DESIGNING INDEXED UNITS
OF ACCOUNT

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ABSTRACT

An indexed unit of account is a unit of measurement defined using an index such as a consumer price index so that prices defined in terms of these units will automatically adjust to changing economic conditions. Evidence on sticky prices and money illusion, and evidence from countries (notably Chile) that have created indexed units of account, suggests that creating such units is an important policy option for governments in countries with unstable price levels. A model is given that shows the dynamics of money prices when prices are expressed in the units. Results from the model suggest some design elements for an indexed unit of account: institutions to promote broad use of the unit for pricing, and a formal policy to increase the frequency of index computation when the price level becomes more volatile.

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The general public appears to have sufficient difficulty with indexation, with tying payments to indexes such as the consumer price index, that they will do so only in rare or extreme situations. Even in times of moderate to high inflation, most people will not purchase inflation-indexed debt, will not borrow with an indexed mortgage, will not agree to indexed alimony or child support payments and will not push hard for indexed rent or wage contracts. Prices of many items and wages tend to stay fixed in money terms for periods measured in months and even years, and this stickiness can cause changes in real economic activity and can also cause unfortunate wealth redistributions in times of economic change.

There appear to be multiple reasons for public resistance to indexation. The most obvious reason is that there are costs to computation and menu costs to changing prices in nominal terms. There appear also to be some reasons grounded in problems people have in behaving fully optimally, see Shiller (1997), and related work by Shafir, Diamond and Tversky (1997). These problems include that the public is not fully attentive to the potential uncertainty in future inflation, is not attentive to the income redistributions caused by unexpected inflation, that the public suffers mathematics anxiety in the use of mathematical formulas (indexation rules) in contracts, and that at some level the public habitually thinks in terms of units of money, as if these were the final measure of value.

The impact of these problems can be reduced if the government (or some other public agency) defines indexed units of account for

use by the public in place of money, and if the public learns to use these new units of measurement. In its most widely used form, as with the *unidad de fomento* (UF) in Chile today, an indexed unit of account is defined by a lagged interpolated consumer price index that is published daily. If a payment of x UFs is to be made, the payment is made in money in the amount of x times the lagged interpolated consumer price index for that day. With the indexed units of account, there is a separation of the unit of account function of money from that of the medium of exchange. Defining a payment in terms of the units automatically indexes the payment to inflation. While the same result could be achieved merely by specifying an indexation formula in the contract for the payment, we have noted that the public will generally not do so.

The world outside Latin America has taken little notice of these indexed units of account, and there appear to be no published scholarly articles that are devoted to understanding these units (but see Robert Hall, 1997). Even the Chileans seem often unconvinced of the value of these units, and many advocate their eventual discontinuance now that inflation has been much reduced from its former high levels. Despite this lack of enthusiasm for them, it should be recognized that the indexed units of account are potentially very important. The widespread acceptance of the units of account in Chile is apparently an important reason why Chile's has been the most fully-indexed economy in the world.

Adoption of indexed units of account like the *unidad de fomento*

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is an extremely important policy option to consider for any country with unstable price levels. It should be given serious consideration in countries who have recent histories of rapid price change: Indonesia, Russia and Turkey are obvious examples. These countries have recently seen extreme economic dislocations that are related to their price level uncertainty, and one cannot rule out that it will happen again. Prices set in terms of indexed units of account will have more stable real value in these countries than prices in foreign currencies such as the dollar or euro, because of fluctuations in real exchange rates, as well as potential future fluctuations in the real value of these currencies. In stable price countries like our own, we should also consider adopting the indexed units of account (and Chile should not casually eliminate them) since the potential for unstable prices in the future still poses significant risks to longer-term contracts, and since a public habit of using new units of measurement is not something that can be achieved suddenly in a future time of economic crisis.

Erratic monetary policy, or changes in economic or political factors that constrain monetary policy or interact with monetary policy to change the price level, are very common occurrences historically, hence the importance of indexation. While it is also possible that erratic government policy could frustrate the purpose of indexed units of account, by retroactively ruling indexed contracts invalid, rulings of this kind are much less common historically than are major changes in the price level. Governments' honoring of past contracts is widely recognized as a fundamental component of an orderly and

just society. In contrast, governments make no explicit promise to restrain inflation, and usually have little credibility when they do make such promises.

The essence of the idea behind the indexed units of account might be described as just that changing our units of measurement into indexed units facilitates the specification of prices and contracts in terms of something broadly meaningful to people, a broad market basket rather than in terms of conventional money whose real value may be highly unstable. Since we cannot carry a broad market basket around with us to spend directly, there must then be a separation of the unit of account from the medium of exchange.[1] The meaning of such units might well be easily perceived by the public. We might even name the indexed units of account "baskets" so people will better understand that they represent market baskets.

This essential idea is simple and obvious, but there remains a fundamental question about the functioning of the medium of exchange, the money (dollar or peso), in a system involving systematic use of the indexed units of account, and it is these concerns that have been the serious obstacle to their adoption. The principal argument for the elimination of indexed units of account in Chile, (and Brazil

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[1] Fisher (1913) advocated creation of a "compensated dollar," a hand-to-hand paper currency that the government freely exchanges for gold at an exchange rate that itself changes through time so that the dollar's real purchasing power in terms of a lagged price index remains constant. But, there are fundamental problems with the government's mandating forecastable changes in the exchange rate between two liquid assets. Today, these problems are moot since with electronic payments there is little, and diminishing, need for indexed hand-to-hand paper currency.

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where they actually were eliminated), has been that they impose an inflationary bias, and it is for this reason that their use has always been restrained by governments.

We have to ask how the real value of the medium of exchange will be determined in an economy relying on indexed units of account, and how the value is determined when prices denominated in indexed units of account are not completely flexible or when something akin to money illusion plays a role. A theory of the value of the medium of exchange is central to the idea of indexed units of account since the proper functioning of the units of account depends on this value being fairly stable between index-number computation periods (such as month-to-month), given the lag in the definition of the indexed unit of account. Some observers of the indexed units of account in Chile speak as if the units can work only if the bulk of prices are set in money, that is pesos, and that there are some fundamental problems if they are not. They seem to think that a system of indexed units of account can function only as a minor add-on to a system where prices are set in units of money, and thus that the widespread adoption of indexed units of account is not a feasible fundamental change.

After reviewing here the Chilean experience, I will explore these concerns about indexed units of account in terms of a very simple model. The model suggests some important design options for indexed units of account: institutions could be set up to encourage their use for all prices, laws could be made so that the frequency of the computation of the index will be increased with the volatility of

inflation, and the conduct of monetary policy could be changed to stress more the stabilizing of prices rather than stabilizing business fluctuations.

1 The Chilean Experience with the *Unidad de Fomento*

The Chilean *unidad de fomento* was established in 1967, and its use became widespread in Chile in the early 1980s. The peso value of the UF, a daily interpolated lagged consumer price index, is published in Chilean newspapers every day, and the UF is upheld by the government and by the legal system as a unit of account for transactions. If one defines a payment in UFs, one must then execute the payment in pesos according to the value shown in the newspaper on the day the payment is made. People in Chile today will quote the price of houses for sale and of apartments for rent in UFs, and they specify mortgage payments, tax payments, and even child support and alimony payments in UFs. However, wages and prices of everyday items are still not defined in UFs.

The UF appears to be viewed in Chile as if it were a kind of money, although there are no UF coins or notes. Advertisements in newspapers feature UF-denominated prices prominently, without translating them into pesos. As further evidence that the UF is treated as if it were a kind of money, note also that prices denominated in UFs appear to have taken on some of the stickiness that

we observe in prices denominated in money. UF prices in Chile tend to end in the numeral 9 much more often than the numeral 1.[2] This tendency suggests that people are conscious of the threshold when a price is increased so that the leading digit is changed, and this itself suggests some UF price stickiness. Research on money illusion (Shafir *et al.*, 1997), suggests there may be stickiness in prices in terms of whatever unit they are defined in: we may call it "unit illusion."

Five countries (Brazil, Colombia, Ecuador, Mexico and Uruguay) have followed Chile's lead in establishing indexed units of account, although in Brazil the unit, the *unidade real de valor* (URV), was introduced as a temporary measure and later eliminated. In the Uruguayan case the index is of wages, not consumer prices.[3] There may be an advantage in defining multiple indexed units of account, some in terms of prices, others in terms of wages or incomes, see Shiller (1998). Here, however, I will suppose there is only one unit of account which, like the *unidad de fomento*, is defined using a lagged consumer price index.

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[2] I checked whether this tendency is operative with the UF in Chile by counting the numbers of UF condominium prices by last digit (excluding trailing zeros) quoted in display advertisements (the larger advertisements, often including a photograph of an apartment building or graphic art) in the *Propriedades* (properties) section of the Sunday August 10, 1997 edition of the Santiago newspaper *El Mercurio*. There were 26 UF prices ending in 9, 16 in 8, 11 in 7, 9 in 6, 16 in 5, 4 in 4, 10 in 3, 8 in 2, and 6 in 1.

[3] In Venezuela, apartment rents are often expressed in units of '*salarios minimos*,' the minimum wage.

2 Should All Prices Be Quoted in Indexed Units of Account?

Which prices should be quoted in the indexed units of account? William Stanley Jevons (1875) gave one possible answer; without mentioning the possibility of indexed units of account, he advocated automatic indexation of all contracts over three months' duration. On the assumption that inflation uncertainty over future time intervals of less than three months is likely to be inconsequential, one might defend this simple rule for its simplicity. A conservative principle of tinkering with the economy as little as possible might also lead us to something like Jevon's prescription.

In a sense Chile has adopted approximately Jevons' prescription, since UFs are used primarily for longer-term commitments. Most bank deposits in Chile have been 30-day peso deposits and 90-day UF deposits. But Chile has not adopted Jevons' advice with respect to wages or retail prices, which are still denominated in pesos.

As an alternative to such a conservative policy on dealing with indexation, it is important to recognize that there are arguments leading us the other way, towards tying *all* prices, wages, and payments to indexed units of account. One may argue that there is no clear advantage to tying any payments to money, with its inherent uncertainty. There is a cost of complicating the decisions that the public has to make by keeping alive both the tradition of prices quoted in money and the option of prices quoted in terms of indexed

units of account.

Even in the pricing of everyday items, there would appear to be
some, albeit usually small, advantage to defining payments in indexed
units of account. If, for example, one buys a television and returns
it for a refund in two months. receiving the initial money value back,
one may suffer a loss of a percent or more in situations with moderate
inflation, and this would not happen if the price were set in indexed
units of account. While, in examples like this one, the advantage
to setting prices in terms of indexed units of account may be small,
there seems to be no offsetting advantage to using money sometimes
that would justify making the public have to deal with two kinds of
prices, money prices for everyday items and indexed unit of account
prices for deferred payments. Using the indexed units of account
for all prices, wages, and payments establishes the presumption and
habit that indexing will always be used, just as stopping at a red light
even when there is no traffic coming in the cross street preserves the
proper habit.

3 A Model Representing Indexed Units of Account Used for All Prices

We could drive a system of indexed units of account to its extreme
in which the indexed unit completely replaces money for price, wage,
and other payment definition. It is important to consider this ex-
treme at least as an exercise, so that we will better understand the

functioning of an economy using indexed units of account. But this extreme is not only an idle exercise, it could be implemented. People could use their credit cards, debit cards, and smartcards that allow access to their accounts which are defined in terms of money. The individual need have no direct encounters with money. When a purchase is made, the price can be rung up in terms of these units, and the computer can automatically translate the unit price into a money price and debit that person's account. Then it is possible that money itself might eventually virtually disappear as a unit of account. Even the last strongholds of coin usage, the vending machines and newspaper stands, could be incorporated into an indexed unit of account debit card system with today's technology.

The idea of indexing all prices seems circular to some people. If all prices, other than the money price of the indexed unit of account itself, are indexed, they ask, then how can the government find out what is the money price of the indexed unit of account? What determines the change in value of the unit of account from month to month? The answer to this question has to do with a lag in the definition of the unit, so that the system is not simultaneous. The lag, given that some rigidity in prices defined in terms of the units is to be expected, also introduces potentially complicated dynamics to prices.

Let us consider a case where an indexed unit of account called a "basket" is adopted, based on the consumer price index, and where all prices are defined in terms of this unit. Let us first consider

how the exchange rate E_t between this indexed unit of account and money, the dollar, could then be defined. Let us for this example disregard the daily interpolation of monthly indices used in Chile, and consider transactions at discrete intervals, so that the value of the indexed unit of account is just the consumer price index lagged one period. I will consider cases where some prices are sticky, because of menu costs of changing prices or because of money illusion.

Even though all prices are in this example specified in terms of the indexed unit of account itself, the money value of the index can always be specified. Since all prices specified in terms of the indexed units of account are translatable immediately into money values based on the known value of the consumer price index last period, the ordinary consumer price index for dollar prices can always be computed. (This is the reason why it is possible to compute consumer price indices even today in countries using indexed units of account for some prices.) Taking E_t, the exchange rate between dollars and baskets, as the of dollar value of the basket at time t and taking $P_{B,i,t}$ as the price of the ith good in terms of baskets at time t, then the consumer price index with base period at $t = base$ is at time t:

$$CPI_t = \frac{\sum_{i=1}^{n} a_i P_{B,i,t} E_t}{\sum_{i=1}^{n} a_i P_{B,i,base} E_{base}} = E_{t+1} \tag{1}$$

where a_i, $i = 1, ..., n$ are the weights in the market basket for each of the n goods, and $CPI_{base} = E_{base+1} = 1$ by construction. All

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information on the right hand side is observable at time t, even if all prices are specified in terms of the indexed units of account.

If prices measured in baskets are relatively sticky, and are to remain relatively constant in the presence of aggregate inflation, one wonders how the dollar value of the indexed unit of account will change, defined as it is in terms of prices in terms of the units themselve. The answer is that the indexed unit of account prices will not all remain constant during a transition period to the different dollar price level.

From equation (1), it is clear that if all prices are denominated in baskets, and all basket prices $P_{B,i,t}$, are infinitely sticky, then the price level, and the exchange rate E_t, can never change. In this case, there is no difference between an economy with prices denominated in baskets and an economy with prices denominated in money. At the other extreme, if all prices denominated in baskets are completely flexible, and assuming that agents set prices optimally subject to no menu costs and with no money illusion, then again there is no difference between an economy with prices denominated in baskets and an economy with prices denominated in money. The question that remains is whether there is a difference between the two in the intermediate case where some prices are sticky measured in baskets and some are not.

Let us consider a simple textbook general equilibrium model of Blanchard and Fischer (1989), based on a monopolistic competition equilibrium theory of Blanchard and Kiyotaki (1987) and drawing

on Dixit and Stiglitz (1977).[4] Their model is very similar to one featured in another textbook by Romer (1996, pp. 256–72.) The formal model in its simplest form has two producers, each producing a unique consumption good, and each of whom is also a consumer. The utility of the ith producer-consumer, $i = 1, 2$, depends positively on the consumption of both goods, positively on real money balances held, and negatively on the output of the ith good, that is, on the labor effort exerted which is transformed one-to-one into the good. The nominal money supply m_t is exogenous; changes in m_t represent changes in monetary policy or could also be interpreted as reflecting changes in the technology of, or demand for, money. Since the utility is assumed to be CES in consumption, it yields simple log-linear demand and pricing equations. In accordance with their model we must also replace equation (1) with a loglinear consumer price index formula, and using lower case letters for logs, taking both a_i equal to 0.5 and choosing a simple normalization this gives us, for the log exchange rate e_t at time t (log dollar value of a basket):

$$e_t = 0.5p_{\$,1,t-1} + 0.5p_{\$,2,t-1} = 0.5(p_{B,1,t-1} + e_{t-1}) + 0.5(p_{B,2,t-1} + e_{t-1})$$

$$(2)$$

where $p_{\$,i,t}$ and $p_{B,i,t}$ are the log price of the ith good at time t in dollars and baskets respectively. We begin here with the Blanchard-

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[4] Since the Blanchard Fischer model assumes monopolistic competition, equilibrium is not Pareto optimal, and in fact a Pareto improvement could be achieved by forcing all producers to lower prices. For welfare comparisons here, I am assuming that given large swings in the money supply, equilibrium with fully flexible prices is close to Pareto optimal, when compared to equilibria with rigid prices.

Fischer (1989, p. 391, eq. 14) derived equation for the utility-maximizing log dollar price $p_{\$,i,t}$, $i = 1, 2$, of the ith producer-consumer at time t, assuming that prices are set in dollars and are not sticky.[5] The equation takes as given the log dollar price of the other producer-consumer, and takes as given the log money supply m_t:

$$p_{\$,1,t} = b p_{\$,2,t} + (1 - b)m_t \tag{3}$$

$$p_{\$,2,t} = b p_{\$,1,t} + (1 - b)m_t \tag{4}$$

Here, the parameter b is determined by utility function parameters, $0 < b < 1$. Each producer sets a dollar price that responds positively to the competitor's price, and positively to the money supply. It responds to the competitor's price since it must compete in the market with this price. It responds to the money supply since changes in the money supply shift the demand curve.

Solving the two equations (3) and (4) for $p_{\$,1,t}$ and $p_{\$,2,t}$, we see that both log prices equal m_t. Therefore, money shocks are neutral when prices are not sticky. For example, starting from an equilibrium with $m_0 = 0$ and both log prices equal to zero, a doubling of the money supply in time 1, changing m_1 to $\ln(2)$, immediately produces, when prices are not sticky, a doubling of all prices, and the relative prices are unchanged.

Blanchard and Fischer use a modification of this model to explore price dynamics under the assumption that the log price in dollars

[5] The same equation appears in Romer (1996) p. 263, Equation 6.52.

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$p_{\$,1,t}$ is set for odd t by producer 1 and the log price $p_{\$,2,t}$ is set for even t by producer 2, so that half of prices are sticky, predetermined, in each period. For our purposes, concerned as we are with the lag built into equation (2), it will be easier just to assume that the price set by producer 1 is always optimal and the price set by producer 2 is infinitely sticky, and remains forever at its initial value, determined either in dollars or baskets depending on which was used to define price. The assumption of fixed price for producer 2 is an extreme form of the assumption that the lag imposed by the stickiness in some prices is much longer than the lag built into equation (2), the lag in the reporting of the consumer price index.[6]

If, again starting from an equilibrium with m_t and both log prices equal to zero, producer 2 sets a log price that is sticky in money terms, setting $p_{\$,2,t} = 0$ for all t, and producer 1 still behaves in an optimal, nonsticky way, then, from the model, $p_{\$,1,t} = (1 - b)m_t$. If the money supply were to double between periods 0 and 1 as above, neither price would double, and in fact even the nonsticky price would less than double. Money is not neutral, and in this model positive money shocks would then would stimulate the real economy, stimulate them forever in this extreme case of perfect price stickiness for producer 2.

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[6] We will have to assume, of course, when considering sticky prices, that the price that is sticky in terms of indexed units of account is stuck at its nonsticky-price equilibrium value if we hope to see a system that converges on the nonsticky-price equilibrium. Ideally, we should consider a model in which neither price is completely sticky, so that even the relatively sticky price adjusts eventually toward an optimum value. However, the dynamics of such models appear to be sufficiently complicated as to obscure the simple point I wish to make here.

If producer 2 determines the basket price instead of the dollar price, setting $P_{B,2,t} = 1$ for all t, thereby in effect setting $p_{\$,2,t} = e_t$, then money will, in contrast to the above, be neutral in the long run. Again let us suppose that initially m_0 and both log prices equal zero, as would be the equilibrium if the m_t had always been zero for $t < 0$, and that the money stock will now change. With a now-sticky basket price for producer 2, equations (2) and (3) give us the two equation system:

$$e_t = 0.5 p_{\$,1,t-1} + 0.5 e_{t-1} \tag{5}$$

$$p_{\$,1,t} = b e_t + (1 - b) m_t \tag{6}$$

Solving for the log exchange rate e_t, we find:

$$e_t = (1 - \rho) \sum_{k=0}^{\infty} \rho^k m_{t-k-1} \tag{7}$$

where $\rho = (1 + b)/2$, $1/2 < \rho < 1$, and $p_{\$,1,t}$ is given by:

$$p_{\$,1,t} = b(1 - \rho) \sum_{k=0}^{\infty} m_{t-k-1} + (1 - b) m_t \tag{8}$$

It follows that the log price set in terms of baskets for producer 1 is:

$$p_{B,1,t} = (1 - b) \sum_{k=0}^{\infty} \rho^k \Delta m_{t-k} \tag{9}$$

where $\Delta m_t = m_t - m_{t-1}$. Note now that a sort of overshooting in the log basket price of the producer whose basket prices are not sticky enforces a move to a new equilibrium with higher e_t but both basket log prices back again to their original values ($p_{B,i,t} = 0$). If the money supply is suddenly doubled (m_1 is increased from 0

to $\ln(2)$ as above and held there forever) then $p_{\$,1,1}$ rises as much as it would in the case considered above where producer 1's price were sticky in money terms, that is, price less than doubles initially. Output is stimulated in the first period by exactly the amount in the case where the log dollar price $p_{\$,2,t}$ was sticky, but now gradually, $p_{\$,1,t}, t > 1$, rises further, so that price eventually is doubled. In contrast, the log basket price $p_{B,1,t}$, rises initially, and then declines exponentially back to its initial value. Eventually, both log basket prices are at their original values of zero and, because of the increase in e_t, money prices have doubled. Eventually, and in contrast to the sticky money supply example, output falls back to its original non-sticky-price value.

This transition to new equilibrium did not keep relative prices constant on the way to the new equilibrium, but it is not possible to achieve that if some prices are sticky. If b is not too large, the transition shown will produce nearly correct prices again within a few periods (months if the price index is computed monthly) of the change of the money supply. The presence of indexed units of account has functioned as a sort of automatic stabilizer, blunting the impact of sticky prices.

3.1   Generalizations of the Model

Instead of assuming for our model that one producer is completely rigid in prices in terms of the unit and the other is completely flexible, we could instead assume, more realistically, that there are many

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producers and there is a distribution across producers in the lag with which they respond to changing economic conditions. This would add considerable complexity to model dynamics. For example, it would mean that pricing decisions today would depend on expected future money supplies (as laid out by Calvo, 1983 and Gali and Gertler, 1999). Alternatively, we could specify that there is a fixed cost to changing prices, a cost that differs across producers. Such a specification would add considerable complexity to the model, and the lag in producers' responses would then depend on the variability of prices, see Ball and Mankiw (1995).

The effects of the adoption of indexed units of account in the context of these alternative models deserve further study. However, there appears to be no reason suggested by these alternatives to suppose that adoption of an indexed unit of account for all prices will cause fundamental instability of the price level.

4   Design Elements for Indexed Units of Account

4.1   Encouraging the Use of the Units for All Transactions

The use of indexed units of account for all prices was not inflationary in this model; it did not produce a higher equilibrium price level e_t than in our nonsticky price level model. It was not inflationary since

agents set the profit maximizing price, and this price is ultimately related to the money supply. Of course, inflationary outcomes might still be produced if we attached to the model a price-destabilizing monetary authority reaction function determining the money supply. We might also conceivably produce inflationary outcomes by adding some assumptions of irrational market psychology to the model. But there appears to be nothing intrinsic to defining all prices in terms of the units of account that is inflationary.

Governments could encourage the habit of using indexed units of account by defining tax payments in terms of the units, a step Chile has taken. There are also other possible ways to encourage their use that Chile has not taken. As noted above, the use of the units for most transactions could be encouraged by subsidizing credit card, debit card and smartcard companies to allow transacting in the indexed units of account without translating prices into currency, and banks to allow checks to be written in terms of the units.

Further use of the indexed units of account could be encouraged by the government's setting, as an example, wages to government employees in terms of the units, and recommending to firms that wages be defined in the units. However, setting wages in terms of the units runs a risk of creating a psychological expectation that real wages can never fall, and making it psychologically more difficult to cut the real wages of employees who are not performing well, when compared to a system in which wages are set in money terms in an inflationary environment. Akerlof, Dickens and Perry (1996) have

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shown that US workers rarely receive nominal wage cuts, apparently viewing cuts as an insult, but passively receive real wage cuts caused by inflation (see also Bewley, 1995). If this nominal concern is transferred to the units when they are adopted for wages, employers who pay in terms of an indexed unit of account might sometimes be forced to lay off less productive workers when they might otherwise have only gradually cut their wage by not offsetting inflation. The effect may be to exacerbate economic fluctuations, when macroeconomic forces make labor temporarily less productive.

This problem with indexation of wages might be dealt with at the time of introduction of the indexed units of account if wage and salary institutions were changed to allow a face-saving way to cut real wages. Consultation with employees and labor unions might result in some idea of more friendly ways to cut real wages when necessary. For example, when wages of are first redefined in terms of the indexed units of account, these might be divided into a smaller-than-normal base wage and a larger-than-normal bonus, with the bonus explained in advance to be more flexible under the new regime. Another approach would be to define wages in terms of an alternative indexed units of account for wages and salaries, a unit that is taken to be an index of normal incomes, excluding exceptional income increases, and thereby to have a downward bias relative to the consumer price index, see Shiller (1998).

4.2 Defining the Interval over which the Price Level Is Computed

The simple model shown above can be used to illustrate the effects of the government's decision to change the frequency at which the price index is computed. Recall that in the above model the unit of time is the time interval between calculations of the price index, and, we may as well regard the model as a continuous time model where equation (6) holds continually, but while equation (5) holds only for integer t (and $e_t = e_{t-k}$ for $0 < k < 1$). Suppose also that the money supply is an exogenous continuous-time process unaffected by changes in the interval between calculations of the price index (unaffected if expressed in calendar time rather than in terms of index interval time). From (7) it can be seen that for integer t, e_t is a distributed lag on log money whose mean lag is set as measured in terms of the numbers of intervals between computations of the index.

Thus, shortening the interval between computations of the price index makes the exchange rate e_t track more closely the current money stock, and hence causes real quantities to track more closely their equilibrium values. Shortening the interval does not cause any increase in instability of prices or quantities.

In determining the interval between computations of the price index, it follows that we must weigh the cost of computing the index more frequently against the cost to society of having an indexed unit of account whose real value is variable because of the lag in the

computation of the index. Since the second of these costs depends on the variability of the price level, it would be plausible to specify in advance that if the price level should become more variable, the price index will be computed more frequently. A procedure could be defined when the indexed units of account are set up specifying the interval between computations as a function of the variability of prices.

Using a daily interpolated consumer price index for the exchange rate e_t, as is done in Chile, helps mitigate the effects of relatively infrequent computation of the price index by preventing sudden jumps. Other methods, statistical methods, could be used to define an exchange rate e_t that tracks even more closely the current price level without increasing the frequency of computation of the index: the exchange rate could be based on daily forecasts of the price level. Introducing such sophistication in the definition of the exchange rate does carry some risks however that the public will not find the concept of the index as easy to understand, and they may begin to fear manipulation of the forecasts.

4.3 Monetary Policy with Indexed Units of Account

While the indexed units of account are proposed to deal with the problem that monetary policy may be erratic, incapable of responding appropriately to exogenous shocks, or destabilizing of the price level, it is still important to ask how monetary policy should ideally be conducted once such units are in place. From the standpoint of the

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above model with all prices expressed in the units, monetary policy has little effect on real quantities unless the money stock is changed rapidly relative to the interval between computations of the price index. The monetary authority would have reason to keep the growth of money prices fairly low and stable, so that society does not need to incur the cost of more frequent computations of the price index.

The textbook model used here assumed away any time-value cost to holding money, so that inflation had none of the usual welfare-triangle costs to inflation. If we recognize such costs, then the monetary authority would, even with the indexed units of account, have a reason to keep inflation low so that people do not suffer excessively economizing on money balances.

The use of monetary policy for conventional countercyclical stabilization policy would have to be rethought after use of indexed units of account became widespread. The monetary authority would appear to have a diminished ability to exert influence over real interest rates, given the reduced role of sticky prices. There may, however, be less need for countercyclical monetary policy, since the aggregate effects of sticky prices on business fluctuations will also be reduced. If indeed the amplitude of the business cycle is reduced by the adoption of indexed units of account, then monetary authorities would be able to focus their attention more on stabilization of the price level.

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