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Abstract

As one component in the determination of price caps for access to regulated gas pipelines under the National Access Code for Natural Gas Pipeline Systems (which is given legal effect through relevant State legislation), regulators utilise the CAPM to determine a "reasonable" rate of return on the capital employed by the pipeline owner in the provision of gas transport services. A key issue in the use of CAPM in this manner is the determination of beta, the coefficient measuring systematic risk in the CAPM. Pipelines are not commonly traded in Australia, and hence market betas cannot be readily calculated from market data. This necessitates estimation of beta by other means. The methods used in practice is essentially a combination of comparisons with like pipelines which are traded (usually in the US or UK) combined with what can best be described as guesswork to incorporate differences between these pipelines and the pipelines being regulated. This process is less than rigorous and subject to rent-seeking behaviour by pipeline owners. This paper considers risk from the perspective of first principles, and derives a methodology for determining beta in the Australian regulatory context based upon a theoretical consideration of diversification choices of individuals.

* Associate Professor Lakshman Alles is from the School of Economics and Finance, Peter Kenyon is the director of IRIC and Mr Nick Wills-Johnson is a Research Associate at IRIC. This paper is partly based on work carried out for the WA Office of Gas Access Regulation (OffGAR). The authors take the opportunity to thank OffGAR for permission to refer to research and information contained in their project, but emphasise that this work is wholly our own and does not necessarily reflect the views of any person at OffGAR. This paper was presented at the 31st Annual Conference of Economists, Adelaide, South Australia, 30th September to 3rd October.

1. Introduction

The Capital Asset Pricing Model (CAPM), originally developed by Sharpe (1964), Lintner (1965) and Mossin (1966) is a well-understood and well-used, if much maligned means of determining returns to equity for firms trading in the stock market. In more recent times, it has come to be used by regulators in Australia and overseas, engaging in incentive based price-cap regulation, in the determination of "reasonable" rates of return, and hence price caps for access to essential infrastructure. The gas pipeline industry in Australia is governed in such a manner.

However, the CAPM was arguably never developed with use in a regulatory framework in mind, and a number of issues exist in relation to its use in this manner. Perhaps the most important of these is that (in Australia at least) most of the regulated assets whose prices hinge upon the use of CAPM, are not traded in stock-markets, often being owned as part of a conglomerate by Australian or overseas interests. This means that the beta for these assets, the degree to which their returns vary compared to returns in the market at large, cannot be determined from market data, as is normally the case, and regulators must rather attempt to "build" a beta from secondary data in order to determine an access price.

This results in some controversy, exacerbated by the fact that no consistent rule has yet been developed to allow firms and regulators to easily and meaningfully differentiate between systematic risks, which CAPM theory suggests should form part of beta, and non-systematic risks, which can be mitigated away by an investor holding a sufficiently diverse portfolio of investments and should not appear in beta. This paper attempts to develop such a differentiation rule, based on a first principles assessment of the behaviour of investors.

Section II of this paper discusses briefly some background surrounding the mechanism by which access prices are determined in the gas pipeline industry in Australia, highlighting the process and problems of beta determination. The process derives directly from the controlling legislation, the *National Access Code for Natural Gas Pipeline Systems* (the Code). The third section summarises considerations of beta in both the CAPM and Arbitrage Pricing Theory (APT) literature. Section IV considers beta and systematic risk from a first principles perspective in a general sense, developing a decision rule to differentiate between systematic and non-systematic risk, which is the applied to the gas pipeline industry in the fifth section. The sixth section discusses some issues and benefits associated with this approach, whilst a conclusion is presented at the end of the paper (Section VII).

2. How Asset Prices Are Determined

The basic task of gas pipeline regulators is to approve a price cap for access to the relevant gas pipeline which mimics the price which would eventuate were the pipeline competitive and not a natural monopoly. That is, regulators attempt to set a price cap equal to long run marginal cost (including sunk costs).

Pipelines are regulated by an "Access Arrangement" which holds for a set period, typically five years. At the conclusion of each Access Arrangement, prices, and other aspects of the access regime, are re-determined. The process for determining access prices is as follows:

- The value of the monopoly asset (gas pipeline) at the outset of the Access Period is determined. For extant pipelines, this is commonly determined to be within the range of the Depreciated Actual Cost and the Depreciated Optimised Replacement Cost.
- A depreciation schedule is established, enabling the calculation of the value of the asset at the close of the Access Period.
- The value of "prudent" new capital expenditure and operational expenditure is established for each year of the access arrangement. "Prudent" refers to the amount of such expenditure which could reasonably be expected by an efficient pipeline operator, and is designed to prevent the gold plating of assets.
- A weighted average cost of capital is established, by reference to "reasonable" parameters which a competitive firm might face. The weighted average cost of capital is used as a discount rate and applied to all future values over the Access Period.
- Demand is forecast over the Access Period for the services of the pipeline.

- The net present value of the assets at the close of the Access Period is subtracted from the value of the assets at the start of the period. To the result of this is added the net present value of the "prudent" operational and new capital expenditure. This provides the total costs of the pipeline operator.
- The total costs are allocated across forecast demand to provide a per unit price. Where multiple services are offered, costs are pro-rated across services according to their demand share. The per-unit price becomes the price cap for access over the Access Period. To allow for inflation and productivity improvements, the cap is allowed to increase according to an annual CPI-X formula.

Problems exist at each of the stages outlined above. For example, determination of asset values is highly problematic, has limited theoretical backing, and has recently lead to substantial disputes in Western Australia between the regulator and some pipeline owners. To cover all of the issues associated with the above process is well beyond the scope of this paper: regulatory decisions, which must cover all of these issues, often run to several hundred pages. This paper focuses on the determination of the weighted average cost of capital (WACC), and more specifically on certain elements of the WACC.

The WACC is determined as a weighted average of the cost of debt and the cost of equity. The precise formula used differs on a case by case basis, depending upon the method in which taxation is treated, and whether results are presented in real or nominal terms. There is substantial debate concerning the correct treatment of tax, and the appropriateness of using real or nominal rates of return. However, these issues are not the focus of this paper.

Determination of the cost of debt is relatively non-problematic: the regulators assess the credit rating of the firms which own the pipelines (or obtain independent assessments) and then use market data to determine an appropriate cost of debt for a firm with this credit rating. The gearing of the firm is also relatively non-problematic. Rightly or wrongly, regulators assume an "efficient firm standard" of 60 percent, and this appears reasonably well accepted by industry. The cost of equity, however, is a different matter.

3. The Use of the Capital Asset Pricing Model

The cost of equity is most commonly calculated according to the CAPM. Although in the academic literature, the CAPM has been criticised as a very poor predictor of actual returns, it remains the preferred model for practitioners.[1] Partially, this is due to the fact that it requires less difficult to collect information than some of its rivals.

To calculate the cost of equity via CAPM, three parameters need to be estimated: the risk free rate of return, the market risk premium and beta, a comparison between movement in the returns of the asset relative to the market, and the variance of market returns. The risk free rate (determined as the rate of return on a appropriate risk free investment, commonly a ten year Treasury Bond) and the market risk premium (an historical average of the premium of stock market returns over risk free returns, currently considered by regulators to be approximately six percent, but decreasing) are both relatively non-problematic. However, the same cannot be said for beta.

4. The Determination of Beta in Regulated Environments – Current Practise

The unique problem faced by regulators of gas pipelines in Australia is that very few of the pipelines being regulated are traded in the marketplace. This means that it is not possible to simply turn to stock market data to empirically determine beta, as the stock price data for the firm in question simply does not exist. In many cases, pipelines are owned by subsidiaries of trans-national companies, whose stocks trade overseas. Even where the owners of pipelines have stocks traded in the Australian stock market, in many cases, the firms in question own a number of pipelines, or they have interests in other sectors as well. The Australian Pipeline Trust, for example, holds equity in six pipelines. For the regulator attempting to determine the beta for each individual pipeline, this is important: whilst it is possible to determine the beta of

[1] Meier & Jagannathan (2002) note somewhat wryly that, internationally, widespread acceptance of the CAPM could be due in no small part to the fact that it is widely taught in US graduate management courses, and this may also have some relevance in the Australian context.

a firm from the weighted sum of the betas of each of its assets, the reverse process of disentangling individual asset betas from a composite beta is more difficult, if not impossible.

Given the difficulty of estimating individual asset betas based on market information at the firm level, the approach of regulators has been to start with betas that can be estimated from widely available information, and then adjust according to perceived differences in risk profiles faced by each pipeline. This method was established in one of the first access regimes determined under the current regime (ACCC 1998), where the regulator examined the asset betas of a number of regulated gas pipelines in the UK and US, deriving a relevant range for beta values. The asset beta eventually used (appropriately re-levered from an asset to an equity beta) was the mid-point of this range. Other regulators have followed a similar approach, often adjusting the resulting beta to reflect the special circumstances of the relevant pipeline (QCA, 2001).

A number of issues exist in relation to this approach. Firstly, the beta values for the original set of US and UK were quite widely dispersed. Taking the mid-point of this range suggests that the risk profile of the Australian pipeline being assessed was approximately at the middle of the US-UK distribution. However, there is limited evidence that this is necessarily the case.

The effects of any inaccuracies in estimating the appropriate starting point, however, are likely to be substantially less than the effects of inaccuracies in the adjustment process. There are two issues:

- In many cases, the "base" beta (determined by reference to other jurisdictions) is adjusted to reflect stated risks, but neither firms nor regulators have provided evidence of the empirical process by which these calculations are made. It appears to be based solely on judgement.
- At least in proposals by industry, there appears to be a substantial (possibly wilful) misunderstanding as to what constitutes systematic risk, with many risks discussed in submissions to regulators not being systematic in nature.

The essential issue is that pipeline owners have no incentive to provide an accurate estimate of the beta value of the pipeline. In fact, they have an incentive to "talk-up" beta. This appears counterintuitive to those more familiar with beta as it is used in a competitive market, where beta is a result of a market process of diversification, and cannot be "talked-up" by the firms in question. However, it is important to note that, in the regulatory context, beta is used solely to determine the price of access. The beta which appears in an Access Arrangement need have no linkage to the risk profile of the firm.[2] This means that, if the pipeline owner can convince the regulator that the beta associated with the pipeline is greater than it actually is, the price of access will rise (ceteris paribus), without an increase in the true risk profile of the firm.

The "incentive problem" outlined above leads to two broad approaches by regulated firms. The first is to try and include as many risks as possible in an ambit claim for systematic risk. The second is to ascribe maximum values to each of these risk components in terms of how they impact beta. The result is a claimed beta which is often substantially larger than the value eventually considered "reasonable" by the regulator.

The regulator must therefore examine each claim on beta in detail and ultimately form a judgement. In many cases, risks claimed by firms are not inherently systematic and diversification instruments exist. The ACCC has led the practice, in these instances, of requiring the relevant risks to be incorporated into cash-flow. As these risks have market based mitigation instruments, determining their value is more transparent, and the degree of judgement required in the regulatory process is reduced.

This approach has intuitive appeal, given the greater transparency of risks priced in markets, but there is no consistent "rule" being applied, particularly in respect to the risks which remain in beta. The result of this is that each case becomes one essentially of one expert judgement against the other, often leading to substantial

[2] Regulators commonly adopt an "efficient firm standard", whereby parameters are calculated based on a hypothetical "efficient firm" (rather than the actual cost structure of the pipeline). This is to prevent consumers from bearing the cost of any inefficiencies pertaining to the owners. As such, the lack of correlation between the beta used in the determination of access price and the beta of the firm owning the assets is not due solely to information asymmetries.

debate. The presence of an easily understood rule would limit the scope for such (essentially unproductive) debate, and is thus the subject of what follows in this paper.

5. A Rule for Differentiating Systematic and Non-System Risk

Consideration of Beta in the Literature

In order to develop a rule for differentiating systematic and non-systematic risk, our first step was to examine the relevant literature. The discussion below is divided into CAPM and Arbitrage Pricing Theory (APT) literature. There are two broad approaches towards beta within the literature. The first of these, the CAPM literature, generally considers beta as the result, empirically determined from stock market data, of market diversification. In this literature, very few attempts are made to examine the underlying determinants of beta. The second thread of literature, the Arbitrage Pricing Theory (APT) literature, does specifically consider beta to be comprised of various elements, and endeavours to determine the contribution of each to the overall beta value.

Consideration of Beta in the CAPM Literature

In most cases, where the stocks of a company are traded in a stock market, beta is a result, calculated via economic regression. Although there has been substantial debate about the stationarity of beta (Fraser & Buckland, 2001, and Lettau & Ludvigson, 2001), examination of the factors which determine beta has been somewhat limited. This is understandable to a degree, beta is a very poor predictor of actual returns (Fama & French, 1992, 1993), and hence it would appear more reasonable to devote resources to ascertaining better predictors, rather than the determinants of a poor predictor. Secondly, CAPM theory is based on the assumption of a single factor (beta) determining variation in a stock, which does not lend itself to the consideration of multiple determinants of systematic risk.

Where the CAPM literature does focus on determinants of beta, much of the focus concentrates accounting variables and the degree to which they are correlated with beta. Rubenstein (1973) has shown that financial leverage is correlated with systematic risk. Thompson & Seket (1982) suggest that firm growth is a correlating factor. Mandelker & Rhee (1984) suggest correlation between operating and financial leverage. Ismail et al (1994), with a model which uses contemporaneous correlation between a market beta and accounting variables to predict beta, examine earnings payout, firm growth, leverage, firm size, liquidity, earnings variability, earnings beta, cash-flow variability and cash-flow beta. Thompson (1976) has perhaps the most substantial list of potential factors, containing some 43 different accounting variables.

However, accounting based measures are inherently endogenous to the firm. Systematic risks are those which cannot be diversified away from through the holding of a different portfolio, and hence must be exogenous to the firm. The accounting variables discussed above, rather than representing determinants of beta, would appear more likely to be variables, correlated with beta, and driven by the same underlying force. For example, it may well be true that gearing is correlated with systematic risk, as many authors have found, but that this correlation is due to both being driven by an exogenous factor such as interest rates. This would appear to limit the use of accounting measures as part of decision rule to differentiate systematic from non-systematic risk and hence establish the contribution of different factors to systematic risk.[3]

Other studies have examined exogenous factors and the correlation of these with beta. A common variable is input prices. Lee et al (1995) examine the impacts of a change in wage rates on beta. Peyser (1994) also examines the role of factor prices, but from the perspective of factor price uncertainty, and Tobin's q on the firm's beta. Another popular variable is the degree of market power or market concentration. Lee et al (1995) examine market power, utilising the reciprocal of the price elasticity of demand. Wong (1995) examines the influence of market power when strategic interaction between firms is allowed for. Finally, the influence of regulation on systematic risk has been studied by a number of authors, including Robinson & Taylor (1998), Morana & Sawkins (2000), Fraser & Buckland (2001), Riddick (1992) and Devany (1991).

[3] A related issue is the formation of "accounting betas", from the accounts of the firm. In regulated industries, this is unlikely to be successful. Absenting from the fact of the information asymmetry between the regulator and the regulated firm, and the limited incentives for firms to truthfully report accounting data, much of the key information in accounts are simply not calculated in an appropriate manner. For example: risks are related to expected future returns and, although the economic value of an asset is also determined by expected future returns, firms commonly record the book value of the asset and so, this would distort the calculation of beta if based on accounting data.

Unlike measures based on the accounts of the firm, input price variation, market structure and the incidence of regulation are factors exogenous to the firm, and as such, may be more appropriate as candidates for inclusion in the family of systematic risks. However, although these factors are exogenous to the firm, they are not necessarily exogenous to the industry. An investor may be able to diversify away from the risks associated with market power, for example, by investing in an industry where market power is less prevalent.

Consideration of Beta in the APT Literature

The Arbitrage Pricing Theory (APT) literature, starting with Ross (1976) examines risk from a different perspective. It assumes that the rate of return associated with an asset comprises the risk free rate plus the weighted sum of a series of "factors." In the context of APT, the CAPM is equivalent to assuming only one "factor" drives rates of return. The consideration of a number of factors provides scope within the APT literature to consider a wider number of variables which may be driving systematic risk. The APT literature is somewhat different to the CAPM literature in its approach. Rather than considering a single market based beta and the correlation of a number of variables with it, the APT literature considers systematic risk to itself be comprised of multiple elements.

In particular, studies in the APT literature have examined a number of macro-economic variables, such as employment, a relevant aggregate price index, award wages, M3, M6, the 90 day bill rate, exchange rates and the current account deficit (Groenwold & Fraser, 1997). As these variables are macroeconomic in nature, rather than pertaining to the firm, they are more likely to be truly representative of systematic risk. Indeed, Clare & Thomas (1994) couch the 18 macroeconomic factors they test in terms of them being "surprises" to the market. Conceptually, this lends itself towards associating these factors with true systematic risks; if changes in these factors really are "surprising" to the market, then the market is clearly not providing appropriate diversification instruments, and hence the risks may be systematic.

However, examination of some of the macroeconomic variables shows that some are in principle diversifiable. Exchange rate risk can, for example, be diversified away in hedging contracts, and if systematic risks were absolute in the sense that they applied in every case, it would be expected that the exchange rate would not be statistically significant in APT regressions. Indeed, Groenewold and Fraser do not find the exchange rate to be significant in their APT regression study for Australia.

Beta Considered From First Principles

The CAPM literature, considering only one factor (beta) as driving rates of return (above the risk free rate and in variance to market returns), provides limited scope for assisting regulators in determining the components of beta and assessing the arguments made by access provider firms. Most of the factors considered in the literature are internal to the firm (or industry) and, whilst undoubtedly correlated with beta in many cases, could not be considered systematic. The APT literature provides scope for the inclusion of a number of macroeconomic variables which appear, at first glance, to be more representative of systematic risk in nature. However, some of the variables tested in the APT literature and found to be significant have well defined hedges available and, on an à priori basis, would not be expected to be representative of pure systematic risk.

It would appear that the set of risks which are absolutely systematic, in that they are always systematic risks for all firms and industries, is either very small or does not exist, and that any decision rule for determining the differentiation between systematic and non-systematic risks can only be based on market behaviour of a more fundamental nature. For this reason, it is necessary to consider the issue afresh, from a first principles perspective.

To begin, consider an environment of perfect foresight: risk would not exist, and hence beta would be zero. Some authors have suggested that this may be an appropriate consideration. Schwartz (1998) suggests forecasting should be conducted according to some form of "certainty equivalent discount rate", with all risks accounted for in cash-flow. However, the empirical estimates of beta from market data suggest that beta is not zero in the majority of cases, and the presence of uncertainty results in beta being different from zero. The key issue is how different?

By definition, beta should reflect only non-diversifiable risks. What, however, constitutes a "non-diversifiable" risk? Perhaps the most accurate conceptual framework is to consider "non-diversifiable" to mean risks for which no market based risk mitigation instrument exists *at any cost*. "Market based" is defined rather loosely to include instruments such as insurance, futures contracts, options, hedges and the like. Such a strict definition of non-diversifiable clearly limits the types of risk which could be incorporated into beta (and may in fact render the set of systematic risks empty, as Schwartz suggests), and hence implies that a first estimate of beta calculated in this manner is unlikely to be substantially different from zero. However, such a definition is perhaps too strict, and is arguably not representative of how the market determines beta.

Consider a competitive market operating efficiently and a rational investor considering a suite of potential investments in this market. Assume that all investment opportunities face some family of risks, although the investment opportunities are heterogeneous in their exposure to them. Assume that all risks are inherently diversifiable, but the costs of doing so are not the same. In fact, assume that some risks can only be diversified at a very high cost, a cost which exceeds the expected loss associated with the particular risk. What would the response of the rational investor be when faced with an investment exposed to such a risk?[4]

Clearly, the rational investor can benefit through exposure to the risk with no diversification. For example, consider an investment which faces the risk of earthquake, a risk which can only be diversified at a cost of $100, but which carries an expected loss to the investor of only $60. The investor would prefer to purchase the investment and wear the risk. To attempt to diversify would incur a larger cost, and result in a misallocation of the investor's resources. It is the aggregate effect of countless decisions of this nature which causes variability in the prices of the firms (heterogeneously) exposed to these risks and hence establishes betas for each of these firms.

[4] For the sake of simplicity, assume this investment produces better returns than all other investments available, regardless of whether the investor decides to diversify or wear the risk. This removes the possibility that the investor might just discard the investment altogether and decide to choose a different investment.

A careful consideration of the above discussion reveals what is occurring: the market is examining (implicitly or explicitly) the impact of risk mitigation/diversification as opposed to investors simply wearing the risk. Where the (negative) impact of the former outweighs the latter, the risk is incorporated into beta, where the latter outweighs the former, investors diversify. Systematic risk, then, represents not some absolute set of risks applying in every case, but rather, the set of risks which results (in each case individually) from all relevant investors employing a consistent decision rule to their individual risk decisions in investment. Given differing exposure between firms to the same risks, information asymmetries between investors on key issues such as the probability of adverse events and the resulting demand patterns for stocks which these engender, the application of the consistent decision rule by all investors results in different betas for different firms. The decision rule, not the risks, is the consistent factor.

A consideration of the above characterisation of systematic risk raises two points. Firstly, systematic risk may in fact be nothing more than a measure of the degree of information asymmetry in the market for a particular risk mitigation instrument. Consider the (admittedly arbitrary) example above of earthquake risk. The marked difference between the cost of the relevant mitigation instrument and the potential consequences of bearing the risk suggests opportunities for arbitrage (such as two investors joining together to purchase the risk mitigation instrument, saving $10 each) which would be competed away in a market characterised by more information.

Secondly, this line of reasoning may provide a theoretical underpinning for the inclusion of variables in APT models. A common criticism of the APT is that it provides limited theoretical justification for the variables which are included as factors, their validity being determined solely by their statistical significance in regression. However, if the above decision rule is correct, then it may provide a theoretical justification for choice of independent variables in APT models.

For example, consider exchange rate risk, and assume that a hedge on a five cent fall in the A$ is available for a cost of $50,000 to a firm, which is considering the purchase of such a hedge to render itself more attractive to risk averse investors. The cost of this hedge is directly incorporated into cash-flow and the resultant increase in costs, with knowledge concerning the cost structure of the firm and demand schedule it faces, can be translated directly into consequences for the net revenue of the firm, which in turn comprises information for the investor. Similarly, knowledge of the impact on costs from a five cent fall in the $A can be translated through to consequences to firm revenue and this, coupled with knowledge on the probability of such a fall can be used to determine the likely impact of wearing the investment risk, again providing information for the investor.

If the negative impact of wearing the risk outweighs the negative impact of diversification (and the decision rule above is correct), it could be expected that a rational investor would diversify, and hence that exchange rate risk would not enter an APT regression as an independent variable, for it would not represent systematic risk. If, on the other hand, the negative impact of wearing the risk is outweighed by the negative impact of diversification (i.e., the decision rule above applies), it would be expected that a rational investor would not diversify, and so exchange rate risk would enter an APT regression as an independent variable. In this case, it does represent systematic, non-diversifiable risk.[5]

6. Towards a New Policy for the Determination of Beta in Regulated Gas Pipeline Industries

The first principles discussion above suggests a mechanism for estimating beta in a regulated environment by the regulator in effect becoming an assessor of the price of risk within the narrow context of determining access prices. The rule that we postulate the regulator should follow is: *consider the impact of addressing each (reasonable) risk through beta and through cash-flow, and choose the alternative that has the smallest impact on access price*.

In the above discussion of the possible use of the decision rule as a theoretical foundation for the specification of an APT model, we have seen that it is the impact on firm revenue which is the key consideration made by investors. For monopoly gas

[5] There is a third possibility. If the APT regression finds that exchange rate movement is a statistically significant factor, but that hedging contracts are available at sufficiently low cost, then this suggests either than an informational asymmetry exists which prevents the investor from undertaking the calculations above, or that the correlation is spurious, and represents simply that both systematic risk and the exchange rate are being driven by some third, exogenous factor.

pipelines, changes in revenue (costs remaining constant) vary directly with changes in access price, the variable controlled by the regulator.

The legislation governing access to gas pipelines requires regulators to adhere to the objective of *"not distorting investment decisions in Pipeline transportations systems, or in upstream and downstream industries"* (Code, Section 8.1 (b)). This, in effect, requires regulators to determine a price cap based upon economic efficiency.[6] Clearly, the decision rule which results in the least distortion of upstream and downstream industries, whilst not impinging upon investment in pipelines by artificially reducing rates of return below efficient levels is one whereby the regulator considers the impact of addressing each (reasonable) risk through beta and in cash-flow, and chooses the smallest impact on access price.[7] For example, if addressing the risk of exchange rate variation in beta resulted in an access price increase of 10 percent, and the purchase of an appropriate futures instrument increased the access price by only five percent, the regulator would, for the purposes of determining access price, consider exchange rate risk as diversifiable, and reflect it in cash-flow.[8]

Issues Associated With This Policy Prescription

Three potential issues are associated with the mechanism for determining beta discussed above. Firstly, some risks may have no mitigation instrument available, or may only be diversifiable at a very high cost. This could result in scope for firms to suggest very large increases in beta to account for these risks.[9] To prevent this, regulators may wish to consider examining a number of these risks on an ex-ante basis and incorporating them into some form of "base beta", allowing firms to deviate from the base beta when considering these risks only in demonstrably germane and

[6] There are other aspects of the Code that direct the regulator to a more general consideration of overall social welfare.

[7] Reference is made to "reasonable" risks to address the issue of ambit claims, and the fact that some risks (such as the risk of asset stranding) can best be addressed by other means under the governing legislation.

[8] This does not imply that a regulator would require a firm to purchase the relevant risk mitigation instrument. The overall purpose of this aspect of essential infrastructure regulation is simply to determine an access price. The decision whether to purchase the risk mitigation instrument or not would be made by the firm. However, it would mean that, should the firm decide not to purchase the instrument and the adverse exchange rate movement occurred, it would not be able to recover the increased costs flowing from its decision from customers.

[9] It is acknowledged that not all risks will increase beta. However, from a practical perspective, it is suggested that firms will never seek to decrease and always seek to increase beta, as higher betas translate to higher prices.

significant circumstances. The regulator would entertain such claims rarely and only when evidence presented was overwhelming.[10]

A second issue is the requirement implicit in the above for firms to calculate the incremental impact on beta of each risk they wish to claim as non-diversifiable. There is the potential inherent in this for an increase in regulatory burden. Such calculation is non-trivial. However, firms are (or should be) likely in any case to be making such calculations in their current estimations of beta. For this reason, the additional informational requirement (which is in any case deductible as a cost from cash-flow and hence passed on to consumers) is not considered substantial and will have the added benefit of improving the information available to the regulator in assessing beta.

A final issue is that the incentive problem (whereby firms have an incentive to "talk-up" their beta) is not eliminated. It is only reduced. The regulated firms still have an incentive to attempt to include as many risks as they can (although this may be tempered by having to calculate impacts on beta for each one), in an ambit claim. However, any regulatory environment which relies on regulator assessment of information provided by firms suffers from this problem. Moreover, a cap has been placed on the change in beta caused by each risk which firms can claim, as it cannot cause a larger impact on final access prices than the impact of a relevant market instrument captured in cash-flow. This may assist in limiting ambit claims.

Benefits Associated With This Policy Prescription

Aside from reducing the scope for "talking-up" beta, the main advantage of the approach outlined in this paper lies in its effects on risk mitigation markets, effects which may then flow through to benefit the regulator. As successive regulatory determinations become public knowledge, any arbitrage opportunities evident in the allowed treatment of risk will become evident to those providing risk mitigation services, and it may be expected that these would be acted upon. For example, if a regulator allows an increase of beta to account for a risk, which translates to an equivalent discounted cash-flow item of $50,000, and an insurer (perhaps by bundling

[10] Regulation always requires judgement, but practice and precedence will over time set the parameters.

such risks) is able to offer insurance for the risk for $40,000, it is to the benefit of both parties for the firm to take out insurance. The next time an access arrangement is assessed, however, that particular risk will have a specific mitigation instrument, available at lower cost. Over time, it may be expected that more efficient accounting for risk within the gas pipeline industry (and the concomitant effect of this on broader markets which rely on the gas industry) would result.

7. Conclusion

The application of the CAPM in a regulatory framework where regulated assets are not traded results in some substantial difficulties and controversy between the regulators and the regulated firms concerning appropriate values of beta. Briefly, the firms have an incentive to "talk-up" the beta used to determine "reasonable" rates of return for the purposes of access pricing, and can do so without any consequence to their actual risk profiles. Regulators, on the other hand, attempt to reduce both the number of risks claimed and the impact of each risk, often by requiring risks to be addressed through diversification instruments accounted for in cash-flow.

The main issue is that, to date, there has not been a consistent "decision rule" to differentiate between systematic and non-systematic risks, and hence the debate becomes one of the arraying of "expert judgements" assembled by the regulators and the regulated. This paper attempts to introduce an appropriate decision rule, based on a first principles examination of the behavioural responses of investors to the options of wearing and diversifying away from risks. This first principles consideration finds that systematic risks, in the sense of absolute risks which affect all firms, are very limited in number. We argue that systematic risks result from investors applying a consistent decision rule to the issue of whether to diversify or not, and that the use of this decision rule by all capital market stakeholders provides market based betas.

This decision rule is then applied in the context of the regulated gas pipeline market, where we conclude that the regulatory equivalent involves the regulator considering the impact on the price of access resulting from each risk being treated as part of beta, or as a diversifiable risk, whose cost of diversification is reflected in cash-flow. The regulator should then base access price determination on whether the treatment of each risk in beta or cash-flow results in the smallest increase in access price. This decision rule supports the economically efficient allocation of resources which is the prime motivation for regulation in the gas pipeline sector.

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