Financing transportation infrastructure investment in Colombia with pension savings

What are the investment attractions? What are the investment constraints? What are the priorities for government action?

**Paper intended for Colombia's Ministry of Finance (Ministerio de Hacienda y Crédito Publico), Ministry of Transport (Ministerio de Transporte) and National Planning Department (Departamento Nacional de Planeación).*

Tristan Hanson

Advisor: Akash Deep
Seminar Leader: Filipe Campante

This paper has been prepared to fulfil the Second Year Policy Analysis paper requirement for the Master of Public Administration in International Development degree at the John F. Kennedy School of Government, Harvard University. The author is extremely grateful to both Professor Akash Deep and Professor Filipe Campante for their valuable advice and feedback. The author would also like to thank Professors John Campbell and Luis Viceira for helpful comments. The author is grateful for the insights provided by a Chief Investment Officer at a Colombian pension fund that helped inform this analysis.

*These are hypothetical clients.

Executive Summary

Private investment in infrastructure has become a priority of economic policy for the present Colombian administration. Almost half of the ambitious new infrastructure investment program is planned to come from the private sector. The exponential growth in pension fund assets since the mid-1990s, now the largest pool of domestic savings, therefore represents an unprecedented opportunity to finance the level of private investment that the Colombian government is targeting.

This paper analyses the attractiveness of transport infrastructure as an asset class to pension fund investors. The normative characteristics of infrastructure assets, international empirical evidence and a stylised asset allocation model for a typical Colombian pension fund are considered in turn (Section III). The analysis provides strong evidence that infrastructure bonds in particular represent an attractive investment for Colombian pension funds. Infrastructure bonds could provide the long-duration, inflation-protected assets that pension funds seek, especially in light of the limited supply of long-maturity corporate and inflation-protected government debt in Colombia.

Why then have Colombian pension funds not invested heavily in infrastructure to date? The constraints to pension fund investment are discussed in Section IV. Among other explanations, it appears that a number of institutional inadequacies related to infrastructure concessions and distortive pension fund minimum return regulations deter pension funds from doing so.

The following recommendations aimed at alleviating these constraints are proposed to the Ministries of Transport and Finance and the National Planning Department: (i) conduct a thorough evaluation of INCO and strengthen the institution's capabilities based on weaknesses identified; (ii) create an independent regulatory commission for transportation concessions; (iii) kick-start a process to foster better coordination among relevant parties within the private sector through links with the CPC; (iv) involve multilateral organisations in the design of concessions; and (v) reform the minimum return requirement for pension funds. The Ministry of Finance has already proposed introducing (vi) a multi-funds pension system, which would likely stimulate pension fund interest in infrastructure projects, but this is the least compelling recommendation in this paper. These recommendations should help encourage private investment in infrastructure both in the next few years and into the future. They have been made with political feasibility in mind, a point discussed in Section VI. Moreover, it is intended that the proposed reforms could be implemented on a two-year time frame.

Contents

I. Introduction

Improving the state of Colombia's infrastructure has become a priority of government economic policy. A number of indicators highlight the poor quality of Colombian infrastructure, especially in terms of transportation. The World Economic Forum[1] (WEF) ranks Colombia 89th out of 131 countries for overall infrastructure, 94th for roads and 104th for ports. This compares to Colombia's WEF rank of 69th for overall competitiveness. Colombia's network of paved roads amounts to less than 400km per million inhabitants, behind other Latin American countries with lower GDP per capita such as Ecuador and Bolivia[2]. Transport costs constitute 19% of sales in Colombia compared to 6% in Argentina and Brazil[3] (see Figures 1&2, Appendix I). Moreover, it has been argued that transporting a container from the Colombian capital, Bogota, to the west-coast port of Buenaventura can cost as much as shipping it from the port to Asia[4].

In the most recent National Development Plan (2006), the present Colombian administration outlined plans for US$33bn of infrastructure investment in the period to 2010, thirty percent of the overall planned investment budget (US$109bn). Around US$11.5bn of investment (public and private) is planned for transport infrastructure over the period. Included in the transportation budget are an ambitious plan to add 2,500km of paved roads (*Plan 2500*) equivalent to 15% of the existing network, the construction of several major tolled highways, investment in airports, the development of existing and greenfield seaports, railways investments and concessions to develop urban transportation. As part of the investment budget for transportation infrastructure, the Colombian government is targeting a contribution of

[1] WEF (2007)
[2] CIA World Factbook (2008)
[3] Cámara Colombiana de la Infraestructura cited by the Consejo Privado de Competitividad (2007).
[4] Crowe (2005)

US$5.1bn (44%) from private sector sources over the 2006-2010 period. The sums are material in the context of Colombia's 2006 GDP of US$136bn (IMF).

While macroeconomic conditions have improved significantly over the past five years, the strength of the government's fiscal position remains uncertain. A series of fiscal deficits during the crisis increased Colombia's public debt as a proportion of GDP from 30% in 1996 to 57% in 2002[5]. Supported by strong GDP growth, the ratio has since declined to below 45%. This is a significant improvement from the crisis years, but Colombia's fiscal situation remains such that significant private investment will be required if the government is serious about its ambitious investment targets (see Figures 3&4, Appendix I).

Private investment in infrastructure is nothing new to Colombia. Following a series of liberalization reforms in the 1990s, private funds contributed a significant portion of infrastructure investment, although the majority of funds were directed at the energy, electricity and communications sectors. Foreign investment played a major role[6], although again mostly in non-transportation infrastructure. With the onset of economic crisis in the late 1990s which lasted until 2002, coinciding with a deterioration of the country's security situation, private investment in infrastructure waned at a time when the government's fiscal situation was deteriorating. Infrastructure investment (public and private) declined materially during this period (Figure 5, Appendix I).

In contrast to the 1990s, there is now a large and growing pool of private institutional savings in Colombia in the form of domestic pension funds. First introduced in 1994, these funds have grown to become the largest single source of private domestic savings in the Colombian economy. The growth in Colombian pension assets presents an unprecedented opportunity for the government to attract private domestic savings into infrastructure investment, in

[5] Source: IMF, EIU.
[6] Srinivas (2004)

line with its stated policy priorities. From the government's perspective private domestic savings should be considered a more attractive source of finance than foreign investors as the removal of foreign exchange risk, material in Colombia's case, increases the value of infrastructure assets to domestic investors relative to foreign investors. Moreover, pension savings provide a more predictable source of finance than international capital flows (Figure 6, Appendix I).

The desire of the Colombian government to attract private investment into infrastructure is clear. The regulatory challenge is to analyse what, if anything, needs to be done in order to encourage the participation of domestic pension funds. As yet, these funds have invested little in infrastructure assets.

The remainder of the paper is structured as follows. The development of Colombia's pension fund system is outlined in the following section. Section III provides analysis of the investment attractions of infrastructure assets to pension funds. This section includes a stylized asset allocation model for a typical Colombian pension fund. Section IV discusses the existing institutional constraints that limit the willingness of Colombian pension funds to invest in infrastructure. Section V provides policy recommendations based on the analysis undertaken.

II. Colombia's Pension Fund Industry

With the introduction of *Ley 100/93*, a privatised, fully-funded pension system was introduced in Colombia in December 1993, much in the spirit of earlier reforms in Chile (1981) and consistent with the trend in the region at the time[7]. The new system[8] operates alongside the previously existing pay-as-you-go (PAYG) scheme and individuals retain the choice to subscribe to either, with

[7] Pension reforms similar in nature were approved in several countries across the region in the 1990s: Peru (1992), Argentina (1993), Mexico (1995), Uruguay (1995), Bolivia (1996), El Salvador (1996), Panama (1997), Costa Rica (2000), Dominican Republic (2001). Source: www.fiap.cl.

[8] The information on the Colombian pension system provided here is sourced from FIAP (*Federación Internacional De Administradoras De Fondos De Pensiones*). See www.fiap.cl.

certain restrictions. Under the new defined-contribution system, individuals have a choice of six private pension providers with which to open an account and make mandatory contributions ('obligatory pensions' or hereafter FPOs[9]). Contributions are made jointly by the individual (25% of the contribution) and the employer (75%). The mandatory contribution rate has increased over the years and currently stands at 15.5% of income. Of this contribution, 11 percentage points are attributed to the savings account, 1.6 percentage points are paid to commission, 1.4 percentage points are spent on insurance and 1.5 percentage points go to a Minimum Guaranteed Pension Fund. From 2008 onwards, the government will contribute a further 1 percentage point to the accumulation account if GDP growth has averaged over 4% for two years.

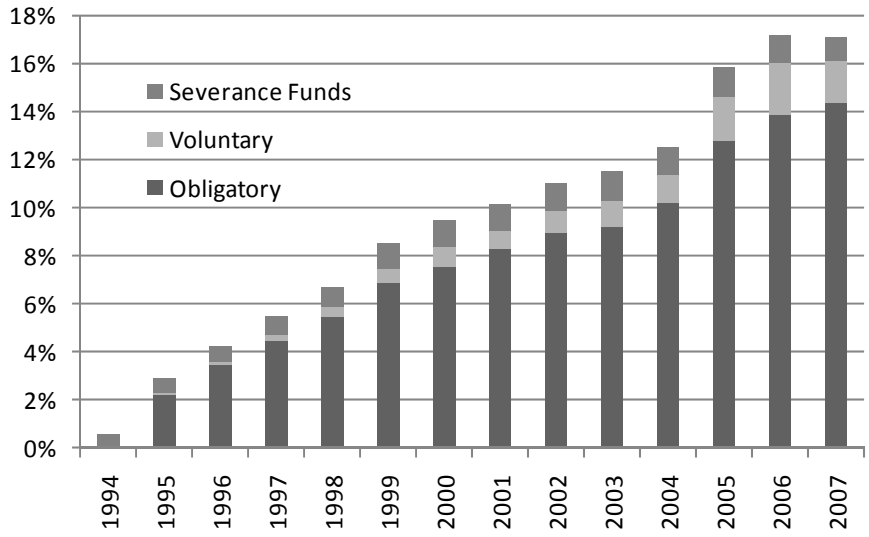
A combination of high investment returns and rapid increases in the number of contributors has produced stunning growth in Colombian pension assets under the new defined-contribution system (Figure 1). Over 14 years, obligatory pension assets have grown to 14.3% of GDP, making them currently the single largest source of private domestic savings in Colombia. Assets in voluntary[10] pensions have also grown significantly, although continue to represent a much smaller proportion of savings.

Since inception, FPO accounts have delivered an average annual compound real return of 10.8%. The impressive performance over the period is largely attributable to the decline in bond yields from high initial levels, and also strong equity market performance. Returns have fallen sharply in recent years, however. Figure 2 shows the evolution of pension fund real returns on both a three-year rolling basis[11] (i.e. returns over the last three years have averaged 6% per annum) and an annual basis. Poor returns during the past two years and

[9] FPO = Fondos de Pensiones Obligatorias.
[10] Individuals are free to open additional voluntary pension accounts which are distinct from the mandatory savings accounts.
[11] Three-year rolling returns are relevant because they are used to calculate the minimum return requirement discussed below.

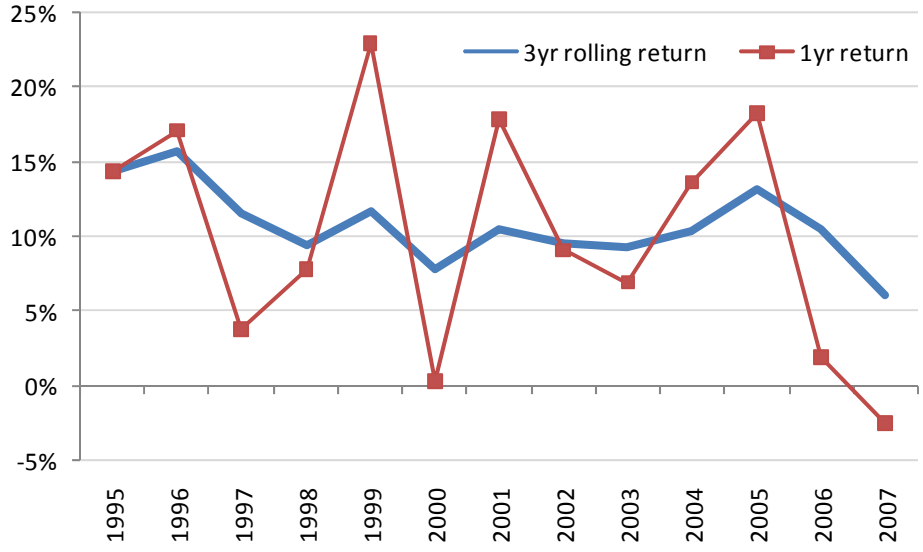
early losses in 2008 suggest the three-year rolling return is about to drop significantly.

Fig 1: Colombian pension fund assets (% of GDP)



Source: Asofondos.

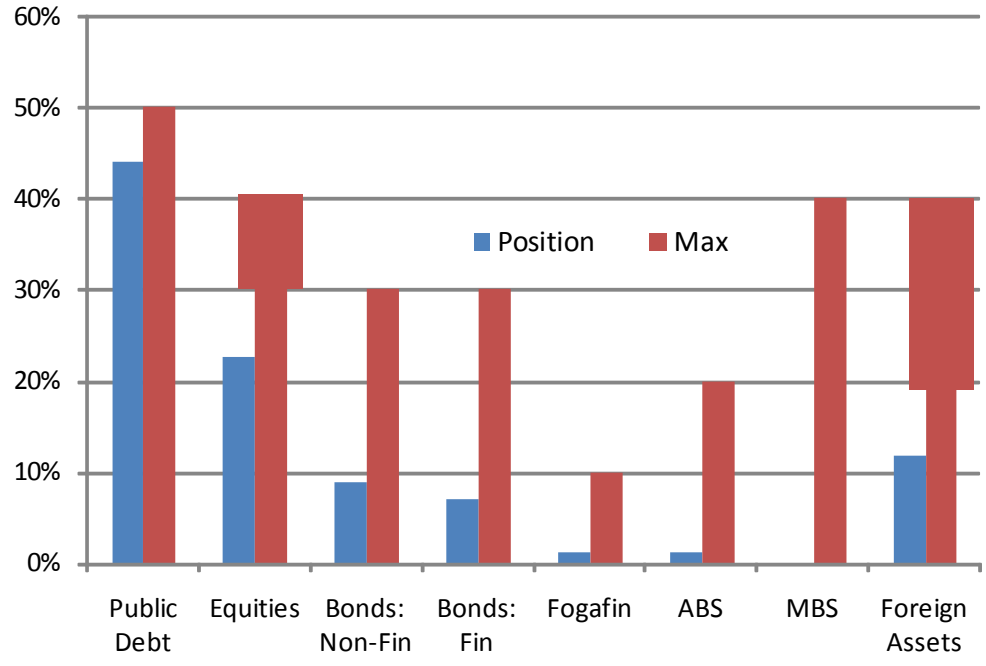
Fig 2: Colombian pension fund real returns



Source: Asofondos; author calculations (Asofondos provides performance data for the first year, first two years and subsequently three year rolling returns from which implicit annual returns have been calculated).

As is common in much of Latin America, domestic government bonds represent the largest holding of Colombian pension funds (44%, December 2007). Colombian government debt has delivered high returns over the past decade but prospectively offers much lower expected returns, since there is less scope for similar declines in bond yields. The remainder of Colombian pension fund portfolios is largely split between domestic corporate debt (16%) and equities (23% including mutual funds), with 12% of the portfolio invested overseas (Figure 3). Holdings of infrastructure assets are very small, likely below 0.5%[12] (falling under corporate bonds). All holdings of asset-backed securities (ABS), including project finance loans, amount to 1% of assets. As Table A1, Appendix I, illustrates, the asset allocation of Colombian pension funds is not out of line with other Latin American countries.

Fig 3: Colombian FPO asset allocation (Dec 2007)



Source: SFC.

[12] Estimate based on Asofondos' (2005) estimation of FPO infrastructure holdings. At 2004 year-end, FPO infrastructure investments totalled COP 115bn, equivalent to 0.2% of current assets.

A number of regulations govern Colombian pension fund portfolios. Two types of regulation are especially important to note at this stage: (1) quantitative investment limits placed on various asset classes and (2) regulations regarding minimum return requirements.

Quantitative investment limits

Investments by Colombian FPOs are subject to strict limits as dictated by the *Circular Basica Juridica* (1996)[13]. These limits are frequently revised, with the latest revisions taking effect from March 2008. Figure 3 highlights the most relevant investment limits[14], with the latest changes indicated by arrows. In addition, the new changes allow FPOs to hold a wider variety of overseas assets and up to 5% of the portfolio in private equity funds. What is especially interesting is that none of the investment limits are currently binding (in the aggregate): Colombian pension funds could in theory increase exposure to any desired asset class from current levels. Of course, other regulations may dissuade them from doing so.

In addition to investment limits at the asset class level, FPOs can only invest up to 10% of the fund in securities of any single issuer, including affiliates and subsidiaries. Moreover, an individual FPO can only purchase up to 30% of any single offering of securities, including securitised assets.

Minimum Return Requirement

FPOs in Colombia are subject to a minimum return requirement calculated by the financial sector regulator (SFC). Should a pension fund

[13] The 1996 regulation has been subject to several modifications over the years, most recently in February 2008. See: http://www.superfinanciera.gov.co/Normativa/NormasyReglamentaciones/cir007/t4.doc for the latest version. "Titulo IV - Capitulo Cuarto" defines the relevant investment limits. The most recent changes were dictated by "Circular Externa 005 del 2008" of the Superintendencia Financiera de Colombia (SFC), Colombia's financial sector regulator.

[14] The regulations referenced above provide a much more detailed list of permitted investments.

provider's performance (measured over a trailing 36 month period) fail to meet the minimum return requirement, then the provider would be obliged to use its own capital to meet the shortfall.

Decreto 2664 of the Ministerio de Hacienda y Crédito Publico (July 2007) revised the minimum return requirement for FPOs. The minimum return requirement for FPOs is calculated in relation to the average return generated across the six providers, returns generated by certain benchmark indices and a reference portfolio constructed by the SFC. The calculation is as follows[15]:

Minimum Return = minimum of 0.7 *[(A+B)/2] or **[(A+B)/2] – 2.60%**

Where:
A = average return generated across the pension fund system
B = [US equity index return * α] + [Colombian equity index return * β] + [reference portfolio return * (1- α- β)]
α = average weighting of pension funds in foreign equities
β = average weighting of pension funds in domestic equities
Reference portfolio = portfolio of domestic fixed income assets (constructed by SFC)

While the minimum return calculation is rather cumbersome, it has evolved from a desire to include benchmark indices and a reference portfolio, rather than relying on a minimum return requirement based solely on the system's average performance as occurs in Argentina and Uruguay[16]. Such minimum return requirements are common in many privatised systems around the world (the exceptions in Latin America being Mexico, Costa Rica and Bolivia[17]).

Pension systems compared: the cases of Chile, Peru & Mexico

The Colombian government's recent financial reform proposal (*Proyecto de Ley de Reforma Financiera*, 2007) recommends the introduction of a multi-funds pension system, as exist in Chile, Peru and Mexico. For this reason, a brief comparison of these systems is warranted[18].

[15] Source: Ministerio de Hacienda; Hanson (2007).
[16] Borrero Restrepo (2005), presentation on behalf of SFC.
[17] AIOS (2007)
[18] For more detail see FIAP (2007).

Under a multi-fund system, each pension fund provider offers multiple funds (5 in Chile, 3 in Peru and 2 in Mexico[19]) with varying degrees of risk (different investment restrictions apply to funds in each risk category). Contributors can choose (with certain restrictions) which risk exposure they desire and if no choice is exercised the contributor is assigned a default fund depending on age. The default portfolios for younger contributors are riskier; older contributors' portfolios are invested largely in government debt.

These three regimes provide interesting alternatives in terms of minimum return regulation. Chile adopts a symmetrical target relative to the average return (within each risk category) calculated over the previous 36 months. For riskier funds A and B, the minimum return is the lower of (i) the average for the respective category less 4 percentage points or (ii) 50% of the category's average return. For the lower risk funds C to E, the minimum return is calculated as the lower of the average for the category less 2 percentage points or 50% of the category's average return[20]. However, the regulation includes a "Profitability Fluctuation Reserve[21]", whereby a pension fund keeps in reserve excess returns above a 'maximum' target calculated in a symmetrical manner to the minimum return for each category. Any funds accumulated in this reserve can be used in the event that the minimum return is breached at a future date. The Chilean policy has several attractions. First, it is simple. Second, by introducing a symmetrical 'maximum return', the policy offers an incentive to outperform and therefore maximise efficiency. Moreover, the accumulated reserves reduce the risk of future shortfalls (at the extreme also reducing the implicit government liability) and may permit a reduction in fees charged to the contributor for risk protection. In Colombia, this is an important consideration since of the contribution of earnings that each contributor makes almost 20% is spent on risk

[19] Soon to be increased to 5 funds in the Mexican case.
[20] FIAP (2007)
[21] Ibid

protection[22]. The downside of the Chilean policy is that a herding effect[23] remains since minimum and maximum returns are calculated relative to peers.

The Peruvian system provides a very different model for its minimum return guarantee[24]. Each pension fund provides the regulator with a description of the benchmark asset or index that corresponds to each holding in the portfolio (for example, the MSCI World Equity Index for holdings of foreign equities). These benchmarks must be agreed in advance by the regulator. The minimum required return is then calculated relative to the weighted average of the benchmark returns (after an adjustment[25]). In other words, this regulation retrospectively punishes poor investment performance or tracking error relative to a benchmark, not low returns relative to the system. The attractive feature of this regulation is that herding incentives are removed since there is no reference to peer returns. The downside to the regulation is a lack of transparency and the fact that minimum returns will vary for each pension fund provider. This is a potential source of confusion to contributors.

In contrast to regulations in Chile and Peru, in Mexico there is no minimum guaranteed return[26]. Instead, a value-at-risk (VaR) measure is employed to limit risk. A portfolio's VaR is calculated as the expected portfolio loss at a given confidence level (e.g. 1% or 5% are common cut-offs) over a pre-determined period of time. For example, with a probability of 5% a fund may expect to lose $1 million over a one-day period, giving it a daily VaR of $1 million. While VaR can be calculated in a variety of ways (e.g. Monte Carlo simulation or parametric estimation where a distribution of returns is assumed), the Mexican pension

[22] As highlighted earlier, of the 15.5% contribution from earnings, 1.5 percentage points is paid to the minimum pension guarantee fund and 1.4 percentage points is spent on insurance against default.
[23] Discussed later. See Srinivas (2004) and Chan-Lau (2004) for more details.
[24] AIOS (2007)
[25] AIOS (2007) states that Peru's minimum return regulation is under revision. Without being specific, Peru's regulator SBS (2006) states that the minimum return is calculated based on a relative VaR (value-at-risk) calculation.
[26] There is a guaranteed minimum pension in Mexico, but there is no guarantee of pension fund returns. As such, unlike in the other systems discussed, Mexican pension fund providers do not share the risk of low returns with the government.

regulation specifies that volatilities and correlations experienced over the previous 500 trading days will be used to calculate VaR at a 5% significance level[27]. Under the current system, Mexican pension providers manage two portfolios of varying risk. The low-risk portfolio has a maximum permitted daily VaR of 0.6% of assets and the higher-risk portfolio has a permitted daily VaR of up to 1%[28]. The advantage of this system is that it incentivises portfolio efficiency and eliminates any herding effect. Moreover, the regulation encourages pension funds to seek uncorrelated assets and to reduce risk when volatility is high (since a wider distribution of returns suggests a larger VaR for any given cut-off). The downside to the regulation is that the prior trading period of 500 days may not be an accurate description of future risks confronting the portfolio manager (uncorrelated assets can quickly become correlated) and therefore risks may be misunderstood.

III. What are the investor attractions of transport infrastructure assets?

Global interest in infrastructure investment has grown spectacularly in recent years. McKinsey (2008) estimates that private investment funds dedicated to infrastructure have raised over $105bn since 2006; Orr (2007) estimates an even larger figure of $160bn over the same period. Major pension funds around the globe now view infrastructure as its own asset class and their investment has contributed significantly to the growth in new funds[29].

This section analyses the attractions of infrastructure assets[30] to pension funds. The characteristics of infrastructure assets are discussed. Empirical evidence is provided relating to the global experience of infrastructure

[27] Brunner et al. (2007)
[28] Ibid
[29] See CalPERS (2007), ABP Investments (2007) and information regarding the Canadian Pension Plan's investment in infrastructure, available at: http://www.cppib.ca/Investments/Inflation_Sensitive_Investments/infrastructure.html.
[30] This paper is only concerned with transport infrastructure assets, such as toll roads, ports, airports or railways.

investment. Furthermore, a stylised asset allocation model is constructed to analyse the potential attractiveness of infrastructure assets specifically to Colombian pension funds.

The characteristics of infrastructure assets

Infrastructure assets are typically thought to offer the following characteristics[31]:

- *Long duration*: infrastructure assets are long-life assets that provide cash flows usually over 20 to 50+ year periods, depending on concession arrangements. Recent investments in North America have even been awarded concessions as long as 99 years.

- *Inflation protection*: infrastructure is a 'real asset' that provides a hedge against inflation. Concession contracts frequently apply a rising tariff schedule that is linked in some way to consumer price inflation (CPI).

- *Diversification*: infrastructure assets offer diversifying qualities to a portfolio of other traditional assets. Infrastructure is not believed to be perfectly correlated with either equities or the business cycle, although some positive correlation is usually assumed.

- *Regulated assets*: infrastructure assets are usually highly regulated. Government plays a significant role at each stage of the project's development: planning, concession granting and regulation. Since infrastructure is a public good, the government is a key stakeholder in any project. Concession agreements are typically legally enforceable contracts "signed with a government…and [which] set out the concessionaire's

[31] Macquarie (2007a), CalPERS (2007), ABP Investments (2007) and Deutsche Bank (2007) have been used to summarise infrastructure characteristics.

obligations and rights for operations[32]". In countries with strong legal systems and good contract enforcement, the regulated nature of infrastructure is attractive. However, regulatory risk remains a concern in countries with weaker legal systems.

- *Stable cash returns*: infrastructure assets are thought to deliver relatively stable or predictable cash flows. To some extent, infrastructure benefits from a certain monopoly power: high up-front fixed costs provide a barrier to entry and regulation can provide relatively predictable tariff increases. While transport infrastructure is subject to macroeconomic risks (e.g. traffic growth), the assets are not perfectly correlated with the business cycle (and are typically less volatile). For example, UK motorway traffic has grown each year since records began in 1955[33].

- *Capital intensive*: developing infrastructure involves significant up-front fixed investment costs and initially several years of negative cash flows. While this feature provides some advantage in terms of monopoly power, it also makes infrastructure undesirable to certain investors.

- *Illiquidity*: depending on how infrastructure is funded (listed or unlisted equity, debt, project finance) investors may find themselves holding an illiquid asset. This is undesirable for some investors, but others may view the expected liquidity premium sufficiently attractive compensation.

- *Expropriation risk*: private investment in infrastructure suffers from the traditional "hold-up" problem: once it is built and the up-front costs incurred, the government may have an incentive to expropriate the asset. Any government, however, clearly has to weigh up the net benefit of such

[32] Macquarie (2007a)
[33] Ibid

action in terms of future private infrastructure investment that will not be forthcoming. While this is less of an issue in countries with strong contract enforcement, expropriation remains a concern in many developing countries.

In addition to the above, infrastructure presents a number of risks which may vary depending on the maturity of the asset (e.g. greenfield development versus an existing asset), with early-stage assets presenting the greatest risks. For greenfield developments, construction risks are material: infrastructure projects are often subject to cost overruns and delays in the construction phase. Operational risks apply to all projects: traffic growth, for example, is hard to forecast accurately and is often overestimated at the project outset[34]. Market risks in terms of interest rate or foreign currency mismatches can be relevant, but easily hedged if domestic financial markets are sufficiently developed. Furthermore, because of the contract-intensive nature of infrastructure, political and legal risks are very much a concern especially in countries where contract enforcement is weak. Socio-political risks can arise in the form of social pressures to limit tariff increases. Finally, in a country such as Colombia, terrorism can be a material risk.

How risks are allocated is a crucial aspect of infrastructure contracts. Much of the risk allocation will depend on the nature of the contract and extent of private participation. Gausch (2004) provides a schematic diagram of the most common types of infrastructure projects, ranging from fully public to privatisations (Appendix I, Figure 7). A general principle should be that risks are allocated to the parties best suited to manage them[35]. Typically the private investor will be left bearing construction, traffic, operating and credit risks[36]. Other risks may be best shared or left with the government. Detailed contracts

[34] Gausch et al (2005)
[35] Harris (2004)
[36] Atlantia (2007)

can mitigate the risk of expropriation by the government, although the private party will be left with legal risk related to contract enforcement. Political risk insurance, such as that provided by MIGA (Multilateral Investment Guarantee Agency), may cover such risk. Private investors should be protected from inflation risk, which is ultimately under government control. Regulatory risks should arguably be shared by the two parties since, although governments control regulation, it may occasionally be in its best interest to renegotiate the concession agreement[37].

Often government guarantees are provided to share (or even assume) various risks in order to encourage private participation. These might include traffic guarantees, whereby the government will pay the private owner for any difference between forecast and actual traffic revenues. Similarly, in various cases government guarantees have been extended for construction risks. Government guarantees have often been controversial, costly (as has been the case historically in Colombia[38]) and discouraged governments from embarking on further PPP (Public Private Partnership) infrastructure projects.

Infrastructure as an asset class: global evidence

To what extent does the empirical evidence support the theoretical characteristics of infrastructure assets? And given the characteristics of infrastructure assets outlined above, what should investors expect in terms of risk and return relative to other asset classes? More specifically, what can pension funds expect from domestic infrastructure investments in Colombia? This section attempts to address these questions.

Table A2 (Appendix I) provides summary details for a number of toll road concessions owned by Cintra, a major Spanish infrastructure company with global reach that provides the most transparent information on toll increases.

[37] Thobani (1999)
[38] See Benavides et al (1999), Engel et al (2003) and INCO (2004).

The data is noteworthy for several reasons. Cintra's concession agreements are very long, ranging from 16 years in Chile to 99 years for its Canadian toll road. The company's concessions in Chile are on average shorter (average 22 years) versus 52 years for its remaining portfolio (which includes concessions for which toll prices are not available and therefore omitted from the table). All Cintra's concession agreements link toll increases to inflation, occasionally with some agreed adjustment. Toll schedules in Chile increase in line with inflation plus a road safety bonus of up to 5%; toll increases in Spain track inflation with an adjustment down (up) if traffic is better (worse) than forecast. For each of the Cintra concessions where there is more than two years of data, toll increases have bettered inflation. This is powerful evidence supporting the view of infrastructure as a long-dated asset offering inflation protection[39].

Other major infrastructure players provide less data on tariff increases for individual investments, but concession lengths are also very long. Macquarie Infrastructure Group (from Australia) boasts an average remaining concession length of 61 years; Brisa (Portugal) 24 years and Abertis (Spain) 23 years[40]. Furthermore, minimum tariff increases on European motorway concessions reinforces the evidence that toll roads can offer considerable protection against inflation (Table A3, Appendix I).

There is little history of investment returns for infrastructure. Most indices are fairly new and there appear to have been only a handful of studies conducted that estimate the returns from infrastructure investment. Much of what evidence is available is concentrated in developed markets. Table A4 (Appendix I) provides a summary of some of the literature that attempts to analyse equity returns from infrastructure. While, there is a wide spread of estimated returns, the data broadly suggests infrastructure has delivered high returns over the past decade with moderate volatility (the long term average annual volatility of the

[39] Of course, it may be the case that Cintra invests only in good assets.
[40] Source: Company annual reports and web-sites.

US S&P 500 stock index is around 18%[41]). It is plausible that such high ex-post returns have stimulated the recent enthusiasm for infrastructure investment among investors globally. However, it is unreasonable to expect the same high returns and moderate volatility looking forwards (doing so would be inconsistent with financial theory[42]).

In addition to this analysis, Table A5 (Appendix I) provides analysis of equity returns for a number of the world's major infrastructure companies. The data shows high realised real returns over the past decade (sample average annual real return of 22%) with an average volatility of 28%. Returns have been slightly higher on average in developing countries and more volatile (although a number of the developed country companies also have material exposures to developing countries). The average correlation of (monthly) returns with local equity markets is 37% and the average beta is 0.54.

On balance, the global data suggests infrastructure does indeed offer the potential for inflation-protected cash flows over long asset lives. Moreover, equity returns for infrastructure companies have been high on average over the past decade. It would be unrealistic, however, to assume such high expected returns on a forward-looking basis. It should also be noted that many of these companies are highly leveraged. As a result, historical real returns provide perhaps less useful information than correlation and volatility data in terms of forward-looking analysis.

Colombian Pension Funds: An Asset Allocation Model

This section provides a stylised asset allocation model for a typical Colombian pension fund. The modelling framework used in this section is taken from Campbell & Viceira (2002).

[41] Campbell & Viceira (2002)
[42] It is assumed that infrastructure equity is positively correlated with equity markets.

The pension fund investor maximises expected utility of wealth at a 15 year horizon where future wealth is a function of current wealth and portfolio returns. The pension fund optimises its allocation to assets (risky and risk free) in order to maximise utility. A 15 year horizon is used for two reasons. First, for pension funds it is realistic to assume a long investment horizon[43]. Second, the maximum maturity of domestic Colombian bonds is approximately 15 years and therefore the model is simplified by assuming a 15 year investment horizon (without any real loss of generality).

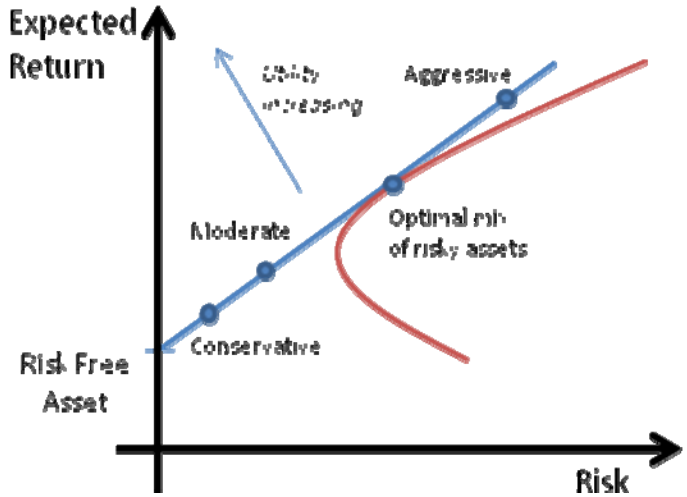
Specifics of the model are discussed in more detail in the appendix. The model assumes a power utility function of wealth. It is also assumed that asset returns are lognormal and i.i.d. (independently and identically and distributed), in other words not predictable. This assumption is restrictive[44], but it comes with several benefits and no real loss of generality related to the question of interest to this research – should Colombian FPOs hold infrastructure assets? Assuming predictable asset returns yields insights for long term portfolio management based on dynamic optimisation models. However, most analyses of asset predictability are limited to the US market. There is little data with which to build a reliable model of Colombian asset returns and using estimates from US data to model Colombian assets is problematic. Moreover, we are less interested in the benefits of dynamic rebalancing (although they may be large) than we are in the more straightforward risk/return benefits of holding infrastructure assets in a portfolio. Assuming asset returns are i.i.d. simplifies a model of long horizon portfolio optimisation to a myopic model, where the investor only cares about one-period returns. A myopic model is analogous to the well-known Markowitz mean-variance analysis (illustrated in Figure 4). Based on the assumptions made in this case, we can use a myopic framework to model a single period return that

[43] An even longer horizon could be justified given the age profile of Colombian pension contributors – see Figure 8, Appendix I.

[44] Much of the financial economics literature finds evidence of predictability of stock or bond market returns, at least in the US. See Campbell & Viceira (1999, 2002) for more details.

is 15 years long. The mathematical solution to the model is provided in the Appendix II. Here we are more concerned with quantifying the theoretical model using a stylised menu of assets available to Colombian FPOs.

Figure 4: Mean-Standard Deviation of Returns



Source: adapted from Campbell & Viceira (2002). Optimal portfolios for various investor types highlighted.

To quantify the model for Colombian pension funds the following (simplified) set of available assets is assumed:

Table 1: Stylised asset menu assumed for Colombian FPOs

		E[R], real (%)	*Volatility (%)*	*Risk Premium (%)*
Domestic	Government bond: index-linked (15yr)	5.6	0	0
	Government bond: nominal (15yr)	5.6	7	0
	Money Market (3mth)	5.6	4	0
	Equities	9.5	39	3.9
	Corporate Bonds	6.6	15	1.0
	Infrastructure – Bonds	6.6	10	1.0
	Infrastructure – Equity	7.9	40	2.3
Global	Global Equities	8.3	22	2.7

Source: author calculations (explained in text).

It is assumed that the investor holds bonds to maturity (hence the choice of the 15-year horizon approximating the maximum maturity of Colombian government debt). The 15-year inflation index-linked bond is the risk-free asset for this investor since there is zero uncertainty over its expected real return over the relevant horizon. The expected return of 5.6% is taken from the January 2008 auction cut-off rate for the 2023 maturity index-linked domestic government bond. Nominal government bonds are also held to maturity here. Therefore, they do not suffer from interest rate risk but are subject to inflation risk and thus offer uncertain real returns. The expected return is assumed equal to the expected return on inflation-protected bonds[45]. The estimated volatility has been calculated based on the volatility of inflation in Colombia since 1993, the first full year of central bank independence. Short-term money market assets (e.g. 3m bills) are subject to real interest rate risk over longer horizons, but it has been assumed that they are protected from inflation. Therefore, in this model, money market assets are lower volatility than long-term nominal bonds (because real interest rate risk is lower than inflation risk). This makes sense for practical purposes. To model money market instruments as nominal assets without a model of inflation persistence, it would be necessary to assume inflation risk for long-term nominal bonds is the same as that for short-term assets, which seems very unrealistic in the case of Colombia. The result of doing so would be to underestimate the relative risk profile of nominal long-term bonds. The volatility of real money market returns has also been calculated using data since 1993. Again, money market assets are assumed to have an expected real return of 5.6% over the forecast period, consistent with the expectations hypothesis of interest rates[46].

[45] The January 2008 auction yield on the 2020 domestic nominal government bond was 10.5%. Assuming a flat yield curve for 2020-2023, this implies a break-even inflation rate in the region of 4.9%. For reference, the Colombian central bank's inflation target for 2008 is 4.5%.

[46] The model does not, therefore, incorporate term or inflation risk premia for longer maturity bonds.

Expected equity returns have been based on a modified CAPM basis according to publicly available information from a major Colombian bank (Bancolombia (2007))[47]. An alternative method of calculating expected equity returns in developing countries produces a slightly higher expected return[48], but the Bancolombia method is used in this analysis. Colombian equity volatility is based on real returns data since 1954. Historical real Colombian equity returns have not been used to estimate expected future returns since their long-term performance has been very poor (and most likely lower than the ex-ante expectation).

A spread of 100 basis points has been assumed for corporate bonds. This seems as reasonable an expectation as any: the Colombian corporate bonds indexed to inflation with maturities in excess of five years that were issued in 2007 offered real yields in the region of 5.2% to 6.8% (all either AAA or AA+[49]). A volatility of 15% has been assumed to take account of inflation risk and credit risk. MSCI World equity returns since 1969 (measured in Colombian pesos) have been used to estimate the return and volatility characteristics of global equities.

Expected infrastructure returns have been assumed for both bonds and equity. Similar to other corporate bonds, an expected return of 6.6% has been assumed for infrastructure bonds (implicitly AAA or AA rated). A lower volatility (10%) than that of standard corporate debt has been assumed since infrastructure bonds are likely to offer better inflation protection. Expected returns on infrastructure equity have been assumed using CAPM and a beta of 0.6 (in line with international experience – Table A5, Appendix I). Such an

[47] Expected equity return calculation: US 10yr inflation-protected yield (1.6%) + Colombia EMBI spread (1.9% (at Dec 2007)) + 6% equity risk premium = 9.5%. The author has adjusted the Bancolombia calculation to express the expected return in real terms (i.e. nominal US bond replaced with real bond yield). The author acknowledges that this method is not theoretically rigorous but it reflects current practice.

[48] Using sensible assumptions, the Godfrey-Espinosa approach (see Estrada (2007)) yields an expected return on Colombian equity of 10.7%. This method (similarly ungrounded in theory) is not used in this paper.

[49] Virtually all Colombian corporate debt held by FPOs is rated AAA or AA (source: BRC (2007)).

expected real return looks realistic given historical data and various expectations provided in the literature[50] (Tables A4, A5 & A6, Appendix I).

Portfolio optimisation requires not just individual asset characteristics but also estimated correlations. The following correlation matrix (Table 2) is used in calculating the optimal portfolios. The figures for domestic equities, foreign equities, government bonds and money market assets are based on historical correlations ranging up to twenty years of data. The figures for infrastructure and corporate bonds have simply been assumed in line with what the author believes to be reasonable[51].

Table 2: Correlation Matrix

	Domestic							*Global*
	ILB	NOM	MONY	EQTY	CORP	INFRA bond	INFRA equity	MSCIW
Govt bond: ILB* (15yr)	1	0	0	0	0	0	0	0
Govt bond: nominal (15yr)		1	-0.28	0	0.20	0	0	0
Money Market (3mth)			1	-0.22	0	0	0	0.56
Equities				1	0.20	0.20	0.40	0
Corporate Bonds (CORP)					1	0.20	0.10	0
Infrastructure – Bonds						1	0.20	0
Infrastructure – Equity							1	0
Global Equities (MSCIW)								1

Source: Correlations based on Global Financial Data and Banco de la Republica data (author assumptions for infrastructure and corporate bonds); *ILB = inflation index-linked bond.

Perhaps the simplest way of presenting the model's results is to show optimised portfolio weights for an investor that minimises risk for a given expected return. Three scenarios are modelled (expected real returns of 6%, 7% and 8%), which represent three different levels of risk aversion. This way, harder

[50] Assuming an inflation expectation of 5% would suggest a nominal expected return on infrastructure equity of around 13%.

[51] The correlation of infrastructure equity with the local equity market is assumed to be similar to that experienced in other emerging markets (Table A5, Appendix I).

to conceptualise coefficients of relative risk aversion do not need to be specified[52]. Four different models are constructed as follows:

- Model 1: Unconstrained (all assets available)
- Model 2: Excluding infrastructure equity
- Model 3: Excluding infrastructure bonds
- Model 4: Excluding all types of infrastructure

Table 3 provides the optimal weights allocated to each asset for different expected returns across the four models (given the asset characteristics specified above). It has been assumed that FPOs cannot sell short any asset. In addition, quantitative investment restrictions have been incorporated to reflect the latest pension fund regulation. Naturally, higher expected returns come with higher volatility. It is therefore the choice of the pension fund investor to decide which combination of assets is optimal based on preferences regarding risk and return. A range of expected real returns from 6% to 8% is shown since the real risk-free rate is estimated to be 5.6% currently and, given the assumptions above and current regulations, the maximum expected real return of the portfolio would be 8.4%.

It must be emphasised that the portfolio optimisation model relies on a number of assumptions and there exists significant uncertainty surrounding the model's inputs. A different set of assumptions would yield different optimised portfolio weights. Moreover, the model is a simplification of the reality facing pension fund investors (for reasons explained above) and omits some (smaller) asset classes that are available to FPOs.

[52] The model used to present the results here is effectively the mean-variance model from Campbell & Viceira (2002, Ch.2.1.1). This is equivalent to the model described above and in Appendix II that incorporates preferences.

Table 3: Optimal portfolio weights (12/07 approximates Dec-07 position)

		Real E[r] = 6%				Real E[r] = 7%				Real E[r] = 8%			
Model #	**12/07**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Target Return	7.1%	6.0%	6.0%	6.0%	6.0%	7.0%	7.0%	7.0%	7.0%	8.0%	8.0%	8.0%	8.0%
Risk (Std Dev)	10.9%	2.9%	2.9%	4.4%	4.4%	7.7%	7.7%	8.4%	8.5%	14.0%	14.0%	14.7%	14.8%
Optimal Weights													
Govt bond: ILB	17%	50%	50%	50%	50%	26%	26%	42%	43%	0%	0%	0%	0%
Govt bond nom.	29%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Money Market[53]	-	18%	18%	18%	18%	0%	0%	0%	0%	0%	0%	0%	0%
Equities	24%	1%	1%	0%	0%	8%	9%	11%	12%	24%	25%	23%	25%
Corporate Bonds	17%	7%	7%	27%	27%	11%	11%	16%	17%	6%	6%	32%	35%
INFRA – bonds	-	20%	21%	-	-	30%	30%	-	-	28%	30%	-	-
INFRA – equity	-	0%	-	1%	-	1%	-	2%	-	2%	-	5%	-
Global Equities	13%	4%	4%	4%	5%	24%	24%	28%	29%	40%	40%	40%	40%
Sharpe ratio	13.3%	13.8%	13.8%	9.2%	9.1%	18.2%	18.1%	16.6%	16.5%	17.2%	17.1%	16.3%	16.2%

Source: Model results. Other securities not included in the model account for 5% of the current FPO portfolio, so the 12/07 positions shown above have been scaled accordingly (by 100/95) to estimate an expected return and standard deviation. Weights may not sum to 100% because of rounding. It is not possible to ascertain the current weighting in infrastructure but it is assumed to be less than 0.5% (see Section II).

Nevertheless, Table 3 provides a number of interesting observations. Nominal government bonds do not feature in any of the portfolios. There is a large weight placed on inflation-protected government bonds and money market instruments in more conservative portfolios, but zero weight in the most aggressive portfolios. In all but the least risky portfolio, foreign equity has a significant weighting[54]. Infrastructure equity does not appear to add much to portfolio efficiency (given the characteristics we have assumed): there is little to separate models 1 and 2. By contrast, infrastructure bonds appear to be a very useful addition to the portfolio and they act as a substitute for government inflation-indexed debt, other corporate debt and to a lesser extent equities.

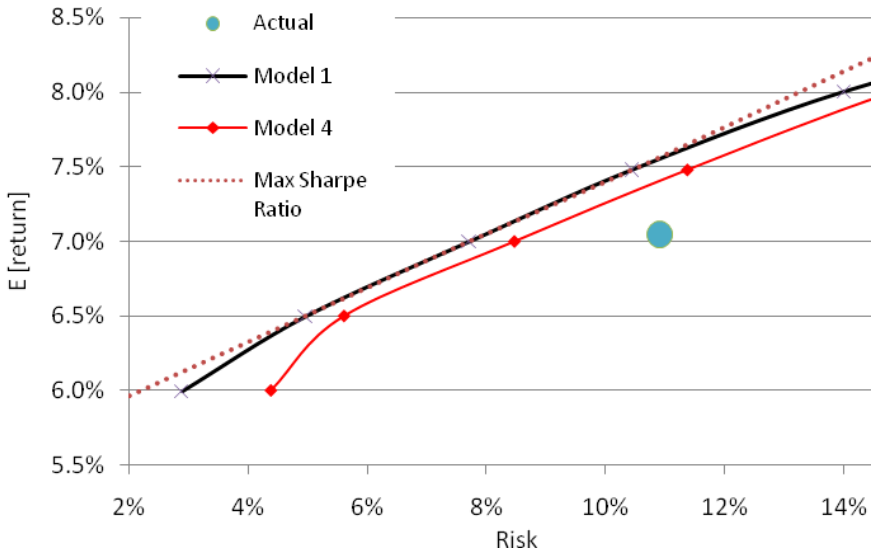
[53] Repo transactions are classified as money market investments in this model, allowing a maximum limit of 18% of portfolio assets.

[54] Note that the quantitative investment limit on foreign assets has only recently (March 2008) been increased from 20% to 40% . That said, the current FPO weighting in foreign assets of 12% was well below the previous limit. The results above for the riskier portfolios concur with Jara et al. (2005) who argue that efficient FPO portfolios have a significant weighting in foreign assets (>20%).

Models 1 and 2 have high weightings in infrastructure bonds in the region of 20% to 30%.

Figure 5 plots the efficient frontier for Models 1 (unconstrained) and 4 (no infrastructure), again incorporating current FPO regulations. The figure illustrates the potential benefit FPOs could gain from adding infrastructure to their available menu of assets (higher portfolio returns for a given risk). The maximum Sharpe ratio is achieved by Model 1 with a target real return of 7%. The inability of pension funds to borrow (model assumption) and the various investment restrictions are the reason why the optimised frontier for model 1 lies below the maximum Sharpe ratio line at all other points. The graph also highlights an estimated expected return and volatility for FPOs given their actual asset allocation.

Fig 5: Colombian FPO efficient frontiers



Source: Model results.

One question immediately springs to mind: why is actual FPO asset allocation so different from the optimised portfolios? First, the above models incorporate the latest regulations (applicable from March 2008) that allow larger weightings in overseas securities (changes from 20% to 40%) and domestic

equities (from 30% to 40%). But that is only part of the explanation. One possibility argued later in the paper is that pension fund regulation encourages herding and risk aversion (i.e. higher weightings in government debt). A further explanation may be a shortage of supply in certain assets. The latter constraint seems especially relevant in the cases of corporate bonds and inflation-protected government bonds. FPOs already hold about two thirds of the stock of Colombian corporate bonds[55] and the entire stock of government inflation-protected domestic debt is equivalent to only 57% of FPO assets under management[56]. For this reason, a further model is developed constraining FPOs to a 17% weighting in corporate debt, a 25% weighting in index-linked government bonds and applying the previous restrictions placed on foreign assets and domestic equities. Table 4 shows the results:

Table 4: Optimal portfolio weights (restricted model & Dec-07 position)

		Model 5: old regulations + restrictions		
	12/07	**Real E[r] = 6.2%**	**Real E[r] = 7%**	**Real E[r] = 7.5%**
Target Return	7.1%	6.2%	7.0%	7.5%
Risk (Std Dev)	10.9%	5.0%	9.1%	13.2%
Optimal Weights				
Govt bond: ILB	17%	25%	25%	25%
Govt bond nom.	29%	25%	6%	0%
Money Market	-	18%	14%	8%
Equities	24%	0%	18%	30%
Corporate Bonds	17%	17%	17%	17%
INFRA – bonds	-	-	-	-
INFRA – equity	-	-	-	-
Global Equities	13%	15%	20%	20%
Sharpe ratio	13.3%	11.6%	15.4%	14.2%

Source: Model results. Model 5 includes the following limits: money market (18%), corporate bonds (17%), domestic equity (30%), foreign assets (20%), inflation-protected government debt (25%), total government debt (50%). Note that given the restrictions included in the model the range of possible real returns is 6.2% to 7.5%.

[55] World Bank (2006)

[56] The entire domestic market for Colombia inflation-protected government debt is only COP 29 trillion, equivalent to 57% of FPO assets. Moreover, the duration of existing government inflation-protected debt is under 4 years. Source: Ministerio de Hacienda y Crédito Publico.

The additional constraints impose a negative shift in the efficient frontier, which accounts for some (if not all) of the apparent inefficiency of actual FPO portfolios (Figure 9, Appendix I). Under Model 5 conditions, a target real return of 7% broadly appears to be most consistent with current asset allocation. Even so, FPOs continue to hold too little inflation-protected public debt and too much nominal public debt.

Pension funds around the globe have indicated a desire to increase exposure to infrastructure. The conclusion of this section is that infrastructure also represents an attractive asset for FPOs in Colombia. A stylised asset allocation model that captures current investment regulations and makes reasonable assumptions about expected returns and risks suggests Colombian FPOs may wish to hold up to 30% of their portfolio in infrastructure assets. Any spot figure must be treated with great caution: the more important finding is that infrastructure bonds could contribute to a material improvement in portfolio efficiency.

The models above suggest an efficient weighting in infrastructure much higher than that of most pension funds internationally. But in Colombia's case this makes a lot of sense. The inefficiency of FPO portfolios can in part be explained by a shortage of corporate bond and public inflation-protected bonds. An increase in the supply of infrastructure bonds – effectively a hybrid of these two asset classes - can help fill the gap if the assumed characteristics of such bonds (long-maturity, high credit rating, inflation-protection) can be replicated. Furthermore, the above models fail to incorporate the reality that nominal and inflation-protected government bonds have average maturities of under three and four years respectively (*not the assumed 15 years*). Accordingly, the models significantly understate the need of pension funds for long-dated, inflation-protected assets such as infrastructure.

IV. Constraints to Pension Fund Infrastructure Investment

In spite of its apparent attractiveness, the reality is that Colombian FPOs currently have very little exposure to infrastructure (likely under 0.5% of assets). Furthermore, there appear to be few available infrastructure assets in which to invest. This section discusses the constraints to pension fund investment in infrastructure in Colombia, identifying problems relating to (i) the concessions process, (ii) financial market constraints and (iii) pension fund regulation.

Legacy of previous infrastructure PPPs (Public-Private-Partnerships)

The legacy of previous transportation concessions[57] diminishes the perceived attractiveness of private involvement in infrastructure concessions. Gausch (2004) estimates that 64% of Colombian transport concessions have been renegotiated, with renegotiations predominately driven by the private sector party. Reasons for negotiation have included inadequate planning and design (requiring subsequent revision), delays in obtaining required licences, over-optimistic traffic forecasts and other contractual weaknesses (often the result of hasty or ad hoc contract design). Institutional weaknesses in terms of technical capacity are often highlighted[58]. First generation contracts (mid 1990s) were overly generous in terms of government guarantees, costs were easily passed on by contractors and in some extreme cases concessions were awarded to aggressive bidders who were seemingly intent on renegotiating the contract ex post[59]. Excessive guarantees have been costly for the government (cost to date estimated at US$100m[60]) and INCO (2004) estimates a present value of further

[57] Despite various problems including cost overruns and delays, private investment has delivered broadly successful results in terms of efficiency and quality (World Bank (1997), Engel et al (2003)). However, social benefits of private compared to public sector provision are more a social (or public sector) concern than a concern of the private investor or concessionaire.
[58] For a summary see Benavides et al (1999), Engel et al (2003), INCO (2004) and presentations from the *IV Congreso Nacional de la Infraestructura 2007* available at www.infraestructura.org.co.
[59] Benavides et al (1999)
[60] Gausch et al (2005)

claims totalling US$1.1bn[61]. At the same time, private concessionaires have also suffered from delayed payments under guarantee schemes[62].

The contractual process for 2nd and 3rd generation concessions has improved significantly. Greater emphasis is now placed on detailed planning and the framework for allocating risks is much improved. Adjustable concession lengths have been introduced to guarantee a minimum present value of returns to concessionaires, although overall guarantees have been reduced. However, concerns over institutional quality remain. Moreover, fewer government guarantees passes greater risk onto private concessionaires and the number of new concessions has only totalled six compared to thirteen 1st generation concessions[63].

Weak regulatory regime

There remain pervasive concerns over the regulation of infrastructure concessions. A new regulatory regime was implemented in 2003 with the creation of INCO (*Instituto de Concesiones*), attached to the Ministry of Transport and responsible for structuring, administering and promoting PPP agreements. But the fact that INCO has undergone seven leadership transitions in four years[64] underlines the weakness of the new institution. INCO is perceived to be lacking in technical expertise and under resourced[65].

Furthermore, unlike in other sectors such as electricity, there exists no independent regulatory commission for transport in Colombia. This is a significant institutional weakness in the event of contract disputes and is a deterrent to private investment. The rules of the game "continue to be seen as unpredictable and arbitrary[66]".

[61] Calculated using spot exchange rate of US$1 = COP 1,816 (March 22nd, 2008).
[62] Benavides et al (1999)
[63] Source: INCO (2004), BRC (2007a), Srinivas (2004) and Fedesarrollo (2005).
[64] Caicedo (2007)
[65] Ibid
[66] Srinivas (2004)

Expropriation risk

It is well known that infrastructure investments are subject to the 'hold-up' problem. Infrastructure projects require large, up-front irreversible investment expenditure. Once a private concessionaire has constructed the project the government has an incentive ex-post to expropriate the asset (either through taxation, regulatory changes or seizure). While Colombia has largely avoided this problem in the past, examples are commonplace in Latin America. For example, the La Paz and El Alto water concessions were cancelled in Bolivia in 2005[67] and in Argentina energy tariffs were frozen and converted from US dollars into Argentine pesos in light of the 2001 crisis. In response to a survey conducted for this research, one pension fund Chief Investment Officer commented that taxation risk surrounding infrastructure projects remains a concern.

Legal risk & contract enforcement

In light of the above, legal risk poses a major concern to private investors in infrastructure. Contract enforcement is notoriously slow and costly in Colombia. The IFC's *Doing Business* (2008) states that it takes 1,346 days to resolve contract disputes in Colombia compared to a Latin American average of 754 days. For contract enforcement, Colombia is ranked 147th in the world compared to its overall *Doing Business* rank of 66.

Short concessions, bank loans & fragmented projects

Asofondos (2007) argues that constraints to pension fund investment include relatively short concession lengths typically funded by short-term bank loans, and fragmented projects that have limited the opportunity for returns to

[67] Gausch et al. (2005)

scale. For the infrastructure bonds that financed some of the first generation concessions, BRC (2007) states that maximum maturities ranged from 11 to 13 years. There still appears to exist today a lack of long maturity infrastructure bonds: the infrastructure bonds issued in 2007 had maturities of five to eight years.[68]

Lack of coordination within the private sector

There appears to be a lack of coordination among private sector interests in infrastructure projects. In response to the survey, a pension fund Chief Investment Officer remarked that there is a "*lack of interest on the part of the construction industry to allow pension fund participation in the economically feasible projects*" that do not require government guarantees.

Underdeveloped financial markets

One of the constraints facing pension funds when it comes to infrastructure investment is the underdevelopment of the domestic corporate bond market[69]. An underdeveloped bond market creates a vicious circle of illiquidity and inefficient pricing that constrains both the supply and demand for securities. Figure 10, Appendix I illustrates the small size of the Colombian corporate bond market compared to a number of middle income countries. The factors that have restricted Colombia's corporate bond market include the prevention of over-the-counter (OTC) trading for institutional investors; the restriction of pension funds from holding non-investment grade corporate debt; the lack of a private placement mechanism for corporate bonds; the cost of issuing securities; a culture of family-owned enterprises and an inadequate yield curve for government debt that prevents investors and issuers alike from

[68] Source: Bolsa de Valores de Colombia (2007). Bonds issued in 2007 by the *Concesion Autopista Bogota-Giradot* and *Coviandes* amounted to around COP 148 billion (equivalent to 0.3% of pension fund assets), carried AAA ratings and a maximum maturity of eight years.
[69] See Del Valle (2007) for a detailed analysis.

adequately pricing corporate debt and discerning credit risk from interest rate risk[70]. Moreover, since Colombian government debt remains sub-investment grade, infrastructure bonds typically require credit enhancements to qualify for pension fund investment (e.g. government, multilateral or insurer guarantees).

Pension fund regulation

It is likely that pension fund regulation has to some extent deterred FPOs from investing in infrastructure assets. By imposing a minimum return requirement that is calculated relative to the performance of peers, the current regulation contributes to herd behaviour[71] (FPOs try to replicate each other) and arguably greater risk aversion[72]. The latter point arises because of asymmetric payoffs to the pension fund provider. If the minimum return requirement is breached, the provider must contribute its own capital to meet the shortfall. By contrast, in the event that the FPO generates returns far in excess of the average it is the individual contributors who benefit, not the FPO. As a result of the asymmetric payoff, there is an incentive to minimise the volatility of the tracking error relative to the average portfolio across the system.

Furthermore, the reference portfolio of domestic fixed income securities constructed by the SFC has a weighted average maturity of only 4.7 years with a weighting in nominal securities of 52%[73]. The reference portfolio consists of: 29% nominal public debt, 21% inflation-protected public debt, 15% certificates of deposit and 35% corporate bonds. Given the high weighting FPOs hold in fixed income assets, the SFC reference portfolio is the most important benchmark within the benchmark component of the minimum return calculation. An FPO looking to minimise its risk of breaching the minimum return requirement

[70] For a lengthier discussion see Del Valle et al. (2007) and Asobancaria (2007, 2007a).
[71] Srinivas (2004), Chan-Lau (2004) and Hanson (2007).
[72] Ibid
[73] Calculated from data available on the SFC website (www.superfinanciera.gov.co). The average maturity has been calculated by assuming a maturity of 0.5 years for all bonds maturing in 2008, 1.5 years for all bonds maturing in 2009 and so on.

would therefore seek to replicate this portfolio, which places excessive emphasis on nominal government bonds (relative to the optimised weights calculated in Section III) and short-maturity assets.

The result of current pension regulations is a high proportion of investment in government debt and little incentive for FPOs to innovate or compete in search of portfolio efficiency.

V. Policy recommendations

The evidence suggests infrastructure could play a significant role in the portfolios of Colombian pension funds. This should be welcome news to the DNP, given its desire to increase private investment in infrastructure. Progress towards better contract design has been made between the 1st and 2nd/3rd generation concessions, but it seems likely that further government reforms are required for pension fund investment to happen in scale. Based on the analysis in this paper, several policy recommendations are outlined below that fall into two broad categories: (1) institutional reform surrounding the concessions process and (2) pension fund regulatory reform. For each recommendation, the target audience is indicated[74]. A number of other policy reforms should arguably be undertaken such as measures to improve the liquidity and depth of Colombian financial markets or promote better contract enforcement, but these are beyond the scope of this paper.

(i) Strengthen INCO following a thorough evaluation (MoT, MoF)

INCO is perceived to be technically weak and lacking in resources – fundamental problems given the complexity of planning and structuring concession contracts. Seven leadership transitions in four years indicate the

[74] MoF (Ministry of Finance), MoT (Ministry of Transport) and DNP (National Planning Department).

magnitude of problems facing the institution. It is recommended here that the Ministry of Finance and Ministry of Transport conduct a thorough evaluation of INCO and take measures to increase the organisation's capabilities based on areas of weakness identified in the evaluation process. The two ministries should be willing to commit resources, both financially and in terms of personnel, in order to strengthen an institution that is vital to the success of PPPs in infrastructure. Improved contract design is fundamental to attracting pension fund investment in infrastructure, but it is only possible to pinpoint and rectify INCO's failings following a rigorous evaluation.

(ii) Create an independent regulator for transport infrastructure (DNP, MoF, MoT)

Not only is INCO charged with a long list of responsibilities when it comes to structuring concession contracts[75], but it is also responsible for supervising and evaluating concession regulations once in operation. It is highly problematic for private investors to enter into concession contracts that will be regulated by the other party in the deal. It is therefore recommended that together the DNP, Ministry of Finance and Ministry of Transport create an independent regulatory commission for transportation infrastructure, as exists for other infrastructure sectors such as electricity. Such a measure will not only reduce the demands on INCO, but will also strengthen the rules of the game in the eyes of private concessionaires.

(iii) Foster better cooperation within the private sector (DNP)

The DNP should initiate a process to foster better cooperation within the private sector among parties relevant to infrastructure projects. The DNP is linked through the National Commission of Competitiveness (CNC[76]) with the Private Council of Competitiveness (CPC). The CPC, in operation for over a year

[75] See www.inco.gov.co for details of INCO's responsibilities. The list of functions the institution is charged with totals 19.
[76] See www.snc.gov.co for details.

now, is a think-tank responsible for advocating policies for private sector development to the government and is ideally situated to coordinate dialogue between the investors, construction companies and investment banks necessary for structuring the financial terms of any deals. In this role, the CPC should look to engage with organisations such as the Colombian infrastructure association (Camara Colombiana de Infraestructura (CCI)) which represents engineering and construction firms, and Asofondos, the pension fund association. The institutions are in place to foster the kind of coordination needed for pension funds to contribute infrastructure finance, but it will take leadership on behalf of both the public sector (DNP) and relevant associations to make it happen.

(iv) Involve multilateral organisations in the design of concessions (DNP, MoF, MoT)

The DNP together with the Ministries of Finance and Transport should actively seek the involvement of multilateral organisations in the concessions process. Multilaterals can play a number of important roles. They can provide expertise in terms of contract design; reduce ex ante expropriation risk by investing (governments are less likely to expropriate a multilateral); provide insurance against political risk and they can also provide credit enhancements so that infrastructure bonds achieve high credit ratings. Unlike in Mexico and Chile, for example, there appears to have been little use of 'credit wraps' for transport infrastructure bonds in Colombia[77]. In terms of multilateral involvement, the ongoing concession process of the new "Ruta del Sol[78]" highway has the potential to be a new blueprint for future transport infrastructure concessions in Colombia. IFC is assuming the role of *Principal Assessor*, acting as transaction advisor to the government and assisting in structuring the PPP project[79].

[77] See Graham (2004) and MBIA (2007). 'Credit wraps' are provided by multilaterals or monoline insurers which act as guarantors of the concession company's credit risk in return for a flow of insurance premium payments.
[78] The proposed "Ruta del Sol" highway will run from the capital Bogota to the city of Santa Marta on the north coast, a very important transit route.
[79] See www.ifc.org for more details.

(v) Revise the minimum return regulation for pension funds (MoF)

Colombian FPOs are currently subject to a minimum return requirement (MRR) that encourages herding behaviour, excessive risk aversion and undesirably large weightings in nominal government debt. Regardless of whether Colombia adopts a multi-funds scheme (see below), it is recommended that the Ministry of Finance modifies the current minimum return requirement. An improved MRR can better incentivise FPOs to maximise portfolio efficiency, which should increase demand for infrastructure assets as illustrated above.

The functions of the minimum pension return guarantee are to protect against significant downside risk and to encourage workers to contribute to private individual accounts as opposed to entering the competing PAYG system. The Ministry of Finance could use aspects of overseas regulation (discussed in Section II) to develop an improved system of minimum return regulation in Colombia. One attractive option would be to introduce a similar policy to Peru where the performance of each FPO is measured against pre-agreed benchmarks. Again like in Peru, the minimum return could be based on tracking error versus the benchmark[80]. However, as in the Chilean system, a 'maximum' return could also be introduced such that outperformance is rewarded, incentivising more efficient portfolio allocation. Colombian authorities could also monitor risk with complementary VaR reporting requirements; even if reported VaR were not to influence directly the minimum return calculation, the regulator could require an FPO to reduce its risk exposure in the event of excessive risk-taking.

Such a regulation would (i) eliminate herding behaviour since the new benchmarks do not rely on peer performance; (ii) reduce the extent of risk aversion by introducing a symmetrical performance incentive, with the aim of

[80] This could be achieved in a number of ways: for example, as in Chile (except the benchmark is no longer the peer group average) or by a relative VaR calculation as in Peru. The latter method is similar to traditional VaR but the calculation is based on the distribution of the tracking error relative to the benchmark rather than the distribution of absolute returns. For more details see Maspero & Saita (2002).

improving portfolio efficiency; (iii) reduce the FPO's risk by allowing very high returns to be placed in a reserve fund in case of future returns below the minimum return (which could even allow for a reduction of insurance charges made on the contributor); (iv) allow the SFC to monitor portfolio risk by tracking VaR exposure and (v) would be politically acceptable since the regulation retains a minimum return requirement. Clearly, no reform will be perfect - as in the Peruvian system, one disadvantage of this recommendation would be that minimum returns vary by provider. This recommendation, of course, is not the only reform that would improve on the current Colombian minimum return regulation but it offers a useful starting point from which to tackle the problem.

Since it should be a goal of government policy that pension fund returns at the very least beat inflation over the long run, the Ministry of Finance may also wish to the use the minimum return requirement to encourage investment in inflation-protected assets. This could be achieved either by specifying the revised minimum return requirement in real terms or basing any reference portfolio incorporated into the regulation on inflation-protected assets. As the analysis above argues, any measure that encourages pension funds to hold inflation-protected assets will increase the desire of FPOs to invest in infrastructure assets.

(vi) Introduce a multi-funds pension system (MoF)

The Colombian government recently proposed (*Proyecto de Ley de Reforma Financiera*, 2007) the introduction of a multi-funds pension system, as described in Section II. A multi-funds system offers greater choice and should reduce the effects of herding behaviour by spreading assets across a variety of funds. Given the young age profile of Colombian pension contributors, it is argued that a multi-funds system will channel funds into riskier assets and improve portfolio efficiency. Intuitively this seems appealing given the large weighting of FPOs in *nominal* government bonds. Although a high weighting in *inflation-protected* government bonds may be optimal for risk-averse investors (Table 3), it seems

FPOs are constrained by a supply shortage of such assets. Shifting assets into riskier portfolios would therefore reduce the efficiency costs of this constraint. Moreover, the analysis in Section III may understate the increase in portfolio efficiency because it ignores the mean-reverting property often assumed of equities which acts to reduce their long term volatility. With this in mind, a multi-funds system may be a positive development.

However, a multi-funds system brings its own disadvantage: pension risk faced by the contributor and government risk in terms of guarantees are likely to increase. FPO risk is not obviously affected as long as the minimum return requirement continues to be calculated relative to peer performance (although this is not recommended here). It has been argued that multi-fund schemes increase the availability of funds for new borrowers. This may be the case but it is not an argument made with pensioners' interests in mind.

The government must weigh up these considerations before introducing the multi-funds regime. By no means is it an obvious choice. On balance, the advantages of multi-fund regimes may well outweigh the disadvantages of higher risks if a significant improvement in portfolio efficiency can be achieved along with the positive externalities that may accrue to borrowers who could not previously access financial markets. A multi-funds regime would likely increase pension fund demand for infrastructure assets, in line with government policy. But it is recognised here that a multi-funds scheme is arguably a blunt tool for achieving this goal and therefore represents the least compelling recommendation in this paper. It merits discussion, however, given the current government proposal to introduce such a scheme.

VI. Conclusion

The analysis in this paper presents a strong case for Colombian obligatory pension funds to invest in infrastructure, in particular through the purchase of infrastructure bonds. If anything, the portfolio optimisation models in Section III understate the need for Colombian pension funds to increase their exposure to inflation-protected, long duration assets such as infrastructure: the model's simplifying assumptions overstate the supply of government or corporate debt with such characteristics. The models also ignore what should be an implicit government target that pension returns at the very least beat inflation.

This conclusion coupled with the government's desire to increase private investment in infrastructure begs the question: why haven't pension funds already invested heavily? Institutional inadequacies related to infrastructure concessions and distortive pension fund regulations are identified in this paper as important explanations.

The recommendations provided are designed to help alleviate these constraints. They have also been made with political and technical feasibility in mind. For example, it is recommended that the pension minimum return guarantee not be removed (which would be politically unsupportable[81]), but reformed, even if removing the constraint would increase portfolio efficiency. Fostering cooperation within the private sector might have historically posed a major implementation challenge, but today the institutions are in place to affect such a goal. What is required is leadership on the issue of infrastructure specifically, which appears to be lacking. The recommendations proposed to improve contract design and regulation of PPPs in infrastructure may be costly; but to paraphrase Srinivas (2004), the Colombian government must weigh the costs of reform against costs of inaction in terms of infrastructure foregone.

[81] Removing a pension return guarantee is different to not introducing it in the first place.

It is intended that the implementation of the proposed recommendations could be achieved within a two-year time frame. There are likely many other worthy reforms that would encourage pension fund investment in infrastructure such as those targeting better contract enforcement or deeper financial markets. While beyond the scope of this analysis, it is plausible that many such reforms would take significantly longer to implement than those presented above.

Unlike the 1990s, there is now a large pool of domestic savings in the form of pension funds that should be seeking the characteristics provided by well-structured and regulated infrastructure concessions. The Colombian government therefore has today an unprecedented opportunity to increase private investment in infrastructure, financed by pension funds. It is the hope and intention of the author that the above analysis can help the Colombian government seize this opportunity.

References

Abertis (2007) *Annual Report 2006*.

ABP Investments (2007) "Infrastructure Investments", presentation by Robbert Coomans, Advisor to the Board, February. Available at: http://www.abp.nl/abp/abp/images/Presentatie%20IIR%207%20feb%202007_tcm108-51811.pdf

AIOS (2007) *La Capitalización Individual en los Sistemas de Pensiones de América Latina*.

AMP Capital Investors (2005) "Infrastructure for Investors", Oliver's Insights, #27.

ANIF (2007) "Los Fondos de Pensiones y la Financiación de la Infraestructura" by Clavijo, S., Rojas C. & Vera, A., *Carta Financiera* #137, March/April.

Asobancaria (2007) "La Liquidez y la Profundidad del Mercado de Capitales en Colombia", unpublished paper.

Asobancaria (2007a) "Regulacion en Colombia sobre los sistemas transaccionales y la importancia del mercado OTC", unpublished paper.

Asobancaria (2007b) "El desarrollo del mercado de capitales: Del Diagnostico a la Accion", *La Semana Económica*, #606, May.

Asofondos (2005) "Asociaciones Públicos-Privadas Perspectiva de las AFP", presentation given by Luis Fernando Alarcón Mantilla, Medellin, February.

Asofondos (2007) "La inversión en infraestructura: una visión desde el Régimen de Ahorro Individual", presentation given by Santiago Montenegro, Categena, October.

Atlantia (2007) Presentation delivered in London on 25th October. Available at: http://www.atlantia.it/it/pdf/FINAL-Presentation-at-2100-2007-10-25-London.pdf.

Bancolombia (2007) *2007 Equity Handbook Update*, September.

Benavides, J. & Fainboim, I. (1999) "Private Participation in Infrastructure in Colombia: Renegotiations and Disputes", Inter-American Development Bank.

Bolsa de Valores de Colombia (BVC) (2007) *Informe Semestral*, June.

Borrero Restrepo, L. (2005) "La Rentabilidad Minima y los Portafolios de los Fondos de Pensiones Obligatorias Colombianos", presentation given on behalf of the Superintendencia Bancaria de Colombia (now SFC) in Bogota, November.

BRC Investor Services (2007) "Desarrollo del Mercado de Capitales en Colombia Rompiendo el circulo vicioso: Algunas Reflexiones" presentation by Rafael María González Guillen, Bogotá, February 23.

BRC Investor Services (2007a) "El Riesgo Crediticio de la Concesiones Viales en Colombia", Notas del Mercado de Capitales, #11, June.

Brisa (2007) *Annual Report 2006*.

Brunner, G., Hinz, R. & Rocha, R. (2007) "Risk-Based Supervision of Pension Funds", World Bank.

Caicedo Ferrer, J.M. (2007) "La Marcha de la Infraestructura", comments at the IV Congreso Nacional de la Infraestructura, Cartagena de Indias, Noviembre 16.

CalPERS (2007) CalPERS Infrastructure Program, Investment Program Fact Sheet, September. See: http://www.calpers.ca.gov/eip-docs/about/press/pr-2007/sept/infrastructure0907.pdf.

Campbell, J. & Viceira, L. (1999) "Consumption and Portfolio Decisions when Expected Returns are Time Varying", *Quarterly Journal of Economics* 114, 433-95.

Campbell, J. & Viceira, L. (2001) Appendix to *Strategic Asset Allocation*. Available at: http://www.people.hbs.edu/lviceira/publications.html.

Campbell, J. & Viceira, L. (2002) *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors*, Oxford.

Chan-Lau, J. (2004) "Pension Funds and Emerging Markets", IMF working paper, September.

Cintra (2007) *Annual Report 2006*.

Consejo Privado de Competitividad (2007) *Informe Nacional de Competitividad 2007.*

Crowe, D. (2005) "Keep on Trucking: President Uribe pushes for Colombia's most ambitious highway plan ever", *Latin Trade*, September. Available at http://findarticles.com/p/articles/mi_m0BEK/is_9_13/ai_n15627884/pg_1.

Del Valle, C. & Casas, M. (2007) "Mercado de Bonos Corporativos: Mitos y Perspectivas", working paper, Universidad de Los Andes Facultad de Administracion.

Deutsche Bank (2007) "Performance Characteristics of Infrastructure Investments", RREEF Research, August.

Engel, E., Fischer, R. & Galetovic, A. (2003) "Privatizing Highways in Latin America: Fixing What Went Wrong", *Economia*, Fall 2003.

Estrada, J. (2007) "Discount Rates in Emerging Markets", *Journal of Applied Corporate Finance*, 19 (2).

Fedesarrollo (2005) "La Infraestructura del Transporte en Colombia", working paper, August. Available at: www.fedesarrollo.org.co.

FIAP (2007) "Multifunds: The Cases of Chile, Mexico and Peru", FIAP Compared Regulation Series.
http://www.fiap.cl/prontus_fiap/site/edic/base/port/articulos.html#20070102155434

Gausch, J. (2004) *Granting and Renegotiating Infrastructure Concessions: Doing it Right*, World Bank.

Gausch, J., Laffont, J-J. & Straub, S. (2005) "Concessions of Infrastructure in Latin America: Government-led Renegotiation", unpublished paper, University of Edinburgh. See: http://www.econ.ed.ac.uk/papers/gov_led_reneg_april05.pdf

Graham, J. (2004) "A New Approach to Infrastructure Finance", presentation given on behalf of the IADB, Washington DC.

Hanson, T. (2007) "Financial Sector Development in Colombia: What are the Priorities?", unpublished paper prepared for the Consejo Privado de Competitividad.

Harris, S. (2004) "Public-Private Partnerships: Delivering Better Infrastructure Services" in *Recouping Infrastructure Investment in Latin America and the Caribbean*, ed. Benavides, J., Inter-American Development Bank.

IFC (2008) *Doing Business 2008*.

INCO (2004) "Alternativas de reestructuración para las concesiones de carreteras y ferrocarriles", Documento CONPES borrador #5, Junio.

Jara Pinzón, D., Gómez Restrepo, C. & Pardo Amezquita, A. (2005) "Análisis de Eficiencia de los Portafolios Pensiónales Obligatorios en Colombia", Banco de la República working paper.

Macquarie (2007a) "Why Invest in Toll Roads?" available at: http://www.macquarie.com.au/au/mig/acrobat/mig_toll_roads_factsheet.pdf.

Macquarie (2007b) *Annual Report 2007*, Macquarie Infrastructure Group.

Maspero, D. & Saita, F. (2002) "Risk Measurement for Asset Managers: a Test of Relative VaR", Bocconi University unpublished paper, available at: http://www.gloriamundi.org/picsresources/dmfs.pdf.

MBIA (2007) "La garantía financiera en los mercados de capitales de deuda", presentation given at AIOS seminar in San Jose, Costa Rica, May 28.

McKinsey (2008) "How investors can get more out of infrastructure", *McKinsey Quarterly*, February.

Orr, R. (2007) "The Rise of Infrafunds", *Global Infrastructure Report 2007*, Project Finance International. Available at: http://crgp.stanford.edu/.

Plazas Figueroa, H. (2008) "Intermediarios podran hacer operaciones via telefónica", *La Republica*, March 13.

Sardi, F. (2007) "Reglas claras en la contratación estatal: responsabilidades y beneficios compartidos en las concesiones" interview published by *Infraestructura y Desarrollo*, Revista #19 September/October, Bogota.

SBS (2006) "Multifondos: El Modelo Peruano", presentation delivered on behalf of the Superintendencia de Banca, Seguros y AFP de Peru (SBS) by Escudero Villavicencio, M. at the FIAP seminar, Santiago de Chile, May 2006.

Srinivas, P. (2004) "Colombia: Mobilizing Private Capital for Infrastructure", Recent Economic Developments in Infrastructure (REDI), Background Paper, World Bank.

Thobani, M. (1999) "Private Infrastructure, Public Risk", *Finance & Development*, March.

World Bank (1997) "Colombia's Gradualist Approach to Private Participation in Infrastructure", *Public Policy for the Private Sector*, #113, May.

World Bank (2000) "Portfolio Limits", *World Bank Pension Reform Primer*.

World Bank (2006) *The Colombian Pension System: Assessment and Recommendations for Improvements.*

World Economic Forum (2007) *The Global Competitiveness Report 2007/08*.

Appendix I

Fig 1: Colombia competitiveness ranking

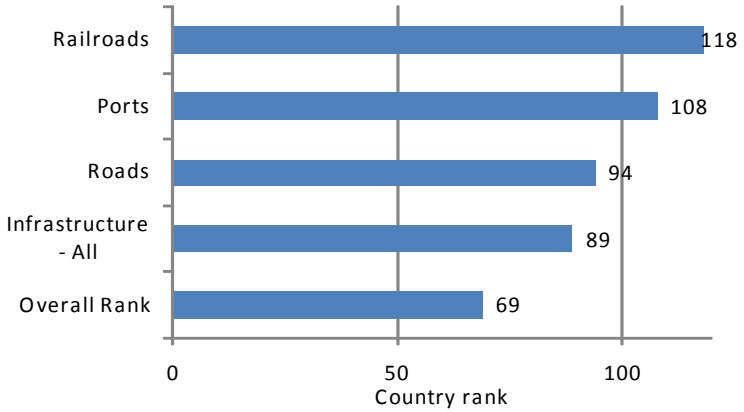


Fig 2: Transport costs as percent of sales (%)

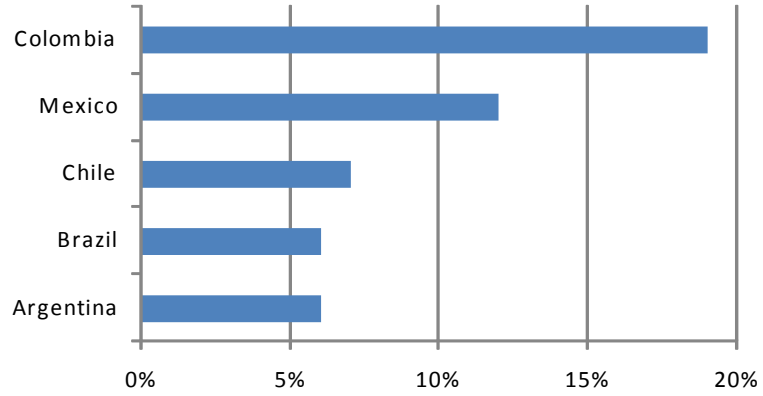


Fig3: Colombian public debt/GDP (%)

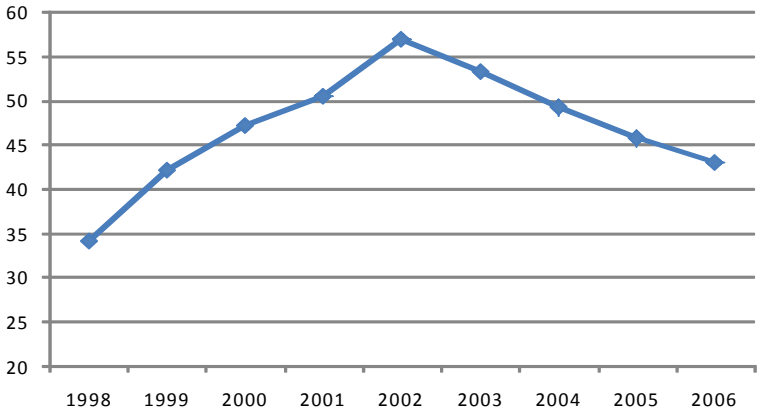
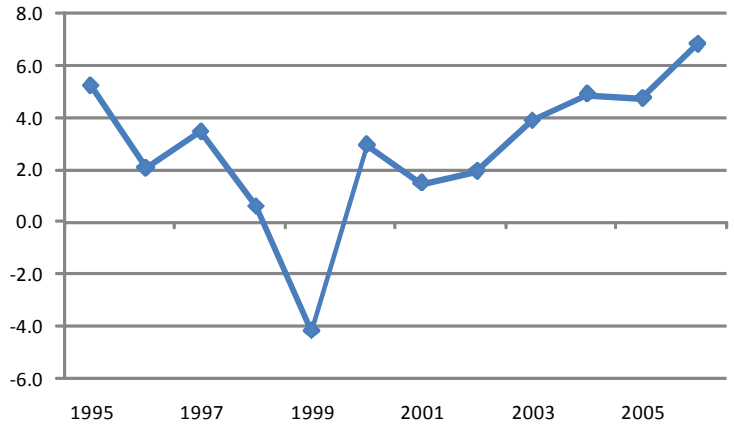
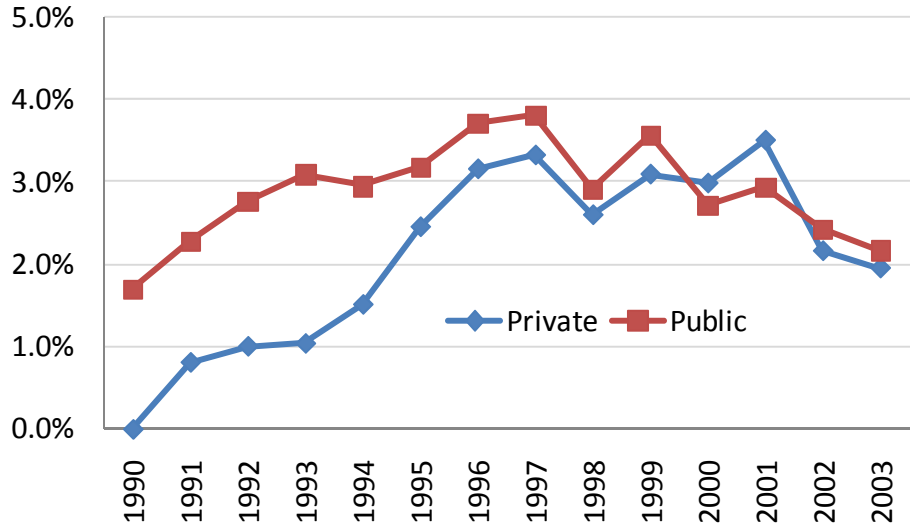


Fig 4: Colombia real GDP growth (%)



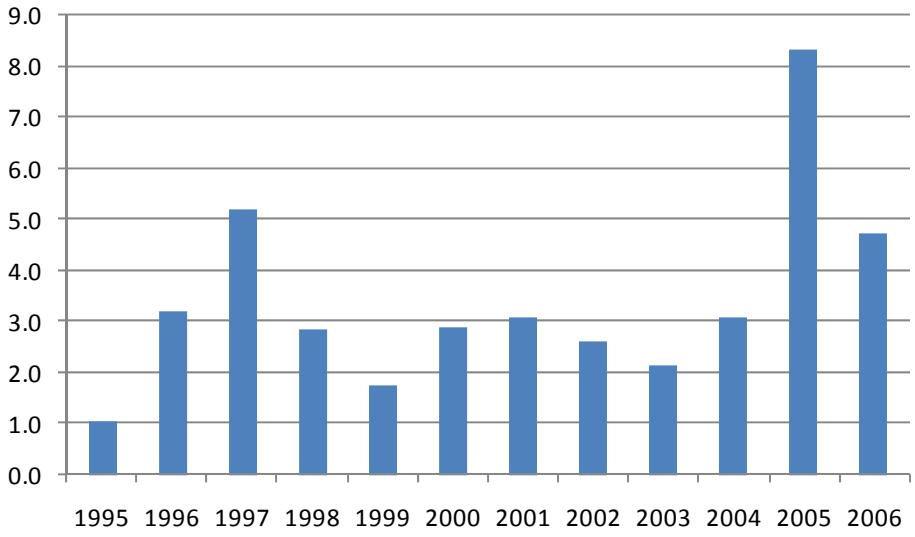
Source: WEF, CPC (2007), IMF, EIU.

Fig 5: Colombian infrastructure investment (% of GDP)



Source: DNP.

Fig 6: Colombian inward FDI (% of GDP)



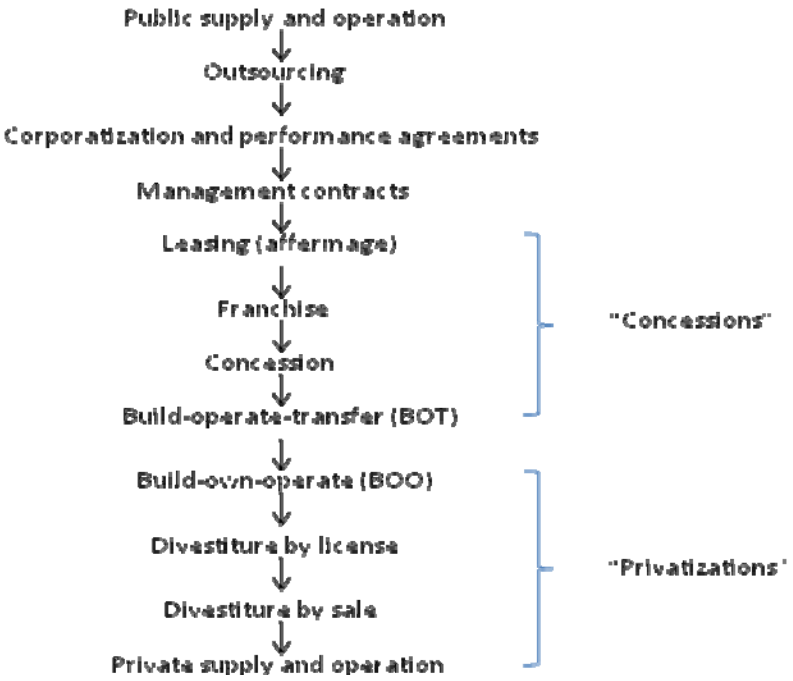
Source: EIU.

Table A1: Latin American pension funds' asset allocation (Dec 2007, %)

	Govt Debt	Financial Sector Bonds	Non-Fin Sector Bonds	Equities	Mutual Funds	Foreign Assets	Other
Argentina	53	-	-	15	10	9	13
Bolivia	72	15	9	0	1	2	1
Chile	8	30	8	15	4	36	0
Colombia	44	7	9	22	0	12	6
Costa Rica	60	14	3	0	5	13	3
El Salvador	79	16	5	0	0	0	0
México	69	6	11	4	0	10	0
Perú	22	8	10	41	1	13	4
Dominican Rep	19	80	1	0	0	0	0
Uruguay	58	39	2	0	0	0	2

Source: AIOS.

Fig 7: Types of private participation in infrastructure



Source: Gausch (2004).

Table A2: Cintra motorway concessions – toll increases (2001-2006)

Concession Name	Country	Concession (years)	Pricing Scheme		Toll Increases 2001	2002	2003	2004	2005	2006	Average
407 ETR	Canada	99	Pricing freedom if traffic vol. > min. level	- *nominal*	5.1%	6.5%	9.1%	7.9%	7.4%	9.3%	7.6%
				- *real*	2.5%	4.1%	6.1%	5.9%	5.1%	7.2%	5.2%
Ausol I	Spain	50	Inflation (+traffic adj)	- *nominal*	3.2%	3.3%	3.8%	3.2%	2.9%	3.3%	3.3%
				- *real*	-0.4%	-0.2%	0.8%	0.2%	-0.5%	-0.2%	0.0%
Ausol I	Spain	55	Inflation (+traffic adj)	- *nominal*		9.9%	2.1%	2.8%	2.4%	2.6%	4.0%
				- *real*		6.2%	-0.9%	-0.2%	-1.0%	-0.9%	0.7%
Madrid-Sur	Spain	65	Inflation (+traffic adj)	- *nominal*					3.4%	3.2%	3.3%
				- *real*					0.0%	-0.3%	-0.1%
Autema	Spain	50	Inflation	- *nominal*		3.5%	3.0%	3.4%	4.4%	4.5%	3.8%
				- *real*		0.0%	0.0%	0.4%	1.0%	1.0%	0.5%
Temuco - Rio Bueno	Chile	25	Inflation + road safety bonus up to 5%	- *nominal*	4.5%	2.6%	2.8%	1.1%	2.4%	4.0%	2.9%
				- *real*	0.9%	0.1%	0.0%	0.0%	-0.7%	0.6%	0.1%
Santiago – Talca	Chile	40 (E)	Inflation + road safety bonus up to 5%	- *nominal*	4.5%	2.6%	2.8%	1.1%	3.1%	4.9%	3.2%
				- *real*	0.9%	0.1%	0.0%	0.0%	0.0%	1.5%	0.4%
Talca – Chillan	Chile	30 (E)	Inflation + road safety bonus up to 5%	- *nominal*	7.1%	5.4%	4.6%	1.1%	5.6%	6.4%	5.0%
				- *real*	3.4%	2.8%	1.8%	0.0%	2.4%	2.9%	2.2%
Chillan – Collipulli	Chile	16 (E)	Inflation + road safety bonus up to 5%	- *nominal*	4.5%	3.0%	3.0%	0.9%	9.8%	4.6%	4.3%
				- *real*	0.9%	0.5%	0.2%	-0.2%	6.5%	1.2%	1.5%
Collipulli – Temuco	Chile	24 (E)	Inflation + road safety bonus up to 5%	- *nominal*	4.5%	2.6%	2.8%	1.1%	2.4%	4.0%	2.9%
				- *real*	0.9%	0.1%	0.0%	0.0%	-0.7%	0.6%	0.1%

Source: Cintra annual report (2006). (E) = expected.

Table A3: Minimum tariff increases for concessions in various European countries

Italy	70% x CPI increase
France	70% x CPI increase
Portugal	90% x CPI increase
Spain	100% x CPI increase – X*

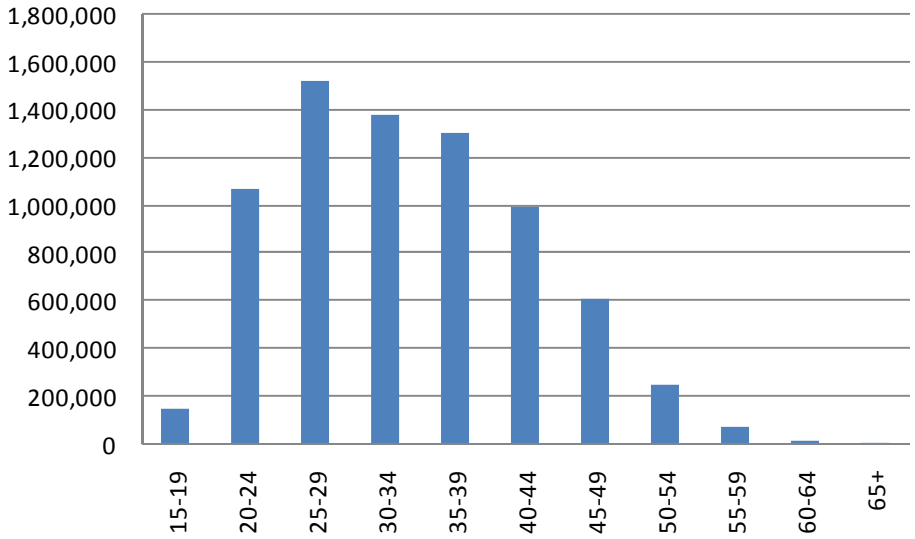
Source: Atlantia company presentation (2007)
Where X* = the percentage difference between forecast and actual traffic growth.

Table A4: Estimates of international infrastructure annual returns

	Region	Listed/unlisted	Return**	Volatility	Period
Peng & Newell	Australia	L	24.9%	23.4%	1995-2006
Peng & Newell	Australia	U	14.1%	5.8%	1995-2007
UBS Index	World	L	14.2%	20.1%	1997-2007
Economy.com Index*	US	L	5.3%	13.1%	1997-2006
S&P index	World	L	23.3%	10.9%	2001-2007

Source: Deutsche Bank (2007), S&P (2007), Peng & Newell (2007); *index includes utilities; **returns are annual in nominal terms. Volatility is measured as annual standard deviation of returns.

Fig 8: Age profile of Colombian pension fund contributors (number)



Source: Asofondos, Hanson (2007).

Table A5: Global infrastructure equity performance

Stock	Listing	Period	Real return* divs reinvested	Volatility**	Correlation^ with equities	Beta^^
Vinci	France	1998-2007	28.5%	26%	33%	0.45
Fraport AG	Germany	2002-2007	16.5%	31%	51%	0.77
Atlantia	Italy	1999-2007	23.8%	29%	34%	0.41
Brisa	Portugal	1998-2007	14.7%	18%	29%	0.26
Abertis	Spain	1998-2007	14.3%	18%	13%	0.11
Cintra	Spain	2004-2007	12.8%	22%	46%	0.92
Ferrovial	Spain	2001-2007	21.9%	23%	22%	0.38
Macquarie Infrastructure Grp.	Australia	1997-2007	22.4%	29%	17%	0.50
Autopistas del Sol	Argentina	2006-2007	-8.1%	37%	59%	0.29
CCR	Brazil	2003-2007	77.0%	41%	55%	0.56
Portuaria Cabo Froward	Chile	1997-2007	15.0%	44%	18%	0.40
Plus Expressways	Malaysia	2003-2007	10.5%	16%	57%	0.76
Grupo Aero. Del Pacifico	Mexico	2006-2007	33.0%	23%	30%	0.79
Grupo Aero. Del Sureste	Mexico	2001-2007	26.3%	34%	48%	0.91
Average			22%	28%	37%	0.54
Average - emerging mkt. stocks			26%	33%	45%	0.62

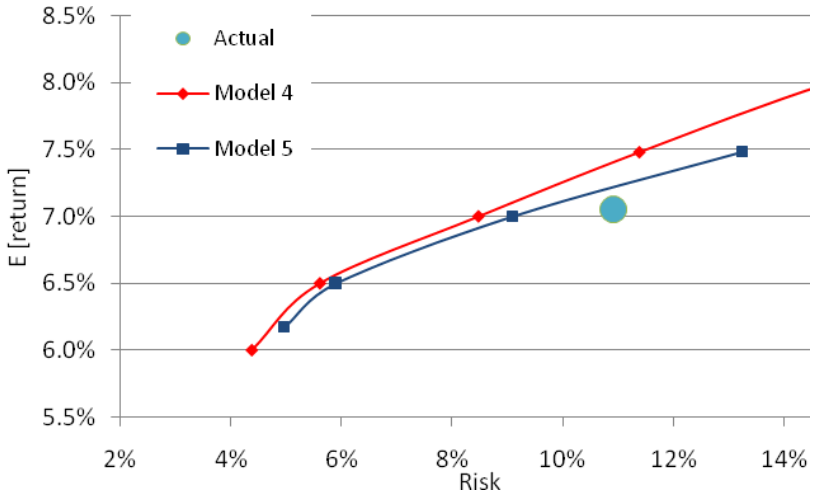
Source: Bloomberg, author calculations. *arithmetic annual real return is calculated using geometric returns with an adjustment (arithmetic average ≈ geometric return + variance/2); nominal returns are deflated by local consumer prices to generate real returns (using Eurozone inflation in case of European stocks); **volatility is the annualised standard deviation of monthly real returns; ^correlations are relative to local equity markets (the DJ Euro Stoxx index in the case of European stocks) and calculated using monthly returns; ^^beta is taken from Bloomberg data using monthly returns for time series over 5 years, otherwise weekly returns.

Table A6: Estimates of expected infrastructure returns

	Target return		
	General	Greenfield	Mature
AMP Capital Partners	11%		
Atlantia		11%-13.5%	5.5%-6.5%
CalPERS*	8%		
ABP Investments**		>13%	8%
Orr (2007)^	14.4%		

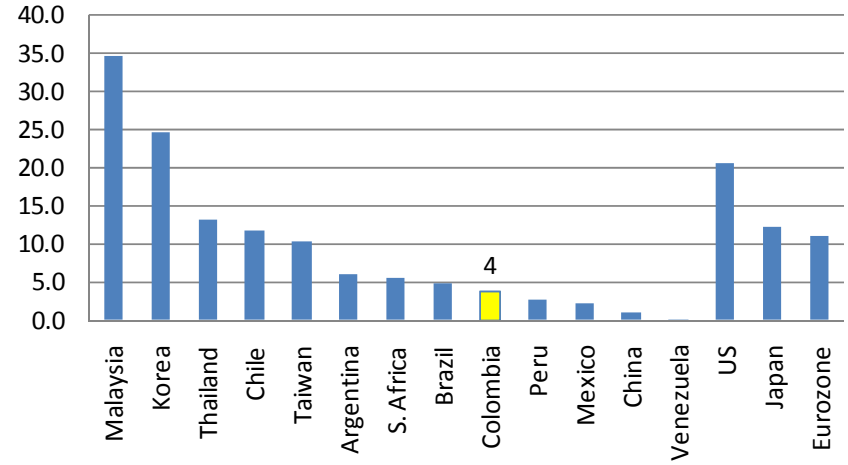
Source: various (see References); *assumes 3% expected US inflation (CPI + 5%); **assumes 5% nominal risk free rate (3%-8% premium over risk-free rate); ^Orr's (2007) data is based on a survey of infrastructure funds.

Fig 9: Colombian FPO efficient frontiers (more restrictive assumptions)



Source: Model results.

Fig 10: Domestic corporate bond markets compared (2005, % of GDP)



Source: BIS, Hanson (2007).

Appendix II

Asset Allocation Model: mathematical formulation.

The one-period asset allocation model described below is taken directly from Campbell & Viceira (2002, Chapter 2.1.3). The model assumes that investors have "power utility and that asset returns are lognormal[82]". This utility function is favoured by Campbell & Viceira (2002) since it implies constant relative risk aversion and that "absolute risk aversion is declining in wealth"[83]. For a relative risk aversion (γ) equal to one, the power utility function becomes a log utility function.

First the model is derived for the case of one risky asset and then generalised to the case where there a many risky assets. The investor's problem is:

max $E_t U(W_{t+1})$ subject to $W_{t+1} = (1 + R_{p,t+1})W_t$

where W_t is initial wealth and $R_{p,t+1}$ is the return on the portfolio over the single period. Incorporating a power utility function, the problem becomes:

max $\dfrac{E_t W_{t+1}^{1-\gamma}}{(1-\gamma)}$

Using the formula $\log E_t X_{t+1} = E_t \log X_{t+1} + \frac{1}{2} Var_t \log X_{t+1} = E_t x_{t+1} + \frac{1}{2}\sigma_{xt}^2$

we can restate the problem as:

max $\log E_t W_{t+1}^{1-\gamma} = (1-\gamma)E_t w_{t+1} + \frac{1}{2}(1-\gamma)^2 \sigma_{wt}^2$

where lower case denotes log values. The budget constraint can be written as:

$w_{t+1} = r_{t+1} + w_t$

[82] Campbell & Viceira (2002).
[83] For further discussion of these particular assumptions of the model see Campbell & Viceira (2002), Chapter 2.

where $r_{p,t+1}$ is the log of the gross portfolio return $(1 + R_{p,t+1})$. By combining the objective function with the budget constraint and dropping scaling factors that are irrelevant to the optimisation problem, we can write the objective function as:

$$\max \; E_t r_{p,t+1} + \frac{1}{2(1-\gamma)}\sigma_{pt}^2. \qquad (1)$$

"Because the portfolio return is assumed to be lognormal[84]", the problem can be restated as:

$$\max \; \log E_t(1 + R_{p,t+1}) - \frac{\gamma}{2}\sigma_{pt}^2. \qquad (2)$$

In effect, the pension fund investor faces a mean-variance optimisation problem. The investor "trades the log of this [arithmetic] mean [return] linearly against the variance of the log return[85]". Returning to equation (1), in order to solve the maximisation problem we first have to use an approximation to "relate the log portfolio return to the log returns on underlying assets[86]". Using this approximation[87] gives:

$$r_{p,t+1} - r_{f,t+1} = \alpha_t(r_{t+1} - r_{f,t+1}) + \frac{1}{2}\alpha_t(1-\alpha_t)\sigma_t^2 \qquad (3)$$

where α_t is the weight of the portfolio invested in the risky asset. The optimisation problem then becomes:

$$\max \; \alpha_t(E_t r_{t+1} - r_{f,t+1}) + \frac{1}{2}\alpha_t(1-\alpha_t)\sigma_t^2 + \frac{1}{2(1-\gamma)\alpha_t^2\sigma_t^2} \qquad (4)$$

Differentiating (4) with respect to α_t and setting equal to zero yields the solution to the problem:

$$\alpha_t = \frac{E_t r_{t+1} - r_{f,t+1} + \frac{\sigma_t^2}{2}}{\gamma\sigma_t^2} \qquad (5)$$

The numerator is the risk premium, equal to $\log\frac{E_t(1+R_{t+1})}{1+R_{ft}}$ assuming log normality.

---

[84] Ibid
[85] Ibid
[86] Ibid
[87] See Campbell & Viceira (2002).

The model for many risky assets is analogous but instead employs linear algebra (bold type indicates vectors or matrices). Campbell & Viceira (2002, p. 29) show that equation (3) can be generalised to:

$$r_{p,t+1} - r_{f,t+1} - \alpha_t'(r_{t+1} - r_{f,t+1}\iota) + \frac{1}{2}\alpha_t'\sigma_t^2 - \frac{1}{2}\alpha_t'\Sigma_t\alpha_t$$

where ι is a vector of ones, Σ_t represents the conditional variance-covariance matrix of log returns of the risky assets and σ_t^2 is the variance of asset returns (and the diagonal elements of Σ_t). The solution to the model with many risky assets is the analogue to equation (5) above:

$$\alpha_t = \frac{1}{\gamma}\Sigma_t^{-1}\left(E_t r_{t+1} - r_{f,t+1}\iota + \frac{\sigma_t^2}{2}\right)$$

For multi-period returns, Campbell & Viceira (2002, p.34) show that if asset returns are i.i.d. then the optimal portfolio has constant weights. In this case, the portfolio weighting solution to a long-term horizon is therefore analogous to the short-term horizon with the expected returns and variances scaled accordingly.

Assuming returns are i.i.d. allows a multi-period model to be modelled as a single period model (Campbell & Viceira (2002), p.32). This is because under this assumption, expected returns and variances are simply scaled by the time period. The K-period return of an asset *i* with constant mean log return of Er_i is KEr_i. Similarly the K-period variance of an asset *i*'s return with constant variance σ_i^2 is $K\sigma_i^2$. The authors note (p.32/3) that the approximation for portfolio returns used in equation (3) above works well for short time intervals (it holds exactly in continuous time) but less well for longer time periods. However, the authors conclude that the time effects are small for practical purposes and therefore have been ignored in this paper.