At last: Inflation derivatives

Managing the impact of the GST on shareholder value

While inflation is recognised as a financial risk for most corporations, few attempts have been made to quantify the impact of adverse inflationary changes on shareholder value. The approaching introduction of a GST brings this issue into focus. JAMES GLOVER and QUANG NGUYEN discuss a corporation's potential exposure to inflation and how CPI derivatives can be used to hedge these exposures.

DR JAMES GLOVER is associate director, quantitative research, Deutsche Bank.

QUANG NGUYEN is senior manager, structured products, Deutsche Bank.

Modern corporations are often well versed in financial risk management techniques, particularly in interest-rate and foreign-exchange markets. Following academic research and the developments of practical techniques, there is a natural inclination to apply these methods to non-traditional areas of financial risks such as inflation (CPI risk).

While exposure to inflation risk is a key concern for many corporations, the financial impact which results from a change in inflation varies. As inflation is an economic variable whose fluctuations have significant financial consequences for capital managers, the development of inflation derivatives is a natural progression in the inflation-linked securities market.

THE IMPACT OF GST

In July 2000 the federal government will switch from the current wholesale sales tax and range of State-based levies to a broad-based 10% goods and services tax (a further excise on cigarettes applies from 1 November 1999). Accompanying the GST will be a reduction in all but the top personal marginal tax rate, although the income level at which the top rate cuts in is set to be raised.

While the government predicts that the GST will result in a 1.9% increase in headline CPI, many believe a 3 percentage points increase to headline CPI may be more likely. The initial contribution (of around 0.4 percentage points) will occur following the introduction of the "per stick" excise on cigarettes with the bulk of the impact (2.4 percentage points) occurring after the introduction of the GST on 1 July 2000. Evidence of such an across-the-board impact can be found in the increase in wholesale sales tax in mid-1995. This experience suggests a concentrated pass-through of the GST.

A corporations CPI risk can arise from various sources, for example, a retailer whose core businesses, buying wholesale and selling retail, are exposed to inflation and so act as a natural hedge. In a high-inflation environment it is possible that the inflation rate can disguise real margin increases. Alternatively, the same environment may lead to some erosion of margins.

This same retailer may have some CPI-linked leases. Since leasing is not part of the core business, a rise in CPI could lead to an increase in the costs of the leases. In this situation it may be desirable for the retailer to replace its CPI-linked payments with constant cashflows or fixed indexation payments.

Other examples of corporations with CPI-linked cashflows are privatised utilities and infrastructure projects. In recent times, the number of corporations exposed to inflation risk has increased. It is now not common for companies to have either specific contractual costs directly linked to the published CPI figure (e.g. CPI-linked leases) or, in the case of many privatised entities (e.g. energy utilities, health care, motorways and airports), increases in gross revenue limited by some function of CPI, for example, CPI less a fixed percentage.

The latter have arisen as governments limit direct earnings increases of privatised companies to efficiency gains rather than increases in upfront rates. As the number of corporations with CPI risks increases, so too does the demand for CPI hedging products. While a corporation with CPI-linked expenses could purchase capital indexed bonds (CIBs) to offset the inflation risk, there are several reasons why this would be undesirable, including:

- most non-financial corporates do not hold long-term financial assets;
- the purchase of the bonds would tie up capital; and
- the maturity of the bond would probably not match the liability.

An obvious solution is a derivative instrument such as a zero-cost swap whose cashflows are designed to remove the inflation risk to the corporate. An example of a zero-cost CPI swap is provided below.

IMPACT OF CPI ON EPS

An adverse change in CPI can affect a companys earnings, hence its share price. A gauge of a corporation's sensitivity to inflation can be obtained by quantifying the changes in a corporation's earnings caused by changes in CPI. This impact on a corporation's earnings can be translated to a change in its theoretical share price through the use of the discounted growth model. This is demonstrated by the following case study.

Consider a typical company with *nominal revenue*, and CPI-linked costs (due to a CPI-linked lease). The company's earnings before interest and tax are simply the difference between its revenues and CPI-linked costs. This company also has interest expenses on its $500 liability, which is calculated in Table 1 before arriving at its earnings before tax and earnings per share.
Having CPI-linked costs and nominal revenue amplifies the effect of a change in CPI on EPS. This is best illustrated by examining the impact of a 1% change in CPI on the above company (see Table 2).

The increase in CPI not only results in an increase in the costs of the corporation but also brings about a 43.78% decrease in EPS in year five. This fall translates to a 24% reduction in shareholder value as measured by the theoretical share price.

Due to the significant impact of inflation on the value of companies, many are beginning to explore CPI hedging instruments.

TABLE 1 Case 1: Calculation of EPS

Base case

Base revenue	100	Inflation	3%	Liability	500	Cost of funds	7.5%
Other costs	40	Shares	100	Tax	36%	Cost of Equity	12%

Year	Revenue	CPI-linked costs*	EBIT	Real interest	EBT	Earnings	EPS ($)
0	100	40.00	60.00	37.50	22.50	14.40	0.144
1	100	41.20	58.80	38.63	20.18	12.91	0.129
2	100	42.44	57.56	39.78	17.78	11.38	0.114
3	100	43.71	56.29	40.98	15.31	9.80	0.098
4	100	45.02	54.98	42.21	12.77	8.17	0.082
5	100	46.37	53.63	43.47	10.16	6.50	0.065

*CPI-linked costs = Other costs (1+ CPI)

TABLE 2 Effect of change in CPI

Base case

Base revenue	100	Inflation	4%	Liability	500	Cost of funds	7.5%
Other costs	40	Shares	100	Tax	36%	Cost of Equity	12%

Year	Revenue	Costs*	EBIT	Real interest	EBT	Earnings	EPS ($)
0	100	40.00	60.00	37.50	22.50	14.40	0.144
1	100	41.60	58.40	39.00	19.40	12.42	0.124
2	100	43.26	56.74	40.56	16.18	10.35	0.104
3	100	44.99	55.01	42.18	12.82	8.21	0.082
4	100	46.79	53.21	43.87	9.34	5.98	0.060
5	100	48.67	51.33	45.62	5.71	3.65	0.037

*A 1% increase in CPI leads to these increases in costs, affecting the company's EPS as shown in the last column.

INFLATION-INDEXED SECURITIES

Inflation-linked securities have been used by investor's wishing to reduce their exposure to inflation risk. A holder of an index-linked security locks in a real yield to prevent the investment from erosion by inflation. While there may be some mismatch between inflation as measured by the (delayed) CPI figure and an investors real basket of expenses, it is generally considered that such securities are fairly efficient hedges against inflation.

In fact, they are the only market-traded direct hedges against inflation. For this reason they are frequently held by insurance companies which are mandated to maintain a fixed percentage of inflation-linked securities. These are often repackaged and sold on to individual investors who wish to receive inflation-hedged income streams, typically in the form of indexed annuities.

The major issuers of inflation-linked securities have been government and semi-government bodies.

The face value of government-issued CIBs is currently:

Maturity	Face Value ($M)
20-Aug-05	532
20-Aug-10	1,452
20-Aug-15	1,696
20-Aug-20	2,076

Compared with the face value of government nominal bonds of more than $73 billion, the total of $5.8 billion represents a relatively small part of government bond outstandings (many nominal bond lines are individually over $5 billion).

After the government, the biggest issuers of index-linked securities is the Treasury Corporation of Victoria. There is $1.4 billion of indexed annuities and $250 million of capital indexed bonds outstanding, making TCV an issuer of comparable size to the Australian government. An ongoing policy of State debt reduction will probably see this fall, further increasing the demand for available index stocks.

HISTORY OF INFLATION IN AUSTRALIA

A rule of thumb familiar to investors in Australian inflation-indexed bonds is that real yields move around 4 basis points for every 10 basis point move in nominal yields. A regression analysis of daily real and nominal yields lends weight to this rule, particularly for the period from August 1991 to today, over which the beta was 0.41 and the correlation 89%. It should be noted that this time period covers a wide range of nominal yields, from 5.5% to 10.5%.

Over the period from July 1986 to November 1990, the beta was 0.37, so the same rule of thumb applied, albeit with a lower correlation. Over the past year, the correlation has been very high at 97%, although the beta, at 0.49, has been a somewhat higher than the rule of thumb suggests. Using the relation

nominal yields = real yield + inflation expectations,

the structural shift can be interpreted as a major change in the market-implied inflation rate. Over the period from November 1990 to August 1991 there was a 1.9% reduction in market-implied inflation expectations. Note that this is a structural reduction in the sense that it applies across a whole range of nominal yields. In the light of recent discussions about a worldwide shift to a low-inflation environment, it becomes interesting to speculate on the possibility of another structural shift in the near future.

Just as nominal and real yields are quoted with respect to a time horizon, so is this the case with inflation. This point is often forgotten, as it is assumed that the term "inflation" means current inflation. This is understandable as most interest in inflation centres on forecasts out to the next year at most. As these estimates involve complicated models of changes in the prices of goods in the underlying market, it is not surprising that such forecast methods are not used for longer-term inflation expectations. What published information there is about long-term inflation comes from consensus figures; for the purpose of valuing long-term cashflows, this information is not demonstrably accurate.

Liquidity in the Australian index security market is in Australian government issues. As these cover maturities at 2005, 2010, 2015 and 2020, it is possible to build an implied inflation curve from market-quoted prices. Given the lack of liquidity and maturity points, it is appropriate to use a simple model with parameters such as short-term and long-term inflation rates and a smooth transition between them. Using data from government and other securities, the implied inflation curve (Figure 2) currently has a short-term rate of 0.25% qoq and a long-term rate of 2.5% pa.

The RBA publishes rates for the 2005, 2010, 2015 and 2020 maturities each afternoon, making it possible to recalculate the government implied inflation curve each day. In practice, most of the liquidity in these bonds is in the 2020. The ability to calculate a daily inflation curve is important for marking-to-market and hence hedging CPI-linked swaps and derivatives.

INFLATION SWAPS

Similar in nature to the interest-rate swap, the CPI swap provides the appropriate means for a corporation to remove its CPI exposure. A corporation can remove its CPI exposure, through a CPI swap, by swapping its CPI-indexed cashflows for constant indexation cashflows or by swapping its indexed cashflows for constant cashflows.

FIGURE 1 **Australian CPI inflation – through year growth**

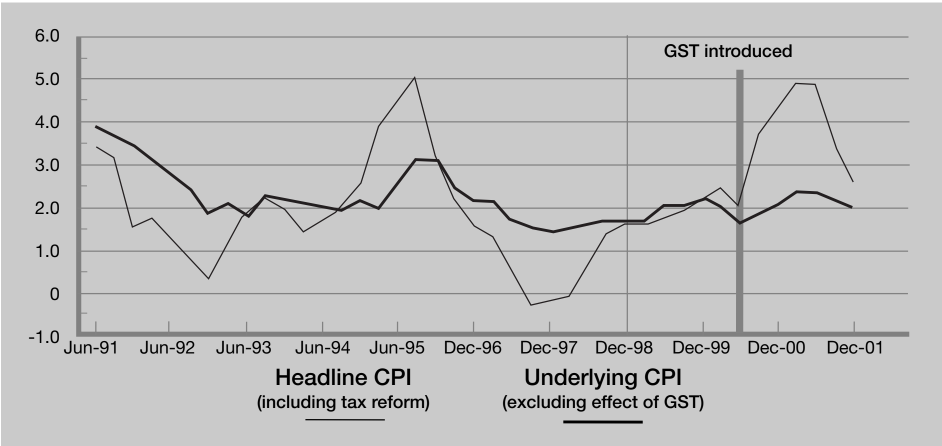
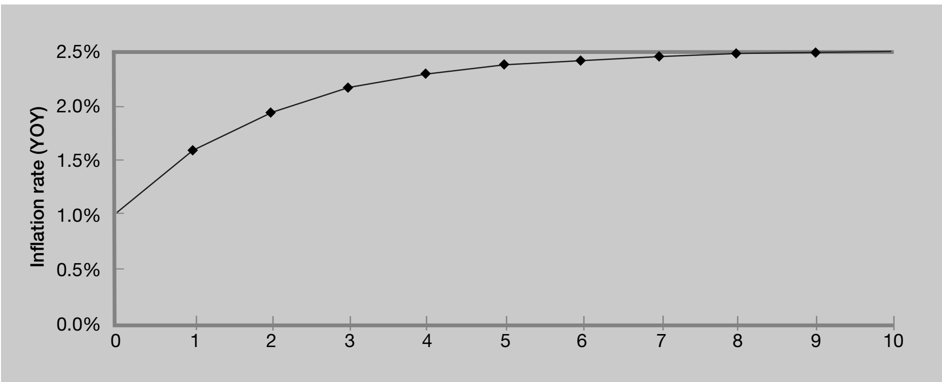


FIGURE 2 **Implied inflation curve**



A corporate typically has periodic CPI cashflows, P_t, indexed by CPI_t so that:

$$P_t = CPI_t/CPI_o \times P_o$$

where CPI_o is the base CPI index and P_o the base payment. Each payment can be written as the previous payment plus an increase/decrease proportional to that quarters CPI rate q_{t+1} where:

$$q_{t+1} = CPI_{t+1}/CPI_t - 1$$

Two inflation swaps which allow the counterparty to manage its CPI risks are the CPI swap and the CPI constant cashflow swap.

Both swaps involve the counterparty paying a CPI linked cashflow stream to a bank and in return receiving a cashflow stream which is independent of inflation.

CPI SWAP

The CPI swap pays the counterparty the difference between the CPI-linked payment P_t and a cashflow stream C_t with fixed indexation rate r where:

$$C_t = (1+r)^t P_o$$

Table 3 shows the variable payments of a CPI-linked cashflow and the fixed indexation sides of a CPI swap for a one-year quarterly swap.

The fair value of the fixed indexation rate r of the CPI swap equates to the discounted cashflows of both sides. Note the compounding effect of CPI rates the rate q_1 affects all future cashflows, not just the first. For this reason r is more than just an average CPI rate; it is an average rate with compounding.

CPI CONSTANT CASHFLOW SWAP

This involves swapping CPI-linked cashflows for constant cashflows (see Table 4). The par constant cashflow is the periodic payment P_o plus a fixed interest charge $h\ P_o$. As a rule of thumb, h is approximately half the number of periods times the average CPI rate.

CPI SWAP EXAMPLE

To continue the earlier example, assume that the company wishes to preserve its real profit margin from the inflationary impact of the GST by removing the CPI component of its costs. To do so, the company utilises a swap contract to replace its CPI-linked expenses for a fixed indexation for the next five years. Assume the current CPI swap rate is 3.5% and a 1% increase in inflation, taking CPI to 4% as above. The hedge would result in the outcome shown in Table 5.

By entering into a CPI swap the company can ensure that its costs are indexed at a constant rate of 3.5%. This will enable more accurate cashflow projections as well as shielding the company from any adverse increase in CPI as demonstrated by the move in theoretical share price.

CPI DERIVATIVES

As with derivative of other underlying instruments, the spectrum of CPI derivative products is comprehensive. As well as the two forms of swap, option-based products such as caps, floors and collars are available to hedge a corporations CPI exposure.

CPI CAP

A CPI cap provides protection against a rise in inflation above the strike level, while leaving a corporation indexing at below-strike inflation rates.

To illustrate the use of a CPI cap, suppose the corporation in the example purchases a CPI cap with a strike o 3.5%. If CPI_0 = 100 and the following CPI rate is 4.0%, then a CPI cap with a strike of 3.0% calculates CPI_1 = 103.5 rather than 104. However, should the CPI be 2%, the corporation will be indexed at the market rate, i.e. CPI_1 = 102. Because of the compounding effect of the adjusted CPI rate, a CPI cap tends to be expensive.

CPI NET CAP AND NET FLOOR

These derivatives remove the compounding effect associated with inflation. The CPI level is always set at the minimum level (CPI net cap) or the maximum level (CPI net floor) it has attained so far. Therefore, if the rate rises, the CPI level stays constant until it falls below the previous minimum for the net cap, and vice versa for the net floor.

EXAMPLE

The intricacies of these instruments are best explained by an example of the net floor. The following steps show how the cashflows are adjusted where the rate strike is 0% for the CPI floor. As expected, the return of the CPI net floor is lower than the CPI floor. This example illustrates a general pattern which is reflected in the prices of the two derivatives. The base payment is \$100 million.

Period 1: Inflation rate is 0.2%, so that $CPI_1 = 100 \times (1 + 0.2\%) = 100.2$. The rate for the CPI floor = max $(0, 0.2\%) = 0.2\%$. The

TABLE 3 CPI swap cashflows

Period	CPI-linked cashflow	Fixed indexation cashflow
Principal	P_o	P_o
1	$(1+q_1)P_o$	$(1+r)^1 P_o$
2	$(1+q_2)(1+q_1)P_o$	$(1+r)^2 P_o$
3	$(1+q_3)(1+q_2)(1+q_1)P_o$	$(1+r)^3 P_o$
4	$(1+q_4)(1+q_3)(1+q_2)(1+q_1)P_o$	$(1+r)^4 P_o$

TABLE 4 CPI fixed cashflow swap cashflows

Period	*CPI-linked cashflow*	*Constant cashflow*
Principal	P_o	P_o
1	$(1+f_1)P_o$	$P_o(1+h)$
2	$(1+f_2)(1+f_1)P_o$	$P_o(1+h)$
3	$(1+f_3)(1+f_2)(1+f_1)P_o$	$P_o(1+h)$
4	$(1+f_4)(1+f_3)(1+f_2)(1+f_1)P_o$	$P_o(1+h)$

index for the CPI net floor = max *(100.2, 100) = 100.2.*

Period 2: Inflation rate is -0.5%, so that – $CPI_2 = 100.2 \times (1 - 0.5\%) = 99.7$. The rate for the CPI floor = max *(0, –0.5%) = 0.0%* so the index for the floor is 100.2. The index for the CPI net floor = max *(100.2, 99.7) = 100.2.*

Period 3: Inflation rate is 0.3%, so that $CPI_3 = 99.7 \times (1 + 0.3\%) = 100.0$. The rate for the CPI floor = max *(0, 0.3%) = 0.3%* so the index for the floor is *100.5 = 100.2 x (1 + 0.3%).* The index for the CPI net floor = max *(100.2, 100) = 100.2.*

Period 4: Inflation rate is 0.5%, so that $CPI_4 = 100.0 \times (1 + 0.5\%) = 100.5$. The rate for the CPI floor = max *(0, 0.5%) = 0.5%* so the index for the floor is *101.0 = 100.5 x (1 + 0.5%).* The index for the CPI net floor = max *(100.2, 100.5) = 100.5.*

Note that provided there are no more negative inflation figures, the CPI net floor will track the actual CPI rate. However, the CPI floor will remain above it. For this reason a CPI floor, providing long-term insurance against a short-term downturn in the inflation rate, is expensive, whereas a CPI net floor provides temporary insurance, and in the long run tracks the actual CPI rate and is therefore cheaper.

Table 6 and Figure 3 show the cashflows for the above example.

CONCLUSION

The above discussion highlights the trend among corporates to ignore their inflation exposures. By using a simplistic case, we were able to quantify the impact of an adverse change in inflation on shareholder value. Models such as these could be extended to measure the likely impact of CPI movements on companies share prices.

Further, we have provided a brief description of some common CPI derivative instruments that can be used to manage the CPI exposures of a companys expenses and revenue streams. These instruments are expected to feature in the growth of the indexed derivatives market in Australia.

FIGURE 3 **Case 2: CPI hedge**

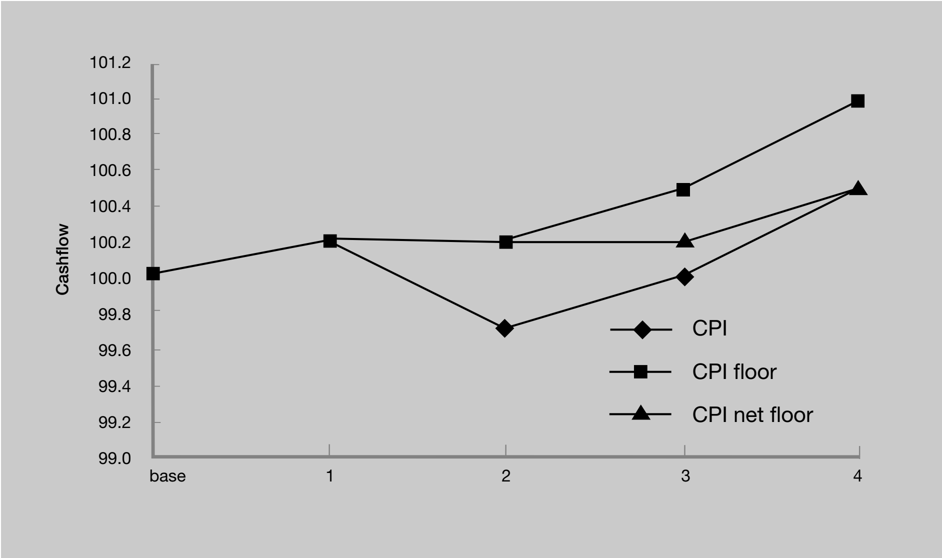


TABLE 5 **Case 2: CPI hedge**

Base case

Base revenue	100	Inflation	3.50%	Liability	500	Cost of funds	7.5%
Other costs	40	Shares	100	Tax	36%	Cost of Equity	12%

Year	Revenue	Costs*	EBIT	Real interest	EBT	Earnings	EPS ($)
0	100	40.00	60.00	37.50	22.50	14.40	0.144
1	100	41.40	58.60	39.00	19.60	12.54	0.125
2	100	42.85	57.15	40.56	16.59	10.62	0.106
3	100	44.35	55.65	42.18	13.47	8.62	0.086
4	100	45.90	54.10	43.87	10.23	6.55	0.065
5	100	47.51	52.49	45.62	6.87	4.40	0.044

*The adverse impact of a 1% increase in CPI is reduced by using a CPI swap to fix the level of indexation on costs. This results in higher EPS and theoretical share price.

TABLE 6 **Floor and net floor cashflows**

	Inflation rate	CPI index	CPI floor	CPI net floor
Base				
		100	100	100
1	0.2%	100.2	100.2	100.2
2	–0.5%	99.7	100.2	100.2
3	0.3%	100.0	100.5	100.2
4	0.5%	100.5	101.0	100.5
Net payment			1.5	0.7