ECONOMIC AFFAIRS

No. 6

Indexation 101

Lúðvík Elíasson

January 2014

Published by:
The Central Bank of Iceland, Kalkofnsvegur 1, 150 Reykjavík, Iceland
Tel: (+354) 569 9600, fax: (+354) 569 9605
E-mail: sedlabanki@sedlabanki.is
Website: www.sedlabanki.is

Vol. 6, January 2014
Online
ISSN 1670-8172

Icelandic letters:

ð/Ð (pronounced like th in English this)
þ/Þ (pronounced like th in English think)
In *Economic Affairs*, ð is transliterated as d and þ as th in personal names, for consistency with international references, but otherwise the Icelandic letters are retained.

Symbols:

*	Preliminary or estimated data.
0	Less than half of the unit used.
-	Nil.
...	Not available.
.	Not applicable.

Indexation[1]

Price indexation and its various aspects have been prominent topics of public discussion in the recent term, owing to wide swings in inflation and divergent developments in wages and prices from year to year. A great deal has been written about indexation, both in Iceland and elsewhere, in recent decades. Indexation was a popular research topic among scholars in the 1970s. Ever since the mid-20th century, experiments have been carried out with it around the world, and it has steadily become more widespread in the recent past. There is good reason to review both what is known about indexation and what has been learned from scholarly research and from decades-long experience in Iceland and many other countries. Such a review will hopefully enhance the quality of the discourse on indexation. One of the main points made in this paper is that the most salient cost of inflation is not the erosion of purchasing power but the random transfer of assets between debtors and savers, which results from unexpected inflation. Indexation eliminates this risk and is therefore helpful to lenders and borrowers alike. This is why real interest rates on indexed loans are usually lower than those on non-indexed loans. Indexation increases the number of options in the credit market, which generally enhances public welfare, whereas a reduction in the number of available options erodes it.

1 Introduction

This paper focuses on various aspects of the indexation of financial obligations. The discussion presented here is not intended as an in-depth theoretical analysis but rather as an attempt to make the topic as accessible as possible to as wide an audience as possible. Nor is it exhaustive. The contents derive to a large extent from the author's previous writings on the subject and from recent discussion in publications from the Central Bank of Iceland and others. Section 2 presents definitions of the value of money and what is meant by inflation and indexation. An attempt is made to explain the meaning of these terms through examples. Section 3 focuses on the structure of indexation in Iceland and various other countries. The author has avoided a technical approach to the discussion, opting instead for a brief historical summary and selected examples from a number of countries. Section 4 explores specific issues related to indexation of financial obligations. It contains a short discussion of bond indexation and a longer discussion of mortgage indexation, followed by a short summary of indexation and debt problems, money illusion and opposition to indexation, the legality of indexation, indexation imbalances, and indexation and the effectiveness of monetary policy. The paper concludes with a summary of assertions or facts related to public discussion of indexation.

---

1. The author is an economist in the Financial Stability Department of the Central Bank of Iceland. The opinions expressed in this paper are those of the author and should not be interpreted as the views of the Central Bank of Iceland. The author wishes to thank Ásgeir Daníelsson and Thórarinn G. Pétursson for reading the paper and providing helpful comments.

2 The value of money, inflation, and indexation

2.1 The value of money

Money is usually used as a unit of measure for valuables. Unlike other units of measure, such as metres and kilograms, the value of each monetary unit changes over time.

When the values of various goods are compared, they are expressed in terms of units of the currency used in business transactions. The volume of each item under scrutiny is thereby converted to a monetary amount. This approach makes it easy to compare different items. It is the method used, for instance, to add apples and oranges: when both items have been expressed in terms of money, calculation is simple.

The price at which goods are traded is a measure of their value, and the price is therefore measured in units of the medium used for payment. It follows naturally from the role of money as a medium of payment that this value is expressed in terms of the amount of money paid. In the same way that the price of goods exchanged for money is measured in terms of monetary volume, it is possible to use the volume or amount of units of the product concerned to measure the value of money. Because it is customary to measure the value of all other goods in terms of the volume of money that can be obtained in exchange for them, measuring the value of money becomes somewhat complicated. If only one specific product is used as a reference, changes in the supply of and demand for that product have a profound effect on the value of money. For this reason, it is common to use a "basket" comprising a specified volume of a number of selected items that remains unchanged between periods; the periods are then compared to one another. Both the goods in the basket and the volume of individual items in the basket must be chosen so as to reflect as accurately as possible the value of money. Most often, the basket is selected to reflect the average household's demand for consumer products. The price of the basket is then measured on a regular basis – for instance, once a month – thereby yielding a time series index that shows how the value of money develops. If the price of the consumer goods rises, this is equivalent to a decline in the value of money. Such erosion of the value of money is generally called inflation.

2.2 Price levels: nominal and real prices

Amounts measured in krónur are determined, among other things, by the value of the króna at the time of measurement. This applies to all currencies, no matter what they are called. In order to compare values over time, it is necessary to set aside that portion of the price change stemming from changes in the value of the currency. Amounts are entered at constant prices in order to make possible a comparison of values over time.

When comparing the price of a given product at various points in time, it is possible to use the price index of the consumer basket (the consumer price index, or CPI) to correct the price of the product for changes in the value of money. The price of a product as expressed in terms of a monetary amount at any given time is the current or

nominal price of the product, and the price adjusted for changes in the value of money by separating changes in the CPI from changes in the price of the product is called the price at constant prices, or the real price. Box 1 gives two examples of the importance of discerning between nominal and real price developments.

Box 1

The difference between nominal and real prices

The price of cinema tickets

The average price of a cinema ticket was 1,250 kr. in 2012, as opposed to 238 kr. in 1987. The price therefore increased more than fivefold over this period (the increase measured 425.2% of the 1987 price). But this does not mean that the ticket was five times more expensive or five times more valuable in 2012 than it was in 1987. Part of the price increase is due to shrinkage of the unit of measure in the meantime. The price at any point in time reflects the value of the ticket in comparison with the value of other goods at that time. Comparing prices by looking at the price paid in krónur for the ticket at different points in time is misleading because the krónur used as a unit of measure differ in value. In order to conduct a reliable comparison, it is therefore necessary to express the ticket price at fixed price levels before comparing two different periods of time.

The consumer price index (CPI), which measures the price of a typical basket of goods consumed by the average family, averaged 440,498.5 in 1987. By 2012 it had risen to 2,098,703.9. (This is based on the CPI that was assigned a value of 100 in 1939). The CPI, which measures the general price level, therefore rose by 376.4% over this 25-year period. Developments in the general price level are the best measure we have of the value of money. 376.4% of the 425.2% increase in a cinema ticket price over the 25-year period from 1987 to 2012 is therefore attributable to erosion of the value of money. Comparing the ticket prices in 1987 and 2012 at constant prices – that is, excluding the erosion in the value of money during the intervening period – reveals that the ticket is 10.2% more expensive in 2012 than in 1987 (Table 1).

Table 1 Development of the consumer price index (CPI) and nominal and real price of cinema tickets. Accumulated percentage change since 1987

	CPI	*Kr.*	*Kr. at 2012 prices*
1987	0.0	0.0	0.0
1992	93.3	110.1	8.7
1997	116.2	147.1	14.3
2002	167.0	236.1	25.9
2007	228.2	278.2	15.2
2012	376.4	425.2	10.2

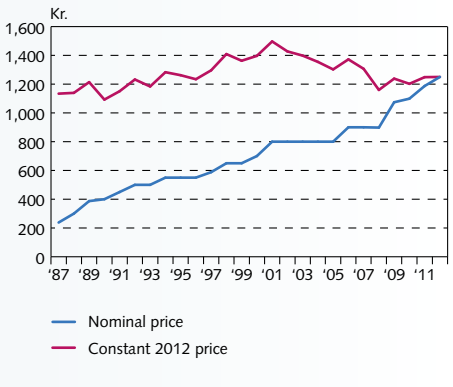
Sources: Statistics Iceland and author's calculations.

The change in the CPI during a given period can be used to measure how much money has diminished in value during that period. Given that 2,098,703.9 kr. were needed in 2012 to pay for the same volume of consumer goods as could be obtained for 440,498.5 kr. in 1987, the króna deteriorated in value by 79.0% during the period.

Chart 1 shows that the price of a cinema ticket rose from 238 kr. in 1987 to 1,250 kr. in 2012. The main reason for the increase

Chart 1

Cinema ticket prices at nominal and constant prices 1987-2012

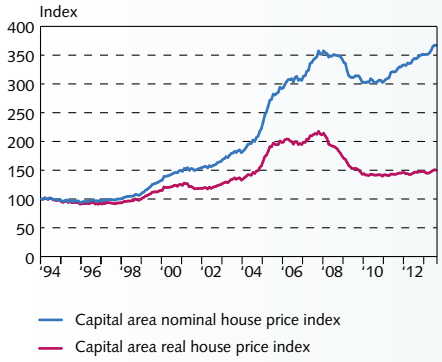


Sources: Statistics Iceland, author's calculations.

was not that cinema tickets had become more expensive but because they were being bought with increasingly less valuable krónur. An examination of the real price, also shown in Chart 1, shows that when the price of the króna is held unchanged (that is, the unit of measure is fixed, as is the case when length is measured in metres and weight in kilograms), the price of the cinema ticket at year-2012 prices ranges from 1,092 kr. to 1,497 kr. during the period in question. Between 1987 and 2012, the ticket price was highest in 2001 and lowest in 1990. To maintain that the ticket was more expensive in 2012 because more krónur were required to pay for it than in 1987 would be analogous to maintaining that a person had gained weight because he weighed more in pounds this year than he weighed in kilograms the year before. Year-1987 krónur are a different unit than year-2012 krónur, just as kilograms are a different unit than pounds. Comparing amounts measured at different points in time is meaningless unless the amounts have been converted to a common unit; that is, to a fixed price level. This is done by correcting for price level changes during the interim.

Chart 2

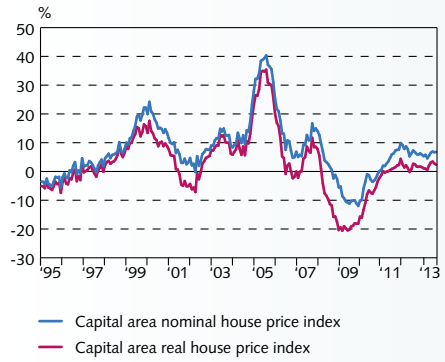
Indices of nominal and real house prices in greater Reykjavík[1]



1. Monthly data 1994-2013.
Sources: Statistics Iceland, Registers Iceland, author's calculations.

Chart 3

Changes in nominal and real house prices in greater Reykjavík[1]



1. Monthly data 1995-2013.
Sources: Statistics Iceland, Registers Iceland, author's calculations.

House prices

Chart 2 shows two house price indices, which were assigned a value of 100 in January 1994. As the chart shows, nominal house prices, which are published monthly by Registers Iceland (previously the Land Registry of Iceland) changed very little between 1994 and 1998 but then began to rise in 1999. By the beginning of 2001, house prices were 50% higher than at the beginning of 1994. They continued to rise, and by the end of 2003 they were 80% higher than in 1994. The price increase accelerated markedly from 2004 onwards: by the beginning of 2008 prices had nearly doubled in four years and had risen by some 250% since 1994 (and 1998). Nominal house prices stopped rising for a time but then began to fall in late 2008. They bottomed out at the end of 2009 and have risen by just over 20% since then. The steep rise in the index between 2003 and 2007, the relatively small decline after the financial crisis struck in 2008, and the rather quick increase in the past three years characterise this period. To a degree, however, these developments in house prices reflect changes in the general price level, as can be seen by examining developments in real house prices (Chart 2). Although the changes in real prices somewhat resemble the nominal price changes, the rise in real prices is strikingly smaller than the nominal increase. When they peaked early in 2001, real prices had risen by only 28% since the beginning of 1994 (26% since the beginning of 1999), whereas nominal prices had risen by 53% (37% since the beginning of 1999). Real prices then declined in 2001, while nominal prices continued to rise. The rise in real prices between 2004 and 2007 was also considerably smaller than the nominal increase, although it was still substantial. Real house prices rose by 61% from December 2003 through January 2008, and nominal prices rose 98% over the same period. From January 2008 through December 2009, nominal prices fell by 15.5%, while real prices fell by a third. The drop in nominal prices has now reversed; in fact, nominal house prices hit an all-time high in autumn 2013. At that time, real prices had risen 5.5% since year-end 2009. The difference in developments in nominal versus real prices lies in the steep rise in the general price level, and a portion of the measured increase in house prices is due to the erosion of the value of money during the period in question.

Chart 3, which shows the twelve-month change in nominal and real house price indices, tells the same story about price developments. It illustrates clearly that the nominal price index usually rises more and falls less than the real price index, as it also measures

increases stemming from the deterioration in the value of money (in other words, inflation) during the period.[1]

1. When the real price of property is to be determined, the question often arises of whether it is appropriate to use the CPI, in which housing costs weigh heavily and which is strongly affected by real estate prices, or the CPI excluding the housing component. Because housing consumption is a large part of the average household's consumption, it is appropriate to include it in the goods basket used to assess developments in price levels and inflation. If house prices rise or fall much more than the price of other goods, this can make a strong impact on inflation for some time because consumption is affected. For example, if house prices rise much more than the price of other goods over a protracted period, it not only affects inflation but also increases the weight of the housing component in the goods basket.

2.3 Inflation and the associated costs

The lasting damage from inflation therefore stems mainly from the erosion of the real value of capital, which is defined in terms of the nominal value of the monetary unit. In addition to the social ramifications, which can be assessed in various ways, this shift of capital affects the capital market, causing a severe contraction in saving, on the one hand, and a surge in demand for capital, in excess of its actual function. This is particularly the case when inflation exists or appears likely to resume. (Bjarni Bragi Jónsson, 1978, p. 7).

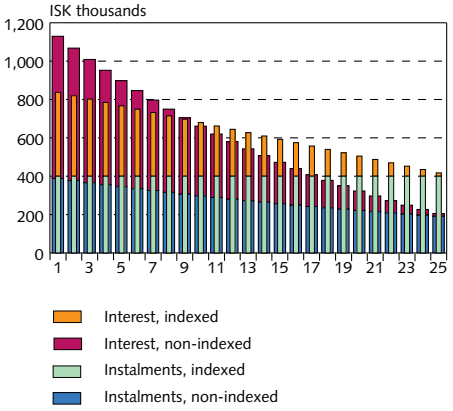
The cost of inflation varies directly with the rate and volatility of inflation; that is, with increasing uncertainty about it. This cost emerges in various ways (see, for instance, Pétursson, 2007, and Mankiw, 2007, pp. 97-103). The larger and more frequent price changes are, the more is the uncertainty about relative prices. Effective price formation in a market provides important information about supply and demand for goods, which affects who produces what and for whom: that is, how goods are allocated. Inflation creates uncertainty about relative prices, diminishes the effectiveness of the market economy, and distances economic activity from that which maximises general welfare. Furthermore, it is more difficult to plan and to make sensible investment decisions when there is uncertainty about relative prices. The tax system also affects behaviour differently, depending on whether inflation is high or low. Taxation of nominal interest rates rather than real interest rates reduces saving, and the effects grow stronger as inflation rises. Mortgage interest subsidies that are linked to nominal interest payments rise with inflation and promote increased investment in housing at the expense of other investments. Pétursson (2007, pp. 75-76) points out as well that, with increased inflation, "Income is transferred from small savers to professional investors, who are more able to protect themselves against inflation; from low-income groups to high-income groups; and from renters to homeowners …".

In general, the higher inflation is on average, the more volatile it is (Ball, Mankiw, and Romer, 1991). Uncertainty about future inflation is generally greater in high-inflation countries than in countries with low inflation. One of the main benefits of low inflation over high inflation is the increased probability that inflation will remain low, thereby diminishing this uncertainty.

When long-term loans are granted, there is uncertainty about the value of the payments because it is impossible to know in advance how prices will develop. This uncertainty is therefore greater as loan maturities grow longer and inflation is more volatile. This is why long-term loans such as mortgages commonly contain provisions designed to reduce this uncertainty. Examples of such provisions are interest rate review clauses, where loan interest is not fixed for the entire loan period but only for a given portion of it. Another such provision is a variable-rate clause, where the loan interest changes monthly (or even more often, if inflation is extremely high) or every several months, in response to market rates, which in turn reflect changes in inflation and inflation expectations. If inflation increases, variable rates or rates subject to review clauses rise, as rising prices mean that the value of the negotiated payments is less than originally intended. The portion of the interest that was intended to compensate for potential price level increases is then revised upwards.

Yet another means of mitigating this uncertainty is to apply indexation to financial obligations. Indexed loans are negotiated using amounts at constant prices based on a given price index, and the loan amount is updated automatically to reflect developments in inflation. In the main, indexation works in the same way as a variable-rate loan that is adjusted in line with price level changes.

Chart 1
Repayments of indexed and non-indexed loans[1]



1. 25-yr loan with annual instalments. Assuming fixed interest and assuming that the nominal rate on the non-indexed loan (7.6%) is equal to inflation (3%) plus the real rate on the indexed loan (4.5%). All payments are shown at the price level of the year in which the loan is taken.
Sources: Statistics Iceland, Registers Iceland, author's calculations.

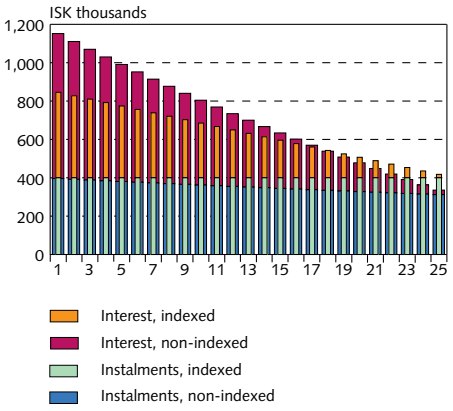
2.4 Indexation - inflation risk eliminated

By affixing the value of the contract to the value of money at the time the contract is concluded, and linking all amounts to developments in an index that measures changes in the value of money during the loan period, it is possible to avoid the imprecision entailed in applying an interest rate that estimates price erosion for the lifetime of the loan. If amounts are indexed in this manner, it is clear what the value of contractual payments is. Indexation thereby eliminates uncertainty about future developments in inflation, for borrower and lender alike.

Indexation and unexpected inflation[2]

The effects of unexpected changes in inflation depend on whether loans are indexed or not. A portion of the interest expense on a loan is due to the expected erosion of the value of money during the loan period. In other words, this portion of the interest payment is intended to compensate for the expected increase in the general price level over the loan period and to compensate the lender for the fact that the money loaned is of lesser value when it is paid back. If inflation developes in accordance with expectations at the beginning of the loan period, the present value of the repayment profile is the same for indexed or non-indexed loans. If we assume that the real interest rate on both types of loans is the same, the nominal interest rate on the indexed loan will be lower than that on the non-indexed loan by the amount corresponding to inflation (Chart 1).[3] The amount paid on

Chart 2
Inflation below expectations[1]



1. The chart shows the same payments as Chart 1, except that inflation proves to be only 1% per year instead of the expected 3%. All payments are shown at the price level of the year in which the loan is taken.
Sources: Statistics Iceland, Registers Iceland, author's calculations.

2. This section is based on Box 4.4 of the Parliamentary Special Investigation Commission Report on the Housing Financing Fund, etc., Volume 1 (pp. 59-61).

3. Provided that the real interest rates on the loans are the same. As is discussed below, real rates on indexed loans are often lower because of reduced inflation risk.

the interest and principal is lower on the indexed loan than the non-indexed loan at the beginning of the loan period but later in the period payments on the indexed loan are higher. The value of the loans will, however, be the same when all payments are entered at present value.

But if inflation develops differently than expected during the loan period, the value of future payments already negotiated will be different than was expected at the beginning of the loan period. Chart 2 shows that if inflation is lower than anticipated, the real value of payments on a non-indexed loan will be larger than intended. In such an instance, the borrower loses and the lender profits. But if inflation is higher than expected, as is shown in Chart 3, payments on a non-indexed loan will be lower in value than intended. In this case, the borrower profits and the lender loses. The payments on the indexed loan retain their value, irrespective of the inflation rate during the loan period, and the payments expressed at constant price levels are unchanged.

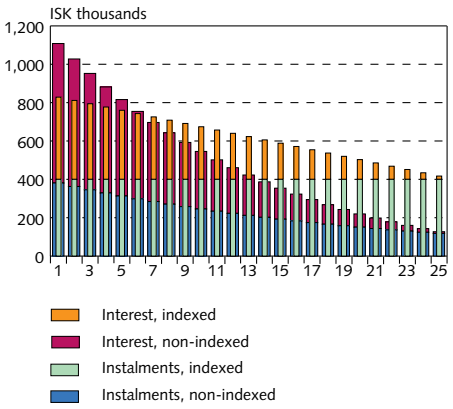
This simple example shows clearly the principal advantage of indexation: that inflation eliminates inflation risk. It is precisely for this reason that the real interest rate on indexed loans is usually lower than that on non-indexed loans: because non-indexed loans factor in additional uncertainty about the value of the payments – or, in other words, non-indexed long-term loans are riskier than indexed loans for both lender and borrower.[4] This can be seen in Chart 4, which shows that, on average, real interest rates have been higher on non-indexed loans than on indexed loans.

2.5 Mismatches between prices and wages

If wages and prices develop in divergent ways over a long period of time, changes in real wages affect households' behaviour. For instance, if wages rise in excess of prices, purchasing power and consumption will rise over time. A lasting increase in purchasing power is based on increased productivity, however, such as one resulting from technological advancements. Temporary factors can also cause wages and prices to diverge, although wage increases far in excess of productivity increases will ultimately correct themselves. If the increase in real wages is perceived to be permanent – as can happen if the misalignment of wages and prices persists over a long period of time – consumption (including expenditure on housing) will increase even more. Those who previously chose to borrow money will then borrow more. Indebtedness will rise, irrespective of whether loans are indexed or not.

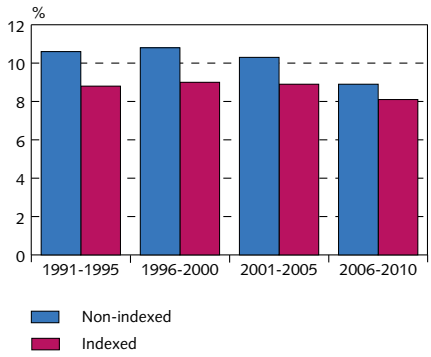
If wage increases do not keep pace with price increases over time, debt service will rise unless loans are non-indexed and carry fixed interest. Debt service on indexed loan agreements follows the price level and is therefore a known quantity in real terms. It will also become heavier if real wages decline. The risk of this develops, for instance, if purchasing power has risen sharply as a result of factors such as foreign capital inflows, but can fall abruptly if the inflows reverse

Chart 3
Inflation above expectations[1]



1. The chart shows the same payments as Chart 1, except that inflation proves to be 5% per year instead of the expected 3%. All payments are shown at the price level of the year in which the loan is taken.
Sources: Statistics Iceland, Registers Iceland, author's calculations.

Chart 4
Average annual interest on general DMB loans[1]



1. Change year-on-year. Real interest rates, 1991-2010. Simple five-year averages.
Sources: Statistics Iceland, author's calculations.

4. It should be noted that, although the chart compares average interest rates on long loans, the indexed and non-indexed loans illustrated are not entirely comparable.

suddenly. The real value of non-indexed loans declines if inflation rises and rises if inflation slows down. The real value of indexed loans is a known quantity, however, and does not fluctuate with inflation.

If inflation has been low for a period of time and real wages become temporarily inflated, there is a risk that borrowers will take on too much debt. Indexation prevents automatic reduction of debt during inflationary periods, however, and is seen as a flaw by borrowers who have taken on excessive debt, expecting permanent real wage increases that have not materialised.

The problems deriving from misalignment of prices and wages are well known in many places where the majority of debt is indexed. In Chile, for instance, where inflation is high, indexation has caused discontent because indexed loans are updated daily, while nominal wages are determined once a year. Shiller (2002) does not consider this a justification for abandoning indexation but instead considers it more beneficial to update debt and instalment payments in line with wage developments. In 1991, the Chilean government prepared a draft bill of legislation providing for the possibility of linking collateralised loan payments to wage developments. Such linking has been practised in Uruguay. Shiller suggests, for instance, using the consumer price index for indexation of the price of housing, rent, and various other goods that generally remain unchanged for long periods of time, but using the wage index to fix the price of amortisation and instalments of mortgage debt.

3 Application of indexation

3.1 Indexation in Iceland – a brief history

Indexation was applied for the first fime in Iceland with a royal decree dated 20 March 1815, as is described by Bjarni Bragi Jónsson (1998). The decree was consistent with one implemented for Denmark, which introduced retroactive indexation of financial obligations in order to adjust for the effects of high inflation due to the Napoleonic Wars.

> *This reinforced the emphasis on the fundamental principle of the real value of money as related to precious metals, their rarity, and their manufacturing cost, which was confirmed with currency reforms. Seen in this light, some sort of indexation of monetary capital was the general rule over a long period in history, whereas steadily depreciating paper currency and erosion of debt values are primarily a recent phenomenon. (Bjarni Bragi Jónsson, 1998, p. 38).*

Indexation of financial obligations was applied again in Iceland in 1955, to stimulate domestic saving through a school children's savings plan. So-called indexed bank books, which were indexed savings accounts, were offered from 1957, with balances tied for a period of five to 10 years. These savings accounts were only indexed in part, however, as the indexation was always calculated on the original principal (Bjarni Bragi Jónsson, 1998, p. 38).

The Housing Affairs Act (mortgage lending for residential construction and elimination of hazardous housing, no. 55 of 20 May 1955) contained provisions concerning indexation of mortgage lend-

ing for residential construction and its financing. About a fifth of financing instruments were issued as indexed, and a similar proportion of loans were processed with indexed terms, so that instalments and interest payments were linked to the cost-of-living index, and the interest on indexed loans was set at 0.25 percentage points above that on the financing instruments. With the new Housing Affairs Act of 1965, indexation extended to the entire loan amount, and financing and indexation were based on the wage rate index. The ban on indexation of wages, which had been in effect for several years, had been lifted the year before. From 1964, the Treasury's domestic borrowing was through indexed bonds called spariskírteini (Treasury savings bonds), which were initially issued in small units and were linked to the building cost index until 1979, when the credit terms index was introduced.

In 1972 a ceiling was placed on mortgage indexation, which made it ineffective in practice. It became difficult to fund the mortgage lending system thereafter, and the weight of home buyers' financial contribution, mainly in the form of their own contribution of labour, increased dramatically. During this period, the pension funds' participation in non-indexed loan financing eroded their capital and delayed the development of the pension fund system for years. In subsequent years, a number of statutory amendments authorised partial indexation of various types of loans. Initially, the indexation was limited to the corresponding proportion of the lender's funding which was indexed, but later the Housing Affairs Act was amended so that loan indexation was limited to 40% of the increase in the building cost index, and then 60%, and the pension funds were permitted to grant comparable loans. Broad-based indexation was then implemented with Act no. 13 of 10 April 1979, which was commonly referred to as Ólafslög (the Ólafur Act, referring to the then-current Prime Minister, Ólafur Jóhannesson). At that time, indexation was based on the credit terms index, which was a composite of the cost-of-living index (two-thirds) and the building cost index (one-third). Since then, indexed loans have predominated in Iceland, reflecting the country's long history of persistent and volatile inflation.

Box 2

Summary of indexation mechanisms in Iceland

During the period right after indexation became widespread in Iceland, following the passage of the so-called Ólafur Act of 1979, the subindices of the credit terms index were measured quarterly. Monthly index values were calculated from these components, and every third month it was necessary to rely on the forecast for the next value of the base indices. In autumn 1983, inflation was falling rapidly, and monthly index measurement was introduced, probably to speed up the pass-through of the disinflation to the credit terms index. In February 1989, the wage index was incorporated into the credit terms index, and the three base indices – the cost of living index, wage index, and building cost index – were assigned equal weight. The ruling committee on indexation, which was appointed based on the authority in the Ólafur Act, considered this change equivalent to the creation of a new index that could not apply to

pre-existing financial obligations (Morgunbladid, 24 January 1989). Ultimately, the change was implemented with a regulation based on the Act on the Credit Terms Index and was applied to previously existing agreements. A lawsuit was filed in which the plaintiff attempted to overturn the change, but it was unsuccessful at both judicial levels (Bjarni Bragi Jónsson, 1998, p. 58). The credit terms index remained in effect in this form until 1995, when it was discontinued in favour of the consumer price index (previously called the cost of living index).

Originally, the consumer price index (CPI) was calculated by measuring the price level on the first two working days of each month, thus roughly reflecting month-end prices. The average of a given month's CPI and that of the subsequent month was generally used to indicate the average during the first month. The quarterly average was then calculated by weighting together the index values for the months in a given quarter and the first month in the following quarter so that the first and fourth months were assigned half the weight of the second and third.

The CPI value measured at the beginning of the month was usually published at mid-month and was used for indexation from the month-end. The base index for indexed loans remained unchanged for one month at a time and changed at the month-end to reflect the most recent measurement. In indexed bond trading, the index was updated daily by applying annual returns on the month-on-month rise in the index, exponentially weighted with the percentage of days completed in the month. At the beginning of each month, before the month's index was published, the most recent Central Bank inflation forecast for the month was used. Since adopting the inflation target in March 2001, however, the Central Bank has published inflation forecasts on a quarterly basis, and not monthly. When inflation diverged from the Bank's forecast, significant misalignments could result from using the most recent forecast to generate the daily index for the first days of the month, particularly if the most recent forecast was relatively old.

Since the beginning of 2008, inflation measurements have been carried out at mid-month (Statistics Iceland, 2008). This is in line with the practice in other countries. As a result, the index value for each month better reflects the average price level during that month. The index value is now published towards the end of each month and is applied to indexation in the second month following, thus obviating the need to use forecasted values to calculate indexation.

3.2 Foreign examples

Increased interest in indexed bonds worldwide

A market for indexed bonds and loans tends to develop in countries with persistent, high inflation. For instance, indexed government bonds have been issued in Israel since 1955, in Brazil and Iceland since 1964, in Chile and Colombia since 1967, in New Zealand since 1977, in the United Kingdom since 1981, in Australia since 1985, and in Mexico since 1989. This group of countries grew in the 1990s: Canada joined in 1991; Poland in 1992; Sweden in 1994; Hungary in 1995; Greece, Turkey, and the United States in 1997; France in 1998; and Kazakhstan in 1999 (Deacon, Derry, and Mirfendereski, 2004). In the 21st century, even more countries have begun to issue indexed gov-

ernment bonds, and not only those fighting persistent inflation. The purpose of such an issue is primarily to reduce the national treasury's borrowing costs, as real rates on indexed debt are usually lower than those on non-indexed debt. Such bonds have also been in demand by pension funds, as they fit well with the funds' financial obligations.[5] Right after the turn of the century, issuance of indexed government bonds began in South Africa (2000), Bolivia (2002), and Austria and Italy (2003) (see Deacon, Derry, and Mirfendereski, 2004). Germany began issuing indexed government bonds in 2007, and in October 2013, Japan resumed indexed government bond issuance after a five-year hiatus. Denmark began issuing indexed government bonds in 2012, partly in response to demand from pension funds.

Indexed bonds have gained in popularity as markets have matured and investors have become better acquainted with their characteristics. In France, for example, indexed government bond issuance has grown steadily over the past decade, the state's goal has been to have 15% of new bond issues in indexed series. Indexed bonds have become more prominent in Italy, Germany, and other countries as well (Danmarks Nationalbank, 2012). The most active indexed government bond markets are in Australia, Canada, France, Sweden, the UK, the US, Brazil, and Israel.

Other countries have experimented with indexed bond offerings in limited amounts or over defined periods of time, including Argentina (1971-1991), the Czech Republic (1997-2002), Finland (1945-1968), India (one bond in 1997), Norway (two five-year government bonds issued in 1982), and Peru (1994). Indexed mortgage bonds have been issued in Denmark and Ireland. In addition, banks and firms – and, in some instances, municipalities and utility companies – have issued indexed bonds in relatively large volume in Germany, Holland, Norway, Portugal, Spain, and Switzerland (Deacon, Derry, and Mirfendereski, 2004).

Examples of the use of indexation: Denmark

By 1982, when issuance of indexed mortgage loans began in Denmark, inflation had been hovering at or above 10% per year for nearly a decade. The idea behind the loans was to avoid inflation risk, as well as to increase the supply of relatively long housing loans and lighten the debt service burden early on in an inflationary environment. The capital markets in Denmark underwent radical changes in the early 1980s, and in fact, indexed loans were introduced around the time that stability increased in the asset markets and interest rates were determined increasingly by international rates. It was decided to tax only real interest on indexed loans but to tax nominal interest on non-indexed loans. Interest rate subsidies were also higher on nominal instruments. These taxation rules, which provided for different treatment of indexed versus non-indexed debt, strongly affected who chose these instruments (Lunde, 1997).

5. They are also a welcome addition to central banks' analytical tools for monetary policy, as a comparison of returns on indexed and non-indexed bonds provides a reliable indication of developments in inflation expectations.

Indexed bonds issued to finance subsidised housing and property leasing partnerships accounted for over 80% of issued indexed bonds. About two-thirds of them were owned by pension funds. Pension savings were tax-free, and pension funds were large buyers of the bonds. At this point in time, nominal interest rates in Denmark were around 20% and inflation about 10%, but interest on the indexed bonds only about 2.5% per year. As a result, they sold at huge discounts. In December 1982, a tax was levied on pension fund returns, but indexed bonds in their portfolios were exempt. Their prices surged by 60% immediately.

Among the general public, demand for indexed loans was limited. In 1996, issuance of new indexed loans declined, and the amount issued was well below the amount repaid. This limited demand was due to the fact that indexed loans were subject to a different set of rules than non-indexed loans. For instance, it was only permissible to grant indexed loans for new construction. In addition, the borrower bore the prepayment risk. Prepayments on indexed loans were made only at market value, the borrower buying the financing instruments in the market and delivering them to the lender. The above-mentioned difference in tax treatment and the more generous entitlement to reimbursement of interest on non-indexed loans were factors as well. Although the set-up for indexed mortgage lending in Denmark was flawed in many respects, it cannot be concluded that such loans are undesirable.

> *One must remember that index-linked mortgage bonds and loans are supplements to the range of securities and can make further diversification of the portfolios possible. Indexed loans should therefore be available (Lunde, 1997, p. 420).*

Examples of the use of indexation: Israel

The Icelandic Government was a pioneer in the use of indexation in the 20th century. Israel has a long tradition of using indexation as well. In Israel, wage indexation was introduced before mid-century, and in the 1950s, long-term government bonds and long loans to households were indexed as well, as were life insurance and bank deposits. Loan indexation was practically abandoned for a short period in the 1960s but then became more common again. Reference figures in the tax system were linked to the price level in the mid-1970s, and indexation of house purchase agreements, rent payments, property insurance, and some short-term loans was introduced thereafter (Shiffer, 1986). Indexation was considered to diminish the negative effects of inflation, but indexation of wages and tax brackets, together with a falling exchange rate, played a role in pushing inflation upwards after 1975 (Offenbacher and Stein, 2003). As inflation diminished and stability was re-established in Israel, the use of indexation diminished as well. It is still commonly applied to government and corporate bonds, however. Non-indexed variable-rate mortgage loans have become more common in Israel in recent years and are considered to have exacerbated risk in the mortgage lending market. Indexed mortgages became popular again in the wake of the global financial crisis, but in the past two years non-indexed variable-rate mortgages have gained

ground once more. As of year-end 2012, they accounted for about a third of mortgage loans in Israel (Bank of Israel, 2013).

Examples of the use of indexation: Chile

Although indexation is far less common in most countries than it is in Iceland, there are a few countries that have applied it more extensively than Iceland has. Indexation is ubiquitous in Chile, where goods prices are often presented in indexed units of account, which were introduced in 1967. The indexed unit of account (unidad de fomento, or UF) was calculated quarterly at first, and then monthly (from 1975 to 1977), and since then it has been updated daily, with a bridge where the preceding month's index is used from the time it has been calculated. Before the tenth day of each month, when previous month's index is published, the index from the second-last month is used (Shiller, 2002).

Early in the 1980s, soon after the practice of daily calculation was introduced, use of the UF grew markedly. Indexation of deposits is comparable to that in Iceland, and 90-day accounts have been index-linked. Exchange rate linkage based on the US dollar is permitted for deposits with maturities of over 30 days. Most Chilean mortgage loans, motor vehicle loans, and long-term government bonds are indexed as well. All tax payments are indexed, and pension benefits and rent payments are linked to the index, to name a few items. Real estate prices are often quoted in UFs – that is, the price is linked directly to the index measurement, and the "ticket price" is the multiple of the index that must be paid when the purchase takes place. As in Israel, use of indexation has diminished in Chile in recent years, although some 90% of all mortgage loans bore fixed real interest rates as of 2008 (UN-HABITAT, 2009).

Similar forms of indexation are practised in many other countries, although perhaps not as much as in Chile. A comparable indexed unit of account was created in Ecuador in 1993, as well as in Mexico and Colombia in 1995, where indexation is used for mortgage loans, among other things. A similar unit based on the wage index has been used in Uruguay for indexation of pension benefits and, since 1996, for government bonds.

By the beginning of this century, countries in South America had made considerable progress in controlling inflation. Although some of them had adopted systems similar to that in Chile, others were trying to reduce the use of indexation, an idea that has also been aired in Chile. Shiller (2002) points out that the connection between inflation developments and the promulgation of indexation does not indicate that indexation is inflation-inducing. The same does not apply to indexation of wages, however, which functions quite differently. It is known from experience and from theoretical research that wage indexation can simulate inflation.[6] When wages are negotiated in terms

6. Indexation was widely discussed among economists in the 1970s, particularly indexation of wages. See, for example, Friedman (1974) and Fischer (1977). Turnovsky (1983) showed that indexation of wages impedes the use of exchange rate policy to mitigate volatility in real variables. In Turnovsky (1986), the author researched the connection between the most advantageous indexation and monetary policy in small, open economies.

of currency units (that is, non-indexed), inflation erodes purchasing power. Wage negotiations that provide for the maintenance of real value via indexation, however, affect the wage-earner's expectations and put in place a spiral that maintains inflation. Jadresic (2002) is of the opinion that rigorous discipline is needed to keep inflation low in order to prevent the linkage of wages to a lagged price index from triggering further price increases.

4 Various aspects of indexation

4.1 Indexed bonds

Generally speaking, loan agreements involve the exchange of the loan amount for gradual repayment. The borrower reimburses the borrowed amount, plus a fee for the use of the borrowed funds, and the agreement specifies how many payments shall be made and determines the repayment period. Also negotiated are interest payments, which are the fee paid for the use of the money, and a premium for various types of risk associated with the loan.

As is discussed above, indexation is one way to eliminate the uncertainty that develops concerning the effect of volatile inflation on the real value of loan or bond payments. Indexation mitigates this uncertainty and therefore reduces the risk premium. Real rates on indexed bonds will therefore be lower than those on comparable non-indexed bonds (see, for example, Reschreiter, 2004). Indexation can also enhance bond market effectiveness in countries where inflation is likely to be volatile. It mitigates the risk of issuing bonds, but it also mitigates the risk of owning them. An indexed bond is actually an agreement providing for the real value of the bond payments.

A portion of the interest payment on non-indexed bonds is intended as a fee for the estimated erosion of the money over the period of the loan. Because the value of the money is not a fixed quantity, the value of the payments is uncertain. This uncertainty therefore varies directly with the volatility of the value of the money and the length of time until the loan is repaid. Determining an interest rate that accounts for the estimated erosion of the value of money during the loan period is an imprecise science, especially when price developments are uncertain or the term of the loan is long. The actual value of the contractual loan payments therefore becomes highly uncertain. Applying indexation to the bond fixes the real value of the instalments, so that they are a known quantity from outset (see Box 3).

Box 3

Nominal and real bond payment flows

A comparison of payment flows on non-indexed and indexed bonds is shown in Charts 1a and 1b. The examples are based on an annuity bond, where payments are made in five equal annual instalments. It is clear that the non-indexed bond provides for fixed nominal payments, but assuming the presence of inflation, their value diminishes over time. The indexed bond, on the other hand, provides for equal payments in real terms, so that their nominal value will increase in the presence of inflation. The uncertainty about the real value of the payments has been eliminated, however. In other words, the inflation risk has disappeared.

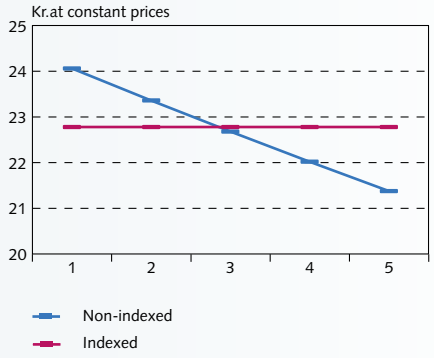
Chart 1a

Nominal value of payment flows on amortised bonds[1]

1. Five annual instalments. Assuming 3% inflation and 4.5% real interest.

Chart 1b

Real value of payment flows on amortised bonds[1]



1. Five annual instalments. Assuming 3% inflation and 4.5% real interest.

4.2 Indexation of mortgages[7]

A mortgage is in most cases the largest financial obligation an individual takes during this lifetime. It can be difficult to finance long loans, as the value of the payments is uncertain. Indexation facilitates credit system funding, as it establishes the value of the payments.

Indexation is also one of many ways to smooth the real debt service burden over time. Such solutions are often used to help households to service debt for investments such as housing. The main disadvantage of conventional non-indexed instalment loans is the heavy debt service, particularly early in the repayment phase, when little principal has been paid down and interest is calculated on a large amount. The bigger the loan relative to income, the bigger obstacle to the capacity to pay this becomes.

Debt service on long loans can be smoothed through other means than indexation, however. Amortisation also lightens the payments during the early part of the loan period, and lengthening the maturity of the loan can do the same. As is shown below, debt service develops differently over the lifetime of the loan, depending on which of these smoothing methods is chosen. The same is true of the outstanding balance of the loan.

7. This section is based on Box 4.3 of the Parliamentary Special Investigation Commission Report on the Housing Financing Fund, etc., Vol. 1 (pp. 45-47).

Debt service and outstanding loan balance

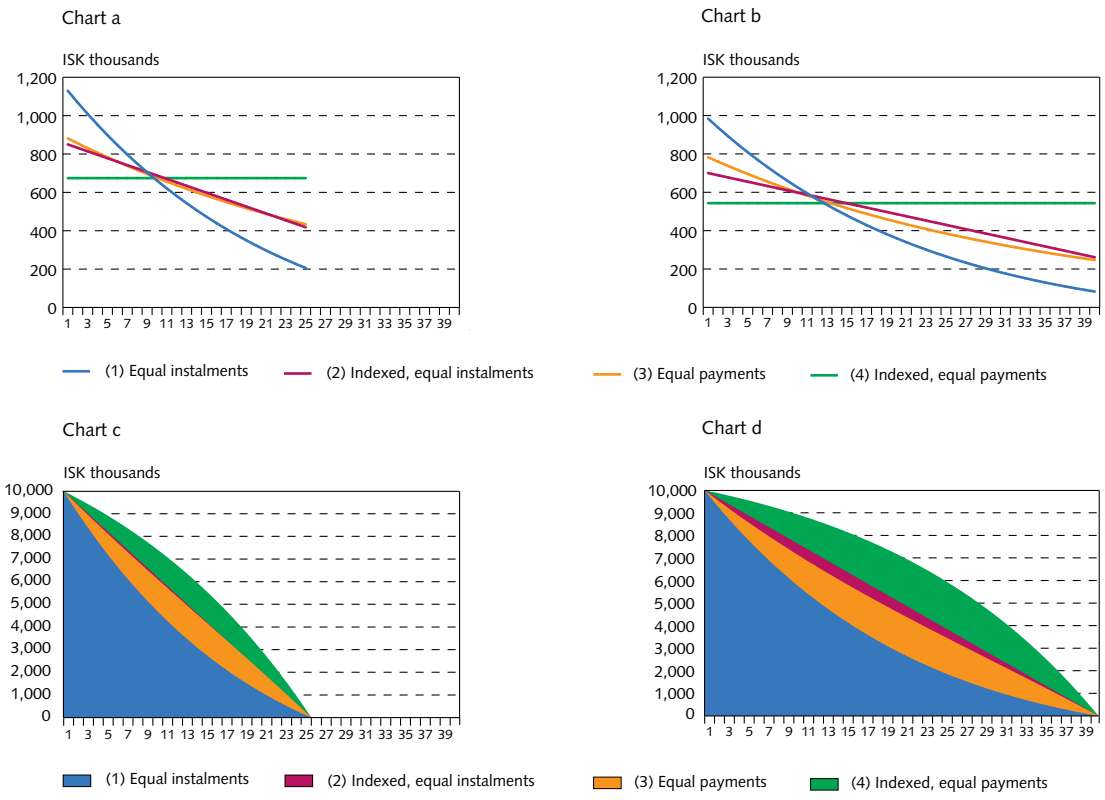
Many factors affect the repayment profile of a loan, including its outstanding balance. The amount of the loan and the interest rate naturally affect the debt service burden, but other aspects of the loan do as well. The repayment profile and outstanding balance of eight different types of loans are shown in Chart 5. All of the loans are for the same amount (original loan amount 10 m.kr.), and all of them bear a real interest rate of 4.5% (inflation is set at 3% for the entire loan period). Nonetheless, the repayment profiles vary greatly.

Non-indexed loans with equal instalments

In Chart 5(a), the blue line (the steepest one) shows how the real value of each year's payments declines over time in the case of a non-indexed loan with equal instalments and a fixed nominal interest rate.[8] Debt service is extremely high at the outset. The example shown in the chart assumes a real interest rate of 4.5% and an inflation rate of 3%. The nominal rate on the loan is therefore 7.6%. In the first year, the borrower pays interest on the entire principal (7.6% of 10 m.kr., or 760,000 kr.) plus the first instalment (a twenty-fifth, or 4%, of the loan amount, or 400,000 kr.). The total payment is therefore

Chart 5

Repayment profiles, 25-year loan[1]



1. Charts (a) and (b) show the repayment profiles of the loans (ISK thousands per year), and Charts (c) and (d) show how the outstanding balance develops over the lifetime of the loans (in ISK thousands). All amounts are shown at the price level of the year in which the loan is taken. The charts at the left, (a) and (c), show developments in 25-year loans, and the charts to the right, (b) and (d), show developments in 40-year loans.
Sources: Author's calculations.

8. If wages are fixed in real terms – that is, if they follow the price level – debt service relative to wages develops accordingly.

1,160,000 kr. nominal value, or 1,126,000 at the price level of the baseline year. Over time, the loan is paid down, the outstanding balance declines, and interest is calculated on an ever-decreasing principal amount. The real value of the payments (and therefore the debt service) also declines because the value of the payments deteriorates by about 3% per year. Even though the inflation and interest rates are assumed to be relatively modest, the debt service burden falls very rapidly. Calculated at the price level of the year the loan was taken, the payment is 661,000 kr. in the tenth year, 323,000 kr. in the twentieth, and just under 206,000 kr. in the twenty-fifth and final year.

Because housing is usually expensive relative to disposable income, debt service on mortgages is usually very high at first, when interest is calculated on the entire principal amount. In consequence, it can be difficult for low-income borrowers with limited capacity to pay to obtain loan financing to purchase a home. In addition, wage-earners often have families to support in the early part of their working life, with the associated increase in consumption expense. Furthermore, many households allocate a larger share of their income to housing as the size of the family increases, if they are able to. In order to avoid staggering debt service in the early years, it is clearly advisable that prospective home buyers save money for a down payment and reduce the amount they need to borrow. This is a way to reduce debt service and make it more manageable. But this requires patience and either an effective rental market or other housing options. Another option is to try to find ways to back-load the debt service burden so as to make it lighter at first and heavier later on, when disposable income is usually higher. Several ways to do this are shown in Chart 5.

Indexed loans

Payments on non-indexed loans are high early in the repayment period because it is then that the interest rate burden is heaviest. This problem escalates as interest rates rise. One of the main determinants of interest rates on non-indexed loans is inflation. A portion of the interest payment is intended to compensate for the decline in value of the payments as a result of inflation. When a loan is indexed so that all payments change in line with the price level, the expected erosion in value of future payments is factored in, and the interest rate is commensurably lower. The example shown in Chart 5 assumes a real interest rate of 4.5% and an inflation rate of 3%. The nominal interest rate is then 7.6%, as in the previous example.[9] But if the payments are allowed to follow the price level, the interest rate is 4.5%. During the first years, the debt service burden will be considerably lighter than in the case of a non-indexed loan with fixed instalments. The debt service burden is shown with the red line in Chart 5(a). It rises gradually in comparison with the non-indexed loan. In the example, the first payment is about a fourth lower if the loan is indexed, and for the first third of the loan period the debt service burden is lower than for the non-indexed loan. The final payment on the indexed loan will be twice

9. This example ignores the factor mentioned above, that real rates are usually lower on indexed loans.

as high as that on the non-indexed loan, but at constant prices, the debt service burden has fallen by about half. Although the debt service burden is higher on the non-indexed loan, it is paid down faster and the borrower's equity rises more quickly during the first third of the loan period, as can be seen in Chart 5(c), where the slope of the blue line tapers much more steeply than the red one. The indexed loan, however, declines linearly as it is paid down.

Non-indexed amortised loans

Other things being equal, negotiating equal payments instead of equal instalments can be similarly effective in smoothing debt service over the lifetime of the loan. This approach involves creating a repayment profile featuring equal payments on each due date. At the beginning, interest weighs heavily in each payment, and only a small proportion is allocated to principal. With each payment, the amount allocated to interest declines and the amount allocated to principal increases, so that the total payment is always the same. At constant prices, the debt service burden declines, as the yellow line in Chart 5(a) shows. In the example shown in the chart, the effect is similar to that obtained with equal instalments on an indexed loan. The outstanding balance also declines similarly, as can be seen in Chart 5(c). The higher the interest rate, the slower the accumulation of equity, as the interest rate affects not only the amount paid but also the weight of interest in each payment.

Indexed amortised loans

It is possible to enhance this effect even further by combining indexation and amortisation, which yields a repayment profile like that shown with the green line in Chart 5(a). All of the payments are equal in real terms, and the first payments are even lower than with the other loan types. In the example shown in the chart, the first payment is less than 60% of the first payment on a conventional amortised loan. Therefore, equity is accumulated even more slowly than with the other loan types, as interest comprises a greater percentage of the early payments (and principal a smaller percentage) than with an indexed loan with equal instalments. The outstanding balance does not decline linearly in this example, however; it tapers off slowly at first and rapidly towards the end of the loan period.

40-yr loans

Chart 5(b) shows the repayment profiles of loans corresponding to those in Chart 5(a), but with the loan period lengthened from 25 years to 40 years. The chart shows that the first payment on a non-indexed amortised loan declines by nearly 13% and debt service is lighter for the first 14 years. By the time the shorter loan is paid up, 16% of the longer loan is still outstanding, at constant prices.

The first payment on an indexed loan with equal instalments declines by about 18% and debt service is lighter for 23 years, or nearly the entire term of the shorter loan. By the time the 25-year loan is paid off, 37.5% of the 40-year loan remains, both in terms of the remaining loan period and the outstanding amount, at constant prices.

Table 1 Nominal and real values of repayments on indexed and non-indexed 40 years mortgages

	Non-indexed		*Indexed*		*Real value of payments on non-indexed loans depends on inflation*				
Year	*Nominal*	*Real*	*Nominal*	*Real*	*-2%*	*2%*	*3%*	*4%*	*8%*
10	805,980	?	?	543,431	986,424	661,184	599,725	544,491	373,325
20	805,980	?	?	543,431	1,207,265	542,401	446,252	367,839	172,922
30	805,980	?	?	543,431	1,477,549	444,958	332,053	248,499	80,096
40	805,980	?	?	543,431	1,808,345	365,021	247,079	167,877	37,100

Lengthening an amortised loan from 25 years to 40 reduces debt service by 11%. According to the example in the chart, about a third of the original loan amount (at constant prices) is still outstanding when the shorter loan has been paid off – that is, when 15 years remain on the longer loan. Lengthening an indexed amortised loan reduces each payment by over 19%. Reduction of principal is slowest for this loan, and after 25 years, when the shorter loan has been paid off, over 58% of the principal of the 40-year loan remains, at constant prices.

Table 1 illustrates how the real value of the payments on the non-indexed loan is affected by developments in inflation. It shows the amount of annual instalments after 10, 20, 30, and 40 years. Payments are initially much higher on the non-indexed amortised loan than on the indexed loan, as a portion of the interest on the non-indexed loan is due to expected inflation (this example does not include a premium for uncertainty about inflation developments). The real value of the payments on the non-indexed loan is not known in advance (indicated by a question mark in the table). The real amount of the payments on the indexed loan is known and does not change even though inflation deviates from the original assumption (although the nominal amount is not known in advance). The last five columns in the table give various examples of how payments on the non-indexed loan develop in real terms, depending on average inflation over the loan period. The example assuming 3% inflation is the one used to determine the interest rate on the loan (although no premium for uncertainty about inflation is included).

4.3 Calculation of mortgage payments

Payments on indexed amortised loans are calculated in exactly the same way as for non-indexed loans, except that interest is considerably lower. Interest is lower on an indexed loan than on a non-indexed loan because there is no need to factor in a fee for the expected erosion of the money by applying a higher interest rate, as payments are negotiated at constant prices. The inflation risk that accompanies non-indexed loans reflects a random transfer of value due to unforeseen price level changes. With indexation, this uncertainty is eliminated, and the risk premium related to it is not applied.

When the repayment profile of an indexed loan has been established, each instalment is entered at the price level of the date of payment because the loan payments were negotiated at constant prices. This is executed as follows: the payment, as calculated based on the original amount and the interest specified as the real interest rate, is multiplied by a coefficient that is calculated as the current value of the index used for indexation divided by its value at the time the loan was

issued. The restated outstanding balance of the loan does not enter into this calculation and therefore has no effect on the payments that take place.

It is possible to divide each payment on an amortised loan into interest and principal. Based on the principal amount, it is possible to calculate the outstanding balance at any given time, which reflects the value of the payment flows that remain. Because the payment flows are restated in terms of the current price level, the outstanding balance (the value of the remaining payments) must also be restated in terms of the current price level; otherwise, it is impossible to assess the value of the payments correctly. Whether the value of the outstanding balance is calculated before and after each payment or not, or whether it is calculated annually or not, makes no impact on the value of the payment profile, and it has no effect on instalments, interest, or the value of the remaining payments.

The equation used to calculate instalments on an amortised loan is as follows:

$$(1) \qquad A = (i/n)[1-1/(1+i/n)]^{-nT}X$$

where X is the loan amount, A is the amount of each payment, i is the nominal interest rate on the loan, n is the number of payments per year, and T is the loan period in years. This amount is always the same and is entirely independent of the outstanding balance at any given time.

As is stated above, the difference between non-indexed and indexed loans is that with a non-indexed loan, the nominal value of the loan payments is negotiated, irrespective of changes in the price level, while payments on indexed loans are negotiated at constant prices. This causes two changes in Equation (1). The first is that interest is usually considerably lower on an indexed loan, as it is calculated using the real rate and not the nominal rate, and the risk premium is lower. The other change is that, in order to determine the amount to be paid at any given time, it is necessary to consider changes in the price level, as indexed loans are negotiated at constant prices. Therefore, the following equation is used to calculate instalments on an indexed amortised loan:

$$(2) \qquad A_t^* = (r/n)[1-1/(1+r/n)]^{-nT} X(P_t/P_0)$$

where r is the real rate on the loan, P_t is the value of the indexation index when payment number t is remitted, and t is 1 for the first payment and increases by 1 each time. For the last payment, then, $t = nT$. The base index for the loan is the value of the index used for indexation at the time the loan was taken; that is, P_0.

Because it does not matter in which order the variables are multiplied, it does not matter whether the loan amount is first restated at the correct price level and the instalment calculated thereafter, or the instalment is calculated based on the original loan amount and then restated at the correct price level. When the loan agreement states that the instalments and interest are restated at the price level of the time when payment takes place, it makes no difference whether the outstanding balance of the loan is updated to the current price level. It

has no effect on the debt service burden of the outstanding balance, and therefore has no effect on the borrower's actual debt position, whether (a) the principal is first restated at the current price level and interest and instalments calculated thereafter, or (b) the interest and instalments are first calculated based on the original principal amount and then restated at the current price level. In short, the order of operations does not affect equations requiring multiplication only.

4.4 Indexation, mortgages, and debt problems

Mortgages are usually granted for long periods of time – often for decades. An effective mortgage lending market therefore requires sound long-term financing. Efforts to provide this were not very successful when the Icelandic mortgage lending market was being developed during the 20th century, mainly because the króna had a tendency to weaken and the price level to rise. Interest rates were determined by the Government and were systematically kept low. As a result, the value of loan payments was often far below the value of the loan amount; that is, real interest rates were negative. As is stated above, this problem was eventually solved by linking loan payments to an index, which is called indexation. This smoothed the way for mortgage financing and made it possible to grant mortgage loans on market-based premises rather than allocating them as subsidies from the Government (see also Lúdvík Elíasson, 2012).

After interest rate decisions were liberalised in 1984-1986, the conditions developed for non-indexed loans on market-based premises. Inflation remained high until the 1990s. To start with, non-indexed loans were granted primarily for short periods of time and usually bore variable interest rates. In a historical light, interest on non-indexed loans was usually unfavourable in comparison with indexed loan interest as long as fear of inflation remained widespread. Non-indexed loans gained gradually in popularity as inflation remained under control for longer periods and the pricing of the loans became more competitive with that of indexed loans.

In the first decade of the 21st century, wages rose well in excess of prices, particularly in 2005 and 2006, and taxes were cut. Asset prices rose steeply, as did real wages. Optimism reigned, access to credit opened up, and the króna remained strong. During the upswing, many were tempted to borrow and to lend on the assumption that the upswing was a permanent situation. When the bubble burst, it came to light that many borrowers had taken loans to finance goods, homes, motor vehicles, and overseas travel that they could not afford, and they had difficulty servicing their debt.

Household leveraging increased sharply during the boom years, not because of indexation but because households took loans and credit institutions granted them at a time when borrowers and lenders alike were unrealistically optimistic about the borrowers' ability to pay. When all was said and done, the upswing proved to be an abnormal situation, and the same problems surfaced in other countries facing the same conditions, irrespective of whether loans were indexed or not.

4.5 Money illusion

Money illusion – that is, when no distinction is made between changes in nominal and real prices – appears to play a major role in opposition to indexation. Many appear to believe that inflation erodes households' purchasing power because wages lag behind the price level and wage-earners are therefore unable to keep pace with their indexed loan payments. However, wages change more frequently where inflation is high, and wages are usually determined for several months at a time, based on expected developments in prices, among other factors. The main consequence of unexpected inflation is the transfer of value between borrowers and lenders, and not declining purchasing power. The Nobel laureate Robert J. Shiller (2002) points out the general consensus that inflation is harmful to all parties. Shiller says that antipathy towards indexation is also due to a lack of understanding of the uncertainty that inflation causes about price levels in the distant future.

> *People who are owed money normally have no legal resources 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? (Shiller, 2002, p. 131).*

Box 4

"My loans grow and grow, no matter how much I pay"

A common complaint from homeowners with indexed mortgages is that their outstanding loan balance never appears to diminish, even though payments are made on time. But closer scrutiny reveals a misunderstanding related to the phenomenon known as money illusion.

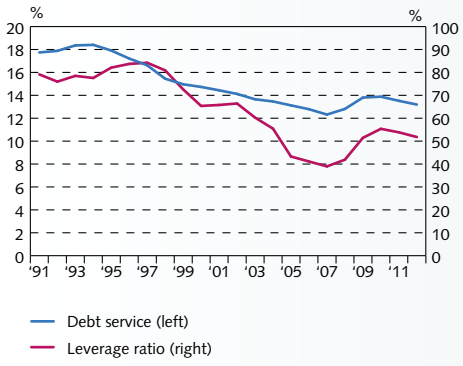
Nowadays it is common that mortgages are granted for a period of 40 years. For a 5 m.kr. mortgage taken in 1990 and bearing a real interest rate of 5%, payments on the loan from 1991 through 2012 would total 6.4 m.kr. at the original price level. After accounting for inflation, payments for 1991 would have totalled 311,000 kr. This amount would have risen each year in line with the price level, and by 2012 the payment would have totalled 796,000 kr. Adding all of the payments from 1991 through 2012 together (which is meaningless, as is pointed out in the main text of the paper) gives a total of 10.5 m.kr. and leaves an outstanding balance of 9.3 m.kr. But such speculations often ignore the fact that, over this two-decade period, neither wages nor the value of the underlying asset has stood still. If wages and house prices move in line with prices, it comes to light that a monthly salary of 135,000 in 1991 would have been equivalent to 345,000 in 2012; moreover, the debt service burden would actually have remained unchanged at 18% of total wages, and the debt on the home would have fallen by about 25% of the value of the property.

If we assume that, during this period, wages have developed in line with the Statistics Iceland wage index, house prices have developed in line with the house price index, and depreciation is estimated at 1.5% per year, the debt service burden will have developed as is shown in Chart 1. The chart shows that, based on historical data, the debt ratio has declined more than it would have done at constant prices because house prices have risen in excess of the general price level during the period. The debt service burden has grown lighter than at the outset because of the increase in real wages in the

Chart 1

Developments in debt service and leverage ratio, 40-year indexed mortgage[1]

% of GDP



1. Assuming 1.5% depreciation per year. House prices follow the house price index, and wages follow the wage index. The initial loan-to-value ratio is 80%, and debt service is 18% of total wages at the time the loan is taken.

Sources: Statistics Iceland, author's calculations.

interim. The chart shows clearly the temporary setback from 2008 through 2010, which is related to some extent to the rapid decline in these ratios between 1997 and 2007. It can also be seen that the years from 2005 through 2008 were an especially unfavourable time to take on a leveraged house purchase, as debt service and indebtedness levels rose sharply from 2008 through 2010. This trend has reversed in the past few years, however.

4.6 The legality of indexation

On 8 October 2013, the Supreme Court requested an advisory opinion from the EFTA Court on the legality of indexation.[10] Cases recently filed before the Icelandic courts centre, among other things, on whether payment schedules and information on the annual percentage rate of charge are in compliance with national legislation on consumer loans and the EU Directives on which it is based, and whether it is permissible to demand payment of total borrowing costs and indexation not specified in the loan agreement. It is therefore appropriate to review the EFTA Surveillance Authority's (ESA) answer to a query on the legality of indexation in Iceland, which was published on 25 February 2013.[11] The response from ESA clearly states as follows:

1. The Directive does not apply to mortgages or loans taken for real estate purchase. If Iceland chooses to include collateralised loans under legislation on consumer loans, this is done according to national law. From EFTA's point of view, the Directive does not apply to mortgage loans.
2. The Directive discusses disclosure of loan terms, but it does not discuss what those terms are or which methods are used to calculated interest and other costs under a loan agreement.
3. The Directive does not discuss indexation of consumer loans; therefore, it does not prohibit it. Neither does Directive 93/13/EEC on unfair terms in consumer contracts prohibit indexation. The annex to the Directive states that it does not hinder indexation where it is permitted by national law, "provided that the method by which prices vary is explicitly described."

Consequently, it seems far-fetched to expect indexation to be deemed illegal on the grounds that it is inconsistent with EU directives on consumer loans.

4.7 Indexation imbalances

The term indexation imbalances refers to the difference between deposit institutions' (DMB) indexed assets and liabilities, a topic that has been under discussion for at least 20 years. Interest in this topic tends to surge when imbalances are substantial or when inflation deviates markedly from expectations. Particular attention has therefore been directed at the resulting losses or profits carried on the DMBs' books.

10. http://haestirettur.is/domar?nr=9075 [in Icelandic].
11. http://www.eftasurv.int/media/public-documents/657326.pdf.

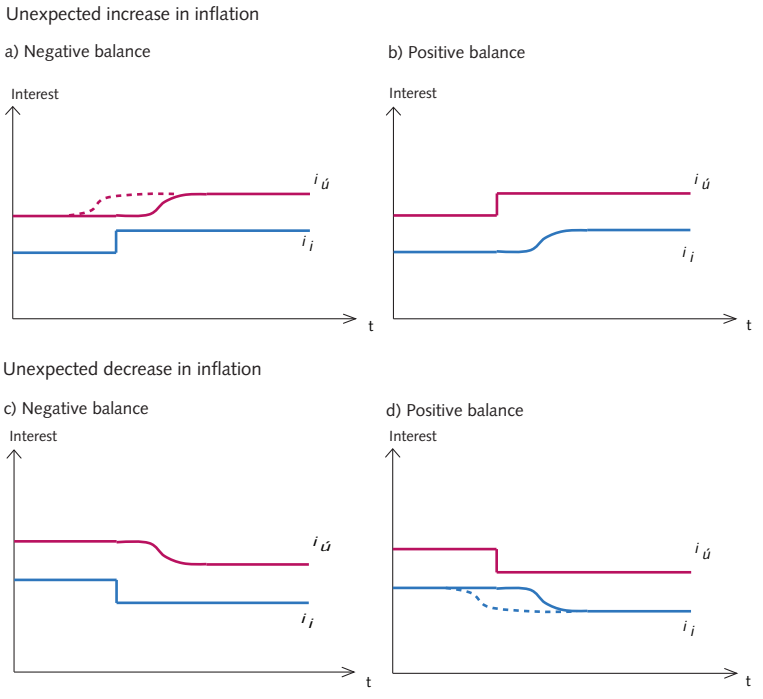
Over time, there have been periods characterised by negative indexation imbalances (where DMBs' indexed liabilities exceed their indexed assets) and positive imbalances (where indexed assets exceed indexed liabilities). Ever since indexation of loans for periods under five years and deposits for terms less than three years was discontinued, the banks' indexation imbalances have generally been positive. This is because indexation, like variable-rate loans, is a means of reducing the uncertainty associated with long loan agreements, and banks' assets tend to have longer maturities than their liabilities.

Indexation imbalance and interest rate differential

Banks earn the income needed to fund their operations through interest rate spreads, or differentials; i.e., by lending money at rates higher than the rates they pay for deposits and other funding. It does not matter to the bank whether loans are indexed or not, and if future inflation is absolutely certain, it does not matter whether there are indexation imbalances between funding and lending or, if imbalances exist, whether they are positive or negative. But if inflation changes unexpectedly, the presence of such imbalances does matter, as does the direction of the imbalance (i.e., whether it is positive or negative).

Charts 6a-6d give a simple example illustrating the connection between indexation imbalances and the effects of unexpected inflation on credit institutions' operating performance (see also Box IV-1 in *Financial Stability* 2013/1). The charts show how banks' average deposit interest and average lending rates develop over time. Initially, they are in balance and inflation develops in line with expectations, and the interest rate spread – that is, the difference between deposit

Chart 6
Unexpected changes in inflation, interest rate differential and indexation imbalance[1]



1. Interst rates on loans ar indicated by $i_{ú}$ and deposits rates by i_i.
Source: Central Bank of Iceland.

interest (the blue line on the bottom) and the lending rate (the red line at the top) is a measure of the bank's income. Then inflation takes an unexpected turn. In Chart 6a, deposits are indexed and loans are not; therefore, the indexation balance is negative. A sudden spurt in inflation causes an immediate rise in the bank's interest expense. The bank responds to the inflation spurt by raising its lending rates. It is not possible to review the interest rate clauses in all loans simultaneously, but rates on new loans take account of the fact that inflation has risen. Over time, interest rates on outstanding loans are gradually raised, loans at lower rates are gradually paid up, and newer loans bear higher rates. The interest rate spread has narrowed markedly as a result of the unexpected spike in inflation but gradually broadens again. The inflation spike therefore causes a temporary drop in the bank's income; in other words, the bank loses if the indexation balance is negative.

Chart 6b illustrates the results of an unexpected surge in inflation when the indexation balance is positive; that is, when loans are indexed but deposits are not. Lending rates rise immediately when inflation rises, but deposit interest adjusts over time. Under these circumstances, an unexpected rise in inflation triggers a temporary rise in the bank's income.

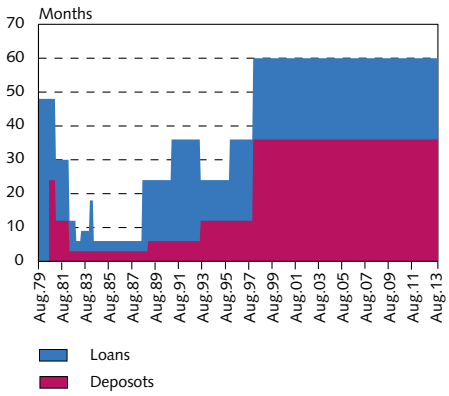
The effects of unexpected disinflation are shown in Charts 6c and 6d. Chart 6c shows that, if the indexation balance is negative, an unexpected dip in inflation reduces funding costs and widens the interest rate spread. If the indexation balance is positive, however, an unexpected drop in inflation causes a temporary narrowing of the interest rate spread, thereby reducing the bank's income until deposit rates have been adjusted downwards (Chart 6d).

Indexation imbalances therefore subject the bank's income to uncertainty. An unexpected inflation spike when the imbalance is positive or an unexpected dip in inflation when it is negative causes the interest rate spread to widen temporarily, increasing the bank's income. Conversely, an unexpected inflation spike when the imbalance is negative or an unexpected dip in inflation when it is positive causes the interest rate spread to narrow temporarily, decreasing the bank's income. If a bank has a negative indexation imbalance and expects inflation to increase, it raises its lending rates immediately, as is shown by the broken line in Chart 6a. Similarly, if a bank expects a drop in inflation and has a positive indexation imbalance, it lowers its deposit rates immediately, as is indicated by the broken line in Chart 6d. The conclusion to be drawn from all this is that if a bank has an indexation imbalance, whether positive or negative, its earnings are subject to greater uncertainty, which it can be expected to try to mitigate – for instance, by increasing its interest rate spread. Other things being equal, the more the competition in the banking market, the less opportunity there is to maintain a wide interest rate spread and the more important it is to keep indexed assets and liabilities in balance.

DMBs' indexation profits and losses

DMBs can sustain losses or profits from imbalances between indexed assets and liabilities, no matter whether the imbalances are positive or negative. The key factor is that unexpected inflation – a deviation in

Chart 7
Minimum commitment period for indexed deposits and loans



Source: Ministry of Commerce (1998, p. 13).

price level changes from that which is expected or considered probable – affects banks' interest rate spreads if there is an imbalance between indexed assets and liabilities, just as when there is an imbalance in maturities of deposits and loans.

Runaway inflation was a persistent problem in Iceland until about 20 years ago. When disinflation was at its most rapid, in late 1983 and 1984, the banks' indexation balance were positive, and they sustained losses because deposit rates were not lowered immediately. After the banks were permitted to decide their own interest rates in the mid-1980s, indexation of deposits became more common, and the banks' indexation imbalances were negative. In 1987, the indexation balances turned around because of an increase in indexed lending and because the banks' required reserves with the Central Bank were transferred to indexed accounts. In addition, competition for saving grew stronger with the sale of indexed savings bonds as an alternative to conventional deposit accounts. In response to the positive indexation imbalances, it was decided to ban indexation of loans for periods under two years (instead of six months), and the minimum tied period for indexed deposits was lengthened from three months to six months. These actions led to ongoing negative indexation imbalances.[12] In the ensuing years, the prohibition of indexation was applied to deposits and loans for increasingly long periods (see Chart 7). As is stated above, the last such change took place in early 1998, when the minimum commitment period for indexed deposits was lengthened from one year to three and it was prohibited to issue indexed bonds for less than five years.

In recent years, the banks' indexation imbalances have been positive; that is, their indexed assets have exceeded their indexed liabilities. As is stated above, whether banks record gains or losses because of indexation imbalances is determined mainly by unexpected changes in inflation. In order to estimate such a "profit" on a bank's indexation balance, it is necessary to compare the bank's inflation estimate to observed inflation. The profit on the indexation balance is then as follows:

$$(3) \qquad \Pi_V = [(1+\pi_t)/(1+\pi^e_{t-1,t})-1]\,(E_V - S_V)$$

where Π_V is the profit on the indexation balance, E_V is the bank's indexed assets and S_V is its indexed liabilities, π is inflation for the period, and π^e is the expected rate of inflation. This variable can be random, and the bank does not control whether it is positive or negative. Banks' interest rate decisions must be based on a specific expected rate of inflation plus a premium for elevated risk, which is greater as the imbalance grows larger.

It therefore appears obvious that the interests of banks, like others, are best protected if inflation is as predictable as possible – i.e., moderate and stable. In this regard, banks' interests coincide with the interests of other players in the economy. It is important to note, however, that indexation as such does not generate a profit for banks. If

12. Further discussion can be found in Björgvin Sighvatsson (1994) and Bjarni Bragi Jónsson (1998).

indexation did not exist, nominal interest rates would adjust and yield a comparable interest rate differential.

4.8 Indexation and the effectiveness of monetary policy

Indexation of long-term loans and its impact on the effectiveness of monetary policy are discussed in Ásgeir Daníelsson (2009). Daníelsson points out that both indexation and amortisation of loans reduce debt service on new loans and mitigate fluctuations in the real debt service burden. However, other things being equal, indexation leads to an increase in credit supply in inflationary countries, thereby enhancing the effectiveness of the domestic financial market, which tends to enhance the effectiveness of monetary policy (see also Bjarni Bragi Jónsson, 1998). To the extent that monetary policy affects new lending, the effects are more palpable when long-term loans bear nominal interest because such loans are paid down faster and, as a result, new loans constitute a larger share of the loan portfolio at any given time. Daníelsson also points out that monetary policy's limited impact on long-term real rates is not a uniquely Icelandic problem, as long-term real rates in small, open economies are affected to a large degree by global interest rates.

The issuance of indexed and non-indexed bonds that are comparable in other respects provides information on risk premia in the bond market, thereby giving a measurement of market agents' inflation expectations. This information is useful to central banks in monetary policy formation, although other factors in addition to inflation expectations affect the interest rate spread on the bonds (Garcia and van Rixtel, 2007).

4.9 Freedom of choice

The possibility of banning loan indexation has been aired recently in Iceland. The arguments in favour of such a ban include assertions that indexation exacerbates inflation, diminishes the effectiveness of monetary policy, and fosters indebtedness because debt service is lower early in the loan period.

It is pointed out above that indexation does not cause inflation (see also Fischer (1975) and Shiller (2002)). A certain risk of rising inflation expectations can develop if wages are indexed, but this depends primarily on the credibility and implementation of economic policy. Indexation of wages was discontinued in Iceland in 1983.

Earlier in this paper is a discussion of the connection between indexation and monetary policy. To that discussion it can be added that the more credible monetary policy is, the less difference indexation makes, and the more reliably independent the central bank is, the less incentive there is for the government to elicit an inflation spurt to reduce public debt at the expense of the general public (Garcia and van Rixtel, 2007).

Indexation reduces debt service early in the loan period, as do amortisation and lengthening of maturities. Debt service is one of the determinants of demand for credit, and the lower it is, the more willing borrowers are to take on debt. All measures or options that lighten the debt service burden are conducive to increasing the demand for credit.

Indexation is one of the options available for long-term loans. Prohibiting indexation would reduce the number options available, and a narrower range of choices generally leads to reduced general welfare. It is hardly likely that reduced welfare is actually the goal of those who support a ban on indexation.

The study by Campbell and Cocco (2003) is interesting in this context, in that it explores the circumstances under which floating-rate mortgages are more advantageous to the borrower than fixed-rate mortgages. The authors found that floating-rate loans mitigated volatility of principal, while loan payments were more stable with fixed-rate loans. They considered indexed fixed-rate loans to combine these two advantages: stability of both loan principal and debt service. They also considered such loans generally more beneficial for borrowers. In this context, attempts to deny borrowers the possibility of choosing such a loan appear poorly grounded.

5 Summary

This paper focuses briefly on selected aspects of indexation, in an attempt to shed light on certain points that are important for any well-grounded discussion of the pros and cons of indexation. The main points of focus are these:

- Price measurement, no matter in what currency, is an imperfect mechanism because the value of currency is constantly changing.
- A comparison of monetary amounts over time is meaningless unless the amounts are first entered at constant price levels.
- The main cost of inflation lies in the random transfer of assets between borrowers and lenders (debtors and savers) in the wake of unexpected inflation; i.e., inflation risk.
- Inflation risk is therefore greater with longer loans, which entail greater uncertainty about future developments in inflation. Indexation mitigates the risk of borrowing and lending by eliminating inflation risk.
- Indexation facilitates long-term financing, lightens the borrower's initial debt services, and generally reduces real interest rates.
- Indexation is emphatically not a uniquely Icelandic phenomenon.
- Issuance of indexed bonds has increased markedly in recent decades, and the number of countries that issue indexed bonds is constantly rising.
- Levels of indebtedness rose across the industrialised world during the period of cheap, abundant credit. Such growth in indebtedness does not stem from indexation.
- Opposition to indexation often appears based on the misconception that inflation implies erosion of purchasing power and that debt service on indexed loans rises constantly.
- The EFTA Surveillance Authority is of the opinion that EU directives on consumer loans do not imply any limitations on indexation of mortgage loans in Iceland.
- In countries with endemic inflation, indexation supports the issuance of long-term bonds, thereby improving monetary policy transmission along the yield curve. Issuance of indexed bonds also

supports monetary policy, as the interest rate spread between indexed and non-indexed bonds provides a reliable indication of developments in inflation expectations.
- A ban on indexation would reduce the number of options available to borrowers and thereby reduce general welfare.

References

Ásgeir Daníelsson (2009). Indexation and monetary policy. Central Bank of Iceland *Economic Affairs* no. 1.

Ball, L., G. Mankiw, and D. Romer (1991). The New-Keynesian economics and the output-inflation trade-off. In *New Keynesian Economics* (eds. G. Mankiw and D. Romer). MIT Press.

Bank of Israel (2013). Annual Report 2012.

Bjarni Bragi Jónsson (1978). Indexation of capital in Iceland. Central Bank of Iceland *Fjármálatídindi*, 25 [in Icelandic].

Bjarni Bragi Jónsson (1998). Financial indexation and interest rate policy in Iceland. Central Bank of Iceland *Special Publication* no. 3 [in Icelandic]..

Björgvin Sighvatsson (1994). Deposit institutions' indexation imbalances 1980-1993. Central Bank of Iceland *Fjármálatídindi*, 41, 38-50 [in Icelandic].

Campbell, J. Y., and J. F. Cocco (2003). Household risk management and optimal mortgage choice. *The Quarterly Journal of Economics*, 118, 1449-1494.

Danmarks Nationalbank (2012). *Danish Government Borrowing and Debt* 2011.

Deacon, M., A. Derry and D. Mirfendereski (2004). *Inflation-Indexed Securities*, 2nd ed. Wiley.

Fischer, S., (1977). Wage indexation and macro-economic stability. In Stabilization of the Domestic and International Economy (eds. K. Brunner and A. Meltzer). *Carnegie-Rochester Conference* Series 5. North-Holland.

Fischer, S., (1983). Indexing and inflation. *Journal of Monetary Economic*s, 12, 519-541.

Friedman, M., (1974). Monetary Correction. In *Essays on Inflation and Indexation* (ed. H. Giersch). American Enterprise Institute for Public Policy Research.

Garcia, J. A., and A. van Rixtel (2007). "Inflation-linked bonds from a central bank perspective" *Occasional Paper Series*, 62. European Central Bank.

Statistics Iceland (2008). Consumer price index in mid-January 2008. Press release no. 15/2008

Jadresic, E., (2002). The macroeconomic consequences of wage indexation revisited. In Indexation, *Inflation, and Monetary Policy* (eds. F. Lefort and K. Schmidt-Hebbel). Central Bank of Chile.

Lunde, J., (1997). Fifteen years with index-linked mortgages: successes and failures. *Netherlands Journal of Housing and the Built Environment*, 12, 401-422.

Lúdvík Elíasson (2012). Indexation and debt problems. *Morgunbladid*, 17 November 2012 [in Icelandic].

Mankiw, N. G. (2007). *Macroeconomics*, 6. ed. Worth.

Morgunbladid (1989). Ruling committee on indexation: Changed credit terms index must be considered as new. 24 January 1989 [in Icelandic].

Offenbacher, A., and R. Stein (2003). Dollarisation and indexation in Israel's inflation and disinflation: "There's more than one way to skin a cat". *Comparative Economic Studies*, 45, 278-305.

Reschreiter, A., (2004). Conditional funding costs of inflation-indexed and conventional government bonds. *Journal of Banking and Finance*, 28, 1299-1318.

Central Bank of Iceland (2013). *Financial Stability* 2013/1.

Shiffer, Z. F. (1986). Adjusting to high inflation: The Israeli Experience. *Federal Reserve Bank of St. Louis Review*, May 1986, 18-29.

Shiller, R. J., (2002). Indexed units of account: Theory and assessment. In *Indexation, Inflation, and Monetary Policy* (eds. F. Lefort and K. Schmidt-Hebbel). Central Bank of Chile.

Sigurdur Hallur Stefánsson, Kirstín Flygenring and Jón Þorvaldur Heidarsson (eds.) (2013). Parliamentary Special Investigation Commission Report on the Housing Financing Fund, etc. *Parliamentary Special Investigation Commission* [in Icelandic].

Turnovsky, S. J., (1983). Wage indexation and exchange market intervention in a small open economy. *NBER Working Paper* 1170.

Turnovsky, S. J., (1986). Optimal monetary policy and wage indexation under alternative disturbances and information structures. *NBER Working Paper* 2042.

UN-HABITAT (2009). *Housing Finance Mechanisms in Chile*. United Nations Human Settlement Program, Nairobi.

Ministry of Commerce (1998). *Review of Government Indexation Policy* [in Icelandic].

Thórarinn G. Pétursson (2007). The role of monetary policy. Central Bank of Iceland *Monetary Bulletin* 2007/3, 71-75.