are expressed in terms of the UF. Interest rates on the indexed deposits are expressed as a premium over the UF. On maturity, the deposits are converted back to pesos at the current UF rate. Because indexed and unindexed bank deposits coexist, one might say that the Chilean banking system is partially indexed using the UF. Deposits denominated in U.S. dollars are also permitted for maturities over thirty days. The UF is used in Chile for nearly all mortgages, car loans, and long-term government securities. All taxes are expressed in UFs. Pension payments are automatically tied to the UF. Executive stock options sometimes have strike prices denominated in UFs. The UF is widely used for rent payments. Alimony and child support payments are often denominated in UFs. Office properties for sale are usually quoted in UFs. Houses for sale are often quoted in UFs, though pesos are also used. The UF is not so commonly used for listing the selling prices of automobiles, however, nor is it used directly for setting salaries. Wages and salaries

are denominated in pesos and only indirectly influenced by the UF, in that the change in the peso value of the UF is taken into account in wage and salary deliberations.

HISTORICAL ANTECEDENTS OF INDEXED UNITS OF ACCOUNT

While the UF is apparently the first successful unit of account indexed to a true price index, units of account separate from money have been used for millennia. Historically, units of account precede money altogether. Trade in terms of precious metals, rather than any money, preceded the invention of coinage in the seventh century B.C. Units of weight, such as the talent or the shekel, evolved into units of money when coins were minted with specified relations to the weight. Because governments could not be trusted to maintain the weight of the coinage, however, a tradition developed of writing contracts in units that did not correspond to any current coins. Einaudi (1953, pp. 234–35) describes the situation as follows:

> Today each country has only one monetary unit: the lira, the franc, mark, pound sterling, or dollar. This is the system established by the French assemblies at the end of the eighteenth century.... Prior to the French Revolution, the monetary system of most European countries was based on altogether different principles. Contemporary authors could take these principles for granted and did not have to explain them to others. Their strange terminology causes us, who live in another world, to wander for a while in a dark forest. By and by, we finally understand the tacit assumptions of their discourses. The key, needed to interpret the apparent confusion of the monetary treatises written prior to the eighteenth century, is the disjunction between a monetary unit and a standard of value and of deferred payment and another monetary unit used as a medium of exchange.

In medieval and Renaissance times, even contracts that were explicitly written in terms of units of currency that were circulating as coins sometimes were understood to be executed in terms of some other measure. For example, in Milan in 1445, a debt of one florin would not be paid with one of the gold florin coins, but rather in an amount computed under the assumption that the florin was still worth 384 silver deniers—and not the 768 deniers that the florin coin was then worth (see Cipolla, 1956).

Since there were often no coins in circulation that corresponded to these units, the actual units of account were sometimes called imaginary money or, alternatively, *moneta numeraria*, money of account, ideal money, political money, or ghost money. From the time of Charlemagne, trade and contracts in Europe were substantially based on the *moneta numeraria* called the pound, (or, equivalently, the livre or lira), which was always worth 20 sous (shillings) and each sou worth 12 deniers (pence) (see Einaudi, 1953). Ultimately, the standard of value represented by this system was the silver denarius issued by Charlemagne in the late eighth and early ninth centuries—coins that were no longer circulating, or even seen, later in the middle ages and in the Renaissance. Charlemagne's denarius weighed one-240th of a troy pound; the earlier Roman denarius had gone through repeated debasements and was not a unit of account in medieval or Renaissance times. Because they are even fractions, the sou (at twelve deniers) and pound were natural units of account, but Charlemagne never issued coins representing these values. Actual exchange was executed in terms of current coinage, which had many names from the realms that issued them, including angels, blanks, crowns, crazies, doblons, dollars, douzains, ducats, ducatoons, écus, farthings, florins, guilders, louis, moutons, nobles, obols, phillipi, reals, sovereigns, stivers, and testoons. Many of these would circulate simultaneously in each country, a situation that would have created tremendous confusion if there had not been a standard unit of account.

Aspects of this ancient system did, of course, continue into the nineteenth century as a result of governments' efforts to maintain bimetallic standards with fixed exchange rates between the coins of different metals. This practice sometimes caused the coin of lower value to disappear from circulation, a tendency that is predicted in Gresham's Law. In other cases, people began to adopt the convention that only one of the coins would be the money of account, while the other's price was allowed to float against it despite government proclamations to the contrary (see Rolnick and Weber, 1986).

The only aspect of the UF that was really new when it was introduced in 1967, therefore, is that it was based not on a single commodity but on a representative consumer basket. This innovation was indeed significant, since the management of risks is much better handled in terms of such an index rather than in terms of a single good. It is not surprising that the innovation represented by the UF was not adopted in ancient or medieval times, despite the apparent

simplicity of the idea of index numbers. There was no published theory of index numbers, and there was no governmental authority that could plausibly have attempted to start a new social convention of denominating contracts in terms of such indexed units. The advantage of defining contracts in terms of the single commodity, the precious metal, rather than the currency, was obvious enough to ensure that the practice would continue over the centuries, but the next step, the indexed unit of account, was not at all obvious or easy.

UF Analogues in Other Countries

The European Currency Unit (called the ecu) might be regarded as a UF analogue, in that it is based on an index of currencies. The ecu, which was created in 1979, was defined as a basket of European currencies. It was regarded as less vulnerable to runaway inflation than were the individual currencies, since it was essentially a diversified portfolio of currencies. Partly for this reason, a substantial amount of European private long-term debt was ultimately denominated in ecus (see Bordo and Schwartz, 1989). (A more important reason for the private use of the ecu may have been circumventing exchange and capital controls.) Since the ecu is not based on a broad index of prices, wages, or incomes, however, I would not call it a true indexed unit of account.

A number of examples of true indexed units of account can be found outside of Chile. While these are not yet as ingrained in their countries' economies as the UF is in Chile, they do represent important beginnings. In 1993 Ecuador created a unit of account modeled after the UF. It is called the *Unidad de Valor Constante* (UVC) (see Polit, 1994). Mexico similarly copied the Chilean UF in 1995 by creating a unit of value called the *Unidad de Inversión* (UDI). The UDIs began at a par of one to one with the peso on April 4, 1995, and the peso value of the UDI increases one to one with consumer inflation. The Bank of Mexico publishes the value of the UDI on the 10th and 26th of every month based on the national consumer price index. Mexican banks offer UDI-denominated instruments and use the interpolated published values of the UDI to make daily advances.

Colombia has also copied the UF, with its *Unidad de Poder Adquisitivo Constante* (UPAC), or unit of constant purchasing power.

The UPAC is used for mortgage loans and for financing construction by savings and housing corporations (see Bernardez, 1996).

Uruguay has a unit of account called the *Unidad Reajustable* (UR), which is used to index government pension payments and, since 1996, to index government bonds. The UR is based on a wage index, rather than a consumer price index; I discuss the possible advantages of such a variation on the UF below.

In the Ukraine, a unit of account called the *uslovnaya edinitsa* (conventional unit) or y.e. has been used since 1995. Prices in stores, as well as houses, cars, and other items advertised for sale in newspapers, are often denominated in these units. The units came into use after the government prohibited pricing in foreign currencies during a period of high inflation in 1995. Despite their superficial similarity to the indexed units of Latin America, however, these units are not true indexed units of account. In fact, the government does not even decree the definition of the units. When the unit is used in ordinary advertisements, such as in an advertisement for a home for sale, it is understood to be a disguised price in the U.S. dollar. Other definitions of the unit are also used. Stores post their conversion rate from y.e. to the currency, which often deviates substantially from the dollar exchange rate.

DEINDEXATION

While the *Unidad de Fomento* is being copied by several countries, other Latin American countries are currently moving to deindex the economy, to reduce or even eliminate the reliance on indexation schemes. Now that the inflation rate is down throughout most of Latin America, many feel that it is time to return to economic institutions that are more akin to those in the rest of the world.

Deindexation proposals are not new in Chile. In 1986, the Pinochet government reacted to complaints from debtors such as farmers with a proposal to freeze the UF and at the same time to extend the repayment of debts. Fortunately, the UF was not frozen, as such a move would have damaged confidence in any future effort to revive the UF.

In the fall of 1996 Nicolás Eyzaguirre, the research director of the Central Bank of Chile, gave a speech in which he questioned whether the widespread use of the UF indexation system should be reconsidered, as it represented a possible obstacle to low inflation in the future. According to Eyzaguirre, "It is a unique paradox, unlike any

other in the world: an extremely low inflation rate with all business and financial contracts protected against inflation."[1] An editorial in the Chilean newspaper *La Nación* concurred:

> Indexation emerged in Chile at a time when high inflation rates compelled the government to adopt precautions in order to strengthen the financial market. The situation has changed, as all the indicators prove, but the indexation mechanism persists and has now become an obstacle to current anti-inflationary aims rather than a palliative. At any rate, putting an end to indexation is not easy because it has become indispensable to the way our economy functions. The economy's different actors have already made contracts based on the system of indexation, contracts which cannot be modified from one day to the next. We need to discover ways of gradually removing the system from our economy.... If we really want to reach inflation rates of two or three percent—an aim set by the Central Bank as ideal—we are going to have to do away with indexation.[2]

Bankers Trust issued a report in 1993 asserting a similar position:

> BT concludes that tight monetary policies won't be enough to cut inflation significantly. The government could instead abolish the *Unidad de Fomento* (UF), the unit of measure that sets worker salary expectations and also is applied as a variable index to virtually all mortgages, car loans, and government debt securities.

On 14 August 1997, Carlos Massad, president of the Central Bank of Chile, gave a speech at the Latin American meeting of the Econometric Society in Santiago, in which he expressed the opinion that the UF should be phased out in a matter of some years.

In Mexico, spokesmen for the Mexican Businessmen's Council (Coparmex) and the newsletter *El Inversionista Mexicano* (EIM) have already criticized the UDI as being inflationary (see Levin, 1995).

Fortunately, deindexation does not seem likely to involve scrapping the indexed units of account any time soon. In Chile, for example, deindexation in the short run may mean little more than lengthening the maturities of nonindexed debt from the very short maturities that currently predominate to something intermediate.

1. "The Counterweight of an Indexed Economy," *La Nación,* 1 November 1996.
2. "The Counterweight of an Indexed Economy," *La Nación,* 1 November 1996.

DEALING WITH THE INFLATIONARY BIAS CAUSED BY INDEXATION

Figure 1 plots the inflation rate in Chile since 1960. Point A marks the date 1967, when the *Unidad de Fomento* was first introduced. Point B on the figure marks 1982, when the *Unidad de Fomento* first became commonplace (roughly speaking). The figure gives no evidence that the introduction of the UF was inflationary.

Still, the concern is legitimate that any indexation scheme for wages and salaries may contain an inflationary bias. When one indexes wages and salaries, one immediately sets expectations. In contrast, when wages or salaries are set in currency units, inflation naturally erodes real buying power. The natural base of comparison for wage and salary changes is thus one of declining real value. If indexation causes wages and salaries to be defined in such terms that the base of comparison is constant or growing in real terms, then worker expectations will tend to rise. This may trigger a vicious cycle, in which inflation expectations yield higher prices and then even higher expectations. This vicious cycle is part of the neostructuralist model of inflation in Latin America.

Figure 1. Annual Inflation Rate in Chile, Based on Consumer Price Index, Annual Data, 1960-96, in Percent
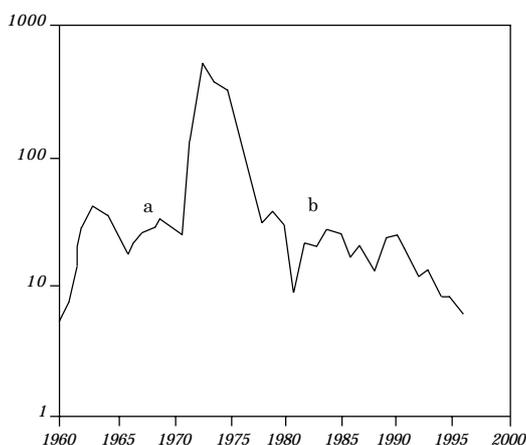
a. Date when UF was created
b. Approximate date when UF became widely used. Log scale is used on vertical axis.

Morandé and Schmidt-Hebbel (1997) find "significant evidence for explicit indexation mechanisms in the behavior of exchange rate depreciation and wage growth, contributing to large observed inflation inertia." Jadresic (in this volume) holds that "unless policymakers are firmly committed to maintaining low inflation, wage indexation to lagged inflation is relatively more likely to increase average inflation." The inflationary impact of wage indexation cannot be summarized so simply, however, since one must consider the alternative to indexation of wages. Jadresic concludes that "wage indexation to lagged inflation can reduce the cost of disinflation if the alternative to indexed wage contracts are contracts that specify preset time-varying wages."

A basic fact of human behavior that is relevant for understanding the impact of indexation is that people are very reluctant to accept a nominal wage cut (see Akerlof, Dickens, and Perry, 1996; Card and Hyslop, 1996). People don't want to have to admit to their families that their wage or salary has been cut. However, economic conditions may sometimes necessitate wage or salary cuts. People seem much more willing to accept real wage cuts caused by consumer price inflation that is greater than their wage increase. Indexed units of account for wage and salary contracts need some kind of humane face-saving mechanism to allow people to deal better with the truth about their incomes.

The face-saving mechanism that I propose is an indexed unit of account that has a slight downward bias, so that over long intervals, wages or salaries that are constant in terms of this unit will decline gradually in real terms; this will be made more concrete below. In countries like Chile, where deindexation is being discussed, a proposal that is more constructive than the proposal to abolish the UF might be to introduce the option of a second UF with a downward bias relative to inflation.

MONEY ILLUSION AND THE NEED FOR INDEXED UNITS OF ACCOUNT

The difference between a government's promoting indexation (such as by setting an example with indexed government debt) and a government's establishing an indexed unit of account might appear to be a very subtle one, little more than a difference in presentation. Indeed, most of the world has not paid much attention to the indexed units of account in Chile and elsewhere, to the extent that some

major surveys on indexation published in Chile hardly address the UF (see Sáez, 1982; Morandé, 1996; Landerretche and Valdés, 1997).

However, the difference between an indexed unit of account and a simple indexation scheme is fundamental. It relates to the way people use money or, one might say, to the "moneyness" of the indexed units of account.

Simon Newcomb, an astronomer renowned for establishing a worldwide unified system of astronomical constants, long ago criticized economists who argued that rational people ought to be able to make proper allowances for inflation in their contracts without any special institutions. He argued that money occupies a special niche in people's thinking:

> So far as the investigations of Walker and other economists extend, their reasoning appears to be perfectly sound. We consider, however, that their results are to a certain extent ill founded from the circumstance of their leaving out of sight one of the most important factors of the problem, namely the effect of changes of the standard of living producing a universal deception among the community in respect to the increase or diminution of wealth. This factor is so important as to need very close consideration (Newcomb, 1879, p. 230).

Because of this universal deception, Newcomb argued, people will always be deceived if their contracts are made in terms of currencies:

> All men in this and other countries are accustomed from youth to measure the increase or diminution of wealth by dollars or other denominations supposed to be units of value.... Even when the facts are understood, the idea that the change is in the value of the commodities measured, and not in that of the dollar itself, is so natural that a long and severe course of mental discipline is necessary to get rid of it. Indeed, we question whether the most profound economist can be entirely successful in this respect (Newcomb, 1879, p. 230).

Newcomb proposed what he called the dollar of uniform value, as measured by the average of commodities. He called his proposal a multiple standard of value since it is based on a weighted average price of multiple commodities. He argued, therefore, that the conventional unit of account must be replaced by a unit that is tied to an average of prices of commodities.

Irving Fisher, the most prominent advocate of indexation in the United States, wrote a book entitled *The Money Illusion* about just

this inability of people to appreciate the subtleties of price level movements (Fisher, 1928). The term money illusion has been part of economists' vocabulary ever since. Like Newcomb, Fisher advocated a compensated dollar, whose purchasing power would be absolutely constant, so that people would not be hampered by money illusion (Fisher, [1911] 1997, 1913a).

The experimental research of Shafir, Diamond, and Tversky (1997) carefully documents the idea that people do indeed have powerful tendencies to make errors in dealing with inflation and that they tend to want to anchor their decisions in terms of currency units. These authors find not only that people make simple mistakes by failing to take inflation into account in their decisionmaking, but also that people behave as if they really have their preferences in terms of currency units rather than money. They find, for example, that people report feeling better off when their wages are increased (in terms of currency) even if they fully understand that prices have increased just as much.

People have serious problems in learning to adopt indexation schemes. Efforts to start indexed government debt in countries with moderate inflation (including Australia, Canada, Sweden, the United Kingdom, and the United States) have met with a very lukewarm public response (see Campbell and Shiller, 1996). Even in some high inflation countries there is little public use of indexation. In Turkey, where inflation rates have been running in the vicinity of 100 percent a year for years and where inflation has not been below 20 percent a year since the late 1970s, there is still very little indexation. The Turkish government did not successfully introduce indexed debt until 1996, and even then the amounts were very small. Private debt is unindexed, except for some indexed savings accounts created by banks at the urging of the government. Remarkably, alimony and child support payments are usually denominated in the Turkish lira, even though the payments are part of schedules that may last a lifetime. The real value of these payments will clearly be reduced to nearly zero in only a few years. (Recipients of these payments regularly apply to the courts for a modification of the payments, which is a costly and difficult procedure that raises many painful issues.) Why don't they just index the payment scheme?

I recently conducted a study (1999), involving interviews and questionnaires to learn why people in both the United States and Turkey are so little interested in indexation. The results are complex and hard to describe in a short space, in part because it is not easy to characterize people's misunderstanding of economic principles. Money

illusion appears to be an important factor in reducing interest in indexation. On rejecting indexation, many people say, "I just want to know how much money I will be getting," as if they regarded money as an end in itself. This appears to be pure money illusion à la Newcomb and Fisher. As mentioned above, many people will openly admit, if asked, that they feel better about a pay increase in money terms even if they fully understand that prices have risen just as much.

More is at work in inhibiting public interest in indexation, however, than just pure money illusion. One factor identified in my study of the United States and Turkey is that people have incorrect theories about the correlation of inflation with real incomes. There is a widespread belief that inflation coincides with stunning reversals in real incomes of ordinary people. The wage-lag hypothesis, long discredited by economists (see Alchian and Kessel, 1960), is alive and well in the public imagination. This is one reason why alimony and child support payments are usually not indexed in the United States and Turkey: people think that if inflation is high, then an indexed alimony and child support payer would not be able to keep up with the increased payments. People also largely believe that inflation hurts firms' profits as well. The idea that the effects of unforecastable inflation are primarily a redistribution between debtors and creditors is not well understood. Inflation is viewed as hurting everybody (see also Shiller, 1997).

Another important reason why people resist indexation is that people do not appreciate the uncertainty that inflation generates in price levels at distant dates (Shiller, 1999). Even in Turkey, where the price level has drifted over orders of magnitude, people seem not to appreciate the uncertainty about future price levels. When I asked Turkish respondents, on the questionnaire, to give a range in which the Turkish price level would probably fall in ten years, the median ratio between the high and low limits of the range was 1.5 to 1. This must be a grotesque understatement of the uncertainty about future price levels. In part, the judgment error probably arises because the media do not give much attention to the true uncertainty that price levels have over long periods. Another factor is the difficulty that the public apparently has in understanding the power of compounding. Even in countries with low inflation, people just haven't thought about how much difference it makes over long time spans if, for example, the inflation rate is 2 percent every year versus 6 percent every year. These differences do not sound like very much, but in fact the difference in

real values of fixed cash payments between these two inflation rates is in the ratio of 1.47 to 1 in ten years and 2.16 to 1 in twenty years.

Indexed units of account, such as the UF in Chile, solve deep and ingrained problems that people have in taking account of the effects of inflation. These units help promote indexation where it would not otherwise occur, or where it would occur only haphazardly or incompletely.

COORDINATION PROBLEMS AND INDEXED UNITS OF ACCOUNTS

The creation by some authority like the government of an indexed unit of account may also solve a sort of coordination problem that otherwise would inhibit indexation. A coordination problem appears when there is an advantage to everyone taking some action together (like adopting some form of indexation) but the actions are not as beneficial when taken individually. If no steps are taken to help people coordinate, then the actions may never be taken. Coordination problems are central to monetary theory. Indeed, the medium of exchange function of money itself may be regarded as helping deal with the coordination problems that would arise when, in a barter economy, people have difficulty locating a double coincidence of wants.

Coordination problems can be solved by social conventions. We all drive on the right-hand side of the road, for example. It wouldn't matter if we all drove on the left-hand side of the road, but it would be a disaster if half of us chose one side and half the other. Once a social convention is established, the coordination problem is solved and people have little or no incentive to change it.

Why don't people in the United States quote prices in CPIs in the absence of any government initiative to create indexed units of account? People could name the price of a product as, say, ten CPIs, meaning that they will charge in dollars ten times the latest CPI. The reason people do not may have to do, in part, with a coordination problem of deciding together that we will do this. Until such a decision is made, individuals will not find it in their individual interest to try to convince people to take the other side of indexed contracts.

Until there is a social convention on how and when to index, people will find it costly to try to come to an agreement on indexation. There are many questions. On what date does the price change? Which CPI should be used? (There are many definitions available.) What do the economists who compute the CPI think about which unit should be

used? At present, in countries where no indexed unit of account exists, each person must answer these questions alone. It is thus not surprising that there is no tendency to quote prices in CPIs.

Another coordination problem involves smoothing the CPI. Prices should not be defined only in terms of the latest CPI because the CPI is vulnerable to sudden jumps from month to month. This is particularly true in the case of indexing financial contracts to the CPI. A unit of account like the UF would smooth out the CPI movements. Otherwise, there would be important jumps in deposit balances on the dates of new announcements of the CPI. Smoothing the CPI has thus been another fundamental aspect of the functioning of the UF as an analogue of money.

WHY SEPARATE THE UNIT OF ACCOUNT FROM CURRENCY?

What is the point of separating the medium of exchange and store of value functions, which are carried out by currency, from the unit of account function, which is effected through the *Unidad de Fomento* and other examples? Many argue that the reliance on indexed units of account like the UF is nothing more than a sign of failure to maintain the currency unit in constant buying power, and that what the authority really should do is just stop inflation dead.

Irving Fisher (1913a) thought that keeping an indexed unit of account separate from the medium of exchange would not be sensible partly because of "laborious calculations in translations from the medium of exchange into the standard of deferred payments and back again." This argument is reminiscent of the arguments made today for the common currency in Europe, by people who are tired of the currency exchanges that they must make whenever they cross a border. Making these exchanges, and also making calculations between the indexed unit of account and the currency, may seem unnecessarily complicated. It is perhaps for this reason that the UF is not used to quote everyday prices in Chile.

The inconveniences generated by keeping a separate unit of account are not really large. In this age of computers, the complications created by the need to calculate how many pesos corresponds to a UF, or the calculations necessary for currency exchanges, can hardly matter. Indeed, the distinction between the currency and the separate unit of account will inevitably become blurred once credit card

companies allow charges to be made directly in the units of account and banks allow checks to be written in terms of the units of account. (This has not happened yet, as far as I have been able to determine.)

Still, keeping the indexed unit of account separate from the currency does involve some slight inconveniences, and so one naturally asks, why not merge the two? Why not just keep the price level steady? The problem with this solution is that the history of inflation around the world does not create any optimism that it is possible to stop inflation dead, at least without some kind of fundamental structural institutional change. In the course of history inflation has often been temporarily stopped, but producing lasting price stability, over many decades, has proved illusive. While economists have proposed other schemes for achieving automatic price stability (notably Hall, 1983, 1997), there is no guarantee that such schemes will fully succeed in their objective. If these alternative schemes are not sure to succeed, it may be better for all longer-term contracts to be defined in terms of a unit of account, which is itself a proxy for a price index, so that the indexation cannot fail.

Simon Newcomb (1879) and Irving Fisher ([1911] 1997) thought they had a mechanism whereby an indexed unit of account could also be a medium of exchange and store of value. They believed they could achieve just this by defining the currency itself as an indexed unit of account. In effect, they wanted to print pieces of paper called UF and use these as money. Newcomb and Fisher were writing at the time of the international gold standard. Any government could merely promise, they argued, to regularly adjust the quantity of gold in its currency so that the real buying power of the gold represented by the currency was kept constant. This proposal became known as the compensated dollar plan after it was published by Irving Fisher (1913a).

There is a potential difficulty, however, in the government's efforts to maintain a compensated dollar. In order to guarantee that the real buying power of the compensated dollar is constant, the government must promise to make the currency freely convertible into gold and back at all times. The problem then, as recognized by Irving Fisher, is that speculators might be able to make large trading profits at the government's expense. As Fisher (1913a) pointed out, if the mint price were $18 per ounce and if it were known that the mint price would shortly be $18.50 per ounce, then speculators could redeem their dollars into gold and buy back their dollars at $18.50. If the buying power of the currency is indeed to be kept steady, then the price index on which it is based must include the prices of many things that are not traded on speculative markets. Notably, it must include the price

of services. Any price index that includes these will almost surely be serially correlated, forecastable into the future. If the buying power of gold falls far enough, the government could find itself obligated to pay out more gold than it has. Given this possibility, public fears that the compensated dollar plan may have to be abandoned could force abandonment of the plan.

Fisher's proposed solution to this problem is that the government would impose a 1 percent bid-asked spread when exchanging gold for compensated dollars, and that the maximum movement of the gold content of the dollar would be 4 percent per annum. This would help prevent speculation, he said. It would also make the buying power of the dollar unresponsive to large changes in the price of gold. Fisher wrote an article (1913b) in which he presented simulations with actual historical data for the period 1896-1911, indicating that speculation and the limit on the change in the gold content would not have been an important problem. He points out that as long as the bid-asked spread, or brassage charge, exceeds the maximum allowed monthly change in the gold content of the dollar, there is no riskless arbitrage profit to be obtained by buying and redeeming dollars over a zero time interval (actually overnight) at month end. Any attempt to profit from the predictable changes in the gold content would then involve some risk, and so presumably such attempts would be limited in importance. Despite the success of his simulations for that period, however, the potential fluctuations in the buying power of gold could be large enough to cause the formula value of the dollar to fluctuate beyond 4 percent in a year, and this possibility suggests serious problems with the compensated dollar plan. Note, for example, that the buying power of gold doubled between 1979 and 1980 and then fell back nearly to its 1979 level by 1982. Fisher's simulations do not address the full complexity of the problem of speculation with the compensated dollar, a problem that involves such issues as the simultaneous determination of the real price of gold and the money supply with public expectations both of future changes in the gold content of the dollar and of the probability of the event that the compensated dollar plan will be suspended.

Fisher's proposals generated much discussion, among both academics and the general public. Fisher reports a list of 344 articles about his idea, many of them critical (Fisher, [1914] 1997). The story of the campaign for the compensated dollar, or the Fisher plan, is recounted in Fisher (1934, appendix I, pp. 374-89). He found much opposition to his proposal, apparently mostly misinformed, but nonetheless effective in

preventing its serious consideration. He later abandoned the proposal without disavowing it: "I had never believed that the compensated dollar plan was the only possible plan, nor even ideally the best.... I am therefore still in favor of it for America, as part of a general plan, although, for simplicity, the method recently adopted in Sweden (a managed currency independent of gold) seems better." (Fisher, 1934, p. 382). He seems to have grown tired of his campaign for a compensated dollar, given the difficulty of convincing the public of its merits, and his attention was distracted by other plans. The significant risks of inflation with the new managed currency independent of gold were not so apparent at the time as they are now, and so the relative attractiveness of the compensated dollar plan was not so prominent.

Fisher's original plan for a compensated dollar defined in terms of gold might possibly be workable today, but it seems to involve more uncertainties as to its ultimate success than are associated with the use of indexed units of account. At this stage in history, of course, there is no reason to return to a monetary system that creates any special function for gold. The potential problems of speculation in the currency-gold ratio, to which Fisher alluded, are shortcomings of the compensated dollar plan. In the age of computers, keeping the unit of account separate from the medium of exchange is not such a problem as it was in Fisher's day. Given the apparent difficulty of guaranteeing the real value of currency, contracts can instead be written in terms of price indexes themselves, that is, in terms of units of account, leaving the medium of exchange function for conventional money.

SHOULD INDEXED UNITS OF ACCOUNT BE SETTLED ON NOMINAL INCOME INDEXES AS WELL AS ON CONSUMER PRICE INDEXES?

While the Chilean example illustrates the use of a single indexed unit of account in a country, there may be reasons to adopt multiple units of account. I have in mind here creating an additional unit of account, beyond the CPI-based unit of account, that is related to a measure of national economic prosperity, such as personal income.

Indexed units of account were first developed in Chile to solve a pressing problem of high inflation. At that time, it would not have mattered very much, compared to the magnitude of the problem of existing nominal contracts, whether the units were denominated in terms of a consumer price index or in terms of nominal income. It was probably natural to create them in the simplest, most direct way

possible, so as to facilitate public acceptance. Public acceptance of the UFs was not assured, and it did not come immediately. The concept of the UFs could be explained more easily in terms of a price index than in terms of nominal income indexes.

The problems caused by tying the UF to the consumer price index in Chile have not gone unnoticed, however. Critics of the UF in Chile have said, for example, that the UF causes problems for mortgage lenders in periods of high inflation, since the UF-denominated mortgages are adjusted daily, whereas salaries are denominated in pesos and are adjusted annually (see Bernardez, 1996).

While some appear to think that this problem should be solved by deindexing, this is not at all a reason to eliminate the indexed units of account. It is, rather, a reason to define additional units that are related to income measures. A number of policymakers have recognized this point. In fact, in 1960 the Chilean government created an indexed unit of account, called the *Unidad Reajustable* (UR), that depended on both wage and price indexes. Although the effort apparently was not very successful, when the UF was created in 1967 there were two indexed units of account simultaneously in use in Chile, namely, the CPI-based UF and the wage-CPI-based UR. Moreover, the Chilean government drafted a bill in 1991 "that would establish a new, optional mechanism for adjusting mortgages by linking them to wages rather than the inflation rate."[3] While a wage-indexed unit of account never got far in Chile, Uruguay did establish a wage-based indexed unit of account, also called the *Unidad Reajustable* (UR), which is in use there today.

When indexed units of account are established in times and places characterized by moderate inflation, then the relative importance of getting the index right becomes central. By moderate inflation I mean the 1 to 5 percent inflation that is common in many countries of the world today, which is small on a year-to-year basis, but large and variable enough to create substantial uncertainty over longer periods.

In an extreme case in which the problem of inflation is utterly solved, such that no inflation ever occurred at all, there would be no need of indexed units of account tied to inflation itself. In this extreme case, however, there may still be a role for indexed units of account tied to income measures.

The importance of creating an optional mechanism for indexing to some income measure such as wages goes far beyond the issue of

3. "Bill Seeks Mortgage Link to Wages, Not Inflation," Lagniappe Letter, May 3, 1991 (via Latin American Information Services).

mortgage loans. In fact, creating units of account tied to some such measure is central to the fundamental problem of individuals' optimal risk management.

LIFE CYCLE SAVINGS

The overlapping generations model is a useful construct for considering what kind of intertemporal contracts ought to be made and how these should be indexed. This analysis is inspired by Fischer (1983), Merton (1983), and others.

First, consider some rudimentary examples. To simplify exposition, suppose that there is no population growth, such that all generations have the same number of individuals. The population is represented as belonging to either of only two generations, and only the young earn income. Suppose also that the utility is additively separable and that future income is uncertain. Then, utility is

$$U = u\left(c_y\right) + \delta u\left(c_0\right) \, ,$$

where c_y is real consumption while young and c_0 is real consumption while old, u(.) is an instantaneous utility (or felicity) function, and δ is a discount factor representing the subjective time preference that people have. Suppose also that there is no storage or investment, and that there is a social planner who wishes to reallocate the income in each time period between the two generations that are alive at the time.

Since the two generations have the same number of individuals, and since the utility function is additively separable, the social planner at time t, who has just learned the level of per capita income y_t at time t, must merely allocate the total income to maximize the utility function where, however, the consumption is the consumption of different people alive at the same time. The social planner needs only solve the problem,

$$\underset{T_t}{\text{Max}} \; u\left(Y_t - T_t\right) + \delta \, u\left(T_t\right) \, ,$$

where T_t is the transfer from young to old at time t. The issue is how this transfer depends on Y_t. Consider the constant relative risk aversion utility function $u(c) = -c^{(1-\gamma)}$ that has been widely used in empirical

literature as a sensible representation of people's utility. Then the optimal transfer is

$$T_t = \frac{Y_t}{\left(1 + \delta^{-1/\gamma}\right)} \; .$$

The transfer is thus directly proportional to income. This means that the optimal redistribution would be indexed to income (namely, nominal income measured in currency) and not to the consumer price index. The same redistribution could be achieved in terms of a social contract based on an indexed unit of account that is tied not to the consumer price index but to total income. This transfer could be effected if young people buy government bonds that pay out in units of account indexed to income (for example, to save for their retirement), and at the same time they are taxed (credited) by the government for any shortfall (surplus) in making the transfer to the then-old people.

For the above model, table 1 shows the welfare loss, as a fraction of income, that is effected by indexing the units of account to the consumer price index rather than to income, where feasible. Note the words, where feasible. In considering any scheme of indexing payments to the elderly, it must be recognized that in some states of the world it will not be easy—and perhaps not even possible—to make the fixed real payment to the elderly, if national income is not large enough to make the payments. Indexed social security plans do not actually provide fixed real payments in all states of the world, even if that is what is promised. Analyzing such social security plans is a bit like analyzing so-called fixed exchange rates: everyone knows that the

Table 1. Simulated Optimal Fixed Real Transfers from Young to Old[a]

Standard deviation	Optimal transfer	Welfare loss
0.100	0.477	0.008
0.200	0.436	0.025
0.300	0.400	0.039
0.400	0.373	0.042

Source: Author's calcuations.
a. Based on a Monte Carlo simulation as described in text, assuming a coefficient of relative risk aversion of 3.00, with zero subjective discount rate, and an iid lognormal distribution for generational incomes, with zero mean and standard deviation shown. Transfers are capped at 70 percent of income and represent the fraction of expected income and welfare loss from maintaining capped fixed real transfers instead of income-related transfers in an overlapping generations model.

exchange rates will in fact be changed if extreme conditions prevail. For the purpose of constructing table 1, I assumed that if the fixed real transfer to the old generation were more than 70 percent of total income available, then the transfer would be capped at 70 percent of total income.

It is assumed for this table that the income of each generation has the same lognormal distribution with zero mean of log income; values are shown for various assumptions about the standard deviation of log income. The table assumes that the transfer made in the consumer price indexed case (so that the real transfer is constant unless it is greater than 70 percent of total income) is the optimal one that maximizes expected utility. A Monte Carlo experiment with 100,000 iterations was used to derive the table, since analytical expressions for the values are not obtainable.

The table shows, for example, that the welfare loss from fixing the amount transferred subject to feasibility is about 4 percent of total income in the case in which the standard deviation is 0.3 or 30 percent. (A standard deviation of 30 percent for real national income in 30 years is not an unreasonable estimate of the uncertainty, given evidence on the variability of national incomes. See Shiller, 1993.) A welfare loss of around 4 percent indicates a very substantial advantage to tying payments to income, given the virtually zero cost of creating indexed units of account.

The above analysis assumes a constant relative risk aversion utility function. One might, as an alternative, suppose that the utility function is not of the constant relative risk aversion variety, but rather is constant absolute risk aversion, that is, exponential utility $u(c) = -\exp(-\lambda c)$. In the context of the above model, the optimal transfer from young to old is then

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Now, the optimal transfer has both a component indexed to nominal income (whose real value Y_t appears in the first term) and a component indexed to the consumer price index (whose real value is represented by the second term). For reasonable values of the parameters δ and λ, the first term is likely to dominate. In fact, it is not clear that there are any reasonable' parameters for the exponential utility; this utility function has the odd property that negative consumption while young is not only possible, but also no disaster.

A utility function that implies that the transfer between generations should be defined in fixed real terms would have the younger generation infinitely less concerned with income fluctuations than is the older generation:

$$U = u(c_0) + c_y ,$$

where $u(c_0)$ is concave, while U depends linearly on c_y. With this utility function, young people again are not particularly concerned with the possibility of negative consumption. It is hard to imagine why there should be such a sharp distinction between the attitudes of the young and old toward poverty.

This simple overlapping generations model deals only with transfers between generations, but the basic principles that it illustrates can obviously be extended to other models. Just as there is an advantage to defining a social security system to tie payments to incomes, there will be an advantage to defining all sorts of payments specified in long-term contracts to income-indexed units of account.

MONETIZED INDEXED UNITS OF ACCOUNT

As indexed units of account become increasingly accepted, there may come a day when institutions are developed that allow all prices or incomes to be denominated in terms of indexed units of account and all exchanges made in terms of the units. I will call the units in such an arrangement monetized indexed units of account, because although they are not really money, they have the appearance of money in that all transactions are made in terms of the units.[4]

In contrast to Newcomb's or Fisher's day, the use of indexed units of account could now be made so easy, through the use of debit card, credit card, or electronic transfer systems, that the presence of the medium of exchange itself might become virtually invisible to most people. Money might be seen only in the account balances representing the individual's cash budget constraint, although even these balances could be translated daily into indexed units of account. Money may

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4. My use of the term monetized is different from the usual sense in economics, since the units will still have to be translated into money by the clearing house for transactions.

then have importance only for account balances and at the clearing house for transactions.

The question arises: how can the price or income index that defines the indexed unit of account then be computed? One may be concerned whether it would be possible to define a price or income index to serve as the basis of an indexed unit of account if all prices are quoted in terms of the same unit. This concern appears to be misplaced. There is no problem in defining a consumer price index or an income index in terms of money, the ultimate medium of exchange, even if all prices or incomes are specified in terms of an indexed unit of account. Because the money equivalent of the indexed unit of account at time *t* is known at time *t*, based as it is on lagged information, the prices or incomes quoted in terms of the indexed units of account can always be converted into money terms. Therefore, the consumer price index or income index can always be computed.

One may then wonder how changes in the supply of or demand for money, the medium of exchange, will find their way into the price level, if all prices are specified in terms of indexed units of account. Here again, there appears to be no cause for concern. Whenever there is an excess supply of the medium of exchange, for example, the immediate effect should be an increase in some prices expressed in terms of the indexed units of account. Those prices that are relatively less sticky should be affected first. Their price rise should then cause an increase in the price or income index, which would then effectively communicate the price increases to the currency value of the indexed unit of account itself. Ultimately, as the consumer price index or income index moves toward its new equilibrium value, these less sticky indexed unit of account prices can return to their original values, all the adjustment being incorporated by the exchange rate between the indexed unit of account and the currency. An example of such an adjustment process is given in Shiller (1999).

DEFINING INDEXED UNITS OF ACCOUNT FOR THE UNITED STATES

A table that defines two indexed units of account for the United States, units which I call units of price (UP) and units of income (UI), and gives their conversion into U.S. dollars is now available on a daily basis on my web site, www.econ.yale.edu/~shiller/uf-usa4.html. Both are based on government statistics, so the underlying data are likely

to be available for the foreseeable future. Since the formulas defining the units (formulas used to construct the tables) are also provided on my web site, these would appear to be usable indexed units of account at the present time. It is, of course, unlikely that many people will use my units. I present them here by way of illustration and example, with the hope that the U.S. government will someday define such units.

The unit of price is based on the U.S. consumer price index, and it is closely analogous to the Chilean UF. This unit might be used to price houses, rents, catalog items, and other items that sell slowly. Pricing in terms of the unit of price means that the price would stay roughly constant relative to a broad market basket of consumer items.

The unit of income is based on growth-corrected per capita personal income. The growth correction divides the per capita personal income by a growth trend line. The growth correction is included here to deal both with possible upward biases in the index as a measure of individual income growth and with the psychological resistance to nominal wage cuts (see Shiller, 1999). This unit might be used, for example, to specify annuity or mortgage payments or for labor contracts. Specifying payments in terms of the unit of income ensures that the payments will be roughly a constant fraction of per capita personal income.

Of these two indexed units of account, the unit of price, rather than the unit of income, might be most readily accepted by the public, since it is tied to a consumer price index as in the Chile case. There is widespread public appreciation of the importance of inflation, and so the public needs much less convincing when the index is tied to the usual measure of inflation, namely, the consumer price index. That an income index may also be used for much the same purpose may not be so obvious to many people. There appears to be less public appreciation of real national income variations than of inflation variations through time. Still, it seems likely that if the two units of account are introduced together, and if people see these two as parallel alternatives, then substantial numbers of people will find ample reason to use the unit of income in appropriate circumstances.

CONCLUSION

Governments of all nations of the world should create indexed units of account for their citizens. It is virtually costless for them to do so.

All the governments need to do is decide on a price and income index, decide on a smoothing method, begin publishing daily values for the unit of account in terms of currency, and make some commitment that the index will continue to be calculated on a consistent basis and without future freezes or other interference. It is also possible that the indexed unit of account could be created by some other agency that can commit to continuing to produce the index in the indefinite future (as in Brazil, where production of the consumer price index was privatized after concerns were expressed about government mishandling of the statistics). Still, some government involvement in establishing the index is probably important for its success. The introduction of the units of account might also be accompanied by policies encouraging the creation of institutions, such as debit cards, credit cards, and checking accounts, that are designed to facilitate quoting everyday prices in terms of the units of account.

To summarize briefly the arguments given above for indexed units of account, the creation of indexed units of account might be considered similar, in a sense, to the creation of daylight savings time (although the units of account are likely to be much more important in economic significance). Technically speaking, if everyone were perfectly rational, there would be no need to set our clocks forward one hour in the summer; we could all just decide to get up an hour earlier. But everyone knows that will never happen. One reason is that there is a coordination problem in getting people to start their business an hour earlier. Coordination problems appear if people in some workplaces arrive at work earlier while their clients and suppliers do not. By analogy, people could just decide to raise all deferred payments in keeping with inflation, just as they could all decide to get out of bed an hour earlier, but if some do this and some do not, or if some use one price index formula and some use another, then a coordination problem will arise here, too. Another advantage of daylight savings time goes beyond the coordination problem. There is the problem of human habit, of looking at the clock and unthinkingly deciding that it is time to do this or that. The advantage to daylight savings time, as opposed to making a collective decision to do everything an hour earlier in the summer, very plainly has something to do with the persistence of such habits. The same advantage is created by indexed units of account. Just as there was apparently no collective decision to change the times of most daily activities seasonally in the years before daylight savings time, the alternative to the indexed

units of account is really a lack of consistent indexation or, more probably, no indexation at all. And with no indexation, the ability to make long-term contracts itself will suffer.

The alternative to the indexed units of account is essentially the same system of fiat money and nominal pricing and contracts that most of the world has experienced since the 1930s. While it has not been a disaster, this system has an absurd quality to it. People make contracts in terms of pieces of paper whose value is ultimately decided by political bodies with vague instructions to promote the general welfare, who have succumbed to political pressures in the past by abandoning their concern for the real value of those pieces of paper. People who are owed money normally have no legal recourse if the real value of the amounts owed is wiped out. Such a system would appear to have been invented by a prankster, who wanted to keep surprising people and stirring up discontent. In viewing the deindexation proposals, one wonders, why would anyone want to return to such a system?

The current move toward deindexation in many countries that had formerly experienced hyperinflation is perhaps motivated in part by the feeling that the indexation was a palliative introduced to deal with an extreme crisis. Now that the crisis is past, it may be reassuring to many to see the indexation ended. I think that the history of the development of indexation, and of the indexed units of account in particular, should have another interpretation. The indexation and the indexed units of account were indeed begun in times of great stress, but the same is true of many other great innovations. Daylight savings time, for example, was introduced during World War I, as an effort to deal with a wartime energy shortage. Such innovations should be viewed as a blessing stemming from an otherwise stressful time, and the system of indexation should not be dismantled in times of lower inflation. The United States does not have much indexation, and has never experienced the indexed units of account, for example, because it has never, in modern times, had the experience with high inflation that might have shaken it from its complacency about nominal contracting.[5]

5. That is, the Unites States has not had really high inflation since the Revolutionary War in the late eighteenth century. It is interesting to note that the very first indexed bond issue in world history occurred in the United States in 1780; see W. Fisher (1913).

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