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## **Abstract**

Over the past 15 years, long-term interest rates have declined to levels not seen since the 1970s. This paper explores possible shifts in global savings and investment that have led to this fall in the world real interest rate. There are several key findings. First, the authors identify the relative weakness in investment demand as more important than the relative increase in desired global savings to explain the decline in global interest rates. Second, the results indicate that the key factors explaining movements in savings and investment are variables that evolve relatively slowly over time, such as labour force growth and age structure. The conclusions suggest that over the coming years, world real interest rates are likely to continue to adjust slowly, reflecting long-term trends.

*JEL classification: E2, E4, F3*

*Bank classification: Interest rates; International topics*

## **Résumé**

Au cours des quinze dernières années, les taux d'intérêt à long terme ont diminué, et ils touchent aujourd'hui des creux qu'on n'avait plus vus depuis les années 1970. Les auteurs examinent les variations du niveau de l'épargne et de l'investissement à l'échelle du globe afin de déterminer si elles ont pu mener au recul du taux d'intérêt réel mondial. Voici les grandes conclusions de leur étude. Tout d'abord, il semble que la faiblesse relative de la demande d'investissement ait joué un rôle plus important que la hausse relative du niveau souhaité de l'épargne dans le repli des taux d'intérêt mondiaux. Deuxièmement, les principaux facteurs à l'origine des mouvements de l'épargne et de l'investissement sont des variables qui évoluent assez lentement, telles la croissance de la population active et la structure par âge. Ces résultats portent à croire que les taux d'intérêt réels mondiaux continueront de s'ajuster lentement dans les années à venir, en réaction aux tendances de long terme.

*Classification JEL : E2, E4, F3*

*Classification de la Banque : Taux d'intérêt; Questions internationales*

## 1. Introduction

Despite a recent rise, reflecting the cyclical expansion in the global economy, long-term nominal interest rates in the major industrialized countries have declined to levels not seen since the 1970s.<sup>1</sup> This trend has been gradual, taking fifteen years or more, and reflects a combination of two factors. On one hand, low nominal rates reflect well-anchored expectations that inflation will remain relatively low and stable. On the other hand, the decline in nominal rate also reflects a fall in the real rate of interest (Figure 1). While it is generally agreed that the success of monetary policy in taming inflation over the last decade accounts for much of the former, the reason for the low real rate of interest is still a matter of debate.

There is widespread agreement, however, that the real interest rate is determined by the forces of productivity and thrift, equilibrating desired savings (providing the net supply of funds) with desired investment (generating the net demand for funds). In an increasingly integrated world with internationally mobile capital, these two forces interact in global capital markets to determine a world real rate of interest. Thus the debate centres around whether real rates are low because of an excessive supply of global savings (Bernanke 2005), or a low level of global investment (Rajan 2006).

The purpose of this paper is to explore the global forces that have led to the decline in the world real interest rate over recent decades, including the key factors that have shaped the behaviour of desired world savings and investment. The paper begins with a review of the literature. Section 3 then summarizes the key factors driving investment demand and desired savings. Section 4 presents the empirical approach and section 5 describes the empirical findings that estimate the contribution of various factors in explaining the decline in world real interest rates, thus providing insights into the factors of particular importance for policy-makers going forward.

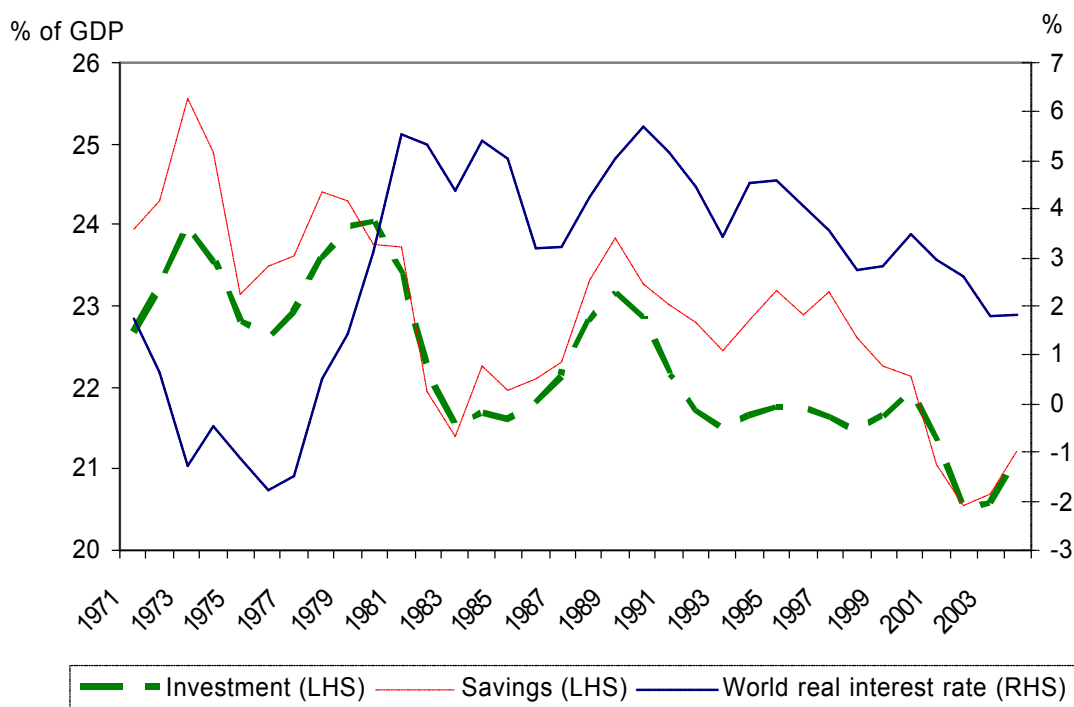
## 2. Previous Literature

Explaining the movements in real interest rates over time has been the subject of a number of studies. Two early papers (Blanchard and Summers (1984) and Barro and Sala-i-Martin (1990)) consider the period of high real interest rates in industrialized countries in the late 1970s and early 1980s. In the first study, Blanchard and Summers assess the importance of various factors that could explain high real interest rates in the period 1981-1984 for six industrialized countries. The explanations considered are adverse shifts in savings (including fiscal expansions), favorable shifts in profitability, contractionary monetary policy and portfolio shifts. The results show that high real interest rates were not due to fiscal policy alone, but to the fiscal-monetary mix. They find evidence that a shift in profitability had also taken place.

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<sup>1</sup> Increased integration of capital markets around the world has led to significant co-movement in national interest rates. The world interest rate shown in Figure 1 is based on the common component of real long-term interest rates across the G-7 countries (see Section 4.1 for more details).

Figure 1: Global Savings, Investment and the Real Interest Rate



Sources: World Bank, BIS, IMF, Bank of Canada calculations.

The Barro and Sala-i-Martin study expands the sample to ten OECD countries and models real interest rates for both the world as a whole and for individual countries. Their analysis offers partial answers regarding the relatively high level of the real rate of interest in the 1980s. Within their empirical framework, the world interest rate is determined by the interaction between global investment demand and desired savings. While the shocks to investment demand are measured with stock market returns (a proxy for expected profitability of investment), the shifts to desired savings are isolated using relative oil prices (an indicator of temporary world income). Their results show that the key elements leading to high world real rates of interest in the period 1981-86 were favorable stock market returns and high oil prices.

More recently, the low level of real interest rates has been the subject of various studies.<sup>2</sup> The proposed explanations for the decline in real interest rates can be divided in three groups: increased monetary policy credibility, portfolio shifts, and savings-investment shifts. These explanations are discussed in an OECD article by Ahrend et al. (2006)

<sup>2</sup> The statistical properties of the real rate of interest over time has also been the subject of a number of recent studies which examine whether the real rate of interest is constant, time varying or a random walk. Most of these papers focus on short-term real rates and find that the real rate of interest is highly autocorrelated. Nevertheless, although Rose (1989) found evidence that the real rate followed a random walk (that is a I(1) series, a result that was also found by Breedon et al. (1999)), the body of evidence now suggests that the real rate is a stationary series (that is, I(0)), that has exhibited structural breaks (Garcia and Perron 1995), or alternatively, periods of deviation from the long-run equilibrium (Mishkin 1991).

which reviews several factors driving long-term interest rates lower in selected industrialized countries. They conclude that several factors have accumulated through time to produce the current situation. In the 1990s, monetary policy credibility played a major role in pushing rates lower, followed by savings behavior in emerging market countries since 1997. Finally, since 2004, portfolio shifts towards bonds has been a dominant factor in narrowing term premia. While providing an excellent discussion of the behaviour of long-term rates, this study does not quantify the relative contribution of the different explanations put forward.

As might be expected, the current low level of the world real interest rate is being closely linked to another major international macroeconomic topic of concern; namely, large imbalances in current account positions among major countries.<sup>3</sup> An IMF study by Terrones and Cardarelli (2005) examines the main factors that have driven movements in world savings and investment, leading to global imbalances and low real interest rates. In particular, they find that low investment demand is crucial in explaining the low level of real long-term interest rates. Using two approaches – econometric analysis and a dynamic panel model for savings and investment – they show that the decline in public savings, financial sector reform and demographic changes are the key factors in explaining movements in savings and investment rates between 1997 and 2004. They also show that the decline in savings and investment is due both to factors that are common across countries and to country-specific developments. While their decomposition of the variations in savings and investment offers an interesting explanation for global current account imbalances, the paper does not estimate the relative contribution of different factors in explaining movements in world real interest rates.

Although the low level of interest rates and global imbalances are undoubtedly related, it is interesting to note that while the emergence of global imbalances is a relatively recent phenomenon, the fall in real interest rates has developed gradually since the 1990s. So while the magnitude of official portfolio flows associated with the accumulation of foreign exchange reserves can partially explain what has been referred to as a “global savings glut” (Bernanke 2005), it cannot offer a satisfying explanation of low real interest rates during the last 15 years. Consequently, any investigation into the causes of the current low real interest rate must take into account not only the recent phenomenon, but also the long-term trends (Knight 2006).

Taking stock of the literature, we adopt a longer-term perspective and look at the fundamental drivers of changes in interest rates which are factors influencing the demand for funds or the supply of funds. To undertake an investigation that estimates the relative importance of the various determinants of the long-term world interest rate, we follow Barro and Sala-i-Martin and focus on the interaction between global desired savings and investment demand. We explicitly model savings and investment behaviors, allowing us

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<sup>3</sup> As discussed in Little and Lafrance (2006), it is possible to argue that low world interest rates can be explained by a combination of forces leading to planned savings exceeding desired investment in the global capital market (the “global savings glut” story). The connection to global imbalances arises because the key determinants of savings and investment affect countries differently. The link between global imbalances and real interest rates is also discussed in IMF (2005) and Bernanke (2005).

to attribute movements in world real long-term interest rates to key determinants of savings and investment.

Our study distinguishes itself from Barro and Sala-i-Martin by including more industrialized and emerging market countries in our sample. As well, we enrich the identification framework by considering additional determinants of investment and savings. Finally, we also consider the most recent decline in long-term real interest rates. Before turning to our empirical framework, the next section describes possible key underlying determinants of shifts in investment demand and desired savings.

### **3. What Determines Savings and Investment?<sup>4</sup>**

#### *3.1 Investment*

Savings and investment decisions are made by each of the three sectors of the world economy: households, firms, and government. In the case of investment, however, firms are by far the most important source of aggregate investment. There are many potential determinants of investment demand, however, in this section we concentrate on a few that would seem most relevant for global investment.

#### *Labour force growth*

One important determinant of investment demand is labour force growth (Solow 1956). Low rates of labour force growth combined with high ratios of capital to labour may help to explain why many industrialized countries face an apparent “dearth” of investment opportunities.<sup>5</sup> Indeed, a fall in labour force growth means that less investment is required to equip the labour force with capital.<sup>6</sup> The negative impact on investment is more significant when the production process is already capital intensive. Thus, an increase in labour force growth in countries that use labour-intensive production techniques will generate a smaller increase in investment demand than it would in countries that employ capital-intensive techniques.

Figure 2 illustrates the GDP-weighted growth rate of the working-age population for the 35 countries in our dataset, along with the world investment rate.<sup>7</sup> It can be seen that although the growth rate of the working-age population increased between 1971 and 1982, it has generally fallen since then.<sup>8</sup>

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<sup>4</sup> See Desroches and Francis (2007) for a detailed review of the main determinants of investment and savings.

<sup>5</sup> This is discussed in Bernanke (2005).

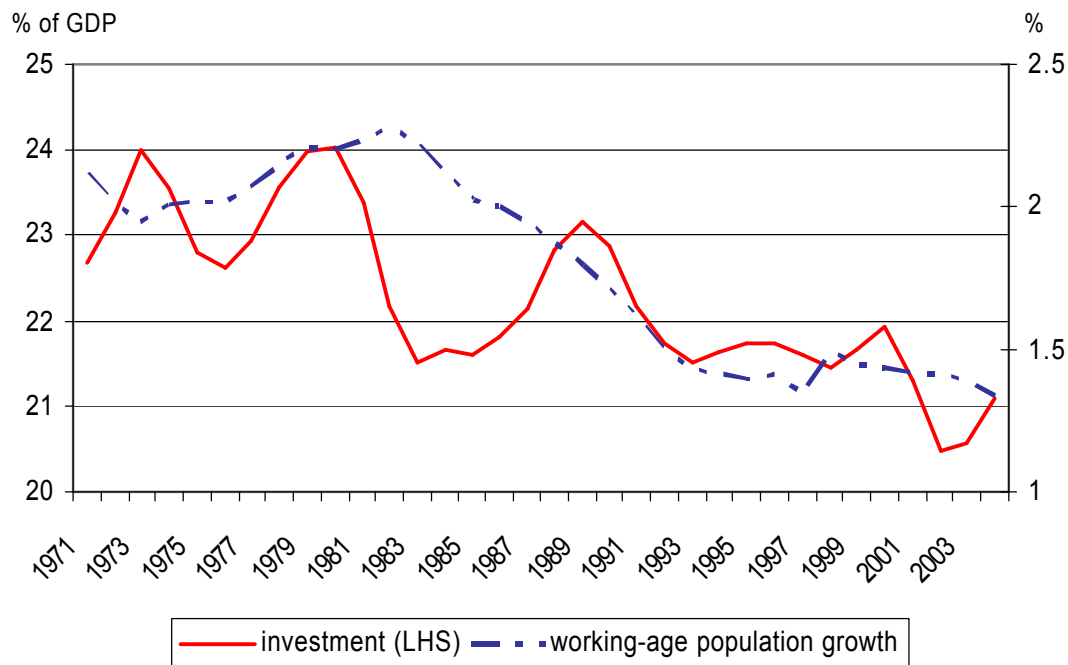
<sup>6</sup> If capital and labour are substitutes, however, a fall in the labour force growth could also be accompanied by an increase in investment.

<sup>7</sup> The working-age population is used as a proxy for the labour force because of limitations on the availability of data. A more detailed measure of the labour force would also take into account participation rates and hours worked. Technically, for the reasons outlined in the text, the aggregate for the working-age population should be capital weighted. However, estimates of capital stocks are often unreliable for the purposes of making international comparisons over time and are unavailable for many of the countries in our data set. We therefore use real GDP weights as a proxy. This is a reasonable approximation because larger economies typically have larger capital stocks.

<sup>8</sup> The fall in labour force growth in the 1980s became especially important in industrialized countries as the impact of baby boomers entering the labour force diminished.



Figure 2: Investment and Labour Force Growth



Sources: World Bank, official sources, Bank of Canada calculations.

*Stock market returns*

Another source of investment demand in addition to labour force growth is productivity growth. This factor, as well as some other determinants of investment demand, are difficult to identify. Empirically, this problem can be partially addressed by examining the behaviour of stock prices.<sup>9</sup> Since the stock market is forward looking, its returns reflect expectations about a variety of factors and can contain information regarding shifts in the investment curve. A change in the marginal product of capital, for example, could be captured by movements in stock market returns. The impact of changes in productivity affecting the firms’ profit expectations and investment demand can also be assessed looking at measures of productivity such as output per hour.

*Economic and financial liberalization*

One of the most significant event affecting the global economy in the post Bretton Woods period has been the substantial reduction in capital controls, tariffs, and other impediments to economic integration. By allowing resources to move more freely to regions and sectors where the return is highest, the removal of such impediments is likely to have raised overall firm profitability and expected returns on investment, thereby

<sup>9</sup> Investment demand can be explained by a Tobin *q*-like variable. Although most firms are not listed on stock exchanges, particularly in small emerging economies, stock prices are generally known to reflect expected future profitability, and hence, the value that can be gained by the firm through investment. Favourable stock market returns are therefore associated with stronger investment demand.

stimulating global investment demand.<sup>10</sup> Various indexes of trade and financial liberalization are used to measure the impact of integration on investment demand in Section 5.

#### *Business environment and uncertainty*

The business environment in which firms operate is also an important determinant of investment demand. Incentives provided to firms through business taxes, for example, can affect investment demand. Uncertainty can also be important. Stock market volatility, for example, can be capturing different sources of uncertainty which might induce firms to postpone investment, therefore reducing current investment plans.

#### *3.2 Savings*

Although firms are the primary source of investment, savings plans by households and government also have a significant effect on aggregate savings. This section describes the various factors that could provide an explanation for the trends in savings rates over the sample.

#### *Demographics*

For households, savings decisions generally reflect a preference by individuals to smooth consumption over life times. As a result of this consumption-smoothing preference, savings rates are thought to vary according to the individual's life cycle (Modigliani 1986). In particular, people are generally believed to have: a relatively low or negative ratio of savings to income when they are young and during the early stage of their careers, a high savings rate as they approach the end of their working life, and a low or negative savings rate in retirement.

Globally, the elderly-dependency ratio (that is those aged 65 and over relative to the population aged 15 to 64) has grown over time.<sup>11</sup> This general trend would predict that savings rates should have declined over time.<sup>12</sup> On the other hand, the ratio of the young to the working-age population has fallen worldwide. These two effects tend to offset one another, thus, in the absence of a structural model their combined effect on the global savings rate is unclear.

#### *Fluctuations in Income*

Assuming that households prefer a smooth rather than a volatile consumption pattern over time, fluctuations in income are also likely to be an important determinant of movements of the savings rate (Friedman 1957). From the point of view of households, a

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<sup>10</sup> Financial liberalization was particularly important for many industrialized economies that substantially deregulated their domestic financial markets in the latter half of the 1970s. In emerging markets, the process of liberalization has been more gradual and still lags behind that of the industrialized economies.

<sup>11</sup> This is true for most regions of the world, but particularly so in Japan where the elderly-dependency ratio has risen from just over 10 per cent of the population in 1970 to close to 30 per cent in 2004. However, in other countries such as the U.S. or Canada, the baby boomers are probably close to the period where they should save the most.

<sup>12</sup> The empirical support for the life-cycle model of savings is mixed (Poterba 2004). Some studies find that households tend to save more than is predicted by the life-cycle model. A bequest motive is one possible explanation. Savings behavior is also a function of life expectancy.

temporary increase in real income (a windfall) can be expected to lead to a temporary increase in the savings rate as households try to save a larger portion of their income in order to finance a permanent rise in consumption. On the other hand, a permanent increase in income would imply a permanent increase in consumption and would therefore not require any changes in the savings rate in order for the household to enjoy a permanent increase in consumption.

As an indicator of world temporary income, the relative price of oil is used.<sup>13</sup> From the point of view of households, a reduction in real incomes owing to an increase in oil prices is likely to have relatively modest effects on aggregate consumption. However, since real incomes fall when oil prices rise, a temporary shock should cause savings rates to fall.<sup>14</sup>

### *Financial Sector Development*

Although it is often overlooked, the state of development in the financial sector — reflected in its ability to mobilize savings, allocate capital, and facilitate risk management — should, in theory, also be an important explanation for household savings rates. But the theoretical arguments go in both directions, and the empirical evidence is mixed. On one hand, a well-developed financial sector could stimulate household savings rates by offering a greater variety of savings vehicles that offer a higher rate of return than might otherwise be the case (Edwards 1995). On the other hand, there is evidence that improved financial sector development can reduce household savings rates by relaxing household borrowing constraints or by providing better insurance instruments that reduce the demand for precautionary savings (Jappelli and Pagano 1994).

As an indicator of financial sector development, measures of domestic credit provided to the private sector and by the banking sector are used. These measures can also be capturing wealth effects associated with the increase in asset prices, in particular housing prices, which are believed to have driven the reduction in household savings in many countries. Housing prices will also be considered separately.

### *Fluctuations in corporate profits and the regulatory environment*

Firms, through their use of retained earnings, can also be an important source of savings. This has been particularly true over recent years, during which the corporate sector in the G-7 countries has gone from being a net borrower of funds to a net lender. One reason for this behaviour might be that firms see recent high profitability as temporary, and like households, are responding cautiously by using the windfall to finance future rather than current investment plans.<sup>15</sup> This postponement of investment implies that firms pay off debt rather than acquire new capital. Other determinants of savings may include regulatory and supervisory changes, which may have induced firms to try to improve

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<sup>13</sup> Most notably, in their study of world real interest rates, Barro and Sala-i-Martin (1990) find the oil price to be an important determinant of savings rates. In this regard, oil prices can also be thought of as a proxy variable, capturing factors such as disruptions of international markets, whose effects go beyond the immediate impact on the supply and demand of oil prices.

<sup>14</sup> For oil exporters, however, a decline in oil prices would increase savings. The net effect of oil prices will be determined in the empirical results.

<sup>15</sup> Lower desired investment could also reflect the absence of investment opportunities with sufficiently high expected returns.

their credit ratings.<sup>16</sup> This may be particularly true for financial sector firms, where improvements in supervisory standards and the removal of government guarantees have induced such firms to increase their capital base.

#### *Fiscal policy*

Governments also have a significant direct impact on aggregate savings. Governments are typically a source of dissaving because they have tended to run budget deficits by spending more than they raise in taxes. At times, the size of government dissaving around the globe has been substantial. For this reason, fiscal deficits were a popular explanation for high world interest rates in the early to mid-1980s, when savings appeared to fall significantly. Since then, fiscal deficits have declined dramatically, which, everything else remaining the same, should have led to higher savings and lower real interest rates.

The Ricardian equivalence hypothesis suggests, however, that aggregate savings should not respond to changes in government spending. For example, households may view the decrease in fiscal deficits experienced in recent years as meaning that their future tax liabilities are also being reduced, and respond by reducing household saving and increasing consumption. In reality, however, the support for the Ricardian equivalence hypothesis is weak. Thus, although there might be a Ricardian equivalence channel, the effect is expected to be partial.

#### *World distribution of income*

Lastly, some observers have argued that global savings and investment rates have changed because of a shift in the world distribution of income.<sup>17</sup> Since income has been growing faster in emerging markets with high savings rates than in advanced economies with relatively low savings rates, the changing distribution of world income might be a possible explanation for the decline in world interest rates over recent years. We find, however, that the change in world income has not contributed significantly to changes in the world savings rate over time, because the share of world savings accounted by the fast growing high savers is too small for this effect to dominate. This factor may however become more important in the future as the significance of the high saving economies is expected to grow.

### **4. The Empirical Approach**

To model global investment and savings and the world real interest rate we start with a dataset which, in our view, is representative of the global economy. It comprises data on savings, investment and their determinants from 35 industrialized and emerging economies and accounts for over 94% of 2004 global real GDP.<sup>18</sup> The sample period,

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<sup>16</sup> For example, the U.S. Sarbanes-Oxley Act of 2002, which was enacted in response to financial scandals, introduced major changes in financial practices and corporate governance. Accounting changes also increased the demand for long-term bonds, contributing to the recent decline in bond yields.

<sup>17</sup> For example, if world income is redistributed from countries with low savings rates to countries with high savings rates, the world savings rate should rise, putting downward pressure on the world interest rate.

<sup>18</sup> One limitation of our dataset is that it omits some significant oil exporting countries such as Iraq, Iran, Kuwait and Venezuela that were significant contributors to global savings in periods of high oil prices. These countries were omitted because of data constraints.

1970-2004, includes the entire period since Bretton Woods and the period of substantial liberalization of global capital flows.<sup>19</sup> Given the breadth of this dataset, we feel comfortable that we can perform our analysis of global savings and investment under the assumption that the countries in our dataset form a “closed” global economy.

The global real interest rate however is not a variable that can be directly observed from the data. Therefore, in order to conduct the empirical analysis, a measure of the world real interest rate is required. We use an ex-ante 5-year world real interest rate for our analysis. How this is constructed is discussed below.

#### *4.1 A measure of the world real rate of interest*

Interestingly, although global financial markets have become highly integrated, a number of studies have rejected the hypothesis that real interest rates on sovereign debt are equal across countries.<sup>20</sup> As Figure 3 also illustrates, however, real interest rates on sovereign debt are generally not equalized across countries, especially for some less-developed economies. These differences may occur because of the existence of country-specific risk premiums, perhaps owing to the possibility of sovereign default in countries with potentially unsustainable government debt burdens, or country-specific events such as the reunification of East and West Germany.

The divergence can also be explained by the fact that capital markets are not fully integrated. The most obvious reason for the narrowing in real interest rate spreads is the removal of capital controls and financial regulations in the post-Bretton-Woods era. Nevertheless, capital controls and regulations that limit arbitrage possibilities remain in a number of emerging markets and less-developed countries.<sup>21</sup>

The existence of these country-specific factors suggests that, in some cases, domestic real interest rates may not fully reflect global economic conditions. These differences make it difficult to estimate accurately a world rate of interest. The real rates shown in Figure 3 for the G-7 countries seem to suggest, however, that there is a common global component to real interest rates. G-7 financial markets are sufficiently integrated with world markets that their interest rates generally reflect the global savings and investment decisions. For this reason, when it comes to identifying the common factor in real interest rates that we refer to as “the world real interest rate” this study focuses on G-7 real interest rates. Because these economies are all open and well diversified, the extent of country-specific

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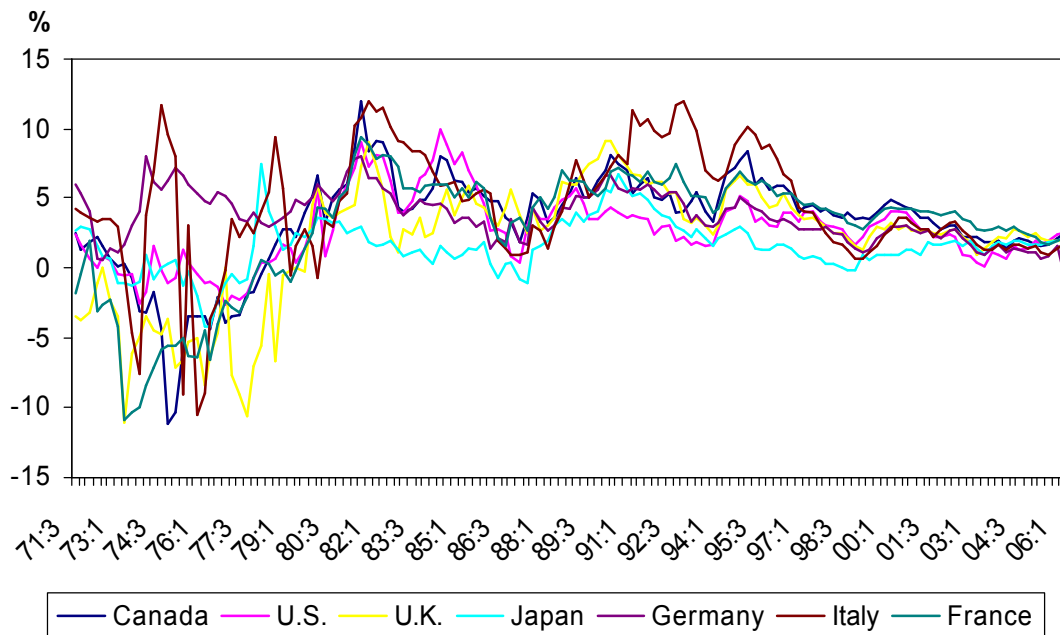
<sup>19</sup> More information on the data sources and statistical properties of the data is given in Appendix A and B.

<sup>20</sup> The hypothesis that real interest rates are not equal across countries has been confirmed by a number of studies. For example, Mishkin (1982) found that short-term ex-post real Euro rates are not equal. Moreover, he found that real interest rates have dissimilar movements through time, although he could not rule out the tendency for real rates to converge over time. More recently, Gagnon and Unferth (1995) and Breedon et al. (1997) have also found that real rates differ significantly across economies. They posit that real interest rates fail to converge to a single world rate because of the presence of country specific risk premia.

<sup>21</sup> A difference in real interest rates can also occur because of an expected movement in real exchange rates. Another possible reason for cross-country differences in observed real rates stems from an inability to define country-specific inflation expectations. Any systemic measurement problem across economies (such as country-specific differences in the calculation of inflation) could lead to systemic differences in the estimated real rates.

factors is likely to be less important compared with other small, less-industrialized countries or relatively closed economies.

Figure 3: Ex Ante 5-Year Real Interest Rates for the G-7 Countries



Sources: BIS, IMF, Bank of Canada calculations.

Data on nominal interest rates are used to construct measures of expected inflation and expected real interest rates. To estimate expected inflation rates, for each G-7 country, we estimate the inflation expectations using a recursive estimation with quarterly data on an index of consumer prices. The inflation expectations are calculated using 5-year ahead dynamic forecasts. The functional form for the inflation regressions is an AR(p), thus expected inflation is based solely on the history of inflation.<sup>22</sup> Because the inflation process is expected to have changed through time, the autoregressive representation of inflation have probably changed as well. Therefore, rolling autoregressive forecasts are used, allowing for changes in inflation processes. We then calculate the expected real interest rates for each G-7 country by subtracting the constructed value for expected inflation rate from the corresponding nominal interest rate.

In our empirical analysis, we consider the common element in these G-7 interest rates as the world interest rate as estimated using a Kalman filter. This approach removes idiosyncratic fluctuations to detect the importance of common factors in explaining world interest rates. Each G-7 real interest rate can be decomposed into two components: a common factor (world real interest rate) and a country-specific component (representing idiosyncratic factors). We extract our measure of the world interest rate by identifying the common component. The following equations describe the model:

<sup>22</sup> The results are broadly similar across G-7 countries. The estimated AR(p) processes have an order between 1 and 6 depending on the country, and the sum of the coefficients is between 0.98 and 1.02. Q-statistics for serial correlation are typically insignificant at the 5% level.

$$r_{it} = r_{wt} + z_{it} \quad \text{for } i = \text{can, us, uk, jp, ger, ita, fra} \quad \text{eq. 1}$$

$$r_{wt} = c + \beta_w r_{w(t-1)} + e_{wt} \quad \text{eq. 2}$$

$$z_{it} = \beta_i z_{i(t-1)} + e_{it} \quad \text{eq. 3}$$

$$\begin{aligned} e_{wt} &\sim \text{i.i.d } N(0, \sigma_w^2) \\ e_{it} &\sim \text{i.i.d } N(0, \sigma_i^2) \end{aligned} \quad \text{eq. 4}$$

where  $r_{it}$  is a vector of observed variables (the ex-ante real rate for each G-7 country),  $r_{wt}$  is the unobserved state variable (the common factor to all G-7 countries) and  $z_{it}$  is the country-specific component. Equation 1 is the measurement equation. Equations 2 and 3 describe the dynamics of the state variables and are the transition equations. Finally, it is assumed that the error terms are independently and identically distributed. The estimated world real interest rate is found in Figure 1.

#### 4.2 Estimation methodology

We start with the premise that the savings rate (savings divided by GDP) in each country (denoted with a  $j$ ) can be written as a linear equation of country-specific variables,  $X$ , (e.g. the dependency ratio), and world variables,  $Z$  (e.g. the world real interest rate).

$$i_{ij} = \mathbf{b}_1 + \mathbf{b}_2 X_{ij}^i + \mathbf{b}_3 Z_t^i \quad \text{eq. 5}$$

With a similar equation for the savings rate in country  $j$ :

$$s_{ij} = \mathbf{a}_1 + \mathbf{a}_2 X_{ij}^s + \mathbf{a}_3 Z_t^s \quad \text{eq. 6}$$

Next, we note that the world savings rate is, by definition, a real GDP weighted sum of the 35 countries savings rates,  $s_t = \sum_j s_{ij} \frac{y_{ij}}{y_t}$ . Likewise for the world investment rate.<sup>23</sup>

We can then write:

$$i_t = \mathbf{b}_1 + \mathbf{b}_2 X_t^i + \mathbf{b}_3 Z_t^i \quad \text{eq. 7}$$

$$s_t = \mathbf{a}_1 + \mathbf{a}_2 X_t^s + \mathbf{a}_3 Z_t^s \quad \text{eq. 8}$$

Where  $X_t^i$  and  $X_t^s$  are vectors of global variables explaining the global investment and savings respectively.<sup>24</sup>

Economic theory often suggests that two or more endogenous variables are determined simultaneously, and this is also true for investment and savings. Without some instrumental variables included to differentiate between the two equations, it would be

<sup>23</sup> Each country's savings rate is defined as gross domestic savings as a share of GDP. The investment rate is defined as gross fixed capital formation as a share of GDP. Because of data constraints, the investment series are not deflated with an investment price index. However, the decline in the nominal investment ratios over time could partly reflect the fact that capital goods have become relatively less expensive. In volume terms, the fall in average investment rates in industrialized countries has been more modest. Using investment price indexes for countries for which we have data show that even when deflating investment with the price of capital, there is a decline in investment rates.

<sup>24</sup> For data definition, see Appendix A. An alternative weighting method is described in Section 5.4.

impossible to distinguish savings from investment. We use a generalized method of moments (GMM) method to identify separately the savings and investment functions specified above.

Finding suitable instruments can be extremely difficult.<sup>25</sup> We build on the identification strategy proposed by Barro and Sala-i-Martin (1990) and also propose additional instruments. To identify the savings function, we consider the following variables as possible determinants of investment demand: real stock market returns, the depreciation rate (on structure and high tech), real macroeconomic conditions (such as industrial production and real GDP growth), volatility measures (exchange rate and stock market), labour force growth, international trade and financial regulation indexes, taxes on business as a share of GDP and productivity (output per hour).<sup>26</sup> To identify the investment function, we consider the following variables as determinants of desired savings: demographic variables (dependency ratios and life expectancy), temporary income shocks (relative price of oil), financial market development (private and bank credit as a share of GDP), real government deficit (as a share of GDP), and housing prices.

## 5. Discussion of Results

In this section, we first summarize the factors important in explaining investment and savings, and then we discuss the contribution of various variables in driving changes in the world real interest rate.<sup>27</sup>

### *5.1 What are the determinants of investment?*

In Tables 1 and 2 we report the results. In Table 1 we present the results of four alternate investment equations. A reassuring finding is that investment demand is negatively related to the world real interest rate. This result is robust and the coefficient on the world real interest rate variable is stable regardless of the specification.

We find a positive and statistically significant relationship between investment demand and the growth in the labour force. This finding supports the view that weak global investment could reflect declining labour force growth, particularly in the industrialized countries. In addition to labour force growth, we find that favourable stock market returns are associated with stronger investment demand in three of the four regressions of Table 1. This finding suggests that improvements in productivity may have important impact on investment. We find that stronger growth in industrial production (another possible proxy

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<sup>25</sup> The Hansen test for over-identifying restrictions will be used to verify that our instruments are valid, lending support to our estimation.

<sup>26</sup> Iron and steel prices were also considered but were not found to be good instruments.

<sup>27</sup> Although world savings and investment must be identical by definition, world savings and investment may not be exactly equal in practice. In our analysis, we focus on a subset of countries in the world economy that account for 94 per cent of world GDP; hence, savings and investment rates are not likely to be equal. Furthermore, measurement problems raise additional complications in that the two statistics rarely equal one another even when a universal data set is used.



for productivity) leads to higher investment demand.<sup>28</sup> The volatility of stock markets can also play an important role in determining investment demand, as verified by our results that show a negative and significant relationship. A higher technological depreciation rate is also expected to lead to an increase in investment demand. However, except in a few cases, that coefficient is usually not significant.<sup>29</sup>

TABLE 1: GMM Results for Investment

Variable	I1	I2	I3	I4
Constant	0.068*** (0.017)	0.200*** (0.031)	0.127*** (0.022)	0.065 (0.069)
Investment	0.542*** (0.095)	0.176 (0.124)	0.429*** (0.086)	0.335* (0.179)
World real interest rate (t)	-0.175*** (0.039)	-0.164*** (0.046)	-0.102*** (0.019)	-0.163** (0.073)
Labour force growth	1.452* (0.867)	0.410** (0.170)	0.336** (0.148)	1.656** (0.817)
Real stock market returns	0.004 (0.003)	0.011** (0.004)	0.011*** (0.002)	0.022*** (0.005)
Growth industrial production	0.151*** (0.023)		0.117*** (0.019)	
Stock market volatility		-0.0001*** (0.00002)	-0.00003 (0.00002)	-0.00009*** (0.00003)
Business taxes	-0.018** (0.008)	-0.016** (0.007)	-0.016*** (0.005)	-0.005 (0.012)
High tech depreciation rate	0.396 (0.273)			
Financial liberalization index				0.001*** (0.000)
Adj. R <sup>2</sup>	0.70	0.48	0.70	0.71
DW	2.0	1.4	1.7	1.6
Hansen test (p-value)	0.57	0.21	0.79	0.48

Notes:

- 1) All regressors are t-1 unless otherwise indicated.
- 2) Standard errors are in parenthesis.
- 3) \*, \*\*, \*\*\* denote significance at the 10%, 5%, and 1% level, respectively.
- 4) The Hansen test of over-identifying restrictions do not reject the null hypothesis of correct specification, indicating that the instruments are valid and lending support to our estimation (we cannot reject the null hypothesis that the over-identifying restrictions are valid).

<sup>28</sup> To assess the impact of productivity specifically, we also tried an OECD aggregate of output per hour, but that variable is not significant in our results. However, productivity is important as an instrument in the savings equations. Because of data limitations, only OECD countries are included in the productivity aggregate.

<sup>29</sup> Nevertheless, the depreciation rate on high tech plays an important role as an investment shifter and it is an important instrument for the savings curve.

Our measures of financial liberalization are also important in explaining investment demand. The removal of capital market controls and restrictions contributes to boosting investment demand. A similar effect on investment demand is observed when looking at the impact of taxes on business: the reduction in taxes raises expected returns on investment, thereby leading to stronger investment, as shown by the negative and significant coefficient in Table 1.

### *5.2 What are the determinants of savings?*

Since our empirical framework (closed-economy assumption) requires savings to be equal to investment, the investment data is used to measure savings in the savings equations. Our identification framework allows us to estimate the expected positive slope of the savings curve, as represented by the positive coefficient of the world interest rate (see Table 2). Again this finding is reassuring, many studies (see IMF 2005) have been unable to find this relationship, and although the effect is not statistically significant in two of our 4 estimated savings equations, the finding that savings is positively related to the world real interest rate is quite robust.

The empirical evidence from our econometric analysis also shows that savings rates are affected by temporary fluctuations in income. Within our model, since real incomes fall when oil prices rise, a temporary shock cause savings rates to fall.<sup>30</sup> The relative price of oil was particularly important in explaining the shift in savings in the period 1979-1983. We also find that financial development is an important element in explaining the decline in savings rates. Our results show that the measure of world private credit is negatively related to global savings with a negative and significant coefficient in all regressions. A global index of housing prices is also included in our analysis and as expected, has a negative impact on savings.

Demographic changes are also important in explaining the global fall in savings rates. When considering the total dependency ratio, however, the results are ambiguous, and we do not identify the negative coefficient that the life-cycle hypothesis would predict (S1 and S2 of Table 2). In order to understand the dynamics of demographic changes better, we separate the total dependency ratio into the elderly and the young dependency ratios (columns S3 and S4). Given that people tend to dissave during their retirement years, an increase in the elderly dependency ratio should reduce savings. However, in one case, the coefficient on the elderly dependency ratio has the opposite sign (i.e. positive) and is significant. This result is not uncommon in the literature. Indeed, some studies based on micro data (Poterba 2004) have cast some doubt on the extent to which the elderly dissave. Possible explanations could be a bequest motive or a change in life expectancy. Faced with uncertainty regarding life spans or higher life expectancy, households would increase savings relative to models that do not include uncertainty. Our results are consistent with this hypothesis: we find that an increase in the life expectancy leads to a rise in savings (S1, S2 and S4).

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<sup>30</sup> For oil exporters, however, a rise in oil prices would increase savings. Empirically, the net effect of oil on savings is negative.

Another important determinant of savings is fiscal policy. We find that the Ricardian equivalence does not hold, as shown by a negative and significant coefficient on the real government deficit. According to our results, everything else being the same, a decline in fiscal deficits contributes to higher savings and lower real interest rates.

TABLE 2: GMM Results for Savings

Variable	S1	S2	S3	S4
Constant	-0.578*** (0.182)	-0.770*** (0.208)	0.004 (0.026)	-0.410 (0.270)
Savings	0.614*** (0.124)	0.669*** (0.122)	0.818*** (0.062)	0.579*** (0.124)
World real interest rate(t)	0.054 (0.059)	0.125* (0.073)	0.051** (0.027)	0.016 (0.045)
Real oil price	-0.0001*** (0.0000)	-0.00009*** (0.00003)	-0.0001*** (0.0000)	-0.00005** (0.00002)
Private credit	-0.001*** (0.0002)	-0.001*** (0.000)	-0.001*** (0.0002)	-0.001*** (0.0002)
Total dependency ratio	0.003** (0.001)	0.004*** (0.001)		
Elderly dependency ratio			1.112*** (0.295)	0.287 (0.388)
Young dependency ratio				0.173 (0.147)
Life expectancy	0.006*** (0.002)	0.008*** (0.002)		0.005** (0.003)
Real government deficit	-0.181*** (0.030)	-0.110*** (0.036)	-0.126*** (0.035)	-0.197*** (0.021)
Housing price index			-0.0002*** (0.0000)	
Adj. R <sup>2</sup>	0.82	0.80	0.79	0.78
DW	1.9	1.5	1.6	1.6
Hansen test (p-value)	0.68	0.36	0.82	0.87

Notes:

- 1) Investment data was used for savings in the regressions.
- 2) All regressors are t-1 unless otherwise indicated. Government deficit excludes Mexico, Turkey and Russia (see Section 5.4).
- 3) Standard errors are in parenthesis.
- 4) \*, \*\*, \*\*\* denote significance at the 10%, 5%, and 1% level, respectively.
- 5) The Hansen test of over-identifying restrictions do not reject the null hypothesis of correct specification, indicating that the instruments are valid and lending support to our estimation (we cannot reject the null hypothesis that the over-identifying restrictions are valid).

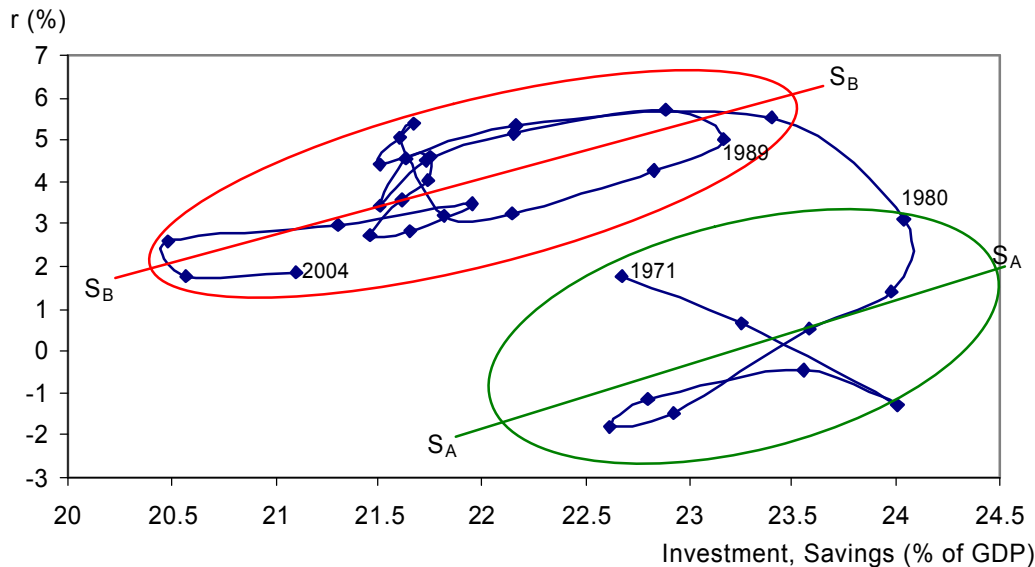
The results suggest that the key factors explaining the trends in investment and savings in the last 35 years are variables that change relatively slowly over time. The variables affecting investment demand are found to include labour force growth, stock market returns, stock market volatility and economic and financial liberalisation. Desired savings is mainly explained by the age structure of the world economy, temporary income and government deficits. Other variables such as the level of financial development—reflected in the ability to mobilize savings, to allocate capital, and to facilitate risk management— also affect savings.

### 5.3 What explains the movements in the world interest rate?

We now turn to looking at how these determinants of investment and savings affect the world real interest rate. There are different time periods that we attempt to explain and they can be summarized in Figure 4.

Figure 4 presents a scatter plot of the world real interest rate against the realized world rate of investment/savings.<sup>31</sup> Although Figure 4 is simply a plot of the data and cannot provide a structural explanation, it suggests that shifts in global savings and investment can be broken down into a number of distinct periods. For example, it appears that there was a significant change in savings behaviour sometime between 1979 and 1983 during which, savings declined significantly (highlighted by the hypothetical shift in the savings-supply curve  $S_A S_A$  to  $S_B S_B$ ). This fall in savings seems to have contributed to a rapid rise in the interest rate at the time. Outside of this period, and particularly after 1983, it appears that the savings-supply equation was *relatively* stable, suggesting that variations in investment demand could be the dominant factor driving changes in the world interest rate.<sup>32</sup> In the period between 1983 and 1989, it appears that interest rates stayed high as investment demand remained strong. However since then, it is likely that the decline in real interest rates is better explained by weak investment demand than by an excess supply of savings. In discussing the determinants of the real interest rate below, we find it useful to use the subperiods identified in Figure 4 as a reference for discussion.

Figure 4: The Market for Savings and Investment



Sources: World Bank, national sources for individual countries, BIS, IMF, Bank of Canada calculations.

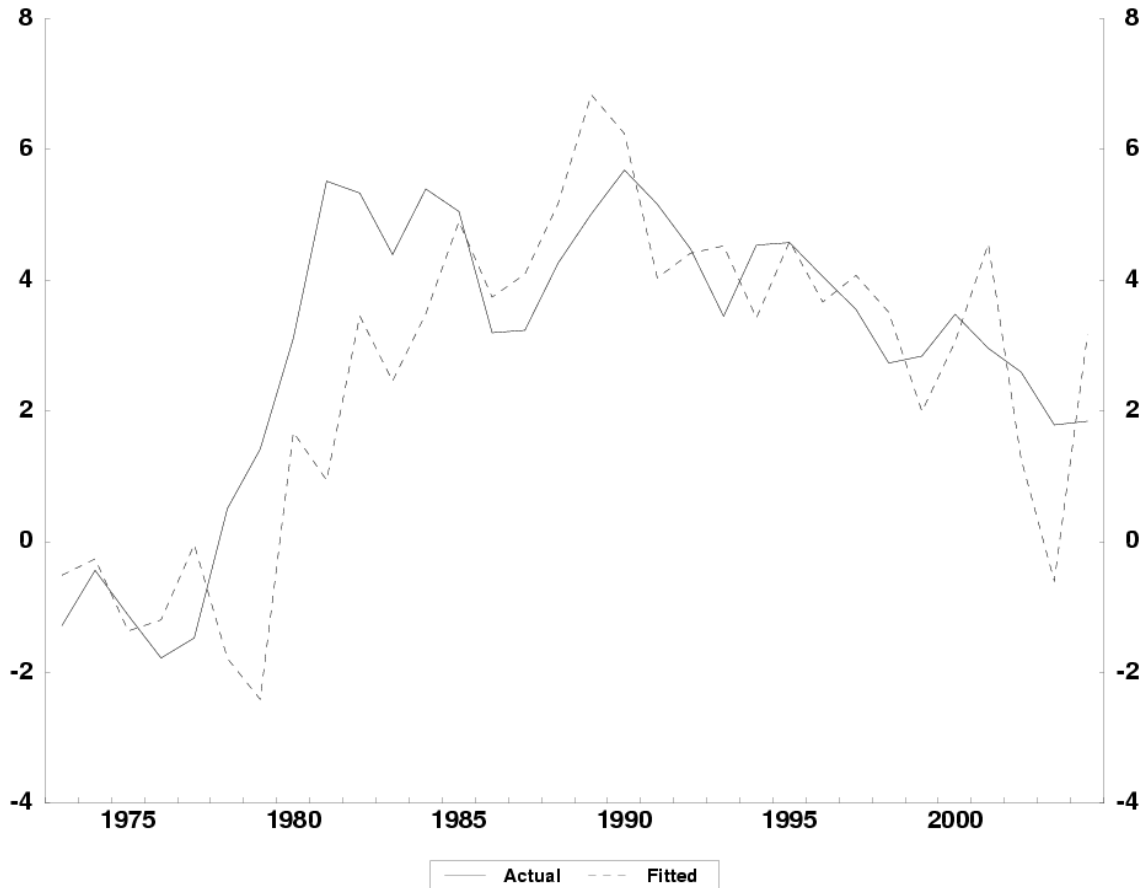
We now use the model for investment (eq. 7) and savings (eq. 8) to assess the reasons behind recent world interest rate movements. The results are illustrated in Figures 5 and 6. In Figure 5 the simulated world interest rate estimated from our model tracks the

<sup>31</sup> Here we plot the investment data, we could have shown savings and the graph would have a similar appearance.

<sup>32</sup> For example, in the late 1970s, there appears to have been an increase in the level of desired investment (a shift in the investment demand curve, not shown), which caused excess demand in the market, pushing real interest rates up along the savings-supply locus  $S_A S_A$ .

actual world interest rate relatively well. Figure 6 presents the decomposition of movements in the real interest rate for the periods of interest: 1970-1979, 1979-1983, 1983-1989 and 1989-2004.<sup>33</sup> A negative contribution of a variable would indicate that this determinant contributes to the decline in the world real interest rate.

Figure 5: Actual and Simulated World Real Interest Rate



Sources: BIS, IMF, Bank of Canada calculations

There are several key findings. First, we identify that the weakness in investment demand has been more important in explaining the decline in world real interest rates over the last 15 years than global savings. Labour force growth has had a particularly important effect on investment. While it explains only a modest portion of the increase in investment demand (and therefore the world interest rate) through 1982, we see in Figure 6 that, from then on, it accounts for a gradual decline in the world real interest rate of about 3.5 percentage points.

Stock market returns are also important in explaining the movements in real interest rates. While favourable stock market returns is a key variable accounting for high world real

<sup>33</sup> Equations I4 and S1 of Tables 1 and 2 are used in Figure 6.

interest rates in the mid-1980s, they also contribute to the decline in the 1990s.<sup>34</sup> Stock market volatility has also contributed to the decline in real interest rates, although at a lesser extent.

While financial and trade liberalization in the 1980s had a significant impact on investment demand and therefore contributed to the increase in real rates, the impact on real interest rates over the last 15 years was reduced.<sup>35</sup>

Figure 6 shows that the oil price shock contributed to a rise in the real interest rate in 1979 that persisted through 1983. In the next period (1983-1989), however, the contribution of oil prices in explaining interest rate movements becomes negative. Together with the change in the contribution of government deficits, this change in the contribution of oil prices is consistent with the hypothesis that the second oil shock offers a possible explanation for the sudden shift in the supply of savings in Figure 4 (from  $S_A S_A$  to  $S_B S_B$ ). Over the more recent period (1989-2004), oil prices play a less important role.

Fiscal deficits are also an important explanation for high world interest rates in the early to mid 1980s. Since then, fiscal deficits have declined dramatically, which, everything else remaining the same, lead to lower real interest rates. Over the most recent period, however, the impact of fiscal deficits was very small.

Among the variables that explain the decline in world real interest rates through their impact on savings, demographics have the most important effect. Figure 6 shows the cumulative contribution of the different demographic variables.<sup>36</sup> While they explain only a smaller portion of the movements in the 1980s, since 1989 demographics account for a gradual decline in the world real interest rate of about 9 percentage points.

Private credit is the most important variable that dampens the downward pressure of other variables on the world real interest rate. As we see in Figure 6, everything else being constant, the significant development of the financial sector over the last 15 years would have led to a rise in world interest rates of about 11 percentage points.

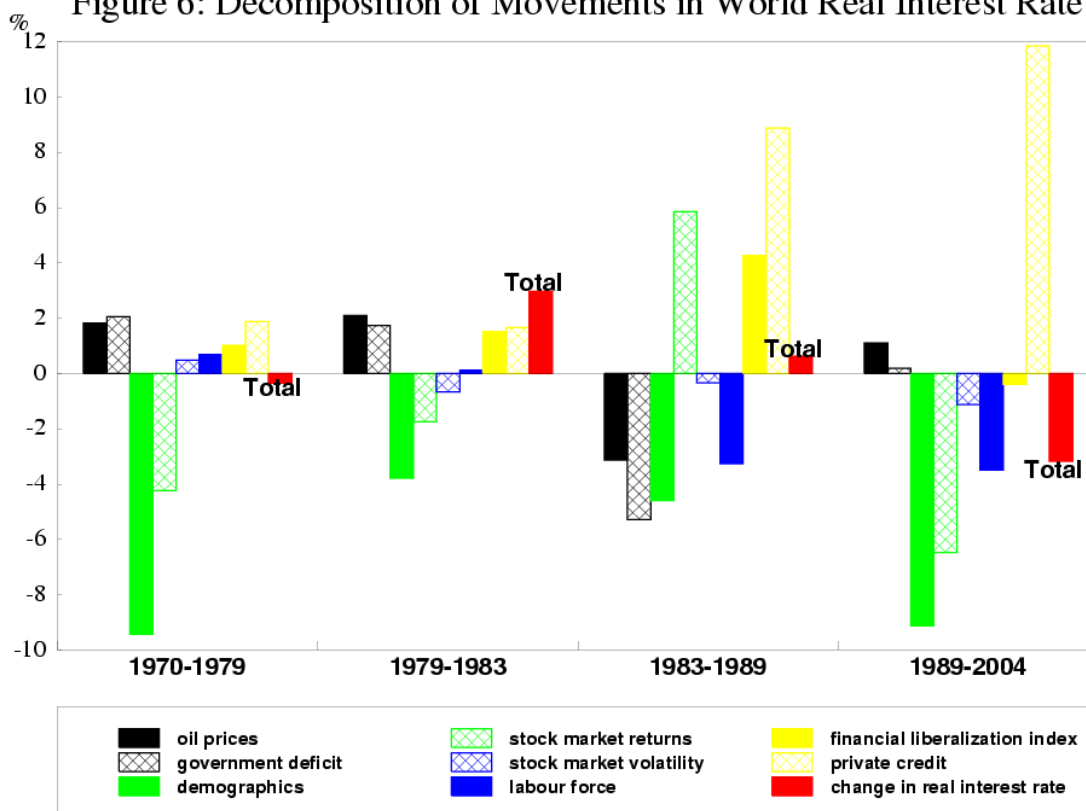
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<sup>34</sup> While stock market returns are still supportive in terms of explaining the *level* of real interest rates over 1989-2004, the relative contribution was reduced over the period, therefore contributing to a negative *change* in world interest rates.

<sup>35</sup> This results from the process of deregulation being partially reversed in the early 1990s, partly reflecting the experiences of many emerging markets with banking crises during the 1980s and 1990s.

<sup>36</sup> Dependency ratios (elderly and young) and life expectancy. The latter is the most important factor.

Figure 6: Decomposition of Movements in World Real Interest Rate



The constant, lags of savings and investment, and business taxes are omitted from this figure for the sake of simplicity. Demographic is the combined effect of life expectancy and the dependency ratio

Sources: Bank of Canada calculations

#### 5.4 Robustness checks

To test the robustness of the results, a sensitivity analysis is performed. The results show that the model is robust to a different weighting method. As an alternative, we calculate the world aggregates by adjusting the real GDP weights with an openness measure which gives Asian countries a larger weight.<sup>37</sup> That weighting method allows smaller but open countries to have a bigger impact on the world aggregates (and hence on global savings, investment, and the world interest rate) than relatively closed economies. The results are qualitatively the same.

Our results are also robust to various measures of several explanatory variables. For example, bank credit is used as an alternative measure of financial development. Also, other real activity measures such as real GDP growth, unemployment and output gaps are considered, but they do not perform as well as industrial production, and the latter is included in the model. We also check for outliers. The government deficit measure is the only variable that presents problems in this regard. Turkey, Russia and Mexico are

<sup>37</sup> Openness is measured as the share of each country's trade in total world trade.

removed from the government deficit measure for the results presented in Tables 1 and 2.<sup>38</sup>

## 6. Conclusion

The foregoing discussion suggests that the behaviour of the world real interest rate has been affected by a number of key variables that change relatively slowly over time. These variables include labour force growth, which affects investment demand, and the age structure of the world economy, which has an effect on savings. Other variables such as the level of financial development—reflected in the ability to mobilize savings, to allocate capital, and to facilitate risk management—also affect savings. Since these variables do not fluctuate dramatically, it is unlikely that these key variables will be a source of significant changes in world interest rates over the coming years.

That said, in the longer term, the analysis suggests that labour force growth is an important determinant of investment demand. Since labour force growth is likely to continue to fall for some time, one might conclude that this source of downward pressure on interest rates would remain. However, such a conclusion does not take into account that emerging markets are becoming more capital intensive and that labour force growth in these economies remains higher than in most industrialised countries. Therefore, emerging markets are likely to become a more important source of investment demand than in the past.

These conclusions suggest that over the long term, the world real interest rate is likely to remain low and to continue to adjust slowly, reflecting long-term trends. In the short term, however, the empirical work suggests that unexpected temporary shocks to income, due to fluctuations in oil prices, for example, could lead to significant short-term fluctuations in savings behaviour and real interest rates.

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<sup>38</sup> As a consequence of financial crises, these countries experienced significant fiscal deficits. Despite their small weight in the aggregate, the large size of these deficits affected the world measure unrealistically and were removed.



## Appendix A: Definitions and Sources of Variables

Data are annual unless indicated otherwise.

The global variables are real GDP-weighted sums of the 35 countries in our sample. Real GDP (at market exchange rates) was used to calculate the time-varying weights.

The countries are:

Argentina, Australia , Austria , Belgium , Brazil , Canada , China , Denmark, Finland , France , Germany, Greece , Hong Kong, India , Indonesia , Ireland , Italy , Japan , Luxembourg , Mexico , Netherlands, Norway, Poland, Portugal, Russia, Saudi Arabia , South Africa , South Korea , Spain , Sweden, Switzerland, Thailand, Turkey, United Kingdom , United States

<i>Nominal interest rate:</i>	Five-year government bonds, quarterly, BIS and IMF.
<i>Inflation:</i>	Consumer price (2000=100) inflation, quarterly, IMF.
<i>Inflation expectations:</i>	Constructed measure of expected inflation, quarterly (see Box 1), authors' calculations.
<i>Real interest rate:</i>	Nominal interest rate minus expected inflation, authors' calculations.
<i>Real GDP:</i>	Real GDP at market exchange rates (deflator = 100 in 2000), World Bank.
<i>Savings rate:</i>	Gross domestic savings (private and public) as a percentage of nominal GDP, World Bank and IMF.
<i>Investment rate:</i>	Gross domestic capital formation as a percentage of nominal GDP, World Bank and IMF.
<i>Labour force:</i>	Working-age population (between age 15-64), World Bank.
<i>Stock market return:</i>	Nominal returns are computed for December on industrial share prices. Consumer price inflation (December-to-December) was subtracted from the nominal returns to calculate the real returns, IMF.
<i>Stock market volatility:</i>	Annual standard deviations of the monthly stock market country indexes divided by the mean in each year, IMF.
<i>Oil prices:</i>	Ratio of oil prices (WTI) to U.S. producer price index (2000=100), IMF.
<i>Financial and trade liberalization index:</i>	Indexes indicating the extent of capital market regulations and trade liberalization (2000=100). An increase in the indexes represents a reduction in capital market regulations or an increase in trade liberalization, Fraser Institute.
<i>Dependency ratios:</i>	<i>Elderly dependency ratio:</i> population aged 65 and over relative to the population aged 15 to 64. <i>Youth dependency ratio:</i> population aged 0 to 14 relative to the population aged 15 to 64. <i>Total dependency ratio:</i> population aged 0 to

	14 and 65 and over relative to the population aged 15 to 64, World Bank.
<i>Life expectancy:</i>	Number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life, World Bank.
<i>Budget deficit:</i>	Ratio of real budget deficit to real GDP. The real budget deficit is the ratio of nominal deficit to the December consumer price index, IMF, EIU, Eurostat, World Bank. <sup>39</sup>
<i>Housing price index:</i>	Residential property prices (2000=100). Various countries from Bordo and Jeanne (2002). This dataset was extended with data from the BIS.
<i>Private credit:</i>	Domestic credit to private sector as a percentage of nominal GDP, World Bank.
<i>Bank credit:</i>	Domestic credit provided by the banking sector as a percentage of nominal GDP, World Bank.
<i>Corporate debt:</i>	Outstanding corporate sector bonds as a percentage of nominal GDP. Data is only available for Canada, U.S., Japan and Germany.
<i>Productivity:</i>	Output per hour in manufacturing, data only available for industrialized countries, Bureau of Labour Statistics.
<i>Business taxes:</i>	Direct taxes on business as a percentage of nominal GDP, OECD.
<i>Industrial Production:</i>	Industrial production index, IMF.
<i>Depreciation rate:</i>	Depreciation rate on high-tech and structures for the U.S., see Gosselin and Lalonde (2005), Bank of Canada calculations.

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<sup>39</sup> Other inflation-adjusted measures of the real deficit are discussed in Desroches and Francis (forthcoming).

### Appendix B: Statistical Description of Data

	Series Mean	Standard Deviation	Maximum	Minimum
World real interest rate	0.044	0.021	0.086	0.012
Investment (% of GDP)	0.223	0.010	0.240	0.205
Savings (% of GDP)	0.229	0.012	0.256	0.205
Trade liberalization index (2000=100)	92.385	4.320	100.000	83.752
Financial liberalization index (2000=100)	95.975	13.123	115.141	77.107
Dependency ratio	0.529	0.033	0.596	0.496
Young dependency ratio	0.348	0.045	0.436	0.289
Elderly dependency ratio	0.117	0.012	0.138	0.097
Life expectancy	74.370	2.122	77.467	70.292
Labour force growth	0.018	0.003	0.023	0.013
Industrial production (growth)	0.022	0.033	0.088	-0.083
Depreciation rate (high tech)	0.049	0.012	0.067	0.033
OECD output per hour (2000=100)	67.058	24.577	128.138	29.032
Business taxes (share of GDP, 2000 = 100)	71.423	12.726	100.000	49.277
G4 corporate debt (% of GDP)	0.201	0.055	0.315	0.122
Private credit (% of GDP, 2000=100)	77.352	16.536	105.569	55.398
Real oil price (2000=100)	93.413	41.219	197.831	28.361
Government deficit (% of GDP)	0.055	0.035	0.160	0.004
Housing price index (2000=100)	57.184	43.300	162.701	0.146
Real stock market return	-0.015	0.137	0.236	-0.307
Stock market volatility	128.081	37.482	217.635	61.619

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