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## The equity premium puzzle and inflation-protected securities

### Abstract

We present data from six countries whose governments issued CPI-indexed bonds. We evaluate the equity risk premium where various bonds serve as the riskless asset. We find that the premium of equity relative to indexed bonds is large and the real return on bonds is low only during periods of disinflation.

**Keywords:** equity premium puzzle, risk-free rate puzzle, inflation-indexed debt.

**JEL Classification:** G12, G15.

### Introduction and summary

The excessive risk premium on equity is a major financial research topic since it was termed an equity premium puzzle by Mehra and Prescott (1985). The numerous papers written on this topic can be broadly divided into two categories. The first category includes empirical papers attempted to document the equity risk premium for many countries and for the longest time periods possible. The overall conclusion is that the equity premium is a global phenomenon that exists over very long time horizons. The second category of papers includes attempts to explain the equity premium and make it consistent with economic theory. Although some of these studies were able to offer partial rationalization of the risk premium, the conclusion within the profession is that the equity premium is still a puzzle. Siegel and Thaler (1997), Mehra (2003), Mehra and Prescott (2003), and DeLong and Magin (2009) offer surveys of this literature.

The equity premium is defined as the additional return on stocks relative to a risk-free security. The latter is usually defined as a nominal short-term bond. However, nominal bonds are not riskless as they bear inflation risk. Inflation linked bonds, on the other hand, guarantee a constant real return when held until maturity, irrespective of unanticipated inflation. As such, securities indexed to inflation rather than nominal bonds should serve as the riskless security. Moreover, because indexed bonds have much longer maturity than short-term nominal bonds, their maturity corresponds closer to that of stocks.

Governments of major developed countries initialized issue of inflation indexed bonds in recent years. The U.K. was the first major developed economy to introduce CPI indexed bonds in 1981, while Australia is a close second in 1984. The governments of Canada and Sweden use indexed bonds as a debt instrument since 1991 and 1994, respectively. The first US government indexed bonds, termed Treasury Inflation Protected Securities, or TIPS, were

issued in 1997. In Israel, on the other hand, indexed bonds started in 1955, and became the major government debt instrument during the high-inflation period of the 1970s-1980s<sup>1</sup>.

An interesting question is whether the introduction of inflation protected securities will make a difference for the equity risk premium. Moreover, Weil (1989) showed the equivalence of the equity premium puzzle and the puzzle of the low return on nominal debt, and it is now denoted also as the risk-free rate puzzle. A related question is therefore the size of real return on various bonds in the presence of CPI-indexed debt and whether the latter bonds bear higher real return than non-indexed ones.

The goal of this paper is to study the equity premium when the role of the riskless asset is played by various bonds: nominal bonds, inflation-linked bonds, and bonds linked to foreign currency. To that end we use data from six countries. The major conclusion is that the only indication of excessive equity risk premium relative to inflation indexed bonds is during periods of disinflation. The Israeli experience is especially illuminating, as the time series is long and volatile. The real return on inflation protected bonds has been remarkably constant, around 2% annually, even though the economy suffered from a series of severe shocks during this time period. The real return on nominal bonds, on the other hand, has been significantly smaller and more volatile. The end result is that the equity risk premium relative to inflation-linked bonds was 1.87% for the 1961-2005 period. The equity premium increases to 4.62% when US dollar-linked bonds serve as the riskless security, and rises further to the 5%-9% range for nominal bonds. The only exception is the steep disinflation period of 1986-1992 when the real return on inflation protected bonds was 0.37%, a very low return, and the equity risk premium was 13.36%, very large.

<sup>1</sup> See Wilcox (1998) on the introduction of US government indexed debt. For the other countries, see Table 1 of Campbell and Shiller (1996).

The time series of inflation protected securities for five other countries are much shorter than the Israeli series. The British disinflationary experience is similar to Israel with low real returns of 1% on indexed bonds and relatively large equity premium of 5.5%. For Australia, Canada, and the USA, the equity risk premium relative to both nominal and indexed bonds is around 2% or smaller, while it is in the 4%-5% range for Sweden. The range of real return on indexed bonds in all four countries is 2%-4%, with low volatility of indexed relative to non-indexed bonds in most cases. Hence, the equity risk premium is small and the riskless return is high relative to historical returns in these four countries<sup>1</sup>.

## 1. Data

The sources of data are as follows. The Israeli data are from the Central Bureau of Statistics, Israel. The stock index is the General Index, and maturity on bonds is the average maturity as defined by the Israeli CBS. The stock index for England is the FTSE 100. The data for government bonds are from the British Debt Management Office. The maturity of bonds is up to seven years, seven to fifteen, and over fifteen years for short-term, medium-term, and long-term bonds, respectively. The stock index for the USA is S&P 500, and data on bonds are from EconStats. Non-indexed short term bonds are one to three years, medium bonds are 3-10 years, and long-term bonds are over ten years. Inflation indexed bonds have maturity of ten years. The Canadian stock index is TSE 300, bonds data are from the Bank of Canada, while maturity of both indexed and non-indexed bonds is identical to American bonds. The S&P/ASX 200 Index is the stock market index of

Australian stocks, and data on bonds are from The Reserve Bank of Australia. The maturity of bonds is five and ten years, respectively, for medium and long-term bonds. Finally, Stockholm All Share Index is the Swedish stock index. Data for Swedish bonds are from Sveriges Riksbank, the central bank of Sweden, and the Swedish National Debt Office. Non-indexed bonds are up to two years long, 5-7 years, and ten years, for short-, medium-, and long-term bonds. Inflation indexed bonds are ten years long. All bonds have been issued by the corresponding national governments.

## 2. Results

Table 1 presents the results for Israel for the 1951-2005 period for stocks and nominal bonds, and for the 1961-2005 period for inflation linked bonds and US dollar linked bonds<sup>2</sup>. The behavior of bonds indexed to inflation and nominal, non-indexed bonds is strikingly different. The real return on the former is remarkably constant, around 2%, even for the turbulent Israeli economy<sup>3</sup>. This includes the severe recession of the 1960s, the rapid growth between the Six Days War of 1967 and the 1973 Yom Kippur war, the hyper inflation of the late 1970s and first half of the 1980s, and the 1993-2005 period of the immigration wave from the former USSR. A remarkable exception is the disinflation period of 1986-1992. The success of the stabilization plan of 1985, which cut the inflation rate from 445% in 1984 to 19.7% in 1986 and 9.4% in 1992, was by and large unanticipated. As a result, inflation premium on CPI-linked bonds fell, which resulted in low real return of 0.37% for that period. The corresponding equity risk premium was very large, 13.36%.

Table 1. Return on financial assets

This table presents results from Israel. All numbers are annual percentage points.

Israel	Annual return				Equity premium				Standard deviation	
	Geometric		Arithmetic		Geometric		Arithmetic		Geometric	
	real	nominal	real	nominal	real	nominal	real	nominal	real	nominal
1961-2005										
Stocks	3.54	34.41	8.43	53.98					32.37	108.60
nominal bonds long-term										
dollar-linked bonds long-term	-1.08	28.26	0.87	42.01	4.62	6.15	7.56	11.98	20.71	99.90
inflation-linked bonds long-term	1.67	31.98	2.17	43.01	1.87	2.43	6.26	10.98	9.57	79.60
1961-1976										
Stocks	0.36	11.54	0.36	13.11					25.44	29.00
nominal bonds long-term	-4.54	6.09	-6.81	4.96	4.91	5.45	7.17	8.14	10.37	12.70

<sup>1</sup> As documented by Goetzmann, and Jorion (1999) and Dimson, Marsh, and Staunton (2002).

<sup>2</sup> There was no data on indexed bonds during the 1955-1960 time period. Similar considerations of availability are valid for other countries as well.

<sup>3</sup> The numbers reported in the body of the paper are for geometric, compound returns. Tables 1 and 2 present also simple arithmetic returns. The conclusions from both series are similar.

Table 1 (cont.). Return on financial assets

Israel	Annual return				Equity premium				Standard deviation	
	Geometric		Arithmetic		Geometric		Arithmetic		Geometric	
	real	nominal	real	nominal	real	nominal	real	nominal	real	nominal
dollar-linked bonds long term	-1.09	10.24	-0.92	13.17	1.45	1.30	1.29	-0.06	17.30	21.30
inflation-linked bonds long-term	1.72	13.05	2.51	16.26	-1.36	-1.51	-2.15	-3.15	5.66	16.90
1973-1985										
Stocks	-0.09	94.49	7.74	136.7					40.95	170.60
nominal bonds long-term										
dollar-linked bonds long-term	-5.03	87.89	0.17	118.70	4.94	6.60	7.57	17.96	35.30	162.50
inflation-linked bonds long-term	2.39	99.31	3.64	118.60	-2.47	-4.82	4.10	18.08	15.24	117.20
1986-1992										
Stocks	13.72	38.01	17.39	41.32					32.7	33.56
nominal bonds long-term										
dollar-linked bonds long-term	0.31	16.79	1.20	17.58	13.40	21.22	16.20	23.74	14.20	14.34
inflation-linked bonds long-term	0.37	21.80	0.92	22.10	13.36	16.21	16.50	19.22	11.10	9.41
1993- 2005										
Stocks	3.52	9.67	7.62	13.66					30.11	30.7
nominal bonds long-term	5.70	11.98	5.88	12.13	-2.18	-2.31	1.73	1.53	6.46	5.99
dollar-linked bonds long-term	1.66	6.89	1.86	7.10	1.86	2.78	5.76	6.56	6.70	7.05
inflation-linked bonds long-term	2.11	8.17	2.22	8.26	1.41	1.50	5.39	5.41	5.15	4.42
1951-1976										
Stocks	-0.85	11.71	2.76	15.22					29.82	30.60
nominal bonds long-term	-9.00	2.52	-8.31	2.97	8.15	9.18	11.07	12.25	10.90	10.21

Nominal bonds, on the other hand, yielded very negative real returns in virtually every sub-period except for the most recent one. During 1951-1976, their return was dismal -9.0%, and for the 1961-1976 it was -4.54%. Non-indexed bonds were virtually written off when the inflation accelerated, and did not exist for the 1977-1992 period. Not only until 1993 was the Israeli public ready for non-indexed bonds again, but only at a steep risk-premium. This, together with the complete, and somewhat surprising, elimination of inflation between 1993 and the 0% inflation of the year 2000 and subsequent years, resulted in large and positive real returns on nominal bonds in this period.

In order to compare the real return on nominal bonds to that of indexed bonds for the entire 1961-2005 period, we have to make an assumption about the return on nominal bonds during the 1977-1992 time period. The hyper-inflation during this period made the nominal bonds virtually worthless. Making an assumption that nominal bonds lost 90% of their real value during this inflationary period, the annual real return for the 1961-2005 period is -5.27%; making

the overly optimistic assumption that the loss during the high inflation years was only 50%, the annual return for the 45-year period is -1.74%. The corresponding equity risk premium will be 8.81% and 5.28%, respectively.

A main conclusion from the Israeli experience is that the equity premium is significantly lower for inflation-linked bonds than other debt securities. The annual real geometric return for the entire 1961-2005 period is 3.54% for stocks, 1.67% for CPI-indexed bonds, and -1.08% for dollar-indexed bonds. The annual equity premium is 1.87% and 4.62% for inflation- and dollar-indexed bonds, respectively. The equity premium for nominal, non-indexed bonds is in the range of 5%-9% for this 45-year period. Moreover, the standard deviation of the return on indexed bonds is much lower than that of other securities for every sub-period. For the 1961-2005 time period, the annual standard deviation of the real return on stocks is 32%, and the corresponding number for CPI-indexed bonds is 9.6%. The standard deviation of the return on nominal bonds takes intermediate values between indexed bonds and stocks. For instance, during the 1961-1976 time

period, the standard deviations are 5.7%, 10.4%, and 25.4% for indexed bonds, nominal bonds, and equity, correspondingly. For the 1993-2005 years, the corresponding numbers are 5.1%, 6.5%, and 30.1%. Hence, indexed bonds carry higher expected yield and less volatile yield than nominal bonds.

The bottom line is that there is no equity premium puzzle in Israel, except for the disinflation period of

1986-1992, if the low risk security is inflation linked bond, but the puzzle does exist for standard, nominal bonds<sup>1</sup>.

Table 2 presents the results for five industrialized countries that issued inflation-linked bonds in recent years. The countries are USA, England, Canada, Australia, and Sweden. The results for each of these countries are as follows.

Table 2. Return on financial assets

This table presents results from England, USA, Canada, Australia, and Sweden. All numbers are annual percentage points.

	Annual return				Equity premium				Standard deviation	
	Geometric		Arithmetic		Geometric		Arithmetic		Geometric	
England	real	nominal	real	nominal	real	nominal	real	nominal	real	nominal
1985-2001										
Stocks	6.51	9.91	7.09	10.51					11.50	11.60
nominal bonds short-term	1.24	4.46	1.24	4.47	5.27	5.44	5.85	6.03	1.07	1.36
nominal bonds medium-term	1.67	4.91	1.70	4.93	4.84	4.99	5.4	5.58	2.10	2.12
nominal bonds long-term	1.71	4.95	1.74	4.98	4.80	4.95	5.35	5.53	2.73	2.67
inflation-linked bonds short-term	0.95	4.16	0.95	4.16	5.57	5.74	6.14	6.34	0.71	1.12
inflation-linked bonds medium-term	1.09	4.31	1.10	4.32	5.42	5.59	5.99	6.19	1.46	1.52
inflation-linked bonds long-term	1.05	4.27	1.08	4.30	5.46	5.63	6.01	6.21	2.30	2.21
USA										
1998-2005										
Stocks	0.82	3.23	2.25	4.60					20.00	20.23
nominal bonds short-term	1.12	3.54	1.13	3.55	-0.31	-0.31	1.12	1.05	1.86	1.90
nominal bonds medium-term	2.23	4.67	2.23	4.88	-1.41	-1.45	0.02	-0.27	1.14	1.08
nominal bonds long-term	2.83	5.29	2.83	5.44	-2.02	-2.06	-0.58	-0.84	0.84	0.62
inflation-linked bonds long-term	1.95	4.38	2.09	4.47	-1.13	-1.16	0.16	0.13	4.73	5.02
Canada										
1995-2005										
Stocks	6.03	8.18	7.25	9.25					4.74	4.72
nominal bonds short-term	2.79	4.87	2.76	4.76	3.25	3.31	4.49	4.49	0.31	1.35
nominal bonds medium-term	3.52	5.61	3.47	5.47	2.52	2.57	3.78	3.78	0.31	1.15
nominal bonds long-term	4.17	6.28	4.10	6.11	1.86	1.90	3.15	3.14	0.31	1.03
inflation-linked bonds long-term	3.83	4.01	3.77	3.94	2.20	4.16	3.48	5.31	0.69	0.76
Australia										
1993-2005										
Stocks	5.61	8.33	6.08	8.77					14.09	14.02

<sup>1</sup> Consumption CAPM predicts that  $\theta$ , the coefficient of relative risk aversion, is given by  $\theta = \frac{E(r^i) - r^f}{\text{COV}(r^i, g^c)}$ , where  $r^i$  is the return on the

risky asset,  $r^f$  is the return on the riskless asset,  $g^c$  is the growth rate of consumption, and  $E$  denotes expectations. See Mehra (2003). Hence, switching from nominal to CPI-indexed bonds cuts  $\theta$  by more than two-thirds.

Table 2 (cont.). Return on financial assets

	Annual return				Equity premium				Standard deviation	
	Geometric		Arithmetic		Geometric		Arithmetic		Geometric	
	real	nominal	real	nominal	real	nominal	real	nominal	real	nominal
Australia										
nominal bonds medium-term	3.91	6.59	3.73	6.40	1.70	1.74	2.34	2.37	1.91	3.40
nominal bonds long-term	4.25	6.95	4.06	6.73	1.35	1.39	2.02	2.04	2.02	3.48
inflation-linked bonds long-term	3.96	6.64	3.89	6.58	1.65	1.69	2.18	2.19	0.65	1.76
Sweden										
1996-2005										
Stocks	8.00	9.61	12.31	13.88					31.87	31.84
nominal bonds short-term	2.89	4.43	2.90	4.43	5.11	5.18	9.42	9.44	1.37	1.04
nominal bonds medium-term	3.59	5.14	3.60	5.15	4.40	4.47	8.71	8.73	1.42	1.05
nominal bonds long-term	3.95	5.50	3.95	5.51	4.05	4.11	8.36	8.37	1.49	1.14
inflation-linked bonds long-term	3.77	5.32	3.77	5.32	4.23	4.29	8.54	8.55	0.73	0.87

In England, during the 1985-2001 period, the real return on CPI-linked bonds was low, and even lower than the return on nominal bonds. Just as in the Israeli case, during a period of disinflation real returns on indexed bonds are low and the equity premium is high. The inflation rate in the UK fell from 18% in 1980 to 6.1% in 1985. It fluctuated in the 4%-7.5% until 1992 and stabilized around 2% since 1993. For medium-run bonds the real returns are 1.09% and 1.67% for indexed and nominal bonds, correspondingly, while the numbers are 1.05% and 1.71% for the long-term securities. The real return on equity for this period was 6.51%, which gives 5.5% equity premium on indexed bonds, and 4.8% on nominal bonds. The historical real return on English equity, as reported in Table 3 of Jorion and Goetzmann (1999), is similar to the 1985-2001 return. It is 8.16% for the 1921-1995 period, and 6.39% for the 1970-1995 period. The annual standard deviations of the returns are approximately 2.0%, 2.5%, and 11.5% for indexed bonds, nominal bonds, and equity. Indexed bonds are therefore less volatile and carry lower return than non-indexed bonds.

During the eight-year period, 1998-2005, when TIPS existed in the USA, the real return on stocks, 0.82%, was very low in US historical standards<sup>1</sup>. In this period, bonds yielded higher returns than stocks. The numbers are 1.12%, 2.23%, and 2.83% for short, medium and long-run nominal bonds, and 1.95% for (long-run) indexed bonds. Hence, in this period the equity premium is in fact negative for all debt instruments. The return on indexed bonds is

lower than that on similar maturity non-indexed bonds. Equity in this period is still much more volatile than bonds.

The examination period in Canada covers eleven years, 1995-2005. During this period, the real return on nominal bonds varied from 2.79% on short-term bonds, to 3.52% on medium-run bonds, to 4.17% on long-term debt. The return on inflation-linked bonds was 3.83% for this period, and the return on equity was 6.03%<sup>2</sup>. Hence, the return on both kinds of bonds, with corresponding maturity, was quite similar. The equity premium varies from 2.2% for indexed bonds, to the range of 1.86%-3.25% for nominal bonds. The standard deviation of bonds, as expected, was significantly lower than that of stocks.

The data for Australia cover a period of 13 years, 1993-2005. The real return on stocks for this period is 5.61%, whereas the return on bonds, both nominal and inflation-linked, is around 4%, to give an equity premium around 1.6%<sup>3</sup>. Returns on stocks were also much more volatile than bond returns, with indexed bonds less volatile than non-indexed ones. Overall, the return on bonds in Australia was high enough such that no excessive equity risk premium was observed.

Finally, the return on Swedish equity during the period of 1996-2005 is 8%<sup>4</sup>. The real return on bonds is also high. The return on non-indexed debt varies from 2.89% on short-term bonds to 3.95% on

<sup>1</sup> Jorion and Goetzmann (1999) report U.S. real stock return of 8.22% and 6.15% for 1921-1995 and 1970-1995, respectively. Numbers in Mehra and Prescott (1985) are similar.

<sup>2</sup> The real return on equity in Canada during 1970-1995 was 4.34%, as in Jorion and Goetzmann (1999).

<sup>3</sup> The real return on Australian stock was 3.65% during 1970-1995, as in Jorion and Goetzmann (1999).

<sup>4</sup> The historical equity returns for Sweden were 7.13% during 1926-1995, and 8.79% during 1970-1995. See Jorion and Goetzmann (1999).

long-term bonds. The return on CPI-linked bonds was 3.77% for this period. This gives equity risk premium of 4%-5%, depending on the low-risk security. The upper bound corresponds to short-term nominal bonds, the standard risk free debt instrument. The standard deviation of the return on Swedish stocks, on the other hand, is 32%, considerably larger than the 1% value for the various bonds. As is usually the case in other countries, the real return on the indexed bonds in Sweden was also more stable than the return on other kinds of bonds.

We conclude that inflation protected securities yielded in most time periods and countries a stable real return of around 2%-4%, and a corresponding equity risk premium lower than 4%. However, the experience of Israel and England shows that the real return on indexed bonds drops to 1% or even lower during periods of disinflation. The corresponding equity premium is 5.5% in England and 13.4% in Israel. Hence, the dual puzzle of high equity premium and low return on riskless securities persists during disinflation.

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