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Network Performance Branch
Commerce Commission
Wellington

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POST-WORKSHOP SUBMISSION ON THE ELECTRICITY DISTRIBUTION EMERGING VIEWS WORKSHOP

- 1 Orion New Zealand Limited (**Orion**) welcomes the opportunity to make a post workshop-submission on several matters that arose at the Commerce Commission (**Commission's**) recent workshop on its Electricity Distribution (Emerging Views) Paper¹ (**EV paper**). We believe the workshops are a useful element of the consultation process and thank the Commission for taking the time to engage with industry participants.
- 2 This submission addresses questions raised by the Commission at the workshop.

Outline of submission

- 3 In this submission we focus on what we see as the key points arising from the Commission's emerging views paper and the workshop, namely:
 - 3.1 the establishment of the initial regulatory asset base (RAB);
 - 3.2 the Australian experience of asset valuation, and whether the HNE test requires a "greenfields" or "brownfields" approach;
 - 3.3 investor expectations;
 - 3.4 rolling forward the RAB and whether the "workable competition" standard requires periodic ODV revaluations;

¹ On 24 and 25 February 2010, the Commission held a workshop on its emerging views on the development of input methodologies for application or potential application in determining default and/or customised price paths for certain services provided by electricity lines and gas pipelines.

- 3.5 the link between optimised depreciated replacement cost (ODRC) and empirical evidence of 'real' market outcomes; and;
 - 3.6 the allocation of common costs.
- 4 We have attached as an Appendix to this submission a report from Orion's economic advisers, NERA Economic Consulting, which reviews the empirical evidence on the relationship between asset values and costs through consideration of estimates of 'Tobin's Q ratio'.

Question 20: 2010 ODV and beyond

- 5 Before any discussion on the stability of long term arrangements can be decided it is essential that the initial valuation of the assets is correctly set. Ensuring an appropriate initial RAB should be the Commission's first priority. As we have previously submitted we believe that consistent with the hypothetical new entrant principle, the first best approach to a starting valuation for the Part 4 regime is an updated 2010 ODV.
- 6 The Commission's proposal outlined in the emerging views paper of an initial RAB value based on EDBs' 2009 information disclosure values (even with the possibility of certain adjustments to the asset register to adjust existing disclosed valuations) has a number of shortcomings which we outlined in our pre workshop submission. Not least of these shortcomings is that it is based on the 2004 ODV with its well-documented problems.
- 7 The inaccuracies in the resulting ODV values based on the 2004 handbook were readily acknowledged by the Commission, but were considered to be acceptable for the limited purpose of deriving *thresholds* under the Part 4A regime. The Commission was clear that business-specific circumstances would be taken into account during a post-breach inquiry, before a decision was made to implement *control*.²
- 8 Orion was not investigated following a breach of its price threshold, and therefore was never afforded the opportunity to challenge the efficacy of our 2004 ODV estimate in the context of a post-breach inquiry.
- 9 We have repeatedly emphasised the many problems implicit in the 2004 estimates – including the inappropriate unit cost estimates – that render

² Commerce Commission, *Regulation of Electricity Lines Businesses – A Companion Report to the Handbook for Optimised Deprival Valuation of System Fixed Assets of Electricity Lines Businesses*, 31 August 2004.

those values unsuitable for the establishment of controlled prices. In our view, the requirements of the purpose statement can best be met by estimating a fresh 2010 ODV. This approach would also be consistent with investors' reasonable expectations, and with the overarching workable competition standard.

- 10 The subsequent separate question is how then to update that initial RAB over time so as best to meet the requirements of the purpose statement. During the conference Associate Commissioner Duignan suggested that if the workably competitive market standard supports the use of ODV, it follows that the standard would require the Commission to periodically update those ODV valuations over time.³ This is not necessarily the case. We think a 'roll-forward' approach,⁴ could also meet the requirements of the purpose statement.
- 11 First, neither a roll-forward approach nor an approach involving periodic ODV revaluations will perfectly mimic workably competitive market outcomes. In the periods between ODV resets, prices may depart from current replacements costs, and so depart from the theoretical benchmark of workable competition. In other words, unless the Commission updates its ODV estimates in real time (which, of course, is completely impracticable), then neither approach will meet the theoretical benchmark of workable competition at all times. Both are approximations.
- 12 Second, the regulated prices delivered by a roll-forward methodology and by an approach in which ODV values are periodically updated are likely to be very similar and, in some circumstances, may be identical. As the Allen Consulting Group (2003) explains:⁵
 - 12.1 re-setting the RAB at an updated ODV at each DPP reset implies that a unique time profile of charges over time would be established. The time profile would reflect the prices that would be charged by the hypothetical new entrant - which in turn would imply a unique profile of regulatory depreciation allowances; and
 - 12.2 in contrast, if the RAB is rolled forward, flexibility potentially exists in relation to the time profile of regulated charges (and regulatory depreciation). Provided the rate of depreciation is sufficiently fast that the provider is able to set prices that recover its revenue

³ Associate Commissioner Duignan, *Electricity Distribution and Gas Pipelines Workshop*, 25 February 2010, p.108.

⁴ A roll-forward approach involves updating the regulatory asset base for an EDB to reflect the actual outcomes for the regulated entity over the previous regulatory period. The updated regulatory asset base would reflect the level of prudent capex (where prudence is determined on an ex-ante and/or ex post basis) and return of funds (regulatory depreciation and disposals) received over the period.

⁵ The Allen Consulting Group *Methodology for updating the regulatory value of electricity transmission assets* Final report, August 2003 for the ACCC at p.40.

requirement, myriad regulatory depreciation profiles (and hence price paths) are possible, including the price path that would apply if ODV's were periodically updated.

13 In other words, the roll-forward approach would permit the same regulatory depreciation profile (and hence time profile of regulated charges) as that implied by the ODV revaluation methodology, but would also permit other profiles of depreciation (and prices) to be selected if they are thought by the Commission to be more efficient in terms of incentives to invest, improve efficiency, and limit ability to extract excessive profits.

14 For these reasons, we think a roll-forward approach and an approach in which ODV values are periodically reset are each permissible once a robust initial RAB has been established. The two approaches each deliver a mix of regulatory options and outcomes which must be assessed against the s52A criteria. We strongly supported periodic ODV resets under the previous thresholds regime. We supported the Commission's previous decision on rolling forward RAB and we see no reason why such an approach could not be made to work under the new arrangements⁶. In particular we supported.⁷ :

- *the move to a five-yearly revaluation cycle*
- *the principle of a "roll-forward" of values in intervening years, although as outlined below we have some concerns regarding the excessive level of detail proposed for various disclosures, and see that we will have some difficulty in complying without considerable effort*
- *the removal of the requirement to provide ODV information in the intervening years*
- *the commitment to update the ODV Handbook prior to each revaluation cycle. However, we note again our concerns that Handbook asset replacement costs typically fall below the "actual"*
- *indexation at CPI in the intervening years. This is consistent with the recommendations we have made in previous submissions*
- *the inclusion of actual costs of capital expenditure in intervening years*
- *the inclusion of an allowance for finance during construction within the distribution ODV Handbook*

⁶ A further potential benefit of an approach in which ODVs are periodically updated is that it obviates the need for the Commission to undertake *ex ante* prudence reviews of capital expenditure forecasts.

⁷ Orion – *Submission on the Commerce Commissions paper "Methodology for rolling forward the regulatory Asset base for System fixed assets"*, 8 May 2006

- *the inclusion of non-system fixed assets at their GAAP valuation*
 - *the pragmatic approach outlined in the paper regarding the carry-forward of apportioned regulatory asset base (RAB) values in the event of a merger or acquisition*
- 15 As recently as October 2009⁸ we expressed our support for ODV updates on a regular basis, eg, every 5 to 10 years.
- 16 Having said that, we recognise that a reasonable regulator might be attracted to the flexibility of depreciation and pricing options offered by a roll-forward approach. Such an approach might also offer benefits, such as additional certainty and reduced transaction costs. We look forward to engaging further with the Commission on the respective merits of the various alternatives approaches. However, it is important to ensure that options for setting the initial RAB are not prematurely and inappropriately discarded on the basis that the RAB should then be updated: the two issues are separate.
- 17 In summary, Orion considers the standard of workable competition can be best met by setting the initial RAB on the basis of an updated ODV value as at 2010 and having periodic revaluations. However, the purpose statement does not require that value to be periodically updated.

Question 19: “Greenfields” and “brownfields” approaches to ODV

- 18 During the workshop, Commissioner Begg enquired about the extent to which the application of the optimised depreciated replacement cost (ODRC) methodology in Australia had involved a ‘greenfields’ approach to optimisation as opposed to a ‘brownfields’ approach.⁹
- 19 A pure ‘greenfields’ approach to valuation assumes the construction of a hypothetically efficient network in an area that is free of development, regardless of the assets in situ. For example, the hypothetical new entrant is assumed to lay its pipes or electricity lines before the establishment of any other infrastructure, obviating the need to dig up and restore roads and footpaths. The result is the most efficient (hypothetical) network possible to meet current demand. In contrast, a ‘brownfields’ approach recognises that networks are not built in this way and that construction plans are often influenced by the assets that are already in place. Allowances are

⁸ Orion *Post-conference cross submission on input methodologies* October 2009

⁹ Commissioner Begg, *Electricity Distribution and Gas Pipelines Workshop*, 25 February 2010, p.104.

therefore made for the extra costs that may be incurred working around existing infrastructure.

- 20 We have been advised by NERA that, to the best of their knowledge, no ODRC valuation undertaken in Australia has been undertaken using a pure 'whole of network' greenfields approach.¹⁰ Rather, valuations of electricity, gas, water and rail infrastructure regulatory assets have generally involved an approach to optimisation that sits somewhere between a pure greenfields approach and a pure brownfields approach. The approach espoused by the Independent Pricing and Regulatory Tribunal (IPART) in its 1999 Draft Decision on AGL Gas Networks' proposed access arrangement is apposite:¹¹

'The Tribunal acknowledges that the actual capital outlay paid by the original investors/owners may be somewhere between the brownfield and greenfield optimised replacement costs, particularly where the system had been built and then gradually expanded in a developing area. To the extent that pipes are replaced rather than refurbished and/or relined, future replacement costs may more closely approximate the brownfields estimate.'

- 21 Such an approach acknowledges that the existing assets will often reflect more closely the realities of providing the relevant services, and consequently the costs that would be incurred by a hypothetical new entrant. Specifically, the existing infrastructure will commonly reflect the relevant geographic, topographic and demographic factors, the precise pattern of demand, and so on. However, it also recognises the possibility that a hypothetical new entrant might feasibly re-design certain assets, in which case something more akin to a greenfields approach might be appropriate for those network elements.

Question 21: Investor expectations and reliance on Commission statements

- 22 As indicated above the Commission has acknowledged repeatedly the deficiencies in the 2004 valuations. Nonetheless, it chose not to update the ODV handbook in 2008 (despite its previous decisions that this would be done) and, more recently, it has indicated its preference to establish the initial RAB values for the new regime on the basis of the deficient 2004 estimates. These departures from its previous decisions were contrary to

¹⁰ This includes valuations of electricity, gas, water and rail infrastructure assets.

¹¹ Independent Pricing and Regulatory Tribunal, *Draft Decision: Access Arrangement for AGL Gas Networks Limited Natural Gas System in NSW*, October 1999, p.94.

investors' reasonable expectations, and inconsistent with good regulatory practice.

- 23 As we have submitted extensively,¹² the Commission's 2006 decision¹³ to undertake five-yearly ODVs and to fully update the ODV handbook prior to the 2009 reset followed extensive industry consultation and discussion. Those decisions were consistent and coherent.¹⁴ A commitment was made to deliver an updated handbook that would then be used to estimate updated asset values when the thresholds were reset in 2008. Periodic ODV revaluations would then be undertaken.
- 24 However, following the announcement of the Commerce Act review in late 2007 the Commission shelved its work on the new ODV handbook and subsequently announced its decision to use the 2004 valuations as the foundation of the Part 4 price-quality paths.
- 25 Although there can be good reasons for a regulator to change its mind, we do not consider that such reasons exist in these circumstances. Good regulatory practice suggests that the Commission follows through on its 2005 commitment to undertake a new ODV prior to the next price reset (which is now a reset of the DPP, rather than a threshold reset), because:
- 25.1 the Commission was *substantively* correct to decide in 2006 that a new ODV valuation should be done before the 2009 reset, in light of the shortcomings in the 2004 valuations;
 - 25.2 the relevant *facts have not changed* – in particular, the problems with the 2004 ODVs and, in consequence, the current information disclosure values persist to this date; and
 - 25.3 the regime has moved from a threshold regime to one of control.
- 26 In our view there is no sound reason for the Commission to have moved from the position it took in 2005/06. It is therefore unreasonable for the

¹² See Orion New Zealand Limited *Submission on the Reset of the DPP* 17 July 2009; and Orion New Zealand Limited *Input Methodologies Post-Conference Submission* 15 October 2009 at para 77.

¹³ Commerce Commission, *Regulation of Electricity Lines Businesses, Valuation of the Regulatory Asset Base, Draft decision paper*, 13 October 2005; and Commerce Commission, *Regulation of Electricity Lines Businesses, Valuation of the Regulatory Asset Base (Implementation Matters) for Distribution Lines Businesses, Decision Paper*, 13 April 2006

¹⁴ The context is explained in ENA's letter to the Chair of the Commerce Commission dated 17 October 2005.

Commission (in developing the Part 4 regulatory instruments) to continue to ignore the deficiencies in the 2004 valuations.

- 27 Any decision by the Commission to resile from its previous commitments will reduce the perceived certainty of the new regulatory arrangements. It will inevitably heighten industry perceptions of regulatory risk and further increase investors' reluctance to invest and to innovate. In other words, such a decision would be inconsistent with the objectives set out in the legislative purpose statement, and with good decision-making more generally.
- 28 Historically, Orion has endeavoured to continue to invest appropriately so as to serve the best interests of our customers. However, we have remained ever conscious of the risk of regulatory uncertainty. Our annual reports have referred repeatedly to the risks posed by regulatory uncertainty, and the potential threats to investment. For example, we have noted:
- 28.1 the importance that EDB's such as Orion should not be overly constrained by regulations that stifle their ability to innovate and earn appropriate financial returns;
 - 28.2 our concern that the settlements reached with Vector and Unison provided little guidance for future investment decisions by network distribution companies;
 - 28.3 our hope that the outcome of the Commerce Act review would improve investor certainty (which has also been a constant theme in Orion's submissions to the Commission throughout the design and implementation of the new regime); and
 - 28.4 our concern that regulations that prevent electricity distribution companies from earning a reasonable rate of return may stop them from making much needed investments in infrastructure assets, and may result in electrical blackouts in the medium to long term.
- 29 Any decision by the Commission to persevere with the deficient 2004 ODV estimates would sharpen our perception of regulatory risk and, we suspect, affect adversely the incentives that other EDBs and their shareholders may have to innovate and invest. In our view, the only appropriate course is for the Commission to undertake a new 2010 ODV based on an updated

handbook. As we have previously submitted¹⁵ this would be consistent with earlier decisions, would address the difficulties with the 2004 valuations, and (as we discuss above) best meets the requirements of the purpose statement.

- 30 In summary, and in response to the Chair's and Commissioner Begg's questions at the workshop,¹⁶ we do not consider it appropriate for the Commission to now reverse its earlier decisions that a full ODV would be undertaken prior to the initial valuation under Part 4 (previously prior to a threshold reset). The previous decisions were well reasoned, were the product of extensive consultation, and were relied upon when EDBs made subsequent investment decisions.

Questions 26 and 27: Commission should not draw a line in the sand or reverse engineer from current prices

- 31 The s52A purpose statement and its focus on the workable competition standard demands a robust and accurate assessment of asset values as the starting point for the new Part 4 regulatory period.
- 32 Subsequent to the input methodologies conference in September 2009, Orion engaged its economic advisors, NERA Economic Consulting (**NERA**), to prepare an expert report on asset valuation in workably competitive markets. NERA concluded that:¹⁷

There is no doubt as to the consistency between the ODV/HNE concepts and the outcomes produced in workably competitive markets. Put simply, when a workably competitive market is in long-run equilibrium, the value of capital assets implied by the market price will reflect their current market value (for new assets) or the depreciated equivalent (for second hand assets), ie, their ODV.

- 33 The inexorable conclusion is that prices in workably competitive markets will, in the long term, reflect the underlying values of the capital assets required to produce the service. It is that workably competitive outcome is demanded by s52A that the ODV methodology (and the associated HNE concept) seeks to replicate.

¹⁵ Orion New Zealand Limited *Input Methodologies Post-Conference Submission* 15 October 2009 at para 80 et seq.

¹⁶ Question 21, and see also Commissioner Begg's question at p123, line 13 of the transcript.

¹⁷ Orion New Zealand Limited *Input Methodologies Post-Conference Submission* 15 October 2009 at para 17.

- 34 It is therefore not obvious whether it would be open for the Commission (as suggested by Vector and, to a lesser extent by Powerco) to 'reverse engineer' the RAB from current prices by assuming a particular rate of return. In Orion's view, adopting such an approach, even with the objective of smoothing price shocks, may not be consistent with the requirements of the purpose statement.
- 35 Neither is such an approach required. As we have previously submitted the legislation makes specific provisions and empowers the Commission with a transparent adjustment mechanism, that can be used (if necessary) to insulate consumers or EDB's (as the case may be) from the effects of 'rate shock'.
- 36 Orion's preferred approach is for a robust 2010 ODV to be used to inform current and projected profitability, and to set prices for the next regulatory period, using if necessary the option of resorting to s 53P(8)(a) adjustment should the Commission subsequently decide that it is necessary or desirable to minimise any price shock to customers or the EDB.
- 37 Although the 'line in the sand' approach may be perceived as a practical and pragmatic option, we are not convinced that it would best meet the requirements of s52A.

Question 28: Tobin's Q

- 38 During the workshop, Associate Commissioner Duignan referred to time-series data reported by the US Federal Reserve in which 'Tobin's Q' was estimated as being less than one. Tobin's Q measures the ratio of the market value of assets and the replacement cost of those assets. A $Q < 1$ implies that market values are below ODRC levels. Associate Commissioner Duignan asked NERA to consider the potential implications for its contention that asset values in workably competitive markets will trend towards ODRC values, and be equivalent in long-term equilibrium.
- 39 NERA's response is appended to this submission. It finds that a number of studies exist that estimate time series average Q values. Of the five studies it identifies, estimates of Q range from 0.7 to 1.2. Given the range of values, their sensitivity to the assumptions made and the shortcomings in the methodologies employed, NERA concludes that the studies do not in any way invalidate the conclusions reached in the previous report, ie, that in workably competitive markets asset values will reflect their ODRC over time.

Concluding remarks

- 40 Thank you for the opportunity to make this submission. Orion does not consider that any part of this submission is confidential. If you have any questions please contact: Dennis Jones (Industry Developments Manager), DDI 03 363 9526, email dennis.jones@oriongroup.co.nz.

Yours sincerely

A handwritten signature in black ink that reads "D. L. Jones". The signature is written in a cursive style with a large, prominent 'D' and 'J'.

Dennis Jones
Industry Developments Manager

APPENDIX

Empirical Estimates of Tobin's Q

15 March 2010

Empirical Estimates of Tobin's Q

A report prepared for Orion

NERA

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1. Introduction

This report has been prepared in response to a request from the New Zealand Commerce Commission ('the Commission') arising from discussions around the setting of the initial regulatory asset base for electricity distribution networks and gas pipelines at the recent *Input Methodologies, Electricity Distribution and Gas Pipelines Workshop* (the Input Methodologies Workshop).¹

In the course of the Input Methodologies Workshop, Associate Commissioner Duignan queried the extent to which statements made in an earlier NERA report,² regarding the link between asset values and their optimised depreciated replacement cost (ODRC), could be reconciled with empirical evidence from the United States on Tobin's Q ratio. In subsequent correspondence with Greg Houston, Associate Commissioner Duignan, indicated that the studies he was referring to had produced estimates of Tobin's Q of between 0.7 and 0.8, which imply that the market value of assets over time is *below* their replacement cost.

Subsequently, the Commission invited NERA, on behalf of Orion, to provide:

'...empirical evidence ... for their assertion that it is an empirical fact that market values correspond to ODRC or trend to that equilibrium and that there is no reason to believe that short-term fluctuations above or below ODRC that occur during periods of disequilibrium will be biased in either direction.' (*The Commission, Invitation for Electricity Distribution/Gas Pipelines Post Workshop Submissions*).

At the outset, we emphasise that our earlier report made no assertions as to the *empirical* relationships between market values and replacement costs. Rather, it made observations of economic principle that were grounded in the links between prices and long run costs in workably competitive markets³ and so, where a material proportion of costs are fixed from one year to another, between asset values, their ODRC and the decisions made by a hypothetical new entrant. Nonetheless, in this report we review the empirical evidence on Tobin's Q and seek to draw implications, if any, for the economic principle described in our earlier report.

The remainder of this report is structured as follows:

§ **section two** describes the relationship between asset values, costs and explains how this relates to 'Tobin's Q' theory;

§ **section three** presents empirical evidence of Tobin's Q values from a range of studies and explores the way in which the assumptions employed in those studies and the limitations of the data may have influenced those estimates; and

§ **section four** concludes.

¹ New Zealand Commerce Commission, *Input Methodologies Electricity Distribution and Gas Pipelines Workshop*, Auckland, 24 and 25 February 2010.

² *Asset Values in Workably Competitive Markets*, NERA on behalf of Orion New Zealand Ltd, 15 October 2009 (hereafter: 'NERA report').

³ *Ibid*, p.8.

2. Asset Values, ODRC and Tobin's Q

In September 2009, NERA prepared a report for Orion for submission to the Commission⁴ setting out the economic framework for considering the relationship between asset prices and costs under perfect competition and workable competition. The report concluded that:

- § under *perfect* competition, the market price for existing capital assets will reflect their optimised depreciated replacement cost (ODRC); and
- § under *workable* competition:
 - market fluctuations can result in prices departing temporarily from costs, and asset values departing temporarily from ODRC;⁵ however
 - over time, supply-side adjustment can be expected that realigns prices with the underlying costs of supply, and asset values with their ODRC, such that normal returns are earned.

This section discusses the link between this finding and 'Tobin's Q theory'.

2.1. Tobin's Q Theory

Tobin's Q is a theoretical model of links that are thought to exist between the financial economy (company debt and equity values) and the real economy (firm's investment decisions).⁶ Specifically, Tobin's Q (or, more correctly, 'marginal Q') measures the ratio of the value to a firm of an additional unit of capital, and its replacement cost, ie:

- § if the market value of an additional unit of capital exceeds its replacement cost (ie, if marginal $Q > 1$), then the firm is able to increase its value by investing in capital and, similarly, new entry is an attractive proposition to other firms; and
- § when the value to a firm from an additional unit of capital is below its replacement cost (marginal $Q < 1$), then new investment would not be attractive for the firm, and market exit becomes more likely.

Tobin's theory recognises that there are costs associated with firms adjusting their capital stock, which means that marginal Q may be above or below one in the short term but will tend toward unity over the longer term.⁷ For example, assuming diminishing marginal productivity of capital, if $Q > 1$ ($Q < 1$) the resulting increase (reduction) in real investment by the firm and/or its competitors will decrease (increase) the market value of capital, and reduce (increase) the marginal Q ratio.

⁴ *Asset Values in Workably Competitive Markets*, NERA on behalf of Orion New Zealand Ltd, 15 October 2009.

⁵ Specifically, barriers to entry/exit and/or the indivisibility of investments can mean that prevailing prices are higher or lower than the underlying costs of supply for a time.

⁶ Tobin, J (1969), A General Equilibrium Approach to Monetary Theory, *Journal of Money, Credit and Banking*, vol. 1, pp. 15–29.

⁷ Assuming no barriers to entry and exit in the long run and that intangible assets have been fully accounted for in the cost of assets.

However, marginal Q is not observable in practice. In consequence, empirical studies typically use *average* Q in its place. Average Q measures the ratio of the market value of the firm and the cost of its existing capital stock, ie:

$$Q_{Average} = \frac{\text{Market value of assets (equity + net debt)}}{\text{Replacement cost of assets}}$$

Hayashi (1982)⁸ examines the conditions under which average Q will be a good approximation of marginal Q.⁹

2.2. Tobin's Q, Asset Values and Costs

Tobin's Q is an alternative statement of the investment theory set out in our earlier report.¹⁰ It is built on the foundation that, in the long term, asset values will adjust to reflect the replacement costs of those assets. Tobin's Q is consistent with workable competition, because it recognises that while market forces will act to align asset values with costs (through new entry or expansion of existing competitors), this process is not instantaneous. This may be because of time lags associated with acquiring and installing new capital or because the necessary investments are 'lumpy'.

We noted in our earlier report that these adjustment costs imply that, in a workably competitive market, firms may earn above or below normal economic profits for a period until such a time as entry, expansion or exit occurs to restore equilibrium. In the same way, the Tobin's Q model recognises that the Q ratio may be above or below one at given points in time, but can be expected to trend towards one over time.

2.3. Measuring the Cost of Assets

In considering empirical estimates of Q and their implications for the long run relationship between asset values and costs, it is important first to be cognisant of the costs actually being measured. In particular, measures of the 'replacement costs' of assets should reflect their optimised depreciated replacement costs.

Optimised depreciated replacement cost is a measure of the cost of replicating the remaining service potential of an asset in the most efficient way possible. The measure is depreciated to reflect the shorter remaining life of the existing asset and optimised to account for changes in technology (because replicating the service potential of an asset does not necessarily involve replicating the same physical asset) and any inefficiency in the construction of the existing asset, for example, over design or over capacity.

⁸ Hayashi, F (1982) 'Tobin's Marginal q and Average q: A Neoclassical Interpretation', *Econometrica*, vol. 50, no. 1, p. 213–24.

⁹ These authors demonstrate that average Q will equal marginal Q in the case where the firm is a price taker (in goods and factor markets), the production function and capital installation function are linearly homogenous (eg, Cobb-Douglas or CES production functions) and the tax treatment of investment does not drive a wedge between average and marginal Q (discussed further in section 3.3).

¹⁰ See Hayashi (1982) for discussion.

Section 2.1 explained that Tobin's Q model implies that the relationship between an asset's value and its underlying replacement cost is driven by:

- § the incentive for marginal investment by firms when a unit of new capital is valued at more than its replacement costs (when marginal $Q > 1$); and
- § the incentive to run down (or redeploy) capital in cases when the market value of capital in a particular use is less than its replacement cost (when marginal $Q < 1$).

Incentives for new investment are therefore based on the relationship between market values and the underlying ODRC. To illustrate, consider a workably competitive market where there have been advances in technology that have reduced the costs of production. In this market, the 'book value' of assets (ie, the assets' depreciated historical cost, before any 'optimisation') employed by those firms who have not invested in the new technology will *not reflect* the underlying ODRC, since an up-to-date ODRC estimation would value those assets (new and old) based on their lower cost modern equivalents, which would reflect any advances in technology.

In a situation where the market value of the firm's assets exceeds the ODRC valuation (but not the DRC valuation), the firm will have an incentive to invest, since the value to it from the investment in new capital is greater than its cost, ie, marginal $Q > 1$. However, a Q ratio calculated using the depreciated replacement cost of capital (rather than the ODRC) is likely to *understate* the 'true Q' in these circumstances. For this reason, it is important to pay careful attention to the costs that are actually being measured before drawing conclusions from empirical studies.

3. Empirical Studies

A significant number of studies have been conducted to estimate the value of Tobin's Q. Most empirical studies provide a sector- or industry-wide estimate of average Q ('Q'). Such estimates provide insight into the average relationship between asset costs and values in these sectors. Many are 'point in time' estimates, prepared for the purposes of determining whether the stock market has under- or over-valued companies in those sectors. This poses a number of potential problems insofar as drawing conclusions about the empirical relationship between asset values and replacement costs.

In particular, a sufficiently long time series is needed in order to 'smooth out' the short term volatility one would expect to observe in estimates of Q over time as the capital stock adjusts to market fluctuations. Indeed, the short run volatility that can reasonably be expected in estimates of Q means that any average of these sector- or industry-wide estimates will be highly sensitive to the time period over which the data are taken. Put simply, observations taken from a relatively short window may reveal very little (if anything) about long term trends.

In the following sections we describe the main studies from the United States (US) that have sought to construct empirical estimates of Q over an extended time period, and set out what meaningfully can be ascertained from that work about the relationship between asset values and replacement costs.

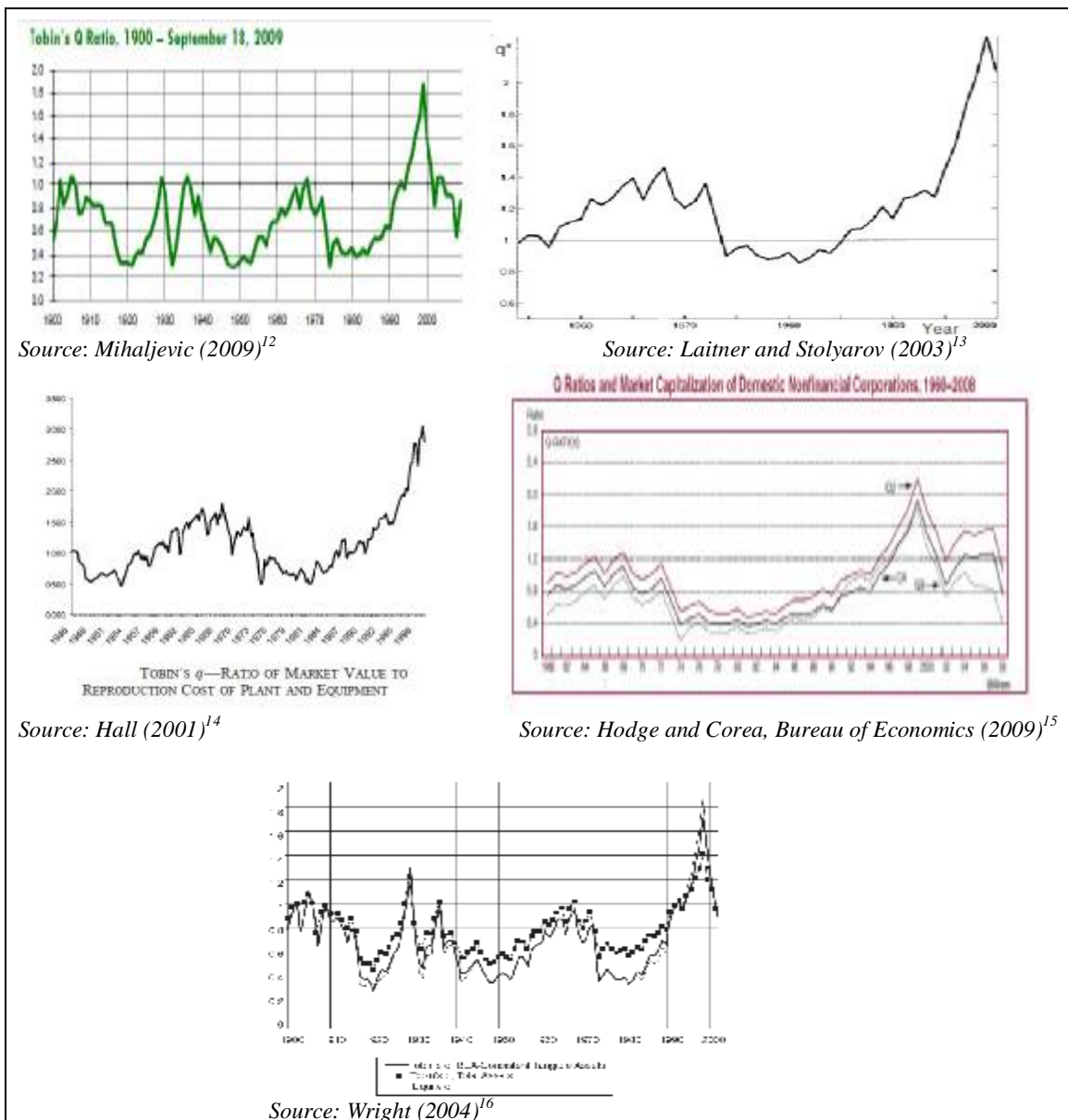
3.1. Estimates of Q

Most of the time series estimates of Q that we identified were based on data from US markets.¹¹ Specifically, we identified five studies that have estimated Q values for the US over an extended time period. The time series estimates of Q from each of these studies are set out in Figure 3.1 below.

¹¹ Chan Lee (1986) summarises estimates for nine OECD countries (including the US) over various periods. These estimates are somewhat dated and, for almost all of the countries, based on less than 20 annual observations. The estimates of the average Q values ranged from France, 0.67 (1971-1983) to Germany, 2.54 (high estimate, 1966-1980). United States, Japan (high estimate), Germany, Canada, Belgium and Finland are all estimated to have average Q values greater than one. France, United Kingdom and Sweden are estimated to have average Q values less than one.

Chan Lee, J.H (1986) 'Pure Profit Rates and Tobin's Q in Nine OECD Countries', *OECD Economics Department Working Papers*, no. 34, OECD Publishing.

Figure 3.1
Estimates of Average Q



¹² Mihaljevic, J (2009) 'Equities and Tobin's Q', *The Manual of Ideas*, www.manualofideas.com (accessed 10 March 2010).

¹³ Laitner, J. and Stolyarov, D (2003) 'Technological Change and the Stock Market', *American Economic Review*, vol. 93, no. 4, pp. 1240–1267.

¹⁴ Hall, R (2001) 'The Stock Market and Capital Accumulation', *American Economic Review*, vol. 91, no. 5, pp. 1185–1202.

¹⁵ Hodge, A.W. and Corea, R.J., Bureau of Economic Analysis (2009) 'Returns for Domestic Nonfinancial Business', *Survey of Current Business*, May 2009.

The estimates of average Q presented in Figure 3.1 all exhibit broadly the same pattern over time, ie, Q is estimated to have been lowest during the late 1970s early 1980s and then to have peaked in the late 1990s. However, in terms of the absolute values of Q there is significant disparity across the studies, eg, Mihaljevic (2009)¹⁷ estimates that Q was just over 0.4 in 1980, whereas Laitner and Stolyarov (2003)¹⁸ estimate that Q exceeded one in the same year.

These differences ultimately affect estimates of the average Q value. Mihaljevic (2009) and Wright (2004)¹⁹ estimate the average of the Q values was below one for the period 1960-2000. On the other hand, Hall (2001)²⁰ and Laitner and Stolyarov (2003) suggest average of the Q values was at or above one over the same period (table 1).

Table 1 summarises the average values of Q reported in the studies. These Q values have been calculated over the time period in which the five studies overlap, ie, 1960-2000. However, we emphasise again that the short run volatility that can reasonably be expected in estimates of Q means that the estimates of the average of the Q values will be highly dependent on the time period chosen.

Table 3.1
Estimates of the Average Value of Q, 1960-2000

Study	Estimate
<i>Mihaljevic (2009)</i>	0.8
<i>Laitner and Stolyarov (2003)</i>	1.2
<i>Hall (2001)</i>	>1 ^a
<i>Hodge and Corea (2009)^b</i>	
Q1	0.8
Q2	1.0
Q3	0.7
<i>Wright (2004)</i>	<1 ^a

Note: ^a Hall (2001) and Wright (2004) do not publish their underlying data so it is not possible to calculate an average Q value. However, it is clear from visual inspection of the series that the average value of Q would be greater than one (Hall) and less than one (Wright) over the relevant period. ^b Hodge and Corea (2009) present three alternative estimates of Q using different methodologies. The difference between these estimates is discussed in section 3.2.

Some possible explanations for the differences between these estimates are set out in section 3.2 below.

¹⁶ Wright, S (2004) 'Measures of Stock Market Value and Returns for the U.S. Nonfinancial Corporate Sector, 1900-2002', *Review of Income and Wealth*, series 50., no. 4, pp. 561-584.

¹⁷ *Ibid.*

¹⁸ *Ibid.*

¹⁹ *Ibid.*

²⁰ *Ibid.*

3.2. Sources of Difference

Each of the time series estimates in Figure 3.1 utilise data on asset values sourced from the Federal Reserve Board's report: *Flow of Funds Accounts of the United States*²¹ (Flow of Funds report). Data on the replacement cost of structures, equipment and inventories come from the Bureau of Economic Analysis (BEA) *Survey of Current Business* (Survey of Current Business) which forms part of the United States National Accounts collection.

Although the studies identified in Figure 3.1 each utilise largely the same data base, the ways in which the data has been used and the particular series that have been used within that data base do vary. Unfortunately, some of the studies do not provide many details about the way in which calculations have been made. This limits the extent to which the differences between the estimates can be attributed precisely to particular factors. However, based on the information that *is* provided in the studies, the differences in the estimates may have arisen for the following reasons:

- § *Different sectors analysed:* Different studies include different samples of corporations to generate their estimates, for example:
 - the Mihaljevic (2009)²², Wright (2004)²³ and Hall (2001)²⁴ estimates are based on data from nonfarm nonfinancial corporations;
 - the Hodge and Corea²⁵ estimates are for nonfinancial corporations; and
 - Laitner and Stolyarov (2003)²⁶ estimate Q across the corporate sector.
- § *Equity only estimates of market value:* Hodge and Corea's (Q1 estimate) and Wright's 'equity Q' estimates are based on the market value of outstanding equity in the relevant sector. By excluding the value of corporate debt from the calculations, these estimates significantly understate Q. The Flow of Funds data for the nonfinancial nonfarm sector suggests that average gearing (ratio of debt to the value of total capitalisation) was around 30 per cent between 2004 and 2008.²⁷ In other words, if the 'true' Q ratio was one (hypothetically), then an estimate that excluded debt would understate Q by more than one third. A further problem with these 'equity only' Q estimates is that they are subject to variation with the level of gearing of the corporations.
- § *Differences in the technique for estimating the market value of debt:* Most of the studies use the book value of debt in the numerator as a proxy for its market value. However, a true estimate of Q would require debt to be included at its market value. There does not

²¹ Federal Reserve Board Statistical release, Z.1 *Flow of Funds Accounts of the United States*, March 2010.

²² *Ibid.*

²³ *Ibid.*

²⁴ *Ibid.*

²⁵ *Ibid.*

²⁶ *Ibid.*

²⁷ Federal Reserve Board Statistical release, Z.1 *Flow of Funds Accounts of the United States*, March 2010, B.102 Balance Sheet of Nonfarm Nonfinancial Corporate Business.

appear to be any readily available estimates of the market value of the debt burden of the relevant corporations. Hodge and Corea²⁸ (Q3 estimate) appears to be the only study that attempts to estimate the market value of debt. The authors do so by adjusting the book value estimates based on assumptions about the average maturity of issued bonds and the coupon rate at the time of issue. It is unclear whether these estimates are likely to be more or less robust than those based on the book value of debt.

§ *Treatment of land.* To measure the replacement costs of assets, several of the studies use estimates from the *Survey of Current Business* for the replacement cost of structures, equipment and inventories.. Because these estimates exclude land, for consistency, estimates of the market value of land should be excluded from the estimates of the market value of assets. However, it is not clear whether all of the studies have made this adjustment to ensure consistency. Those studies that have not will have inflated the estimate of average Q.

Absent a detailed understanding of the precise calculation undertaken by the authors of each study, it is not possible to say which of the estimates are likely to be the most robust. However, the studies do show that estimates of Q are highly sensitive to the assumptions that are employed in the measurement process. It follows that one should be cautious about placing too much weight on a single study, or set of estimates.

Moreover a number of other factors would also need to be taken into account before any of the empirical estimates of Q could be used to draw conclusions about the empirical relationship between market values and costs. These are described in the following section.

3.3. Interpreting the Estimates

The purpose of this report is to consider whether empirical estimates of Tobin's Q are consistent with the proposition that, over time, asset values in workably competitive markets will reflect their ODRC. It is therefore relevant to consider the extent to which the studies described hitherto are actually measuring the relationship of interest, that is, the relationship between asset values and their ODRC. In many important respects, they do not, for example:

§ *Estimates do not account for intangible assets:* A common criticism of empirical estimates of Q is that they do not include intangible assets (such as goodwill or industry 'know how') in the measure of the replacement costs of assets (eg, Mihaljevic (2009)²⁹; Hall (2001)³⁰). Because intangible assets are likely to be reflected in the market value of firms, their exclusion would have the effect of inflating estimates of Q. There is also a suggestion that the value of intangibles has increased over time relative to book value, leading to an increase in this upward bias (Mihaljevic (2009)).

§ *Estimates do no account for tax treatment of investment:* Another potential problem with empirical measurements of Q is the existence of preferential tax treatment for investment. Chan Lee (1986)³¹ notes that subsidised accelerated depreciation schemes or investment

²⁸ *Ibid.*

²⁹ *Ibid.*

³⁰ *Ibid.*

³¹ *Ibid.*

grants reduce the cost of replacing capital for firms relative to the replacement cost of capital captured by statistical data collections. This has the effect of reducing estimates of Q relative to its 'true' value.

Finally, and perhaps most importantly, given our interest in the empirical relationship between asset values and ODRC, the results are compromised by the fact that the estimates of the replacement cost of capital contained in the studies are not 'optimised'.

The Survey of Current Business estimates of the replacement costs of assets are based on measures of the cost of replacing firms' existing assets (see Box 3.1) rather than ODRC valuations based on the cost of providing the existing service potential of those assets in the most efficient manner. As section 2.3 explained, all other things equal, this will lead to empirical estimates of Q understating the 'true' value of Q, since the denominator is artificially inflated by not making the appropriate allowance for asset optimisation. This will particularly be the case in periods of rapid technological change.

Indeed, a number of studies (Greenwood and Jovanovic (1999)³²; Laitner and Stolyarov (2003)³³) have suggested that the significant 'leaps' in technological progress achieved in the mid 1970s (particularly the development and refinement of the microprocessor) may explain the low estimates of Q for this period. In particular, these studies suggest that the technological advances occurring in this period made much of firms' existing knowledge and capital obsolete and therefore decreased their market value. However, the National Accounts measures of physical capital, based on the costs of replacing historical assets, did not adjust in the short to medium term to reflect this obsolescence.

In contrast, an ODRC valuation of firms' assets would have adjusted downwards contemporaneously with these changes to reflect the fact that goods and services could now be produced in lower cost manner by means of these new technologies. Consequently, empirical estimates of Q during this period (including those estimates summarised in Table 1) are likely to significantly understate Q because they are based on the relationship between market values and the replacement costs of historical assets rather than the ODRC of those assets.

³² Greenwood, J. and Jovanovic, B. (1999), 'The Information-Technology Revolution and the Stock Market', *American Economic Review*, no. 89, vol. 2, pp. 116-22.

³³ *Ibid.*

Box 3.1
Survey of Current Business:
Methods for Estimating the Replacement Cost of Assets

The BEA's estimates of the stocks and depreciation of fixed assets and consumer durable goods form part of the US National Accounts. The BEA values the net stocks and depreciation of fixed assets at historical cost, current cost and real cost.

Historical cost valuations are book value estimates of the value of assets based on the prices prevailing when they were purchased. Historical cost estimates of the net capital stock therefore represent the depreciated values of the historical costs of these assets using the BEA's assumed depreciation patterns

Current cost valuations of net stocks reflect the prices that would have been paid for the assets if they had been purchased in a given year. For example, the estimate of the net stock of equipment and software for 2008 reflects the prices that would have been paid for a physically identical version of those assets if they were purchased in 2008. In principle, these current cost valuations reflect the depreciated replacement value of the stock in a given year.

Current cost estimates of net stocks and depreciation are derived by converting the corresponding constant dollar (real cost) estimates of depreciation and net stocks to the prices of the current period.

Source: Bureau of Economic Analysis (2003), *Fixed Assets and Consumer Durable Goods in the United States, 1925-99*, Washington DC.

4. Conclusion

In workably competitive markets there is a strong 'in principle' relationship between prices, costs and the underlying asset values. Although market fluctuations can result in prices departing from costs, and asset values departing from ODRC, the resulting disequilibria should only be temporary. In the long-run, supply- and demand-side adjustments can be expected to realign prices with the underlying costs of supply, and asset values with their ODRC, such that normal returns are earned by market participants. Tobin's Q model is founded on similar principles. Specifically, although Q may be above or below one at given points in time, in the long run the ratio should trend towards one, since:

- § if the market value of an additional unit of capital exceeds its replacement cost (ie, if marginal $Q > 1$), then the firm is able to increase its value by investing in capital and, similarly, new entry is an attractive proposition to other firms; and
- § when the value to a firm from an additional unit of capital is below its replacement cost (marginal $Q < 1$), then new investment would not be attractive for the firm, and market exit becomes more likely.

A number of studies have estimated values of average Q over extended periods. Although the time series pattern of Q values is similar across the studies, the different assumptions made by the authors have translated into material differences in the absolute values of the estimates. For example, in the five US studies that have measured values of Q over time, estimates of the average value of Q over the period 1960-2000 range from 0.7 to 1.2. Because there are few details of the precise calculations undertaken in a number of the studies, it is not possible to say which of the estimates are likely to be the most robust. However, what is clear is that estimates of Q are highly sensitive to the assumptions that are employed in constructing these estimates.

Given the wide range of values and their sensitivity to the assumptions made, we consider that it is difficult to draw any meaningful conclusions from these studies about the long term empirical relationship between asset values and costs. Moreover, there is a need for particular caution about placing too much weight on a single study or set of estimates, since other studies employing different assumptions may contradict those findings. Compounding these difficulties is the fact that there are a number of problems associated with the construction of the estimates — including the fact that the replacement cost estimates are not optimised — that limit their usefulness for understanding the relationship between asset costs and values.

Finally, it should be noted that the results of some of the studies described above seem counterintuitive. For example, if the market value of corporate securities was truly consistently less than the replacement costs of firms' inventory, plant and equipment (ie, if Q averaged less than one), this implies that stock markets are systematically undervaluing the businesses in those sectors over the periods in question. This would also imply that businesses in those sectors could achieve higher returns by running down their assets, or exiting the market. Neither implication seems plausible.

Perhaps instructively, these unusual results have not produced any widespread reaction or questioning of the Q theory in the economics literature.

In consequence, we do not consider that the available empirical studies in any way invalidate the conclusion articulated in our earlier report that in workably competitive markets asset values will reflect their ODRC over time.

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