Bela Enterprises

Comment on the Auckland Airport Input Methodologies Submission

Report Produced for the New Zealand Commerce Commission

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1. Definitions of Terms

AIAL	Auckland Airport
AIAL Report	Input Methodologies Review – response to Process and Issues Paper dated 11 July 2022
COVID-19 period	The period during which the border was closed to foreign international travellers.
First historical five-year period	The five years of historical data that immediately precede that start of the *new input period*.
New input period	The period that the revised inputs will be used for regulatory purposes.
Non-COVID-19 period or *normal period*	The period when the border is not closed, and international travel is not restricted.
NZCC	New Zealand Commerce Commission
Second historical five-year period	The five years of historical data immediately precede the start of the *first historical five-year period*.

2. Introduction

1. The Commerce Commission (i.e., *NZCC*) has asked us to provide feedback on two components of the *AIAL* submission "*Input Methodologies Review – response to Process and Issues Paper*" dated 11 July 2022 (i.e., the *AIAL Report*).

2. The first element is how to handle stock market data from the period that was impacted by COVID-19 in the beta estimation process.

3. The second element relates to the systematic risk of aeronautical services relative to the systematic risk of other airport activities and the appropriateness of the current approach of adjusting airport asset betas by -0.05 to arrive at an asset beta estimate for aeronautical services.

4. We devote a separate section of this report to each issue.

5. We have been asked to suggest possible empirical approaches, rather than to test these approaches using data.

3. The Impact of COVID-19 Period Data

3.1. Background

6. Asset and equity betas are unobservable, so an estimation approach is required. The standard approach is to first estimate the equity beta and then adjust for leverage to arrive at an asset beta estimate.

7. The basic market model involves estimating a firm's equity beta by regressing the firm's excess returns on the excess returns of a representative market index.

8. However, it is well-documented that incorporating information from peer firm asset betas results in a superior estimate of the asset beta of the firm in question.

9. There is no theoretical basis for the choice of data frequency or estimation period length when estimating betas. Betas can be expected to vary over time so using the most recent data is desirable. However, small samples can result in estimation error, and data become noisier at higher frequencies so there is a trade-off.

10. The *NZCC* takes steps to address the issues raised from both cross-sectional and time series perspectives.

11. The *NZCC* estimates asset betas for comparable airports around the world including *AIAL* and assumes that the average asset beta from this comparator sample is the asset beta that applies to *AIAL*. It is more common in the academic literature to use a formula that "shrinks" the beta estimate for a particular firm towards the average beta estimated for peer firms based on metrics such as size and/or industry (e.g., Vasicek, 1973; Karolyi, 1992). However, the *NZCC* approach has the advantage of giving more transparency as to the impact of each of the comparator firms.

12. The *NZCC* approach involves estimating four-weekly equity betas based on monthly returns for each trading day of the month in the most recent five years of historical data (i.e., the *first historical five-year period*). The next step is to adjust for leverage and calculate the asset beta. The four-weekly asset beta estimates are then averaged to generate the overall four-weekly asset beta estimate for the period. This process is then repeated based on weekly returns for each day of the week in the *first historical five-year period*. The weekly asset beta estimates are then averaged to generate the overall weekly asset beta estimate for the period. These estimation processes are repeated for the previous five-year period (i.e., the *second historical five-year period*). The four asset betas (weekly and four-weekly for each of the two periods) are then averaged to form an overall asset beta.

13. We believe that the *NZCC* approach is defendable and consistent with the key themes of the equity beta estimation literature. However, we are not aware of research that finds that the specific *NZCC* approach is superior to alternative approaches, such as using four-weekly returns only and/or using data for the *first historical* five-year period only.[1] Established techniques in the academic literature compare equity beta estimates from various estimation approaches with the equity beta calculated for a subsequent period to determine which one is superior (e.g., Welch, 2022).

14. We make suggestions in the next section that we believe are compatible and with the *NZCC* approach, rather than advocating methods that result in major changes to the *NZCC* framework.

15. We also attempt to strike a balance between rigour and pragmatism with our recommendations. Where more complexity is justified, we advocate for it, but where a simpler approach is adequate, we recommend it.

16. We assume that the 2023 Input Methodology Update will involve asset betas being estimated for application in the April 2023 – March 2028 period (i.e., the *new input period)*. This means that the *first historical five-year period* is defined as starting in April 2018 and ending in March 2023 and the *second historical*

[1] Marshall, Nguyen, and Visaltanachoti (2021) test the efficacy of a range of equity beta estimation techniques using New Zealand data. As part of this analysis, they include an equity beta estimated using five years of monthly data, averaged across all days in the month. However, this differs from the *NZCC* equity beta estimation approach in three important ways. First, no weekly data are included. Second, data from the *second historical five-year period* are not included. Third, no comparator firm equity betas are calculated.

five-year period ranges from April 2013 to March 2018. However, while we use these dates in our report, our recommendations remain if different dates are used.

17. The *AIAL Report* recommends using an asset beta estimate based on the *NZCC* established approach, with no adjustment for any possible influence of COVID-19 on the asset beta estimate. There is a recommendation to make minor adjustments to the comparator firm sample, but this is beyond the scope of our engagement, so we do not comment on this.

3.2. Testing Whether COVID-19 Data Result in Abnormal Asset Betas

18. We suggest that the objective should be to estimate the asset beta that is most likely to prevail in the *new input period*.

19. Given this objective, and the fact that the current approach involves estimating asset betas using a period including COVID-19, the first step is to determine whether COVID-19 has resulted in abnormally high asset betas.

20. The *AIAL report* calculates asset betas for two five-year periods. The first is the five years ending March 2017 and the second is the five years ending March 2022. The average asset beta for the first period is 0.67, and the average asset beta for the second period is 0.86.

21. The asset beta reported for the second period, which includes COVID-19, appears to be materially higher than the asset beta reported for the first period. However, this does not necessarily mean that COVID-19 has caused a statistically significant increase in asset beta.

22. The standard approach for estimating equity beta is to use the following CAPM model:

$$R_t = \alpha_t + \beta_t^{EQUITY} * M_t + \varepsilon_t \quad (1)$$

where R_t denotes excess airport returns, M_t denotes excess market returns, and β_t^{EQUITY} is the equity beta. Assuming the debt beta is zero, the asset beta is the equity beta adjusted for leverage as per Eq. (2):

$$\beta_t^{ASSET} = \beta_t^{EQUITY} * (1 - L_t) \quad (2)$$

We can rearrange Eq. (2) as follows:

$$\beta_t^{EQUITY} = \beta_t^{ASSET} * [\ 1 / (1 - L_t)\ ] \quad (3)$$

where L_t is the ratio of net debt to the sum of net debt and market capitalisation.

Let LF_t be the leverage factor and equal to $1 / (1 - L_t)$, Eq. (3) then becomes:

$$\beta_t^{EQUITY} = \beta_t^{ASSET} * LF_t \quad (4)$$

Substituting Eq. (4) into Eq. (1) gives us:

$$R_t = \alpha_t + \beta_t^{ASSET} * LF_t * M_t + \varepsilon_t \quad (5)$$

The conditional beta literature (e.g., Ferson and Schadt, 1996) provides a framework that allows the beta to be a varying function of the other factors. We employ this principle and allow the asset beta and intercept to be time-varying with the *COVID-19 period* as follows:

$$\beta_t^{ASSET} = \beta_0 + \beta_1 * D_t \quad (6)$$

$$\alpha_t = \alpha_0 + \alpha_1 * D_t \quad (7)$$

where D_t is the dummy variable that equals 1 for the *COVID-19 period* and 0 otherwise. Note details of the *COVID-19 period* are discussed in points 27–30 in this report.

If we substitute Eqs. (6) and (7) into Eq. (5), we have:

$$R_t = \alpha_0 + \alpha_1 * D_t + \beta_0 * LF_t * M_t + \beta_1 * D_t * LF_t * M_t + \varepsilon_t \quad (8)$$

23. We extend Eq. (8) to include all airport firms in the comparator sample to arrive at a panel regression approach as follows:

$$R_{i,t} = \alpha_1 * D_{i,t} + \beta_0 * LF_{i,t} * M_{i,t} + \beta_1 * D_{i,t} * LF_{i,t} * M_{i,t} + \delta_i + \lambda_t + \varepsilon_{i,t} \quad (9)$$

where subscripts i and t denote the cross-sectional and time-series dimensions, respectively. δ_i and λ_t are added in the regression model to denote firm and year fixed effects, respectively. Note that the α_0 is absorbed by the fixed effects.

24. The main objective of Eq. (9) is to test whether β_1=0. If this null hypothesis is rejected, it implies that the *COVID-19 period* affects the systematic risk. We rationalise the significance threshold for this hypothesis and the subsequent decision on asset beta adjustment in more detail in Section 3.3.

25. There are several important considerations when applying the above methodology. First, as suggested in Eq. (9), the panel regression should be run with the firm and year fixed effects and standard errors adjusted for clustering by firm and year. The firm fixed effect, δ_i, controls for the effects of omitted variables that are time-invariant for each firm (e.g., country-specific variables). The year-fixed effect, λ_t, controls the effects of omitted variables that are firm-invariant for each year, i.e., affecting all sample firms in the same year (e.g., global economic variables). Without the fixed effects, the presence of an omitted variable problem in the regression estimation will lead to biased coefficient estimates.

26. Although an alternative is to estimate Eq. (8) for each firm in the sample independently and test the significance of β_1 for each comparator sample firm, this alternative approach is less rigorous and complicates the assessment of COVID-19 abnormality due to the involvement of multiple β_1 estimates.

27. The second consideration involves the choice of the period that was impacted by COVID-19. We recommend that the *COVID-19 period* should be identified as the period during which airport activities were severely affected due to travel restrictions such that their stock-market return relationship was believed to be significantly distorted.

28. There are two approaches to specify the period impacted by COVID-19 for *AIAL* and each comparator firm. First, a New Zealand period could be defined and applied to all sample firms. Second, the period could be defined separately for each country represented in the *AIAL* and comparator sample firms. The first method is simple and less time-consuming, but it may introduce errors in identification. The second approach is less prone to identification errors but more time-consuming. We recommend the second approach.

29. There are at least two possible alternatives to the specification of the period that New Zealand was impacted by COVID-19. First, it could include days when

Alert Level 4 (lockdowns) were imposed.[2] Second, it could cover the entire period during which New Zealand closed its border to foreign international travellers, i.e., from 19 March 2020 to 27 February 2022.[3] We recommend the *COVID-19 period* is defined using the second approach.

30. The third consideration relates to the specification of the *non-COVID-19 period* or the *normal period*. A longer data period that includes older data may be less relevant whereas more recent but shorter data can reduce the power of statistical tests. Given the widespread presence of COVID-19 over the recent five-year period, we believe it is advisable to use a longer data series and start at the first month of the *second historical five-year period*. Therefore, we recommend that the *non-COVID-19 period* starts from April 2013.

31. Monthly data are widely used in empirical research as they are less noisy than higher-frequency data (e.g., Gilbert, Hrdlicka, Kalodimos, and Siegel, 2014). However, for single stock analysis, monthly data can have the limitation of insufficient observations. Therefore, we recommend using monthly return data for a panel of firms including *AIAL* and its comparator firms. We acknowledge that this method based on end-of-month returns in a panel regression deviates from the *NZCC*'s approach of also estimating asset betas based on monthly returns for other days of the month. However, we believe our recommended approach is straightforward and sufficient for this aspect of the analysis. Furthermore, we recommend using end-of-month leverage.

3.3. The Treatment of COVID-19 Data

32. We believe that the approach of adjusting asset betas for different events should be used sparingly. The bar should be high for three reasons. First, there is subjectivity in identifying possible periods to test for their abnormality. Second, there is noise involved in determining whether a particular period is statistically abnormal. Third, it is difficult to avoid an element of subjectivity when making the adjustment following the identification of an abnormal period.

[2] https://covid19.govt.nz/about-our-covid-19-response/history-of-the-covid-19-alert-system/#:~:text=A%20State%20of%20National%20Emergency,Island%20and%20other%20offshore%20islands.
[3] https://covid19.govt.nz/news-and-data/latest-news/new-zealand-border-to-reopen-in-stages-from-27-february/; https://www.immigration.govt.nz/about-us/media-centre/news-notifications/nz-border-fully-reopening-july-2022.

33. To reduce the above potential biases, we suggest that the period being checked for abnormality (in this instance the *COVID-19 period*) should be statistically significantly different from the *normal period* at the 1% level.

34. If this threshold is not reached, we suggest ruling out the possibility that the *COVID-19 period* has significantly distorted the airports' asset beta estimate. Hence, we recommend the estimated asset beta for the *first historical five-year period* to be used as part of the input methodologies review for the *new input period*.

35. Even if the asset beta from the *COVID-19 period* is statistically significantly different to the asset beta from the *normal period* at the 1% level, it does not necessarily mean that an adjustment is required.

36. For example, New Zealand closed its border to foreign international travellers approximately 700 days out of the *first historical five-year period*. This means the *COVID-19 period* represents approximately 39% of this period. Under the current *NZCC* framework, the average of weekly and four-weekly asset betas from this period and the *second historical five-year period* is calculated. The *COVID-19 period* data, therefore, influence approximately 19.5% of the total data for the final asset beta estimate.

37. It then follows that if COVID-19 border closure is expected to occur in 19.5% of the *new input period* (approximately one year), no adjustment should be made to the estimated asset beta of the *first historical five-year period*. This is consistent with the objective stated in point 18.

38. We do not have any training in epidemiology. However, we believe that it is unlikely that politicians will introduce similar border closures in the *new input period*. In December 2022 COVID cases reached 6,099 per week, which is likely an understatement given the lack of reporting, yet no lockdown was mentioned.[4] By way of comparison, COVID cases were less than 50 per day when the first lockdown started.[5]

39. Given the above, we recommend that an adjustment should be made to the asset beta estimation if it is proven that the *COVID-19 period* is associated with

[4] https://www.health.govt.nz/covid-19-novel-coronavirus/covid-19-data-and-statistics/covid-19-current-cases
[5] https://covid19.health.nz/advice/covid-19-data?_ga=2.54138088.1531776571.1671582443-708425402.1669932219

abnormally high asset betas and that similar border closure are not expected in the *new input period*.

40. If so, there are several alternatives regarding the periods to be used for recalculating the asset beta estimates based on the *NZCC* weekly and four-weekly approach.

    a. First, the asset beta estimation could ignore the *first historical five-year period* and be solely based on the *second historical five-year period*.

    b. Second, asset betas for the *first historical five-year period* could be re-estimated excluding the *COVID-19 period* and averaged with the asset beta from the *second historical five-year period*.

    c. Third, the asset beta estimation can be based on the eight years of data from the *first historical five-year period* and the *second historical five-year period* excluding the *COVID-19 period*.

41. We recommend using the third option because it includes more recent data than the first option, and it contains more observations for the regression analysis than the second option.

3.4. Key Conclusions

42. The asset beta estimate for the *new input period* should reflect the systematic risk prevailing during that period.

43. Given the inclusion of the *COVID-19 period* in the estimation process, we recommend that a rigorous but pragmatic statistical technique is applied to evaluate whether that period has affected asset beta estimates.

44. If no abnormal impact is detected, asset beta estimates from the *first historical five-year period* do not need any adjustment and can be used, together with asset beta estimates from the *second historical five-year period*, to derive the final asset beta.

45. If an abnormal impact is found for the *COVID-19 period*, further information is required as follows:

a. If border closures are expected to be imposed to a similar extent as in the *first historical five-year period*, again no adjustment to the estimated asset betas is required. This is based on the expectation that the stock-market return relationship will continue to be affected in a similar manner.

b. If similar border closure is not expected in the *new input period*, we recommend using the asset betas estimated solely from data in the *first historical five-year period* and the *second historical five-year period* that do not include the *COVID-19 period* to derive the final asset beta for the *new input period*.

4. Aeronautical Asset Beta

4.1. Background

46. The *NZCC*'s current practice is to apply a 0.05 downward adjustment to the airport's asset beta to arrive at the aeronautical asset beta. This implies that the systematic risk is lower for the aeronautical (hereafter aero) business than for the non-aeronautical (hereafter non-aero) business.

47. The systematic risks of aero- and non-aero businesses are unobservable and require a model to estimate their asset betas from observable information.

48. Ideally, the model should be able to estimate the systematic risk of the non-aero business and compare it with that of the aero business. The required inputs include the non-aero and aero business returns so the systematic risk of each business can be calculated.

49. Unfortunately, non-aero and aero business stock returns are unobservable. Certain assumptions are required to estimate non-aero and aero business returns, and these could lead to substantial estimation errors. Therefore, any further analysis would produce an unreliable conclusion.

50. The *AIAL Report* argues that there is no evidence of the *AIAL* aero business having lower systematic risk than the non-aero business. This conclusion is drawn from three analyses based on revenues, expenses, and income per passenger (IPP).

51. In the first analysis, the *AIAL Report* shows that the impact of COVID-19 on revenues and expenses of the aero business is "broadly in line with the total company impact". Details of the results are in the *AIAL Report* Attachment A page 5.

52. The second analysis is based on the regression below:

$$\text{IPP-non-aero}_t = \beta_0 + \beta_1 \text{Traffic}_t + \beta_2 \text{Time}_t + \upsilon_t$$

where IPP-non-aero_t is the monthly *AIAL* non-aero income per passenger. Traffic_t is the *AIAL* traffic volume. Time_t is a time variable. The results show that non-aero income is inversely related to traffic volume (β_1 is negative and statistically significant). Details of the results are reported in the *AIAL Report* Attachment A page 6.

53. The third analysis is based on the regression below:

$$\beta_i^{\text{ASSET}} = \alpha_0 + \alpha_1 \text{Non-aero-revenues-share}_i + \varepsilon_i$$

where β_i^{ASSET} is the airport's asset beta. $\text{Non-aero-revenues-share}_i$ is the proportion of the non-aero business revenues to the total revenues of the airport using revenue shares from financial year 2019. The results show that for the 2016–2021 period, there is an inverse relationship between the airport's asset beta and the non-aero-revenues-share (α_1 is negative and statistically significant). However, for the 2011–2016 period, such a relationship does not exist (α_1 is not statistically significant). Details of the results are shown in the *AIAL Report* Attachment A page 7.

54. The three analyses above raise two concerns. First, the *AIAL Report* does not provide evidence that revenues, expenses, or IPP are associated with *AIAL* systematic risk. Also, we are not aware that such evidence exists, either in the *AIAL Report* or the research literature.

55. Second, in the third analysis in the *AIAL Report*, there is a lack of sufficient control for other effects that could affect the systematic risk. Research (e.g., Karolyi, 1992) documents that systematic risk varies due to the unique circumstances of companies. Therefore, omitted variables could lead to biased coefficient estimation.

4.2. Comparing Aeronautical and Non-Aeronautical Asset Betas

56. We propose a panel regression model between asset beta and non-aero business earnings share (details are in point 61 below) to evaluate whether the aero asset beta is significantly different from the non-aero asset beta. Our model addresses the two concerns identified in the previous section.

57. For the first concern, there are several reasons why earnings, not revenues, affect the firm's valuation, which in turn affects its expected return and systematic risk.

    a. First, one of the most important theories in stock valuation is the dividend discount model. The dividend is the proportion of earnings paid out to shareholders (e.g., Ohlson, 1995).

    b. Second, earnings influence stock returns. Several researchers show that stock returns respond to earning announcements (e.g., Chambers and Penman, 1984).

    c. Third, earnings lead to a change in book value. The ratio of book value to market value or the book-to-market ratio correlates with and predicts stock returns (e.g., Fama and French, 1992).

    d. Fourth, earnings are commonly used via the price-to-earnings ratio in comparative valuation (e.g., Ellahie, 2021). Stock returns positively correlate with both earnings levels and the price-to-earnings ratio (e.g., Easton and Harris, 1991).

    e. Fifth, the equity beta estimated from earnings, i.e., the earnings beta, can be used as a proxy for the systematic risk (e.g., Ellahie, 2021).

58. In summary, earnings contain relevant information about systematic risk, so the earnings of airport business segments are a more appropriate proxy for their systematic risk than revenues.

59. Many airports do not report earnings splits between aero and non-aero business segments. Therefore, to calculate the earnings contribution of non-aero business segments, we propose the use of the revenue splits from each segment and the industry average net profit margins for firms operating in the same segment. Peer firms should be chosen from NZ for AIAL and the same country for as each of the comparator firms.

60. For example, assume an airport has the three non-aero business segments of retail, parking, and property. The retail business earnings can be estimated by the proportion of retail revenues multiplied by the retail industry average net profit margin in the same country. The same approach can be applied to calculate the earnings of parking and property businesses. Each year, the non-aero earnings share is the sum of the retail, parking, and property earnings divided by the total airport earnings.

61. The standard approach for estimating equity beta is to use the following CAPM model:

$$R_t = \alpha_t + \beta_t^{EQUITY} * M_t + \varepsilon_t \quad (10)$$

where R_t denotes excess airport returns, M_t denotes excess market returns, and β_t^{EQUITY} is the equity beta. Assuming the debt beta is zero, the asset beta is the equity beta adjusted for leverage as per Eq. (11):

$$\beta_t^{ASSET} = \beta_t^{EQUITY} * (1 - L_t) \quad (11)$$

We can rearrange Eq. (11) as follows:

$$\beta_t^{EQUITY} = \beta_t^{ASSET} * [\ 1 / (1 - L_t)\ ] \quad (12)$$

where L_t is the ratio of net debt to the sum of net debt and market capitalisation.

Let LF_t be the leverage factor and equal to $1 / (1 - L_t)$, Eq. (12) then becomes:

$$\beta_t^{EQUITY} = \beta_t^{ASSET} * LF_t \quad (13)$$

Substituting Eq. (13) into Eq. (10), gives us:

$$R_t = \alpha_t + \beta_t^{ASSET} * LF_t * M_t + \varepsilon_t \quad (14)$$

The conditional beta literature (e.g., Ferson and Schadt, 1996) provides a framework that allows the beta to be a varying function of the other factors. We employ this principle and allow the asset beta and intercept to be varying with the non-aero-earnings-share as follows:

$$\beta_t^{ASSET} = \beta_0 + \beta_1 * \text{Non-aero-earnings-share}_t \quad (15)$$

$$\alpha_t = \alpha_0 + \alpha_1 * \text{Non-aero-earnings-share}_t \quad (16)$$

where non-aero-earning-share$_t$ is the proportion of the earnings of the non-aero business to the total earnings of the airport.

If we substitute Eqs. (15) and (16) into Eq. (14), we have:

$$R_t = \alpha_0 + \alpha_1 * \text{Non-aero-earnings-share}_t + \beta_0 * LF_t * M_t + \beta_1 * \text{Non-aero-earnings-share}_t * LF_t * M_t + \varepsilon_t \quad (17)$$

62. We extend Eq. (17) to include all airport firms in the comparator sample to arrive at a panel regression approach as follows:

$$R_{i,t} = \alpha_1 * \text{Non-aero-earnings-share}_{i,t} + \beta_0 * LF_{i,t} * M_{i,t} + \beta_1 * \text{Non-aero-earnings-share}_{i,t} * LF_{i,t} * M_{i,t} + \delta_i + \lambda_t + \varepsilon_{i,t} \quad (18)$$

where subscripts i and t denote the cross-sectional and time-series dimensions, respectively. δ_i and λ_t are added in the regression model to denote firm and year fixed effects, respectively. The non-aero-earnings-share is the same for all months in the same financial year. Note that the α_0 is absorbed by the fixed effects. Similar to Eq. (9), we recommend using end-of-month return and leverage data to estimate Eq. (18).

63. The panel regression in Eq. (18) is run with firm (δ_i) and period (λ_t) fixed effects and standard errors clustered by firm and period. The firm fixed effect, δ_i, controls for the effects of omitted variables that are time-invariant for each firm (e.g., country-specific variables). The year-fixed effect, λ_t, control the effects of omitted variables that are firm-invariant for each year, i.e., affecting all sample firms in the same year (e.g., global economic variables). Without the fixed effects, the presence of an omitted variable problem in the regression estimation will lead to biased coefficient estimates.

64. The sample period in the Eq. (18) regression should be consistent with that in Section 3.3.

65. There are three possible outcomes from this regression analysis.

a. First, the estimated coefficient β_1 from the Eq. (18) regression is positive and statistically significant, suggesting that the asset beta for non-aero businesses is higher than that of aero businesses. This evidence supports the current practice of assigning a lower aero asset beta.

b. Second, the estimated coefficient β_1 from the Eq. (18) regression is negative and statistically significant, suggesting that the non-aero asset beta is lower than the aero asset beta. This evidence indicates that a downward adjustment of the aero asset beta is not justified.

c. Third, the estimated coefficient β_1 from the Eq. (18) regression is statistically insignificant, suggesting no difference between the aero and non-aero asset betas. This result implies the downward adjustment of the aero asset beta may not be justified.

66. We recommend using the 5% level for the statistical significance test as per convention. We suggest using the 1% level to evaluate the COVID-19 impact on the systematic risk given that the high hurdle is appropriate as explained in point 32. However, we believe that the 5% level is appropriate in this instance.

67. If the net profit margin for the aero business segment equals the average net profit margins (weighted by the revenue splits) across the non-aero business segments, the aero/non-aero revenue split is the same as the earnings split. The revenue share therefore can be used as a proxy for the earnings share in subsequent analysis. If they are not the same, earnings should be calculated. We believe it is unlikely that the profit margin is the same across aero and non-aero business segments. Damodaran provides net profit margins for various industries and documents considerable variation.[6]

68. Note that we recommend the regression in Eq. (18) be used for evaluating whether a downward adjustment of the aero business systematic risk is statistically justified. If such an adjustment is required, a decision around the magnitude of this adjustment would require careful consideration.

4.3. Key Conclusions

69. The aero asset beta should not be adjusted downward if it is proven that the systematic risk of the aero business is not lower than the systematic risk of the other airport activities.

[6] https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

70. The three analyses on the non-aero asset beta in the *AIAL Report* have two issues. First, no evidence that revenue reflects systematic risk is provided. Second, the regression analysis is potentially biased due to the lack of control for the possibility of the asset beta varying across firms and time periods.

71. Given extensive evidence suggests that earnings relate to stock returns and systematic risk, we recommend using non-aero earnings shares derived from industry net profit margins to estimate the earnings of non-aero business segments.

72. A fixed-effect regression model between airport asset betas and the non-aero earnings shares should be used to test the validity of the aero asset beta adjustment. Including firm and year fixed effects addresses the potential omitted variable bias.

73. The aero asset beta downward adjustment is required if airport asset betas show a positive and significant association with non-aero earnings shares. Otherwise, the aero asset beta downward adjustment may not be appropriate.

5. References

Chambers, A.E., & Penman, S.H. (1984). Timeliness of reporting and the stock price reaction to earnings announcements. *Journal of Accounting Research*, 22(1), 21-47.

Easton, P., & Harris, T. (1991). Earnings as an explanatory variable. *Journal of Accounting Research*, 29(1), 19–36.

Ellahie, A. (2021). Earnings beta. *Review of Accounting Studies*, 26(1), 81-122.

Fama, E.F., & French, K.R. (1992). The cross-section of expected stock returns. *Journal of Finance*, *47*(2), 427-465.

Ferson, W.E., & Schadt, R.W. (1996). Measuring fund strategy and performance in changing economic conditions. *Journal of Finance*, *51*(2), 425-461.

Gilbert, T., Hrdlicka, C., Kalodimos, J., & Siegel, S. (2014). Daily data is bad for beta: Opacity and frequency-dependent betas. *Review of Asset Pricing Studies*, 4(1), 78-117.

Karolyi, G.A.. (1992). Predicting risk. Some new generalizations. *Management Science*, 38, 57–74.

Marshall, B.R, Nguyen, N.H., & Visaltanachoti, N. (2021). Beta estimation in New Zealand. *Pacific-Basin Finance Journal*, 70, 101671, 1–12.

Ohlson, J.A. (1995). Earnings, book values, and dividends in equity valuation. *Contemporary Accounting Research*, 11(2), 661-687.

Vasicek, O. (1973). A note on using cross-sectional information in Bayesian estimation of security betas. *Journal of Finance*, 28, 1233–1239.

Welch, I. (2022). Simply better market betas. *Critical Finance Review*, 11(1), 37-64.