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Administrative Intensity and Financial Sustainability: An Empirical Analysis of the Australian Public University System

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ABSTRACT

However, to date no attempt has been made to investigate the impact of administrative intensity on financial sustainability in the university sector. To address this gap in the literature, this paper examines the impact of administrative intensity on financial sustainability in Australian universities over the period 2009/10 to 2018/19. Our findings show that administrative intensity significantly affects the financial sustainability of Australian universities in a U-shaped form. Moreover, significant differences exist between the different categories of university in the association between administrative intensity and financial sustainability. The paper concludes with a brief discussion of its broader policy implications.

KEYWORDS

Administrative intensity; Australia; financial sustainability; higher education

Introduction

In higher education systems worldwide, universities face enduring financial problems including increasing costs (Akin & Vlad, 2011; Alshubiri, 2021; Mamat et al., 2021). These financial problems have inhibited the performance of universities across a range of different objectives. Accordingly, higher education policymakers have sought to determine the nature of these problems and develop remedial policy intervention (Martiz & Fourie, 2015). In this regard, Alshubiri (2021, p. 79) has observed that "financial sustainability is determined by the financial constraints of a country; the amount of expenditure allocated to higher education; and the assessment of needs based on established priorities". This underlines the critical importance of understanding the pillars of financial performance in higher education (Pedersen et al., 2017).

Over recent years, public universities across the globe have witnessed radical changes arising from modifications in public funding, as well as demands for improved performance and greater accountability (Edgar & Geare, 2013; Parker, 2013). These forces have spawned an ongoing financial crisis in many university systems due to spiraling costs, higher enrollments and reduced government funding (Afriyie, 2013; Argento et al., 2020; Mamat et al., 2021; Odzil & Hoque, 2017; Parker, 2013; Wolff et al., 2014). In these circumstances, financial sustainability is critical in ensuring the long run viability of a university system (Alshubiri, 2021). It is thus surprising that the scholarly literature has largely overlooked numerous factors that might affect financial sustainability in universities, including administrative intensity. This oversight is even more surprising given ongoing unfavorable commentary in the popular press on the perils of "bureaucratic bloat" in contemporary universities. For example, the Financial Times (2022) reported that "while criticism of expanding ranks of middle management and excessive red tape is familiar among employees in almost any organisation, concern is rising in universities about the distinctive phenomenon of what might be called 'academic bloat,' which raises fears about undermining the very purpose and operation of higher education." Similarly, Bloomberg (2023) suggested that American universities should focus on downsizing middle management, restructure administrative processes and concentrate on core competences like teaching. While the overhead costs of administration should exhibit economies of scale when total student enrollment increases, this has generally not happened in higher education institutions (Johnson, 2018). Accordingly, if major agency problems exist in universities, they would contribute to "university bloat" (Johnson, 2020). The present paper seeks to address this gap in the empirical literature on higher education by examining the impact of administrative intensity on financial sustainability.

Administrative intensity refers to the administrative costs involved in controlling and managing an organization (Boyne & Meier, 2013). Considerable conceptual

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attention has been invested in the factors underlying the degree of administrative intensity in organizations, especially in the public choice theory literature (Piano, 2019), Johnson (2020, p. 16) has argued that "universities have major agency problems among their top administrators who appear to be protecting their own class at the costs of their institutions". Following public choice theory, "the self-interest of bureaucrats, often through their budget maximizing approaches", contributes to bloat'. To date, the empirical literature has found that administrative intensity can improve organizational performance largely through improved coordination in its operations (Adler & Borys, 1996; Van Helden & Huijben, 2014; Walker, 2013). However, empirical work has also established that administrative intensity can inflict a "bureaucratic burden" on organizations by relocating scarce resources from frontline service delivery to "back-office" administration. Accordingly, a high degree of administrative intensity can diminish organizational performance (Boon & Verhoest, 2014; Peters, 2001). Against this background, the present paper seeks to contribute to the empirical literature by investigating how administrative intensity affects financial sustainability in the Australian public university sector.

In the higher education literature, financial sustainability is usually described as the ability of universities to fully recover economic costs and continue to develop infrastructure (physical, human and intellectual capital) to maintain a sufficient productive capacity (Pedersen et al., 2017). Under this definition, ongoing financial sustainability can be achieved through adequate liquidity, sufficient asset quality and the sound management of operational and financial risk (Baldacci et al., 2008; Maruna et al., 2018). The internal organizational characteristics of universities are also likely to be important, including administrative intensity, as proxied by administration costs.

The present paper aims to address this question by investigating the relationship between administrative intensity and financial sustainability in the institutional milieu of the Australian higher education system. Using a multiple regression model in a pooled data framework for the period 2009/10 to 2018/19, we examined the relationship between administrative intensity and financial sustainability for 37 Australian public universities. We then investigate whether the relationship between administrative intensity and financial sustainability differs significantly between types of public university.

The paper is divided into seven main parts. Section 2 offers a synoptic review of the empirical literature on administrative intensity and financial sustainability. This is followed by the development of hypotheses on the relationship between administrative intensity and financial sustainability in Section 3. Section 4 briefly describes the Australian higher education system to illuminate the institutional context of our study. Section 5 outlines the empirical strategy followed in the paper whereas Section 6 presents the empirical findings of the estimation procedures employed. Section 7 considers the results of the modeling exercise. The paper ends with some brief concluding comments in Section 8.

Scholarly perspectives on financial sustainability and administrative intensity

Section 2 presents a brief review of the scholarly literature on financial sustainability in public organizations in general and higher education in particular. This is followed by a discussion of the literature on administrative intensity and its impact on organizational performance by way of theoretical background for our hypothesis development on the relationship between administrative intensity and financial sustainability in Section 3.

Financial sustainability in higher education

The term "sustainability" plays a pivotal role in contemporary public policy discourse, including in higher education policymaking (Jurewicz, 2018). Financial sustainability has also attracted considerable attention in the higher education literature (Ahmad et al., 2019; Mamat et al., 2021). In its generic sense, financial sustainability refers to "the ability to meet service delivery and financial commitments both now and in the future, applying current policies and maintaining them in the future without causing debt to rise continuously" (Navarro-Galera et al., 2016, p. 3961). In higher education, the empirical literature has considered various dimensions of financial sustainability. For example, Baldacci et al. (2008) and Maruna et al. (2018) examine the foundations of financial sustainability in terms of adequate capital and liquidity, good asset quality and sound operational and financial risk management. In general, financial sustainability refers to as the process of creating, allocating and using funds to achieve ongoing solvency in the long term and efficiently managing expenditure to enhance financial health (Rymanova, 2010; Stanislavchik, 2010), a capacity to meet current liabilities (Kharlamova & Sazonov, 2014), and the creation of investment attractiveness (Ghosh, 2019).

In recent years, higher education has faced major challenges in maintaining financial sustainability in terms of "a response to the new public management-oriented developments in the public sector, especially

with respect to marketisation" (Narayan & Stittle, 2018, p. 505). The "marketisation" of universities has reinforced the commodification of academic education in terms of competitive student fees (Brown, 2010; Mamat et al., 2021). It has been argued that mass higher education has imposed cost pressures on universities, especially when enrollments have risen rapidly, thereby exceeding governments' ability to pay. Expanding class sizes, increasing academic teaching loads and dropping low priority teaching programs have often been adopted as universities react to increasing cost pressures (Altbach et al., 2009; Parker, 2013). Universities have also been pressured to seek alternative sources of funding, optimize resource utilization, compete for research grants and reduce dependency on public funding (Johnson & Hirt, 2011; Parker, 2013).

In recent years, research interest in financial sustainability in higher education has increased substantially across a broad front, including financial health (Mohanlingam & Nguyen, 2013), financial efficiency (Tran & Villano, 2021), corporatization (Parker, 2011), research commercialization (Narayan & Stittle, 2018) and marketization (Molesworth et al., 2010). Parker (2012) has argued that a process of global marketization has seen universities shift their mission from a discourse on knowledge to prioritizing revenue diversification. This argument has been buttressed by recent studies on university support for various revenue diversification and cost-efficiency initiatives (Ahmad et al., 2019; Irvine & Ryan, 2019). In addition, Alshubiri (2021) argued that "failure to cover the costs of higher education through revenues generated from higher education operations may lead to the closure of many colleges and universities and the collapse of higher education altogether." Moreover, inadequate financial management skills on the part of university administrators have led to the incompetent management of "expenses and revenues in higher education" (Alshubiri, 2021, p. 79).

In general, although the empirical analysis of financial sustainability in the university sector has shed light on numerous dimensions of the problem, little is known about the impact of administrative costs on the financial sustainability of universities. In this paper, we thus attempt to address this gap in the empirical literature on higher education by investigating the impact of administrative intensity on the financial sustainability of universities.

Administrative intensity and organisational performance

As we have seen, a substantial empirical literature exists on university performance (see, for instance, Gralka (2018) and De Witte and López-Torres (2017)). However, aside from some work on administrative scale economies and capacity, the impact of administrative intensity on university performance has received much less attention (Elston & Dixon, 2020). As noted earlier, administrative intensity refers to the administrative costs of running an organization. It has been measured in several ways (Elston & Dixon, 2020), including the percentage of total employees devoted to administration and the proportion of total outlays expended on administration (Darnley et al., 2019), as well as the proportion of total revenue (net sales) from organizational operations (Pan & Tsai, 2012). The degree of administrative intensity is affected *inter alia* by internal organizational characteristics (Andrews & Boyne, 2014; Andrews et al., 2017; Boyne & Meier, 2013), as well as the external environment (Kalseth & Rattsø, 1998).

The extant empirical literature has found that administrative intensity significantly affected university performance (Andrews et al., 2017; Rutherford, 2016; Ryu & Christensen, 2019), including financial sustainability (see, for example, Alshubiri, 2021; Irvine & Ryan, 2019; Mamat et al., 2021). On *a priori* theoretical grounds, it has been argued that administrative intensity affects various dimensions of university performance, including financial sustainability and operational efficiency. For example, Rutherford (2016) found that administrative intensity had an inverted U-shaped relationship with organization performance in American higher education. Similarly, an inverted U-shaped relationship was found between administrative intensity and university performance in British universities (Andrews et al., 2017). In addition, interactions between administrative intensity and student numbers are positively related to university performance (Romine et al., 2018). In addition, Ryu and Christensen (2019) found a positive relationship between administrative intensity and organizational performance in Texas school districts. Regarding scale economies in administrative intensity, Rutherford (2016) established that total enrollments negatively affected administrative intensity in US universities. In a recent study by Tran & Dollery (2022), a U-shaped relationship between organizational size and administrative intensity was found in the Australian public university system. However, whether administrative intensity affects financial performance in universities has not yet been examined, notwithstanding the fact that administrative intensity typically represents a substantial component of total expenditure. This suggests that administrative intensity would affect financial sustainability as proxied by net operating results (DESE, 2022a). This provides the conceptual basis for our investigation of the relationship between administrative intensity and financial sustainability in the Australian public university system.

Hypothesis development on administrative intensity and financial sustainability

As we have seen, a substantial empirical literature has considered financial sustainability in the public sector (Ahmad et al., 2019; Alshubiri, 2021; Irvine & Ryan, 2019; Parker, 2011, 2013). However, the relationship between administrative intensity and financial sustainability in higher education has not yet been empirically investigated. We thus seek to address this gap in the empirical literature on higher education by (a) investigating the relationship between administrative intensity and financial sustainability in the Australian public university system and (b) examining whether the type of university influences the association between administrative intensity and financial sustainability.

As we have seen from the literature, there are strong *a priori* grounds for presuming that administrative intensity will affect university financial sustainability through its impact on university performance. Two diametrically opposed schools of thought have arisen. Firstly, some scholars, like Van Helden and Huijben (2014), Walker (2013) and Adler and Borys (1996), contend that organizations with a high degree of administrative intensity will perform better because of their superior operational coordination and concomitant increased efficiency Increasing the size of university bureaucracy may thus be a specific strategy to improve performance (Rutherford, 2016). By contrast, Boon and Verhoest (2014), Peters (2001) and other researchers have argued that administrative intensity inflicts a "bureaucratic burden" on public organizations by channeling scarce resources from frontline service delivery to back-office administration. A high degree of administrative intensity thus serves to impede organizational performance.

The empirical literature has established the existence of a nonlinear relationship between administrative intensity and university performance (Ryu & Christensen, 2019). For instance, Rutherford (2016) found an inverted U-shaped relation between administrative intensity and university performance, indicating that—beyond a certain optimal point—an increase in administrative personnel will unfavorably affect organizational performance. In a similar vein, Andrews et al. (2017) found an inverted U-shaped relationship between administrative intensity and university performance indices, suggesting that administrative intensity initially generates positive performance outcomes, but thereafter imposes a bureaucratic burden. More recently, Ryu and Christensen (2019) found that administrative intensity bears a curvilinear relationship to school performance; as administrative intensity rises, its impact on organizational performance grows.

Given that a relationship between administrative intensity and university performance has already been established in the empirical literature implying a non-linear relationship, it is expected that the association between administrative intensity and financial sustainability is negative in a U-shaped form. This is because the greater administrative intensity, the greater the reduction in net operating result, thereby demonstrating a deterioration in the financial sustainability of universities (Rutherford, 2016; Ryu & Christensen, 2019). Accordingly, we test hypothesis H1 in the Australian higher education system.

H1: There is a non-linear relationship between administrative intensity and financial sustainability.

A subsidiary aim of the paper is to determine empirically whether the association between administrative intensity and financial sustainability varies between different types of university. In the Australian higher education context, substantial differences are apparent among university groups in terms of student size, remoteness, spatial size, research capacity and many other non-discretionary factors (Heffernan, 2017). These differences influence both the expectations that students and staff hold of their universities, as well as university performance itself. To date, the question of whether administrative intensity has had a significant impact on university financial sustainability among university types has not been examined. However, previous empirical work on other dimensions of higher education has indicated that disparities in the characteristics of different types of public organizations, such as local authorities, have affected their performance (Tran & Dollery, 2020, 2021; Drew et al., 2014).

In the current context, we seek thus to determine whether the relationship between administrative intensity and financial sustainability varies between types of university in the Australian public university system. These differences not only affect the financial performance of universities, but also serve to shape the expectations that various stakeholders, including government, hold of these universities. For example, in his study of government funding of Australian universities, Heffernan (2017) found that public funding favored research-intensive universities despite the surplus they secured from government research funding. He added that across the institutional networks, the average financial assistance per student minus one-off grants and research income varied between different categories of university.

At present, Australian universities are classified into five groups comprising the Group of Eight (Go8), the Regional University Network (RUN), the Innovative Research University Network (IRU), the Australian Technology Network (ATN) and the nonaligned universities (NAU). Each university group has focused on different educational and research objectives. For example, the Go8 is focused on developing elite international alliances and research partnerships (G08, 2022) while the ATN brings together five universities focused on enterprise and finding solutions to problems facing the Australian economy and society (ATN, 2022). By contrast, the RUN shares a commitment to transforming their regions through education and research to contribute to regional economic and social development (UNE, 2022). The IRU is committed to inclusive excellence in teaching and research (IRU 2022). Universities in the NAU have their own differential commitments to teaching and research objectives. The list of universities in each group presented in Appendix A1.

Given these differences, it is highly likely that there will be significant variations in financial performance between different kinds of universities and that administrative intensity may have negative impact on financial sustainability. For instance, some Australian universities with a large number of students, such as the Go8 and the NAU, expend proportionately more administrative expenses, like marketing activities and maintaining international relationships. This could potentially affect their financial sustainability.

We thus test the following hypothesis H2:

H2: The effect of financial sustainability varies between university types and there exists a difference between the different groups of university with respect to the relationship between administrative intensity and financial sustainability.

Australian public university system

The Australian higher education sector has experienced substantial structural transformation since the Dawkins reforms in the late 1980s that sought *inter alia* to improve the productivity of universities and generate greater efficiency in university performance. These reforms had far-reaching consequences through *inter alia* introducing mass university education, radically modifying funding arrangements and establishing Australia as a major provider of international higher education services (Worthington & Higgs, 2011). As a result, enrollments at Australian universities increased by 37% over the period 2008 to 2017, with the number of international students enrolled in Australian higher education increasing by 220% between 2002 and 2017. The Australian higher education sector is now a leading contributor to Australian export earnings, ranked the third-largest export by value after iron ore and coal with earnings of AU$40.3 billion in 2019 (Chowdhury, 2022). The student/lecturer ratio averaged 14.4 and the proportion of international students to total student enrollments averaged 26% for the period 2009/10 to 2018/19 (Department of Education and Training, 2019). It was argued that while student numbers rose, staffing resources remained relatively static and government funding for maintaining adequate infrastructure was restricted. In essence, the federal government anticipated greater university export earnings while demanding value for money and employable graduate output (Parker, 2002, 2011).

Together with revenue diversification, cost efficiency has become a strategic instrument in Australian universities generating larger class sizes, increased full-time staff teaching loads, a greater proportion of casualized and contract teaching and administrative staff, reduced library and support services, decreased maintenance services, reduced budget allowances for staff research travel and the frequent discontinuation of low enrollment programs (Parker, 2011, 2013, 2020). Howard (2021) has demonstrated that the proportion of staff costs relative to operating revenue represented a critical university performance benchmark in which non-academic staffing costs increased by $3.99 billion over the 2003 to 2019 period and $1.13 billion over the period 2014 to 2019. Overall, the ratio of academic staff costs to revenue has declined over time whereas the proportion of non-academic costs has been constant. This raises the obvious question of whether universities have been efficient with the administrative component steadily increasing in line with university size by student numbers.

Although a voluminous empirical literature has examined cost efficiency, operational efficiency and productivity in the Australian public university system, including Avkiran (2001), Abbott and Doucouliagos (2003), Abbott and Doucouliagos (2004), Carrington et al. (2005), Madden et al. (1997), Lee and Worthington (2016), Worthington and Lee (2008), Worthington and Higgs (2011) and Zhang and Worthington (2017), little is known about the influence of administrative intensity on financial sustainability of Australian public universities. This represents the rationale for the present study.

Methodology

Empirical models

In this paper, we employed a multiple regression model with a pooled dataset for the ten-year period 2009 to

2018 to address the hypotheses set out earlier. The regression model is used to test whether the hypotheses H1 and H2 are accepted or rejected, controlling for student measures and other factors. Financial, student and other data were collected from Department of Education, Skills and Employment (DESE, 2022b). This data is released annually at the end of December. It was chosen for analysis on grounds of its reliability and coverage. In terms of a ten-year period in a pooled data set, we have 369 observations for the whole sample ($n = 37$ public universities), with one observation missing for a research category. A time trend (t) variable was included in the model to capture change over multiple periods attributed to financial sustainability proxied by net operating results. It should be noted that the international macroeconomic factors, like the global financial crisis over the period 2007 to 2008, were considered in our paper given that its complex nature could not be filtered out from the domestic policy environment.

The following equations were employed to test the hypotheses:

$$\mathrm{FS} = \beta_0 + \beta_1 \mathrm{Time} + \beta_2 \mathrm{AI} + \beta_3 \mathrm{In(Student)} + \beta_4 \mathrm{Z} + \varepsilon \quad (1)$$

$$\mathrm{FS} = \beta_0 + \beta_1 \mathrm{Time} + \beta_2 \mathrm{AI} + \beta_3 \mathrm{AI}^2 + \beta_4 \mathrm{In(Student)} + \beta_5 \mathrm{Z} + \varepsilon \quad (2)$$

$$\mathrm{FS} = \beta_0 + \beta_1 \mathrm{Time} + \beta_2 \mathrm{AI} + \beta_3 \mathrm{AI}^2 + \beta_4 \mathrm{In(Student)} + \beta_5 \mathrm{In(Student)}^2 + \beta_6 \mathrm{Z} + \varepsilon \quad (3)$$

In order to address H2, we re-ran our regression model for various types of university using the same data decomposed by university category to obtain greater insight into the impact of administrative intensity on financial sustainability. We added dummy variables of university type into the regression models to determine if there were differences in the association between financial sustainability indicator and administrative intensity between university categories. The following regression models were tested:

$$\mathrm{FS} = \beta_0 + \beta_1 \mathrm{Time} + \beta_2 \mathrm{AI} + \beta_3 \mathrm{In(Student)} + \beta_4 \mathrm{Unitype} + \beta_5 Z + \varepsilon \quad (4a)$$

$$\mathrm{FS} = \beta_0 + \beta_1 \mathrm{Time} + \beta_2 \mathrm{AI}_U + \beta_3 \mathrm{AI}^2 + \beta_4 \mathrm{In(Student)} + \beta_5 \mathit{Unitype} + \beta_6 Z + \varepsilon \quad (4b)$$

$$\mathrm{FS} = \beta_0 + \beta_1 \mathrm{Time} + \beta_2 \mathrm{AI}_U + \beta_3 \mathrm{AI}^2 + \beta_4 \mathrm{In(Student)} + \beta_5 \mathrm{In(Student)}^2 + \beta_6 \mathrm{Unitype} + \beta_7 Z + \varepsilon \quad (4c)$$

We then stratified our sample into the five types of university (G08, NAU, IRU, ATN and RUN) to investigate the impact of AI and contextual factors on the financial sustainability of individual groups of universities. Accordingly, the following model was examined:

$$\mathrm{FS}_{\mathit{Unitype}} = \beta_0 + \beta_1 \mathrm{Time} + \beta_2 \mathrm{AI} + \beta_3 \mathrm{AI}^2 + \beta_4 \mathrm{In(Student)} + \beta_5 \mathrm{(Student)}^2 + \beta_6 Z + \varepsilon \quad (5)$$

Dependent variables

Financial sustainability (FS) can be measured by various financial indicators, including net operating results, liquidity, capital replacement and internal financing (VAGO, 2018). However, at present, there has no consensus in the literature on the most appropriate financial indexes for financial sustainability in the Australian higher education sector. Accordingly, in this paper, we used the net operating result as a proxy for financial sustainability. As the dependent variable, the net operating result is measured by the difference between total revenue and total expenditure on an annual basis. Net operating results were drawn from the financial performance tables of (DESE, 2022a) for individual universities. A positive result indicates a surplus whereas a negative result indicates a deficit. In a ten-year data period, 17 universities experienced losses in which 7 universities exhibited a loss in two or three years. In total, 33 observations carry negative values for the whole sample with respect to a loss of approximately AU $183 million. The net operating result has been recently used in Tran & Dollery (2021) and Yarram et al. (2022) in empirical research on Australian local government. However, our dependent variable is measured as an absolute value—as shown in DESE (2022a)—rather than as the proportion of the net operating result over total revenue.

Independent variables

Administrative intensity (AI)

AI is the main independent variable in the model. Earlier empirical work has demonstrated the importance of administrative personnel in public organizations. In higher education, it is difficult to distinguish between professional staff and academic managers in teaching and research. AI is thus difficult to conceptualize (Rushing, 1967). Boyne and Meier (2013) noted that administration could include only senior manager level administrators or alternatively clerical and maintenance employees. Accordingly, no agreement exists in the literature on the measurement of AI. Specifically, AI is variously measured as a ratio of administrative to production workers (Ford & Slocum, 1977; Pondy, 1969), as the ratio of administrative to faculty (Gander, 1999;

Romine et al., 2018), as the proportion of managerial staff relative to administrative staff (Donaldson, 2001), as the percentage of total employees in administrative positions (Boyne & Meier, 2013) and as administrative capacity in terms of human resource capacity (Christensen & Gazley, 2008; Ryu & Christensen, 2019). However, these AI proxies can induce problems of definitional dependence (Freeman & Kronenfeld, 1973; Lioukas & Xerokostas, 1982). AI has also been proxied as the proportion of administration and central management expenditure to total staff expenditure (Andrews & Boyne, 2014), as the ratio of administrative expenses to net sales (Pan & Tsai, 2012) and as the proportion of administrative back-office costs to total expenditure (Tran & Dollery, 2021; Ting et al., 2014).

Given these concerns, and based on available financial data on Australian universities, we proxy AI as the ratio of administrative costs to net sales (Pan & Tsai, 2012). Administrative costs refer to annual administrative staff costs and other administration-related costs for each university.

Administrative staff costs (sometimes termed non-academic employee benefits) cover non-academic salaries, non-academic contributions to superannuation and pension schemes, non-academic payroll tax, non-academic workers compensation, non-academic long service leave expense, non-academic annual leave and other non-academic employee benefits, whilst the other administration-related costs refer to other expenses relating administration on grants, prices, advertising, marketing and promotion, net loss on disposal of property, plant and equipment and other expenditure In accounting terms, net sales are total revenue from various income sources presented in the financial reports of individual universities DESE (2022a). It should be noted that administrative staff costs are covered in AI and thus the number of non-academic staff was not included in the models to avoid their overlapping influence on the net operating result. Regarding the relationship between AI and organization performance, as we have seen, it is hypothesized that this relationship may be nonlinear rather than linear in form. The empirical literature has identified a U-shaped relationship between AI and organizational performance (see, for instance, Andrews & Boyne, 2014; Tran & Dollery, 2021), implying that as AI increases, organizational performance first declines, but then increases as AI rises.

Student measures (lnStd and lnStd^2)

As we have seen, the relationship between university size by enrollments and organizational performance has been examined in the empirical literature (Andrews et al., 2017; Rutherford, 2016). University size comprises the total number of students enrolled annually in a given university. Student enrollments include both domestic and international students and it captures changes in financial performance. The non-linear relationship between student size and FS was examined by adding the quadratic term for student size into the model. The resultant relationships might be negative or positive (Andrews & Boyne, 2014). Student size can initially yield scale economies in coordination, but these are eventually replaced by scale diseconomies resulting from very large student sizes (Andrews & Boyne, 2009; Williamson, 1967). However, an inverse relationship could potentially occur: an increase in student size could led to initial scale diseconomies, subsequently replaced with scale economies.

University type

In order to examine whether university type has a differential impact on FS in Australian public universities, we used four dummy variables for RUN, ATN, IRU and NAU, with the Go8 treated as the reference to avoid multicollinearity. Accordingly, the estimated coefficients of RUN, ATN, IRU and NAU in the regression models are compared with the reference Go8. These dummy variables are not used in Model 5. Instead, we stratified the whole sample into five groups and ran regression models for the different groups.

Control variables

The empirical literature has identified relationships between external factors and performance in higher education institutions (Tran, 2021; Tran et al.,2020; Boyne & Meier, 2013). Z is a vector of control variables expected to affect AI that include the student-staff ratio, the proportion of international students and the proportion of indigenous students. These variables could affect the net operating result through annual variations in student revenue. Previous studies indicated a mixed impact of student characteristics on organizational performance in the presence of AI (Rutherford, 2016; Rutherford and Van de Voet, 2019).

Regarding academic staff, total academic employee benefits are covered in the net operating results derived from the difference between total revenue and total operating expenditure. Accordingly, we did not place total academic staff in the regression models to avoid its magnified influence on financial sustainability. Instead, we have added other variables such as the proportion of staff level B[1] and below, the proportion of staff level C[2] and above and the proportion of casual staff to capture

the impact of academic staff on financial sustainability. The change in these proportions would affect the net operating result of universities. Some previous studies have established that staff characteristics have no impact on AI (e.g.,Tran & Dollery, 2022; Ryu & Christensen, 2019). However, using lower-level academic staff could be a way to improve cost efficiency (Alexander & Couto, 2019; Jacobson, 2017; Narayan et al., 2017).

In addition, we considered the impact of research intensity—proxied by the proportion of research income categories 1, 2, 3 and 4 over total research income—on AI (Category 1: Australian competitive grant R&D; Category 2: Other public sector R&D; Category 3: Industry and other R&D; and Category 4: Cooperative Research Centre (CRC) R&D (Department of Education, Skills and Employment DESE (2022b))). In order to avoid multicollinearity, the proportion of research income in category 4 is treated as the reference. Research income categories 1, 2 and 3 are tested against AI and compared to the reference category. The research incomes in these different categories would affect the net operating results through a change in the total revenue of universities. Moreover, it would thus improve the financial indicators (Mamat et al., 2021; Parker, 2020).

Dummy variables for universities located in Queensland, Victoria and New South Wales are used to examine whether university location affects FS (with universities in other states treated as the reference). The impact of these factors depends on the circumstances in question. Cognisant of the extant empirical literature on higher education (Andrews et al., 2017; Rutherford, 2016), we used all these control variables in our empirical analysis of the Australian public university system.

Error term

ε is added to the equation to capture variability in the model. We had the robust variance estimation to generate the robust findings in the regression analysis.

A descriptive analysis of the variables is presented in Table 1

Empirical results

Firstly, we investigate the association between the FS indicator proxied by the net operating result and AI in the presence of student measures. The impact of AI might vary with respect to FS depending on the characteristics captured over time. We also examined the nonlinear influence of AI on the financial indicator. We then tested the influence of dummy variables for various university types on the financial indicator in the presence of AI and the control variables. All models are significant at the 1% level of significance and R^2 lies within the range of 0.65 to 0.83. The estimated regression results for all tested models are presented in Tables 2, 3 and Table 4.

Table 2 shows the linear influence of AI on the financial indicator for the whole sample in the presence of student measures and control variables. As we can see, AI negatively affects the net operating result at the 1% level of significance. This result supports H1 and implies a diminution of FS. Specifically, a 1% increase in AI leads to $7.48 million decrease in the net operating result *ceteris paribus* (Model 1). This indicates that AI significantly affects the net operating result thereby reducing FS in the public university system.

Model 2 in Table 2 presents the nonlinear association between AI and the financial indicator. Our findings indicate that a U-shaped relationship exists between AI and the net operating result at the 5% level of significance. This result is in line with recent empirical research (see, for instance, Andrews & Boyne, 2014; Tran & Dollery, 2021; Drew et al., 2014) that AI bears a negative relationship with financial performance in local government.

However, our findings contrast with the results of previous studies, such as Rutherford (2016) and Andrews et al. (2017), in which AI positively affects university performance as proxied by graduation rates, quality of research, grants and PhD performance. In terms of our results, a U-shaped relationship implies that initially an increase in AI leads to a decline in the net operating result, thereby worsening university FS. However, if AI keeps increasing (on average 1.6 times as many of the AI proportion of the whole sample (Model 2)), then the net operating result starts rising, thus improving the FS of universities. This implies that an increase in AI in the longer term could potentially enhance the growth of universities, generate more revenue and thereby improve the net operating result. In general, these results support H1 that AI affects FS in a nonlinear manner.

Student size bears a U-shaped relationship with the net operating result at the 1% level of significance (Model 3a and Model 3c) implying that when student size increases, the net operating result first declines, but when student size rises beyond 17,172 students, the net operating result starts increasing *ceteris paribus*. This finding accords with Rutherford (2016).

The influence of exogenous factors on the financial sustainability indicator is mixed. For example, the proportion of international students, indigenous students and level B academic staff all have a positive impact on the net operating result. These results accord with recent

Table 1. Definitions and summary statistics of variables, 2009/10–2018/19 ($n = 37$).

Variable	Definition	Mean	Standard deviation	Min	Max
Financial sustainability	Proxied by net operating result that is measured by the difference between total revenue and total costs ($million)	49.121	154.203	−1442.37	1532.1
Administrative intensity (%)	Proxied by the ratio of administrative costs to total revenue	0.56	0.16	0.08	3.16
Student numbers	Total students enrolled	33,372	14,866	7,014	83,560
Student-staff ratio (students)	Task density proxied by the ratio of students to FTE staff	14.40	4.75	5.58	37.36
International students (%)	Task density proxied by the proportion of international students	0.252	0.102	0.045	0.609
Indigenous students (%)	Proportion of indigenous students	0.014	0.012	0.0005	0.097
Staff C level (%)	Proportion of C level staff & upper	0.41	0.081	0.26	0.73
Staff B level (%)	Proportion of B level staff	0.31	0.068	0.16	0.57
Casual staff (%)	Proportion of casual staff	0.21	0.13	0.023	1.19
Research category 1%)	The proportion of research category 1 over total research income	37.94%	12.27%	0.00%	66.62%
Research category 2%)	The proportion of research category 2 over total research income	28.53%	12.20%	6.43%	93.02%
Research category 3%)	The proportion of research category 3 over total research income	28.22%	9.37%	0.89%	63.00%
Research category 4%)	The proportion of research category 4 over total research income	5.31%	6.14%	0.00%	46.91%
QLD universities	Dummy variable, 1 for QLD universities, 0 for others	0.19	0.39	0	1
VIC universities	Dummy variable, 1 for VIC universities, 0 for others	0.22	0.42	0	1
NSW universities	Dummy variable, 1 for NSW universities, 0 for others	0.27	0.45	0	1
G08	Dummy variable, 1 for universities in Group of eight, 0 for others	0.216	0.412	0	1
RUN	Dummy variable, 1 for universities in Regional University Network, 0 for others	0.189	0.392	0	1
ATN	Dummy variable, 1 for universities in Australian Technology Network, 0 for others	0.135	0.342	0	1
IRU	Dummy variable, 1 for universities in Innovative Research University, 0 for others	0.189	0.392	0	1
NAU	Dummy variable, 1 for universities in Non-aligned University 0 for others	0.270	0.445	0	1

QLD: Queensland State; VIC: Victorian State; NSW: New South Wales State; RUN: Regional University Network, ATN: Australian Technology Network, IRU: Innovative Research Universities, NAU: Non-aligned Universities. Research category 1: Australian competitive grant R&D, Research category 2: Other public sector R&D, Research category 3: Industry and other R&D and Research category 4: Cooperative Research Centre (CRC) R&D.

Table 2. Regression results of financial sustainability on administrative intensity 2009/10–2018/19 ($n = 37$).

	Model 1		Model 2		Model 3	
Dependent variable Net operating result	Coefficient	Robust Std. error	Coefficient	Robust Std. error	Coefficient	Robust Std. error
Time trend	3.62*	1.92	3.96**	1.80	3.35**	1.75
Admin intensity	−748.53***	157.20	−1857.04***	353.94	−1871.62***	353.29
Admin intensity^2			352.85***	97.87	358.02***	97.79
LnStudent	46.54***	9.77	41***	7.99	−873.33***	237.69
LnStudent^2					44.67***	11.64
Student-staff ratio	−3.64***	1.33	−1.81**	0.78	−1.37*	0.76
Int'l Students (%)	17.88	49.36	157.72***	54.08	129.29**	52.25
Indigenous Student (%)	515.52	415.44	1383.74**	540.91	1043.86**	514.21
Research Category 1%)	88.03*	52.25	−40.26	67.67	−42.56	68.55
Research Category 2%)	10.96	54.18	−136.51*	75.30	−130.65*	76.05
Research Category 3%)	14.42	61.56	−143.00**	69.72	−132.99*	70.90
C-upper Staff (%)	−133.79*	83.29	−23.85	48.82	18.34	48.36
B-level Staff (%)	18.20	74.97	124.89**	58.26	129.38**	55.94
Casual Staff (%)	−12.17	24.23	−9.38	26.75	−9.29	26.91
Constant	24.67	113.37	561.53***	185.10	5221.63***	1292.96
Observations	369		369		369	
F value	13.32***		66.9***		61.59***	
R^2	0.65		0.79		0.80	

*$p < .1$, **$p < .05$, ***$p < .01$ at the two-tail test.
QLD: Queensland State; VIC: Victorian State; NSW: New South Wales State. Research category 1: Australian competitive grant R&D, Research category 2: Other public sector R&D, Research category 3: Industry and other R&D and Research category 4: Cooperative Research Centre (CRC) R&D—the reference.

Table 3. Financial sustainability on administrative intensity for 2009/10–2018/19 ($n = 37$) (cont.).

	Model 3a		Model 3b		Model 3c	
Dependent variable Net operating result	Coefficient	Robust Std. error	Coefficient	Robust Std. error	Coefficient	Robust Std. error
Time trend	3.58*	2.05	4.01**	1.78	3.63**	1.75
Admin intensity	−756.55***	159.71	−1881.40***	350.41	−1889.57***	350.54
Admin intensity^2			357.52***	96.28	360.88***	96.41
LnStudent	41.37***	10.11			−786.63***	271.16
(LnStudent)^2			31.48***	7.91	40.02***	13.20
Student-staff ratio	−3.55***	1.30	−1.79**	0.79	−1.38*	0.78
Int'l Students (%)	6.53	48.17	136.89***	51.08	121.63**	50.17
Indigenous Student (%)	170.39	474.54	1031.62**	525.41	663.23	540.24
Research Category 1%)	94.81*	54.10	−45.23	65.58	−44.85	66.32
Research Category 2%)	17.33	54.48	−127.86*	72.16	−122.55*	73.41
Research Category 3%)	4.32	66.86	−171.57**	71.74	−157.32**	73.61
C-upper Staff	−104.68	67.09	19.99	46.83	44.96	46.81
B-level Staff	60.63	60.13	167.40	58.52	172.76***	56.89
Casual Staff (%)	−10.18	19.39	−16.12	24.80	−11.92	24.89
QLD	33.30**	16.54	40.52***	14.99	38.46***	14.91
VIC	13.76	18.01	30.88**	14.28	21.07	15.13
NSW	4.37	7.95	18.69**	8.11	16.44**	8.09
Constant	50.19	124.75	637.93***	191.84	4802.35***	1435.18
Observations	369		369		369.00	
F value	11.52***		55.49***		51.36***	
R^2	0.6559		0.7986		0.8031	

*$p < .1$, **$p < .05$, ***$p < .01$ at the two-tail test. QLD: Queensland State; VIC: Victorian State; NSW: New South Wales State. Research category 1: Australian competitive grant R&D, Research category 2: Other public sector R&D, Research category 3: Industry and other R&D and Research category 4: Cooperative Research Centre (CRC) R&D—the reference.

work in the literature indicating that universities have pursued a range of financial strategies, such as increasing international student fee income and improving cost efficiency, by using the lower-level academic staff (Alexander & Couto, 2019; Jacobson, 2017; Narayan et al., 2017; Parker, 2013, 2020). It is noteworthy that the relationship between the student-staff ratio on the net operating result was statistically insignificant though its estimated coefficient carries on a positive sign. This implies that revenues generated from the student numbers were insufficient to cover staff expenditure and thus did not improve financial sustainability as desired. Regarding research categories, the proportion of research income in categories 2 and 3 have a negative influence on the net operating result. This indicates that although a diversity of research income could increase total revenue (Mamat et al., 2021; Parker, 2020), it did not generate a rise in the net operating result as expected.

Table 4. Financial sustainability on administrative intensity with university types, 2009/10–2018/19.

	Model 4a		Model 4b		Model 4c	
Dependent variable Net operating result	Coefficient	Robust Std. error	Coefficient	Robust Std. error	Coefficient	Robust Std. error
Time trend	2.92	2.22	2.67	1.74	2.26	1.68
Admin intensity	−756.66***	157.59	−1879.2***	339.08	−1888.9***	340.16
Admin intensity^2			355.5***	92.86	358.68***	93.21
LnStudent	51.54***	12.80	57.90***	10.75	−405.92*	232.44
(LnStudent)^2					22.90**	11.33
Student-staff ratio	−0.14	0.79	1.11	0.76	1.07	0.75
Int'l Students (%)	5.26	44.08	152.80***	48.05	150.65***	48.12
Indigenous Student (%)	1058.64**	531.66	2025.53***	588.14	1859.05***	609.67
Research Category 1%)	−74.89*	44.71	−195.53***	75.55	−183.03**	76.39
Research Category 2%)	−39.38	51.42	−165.99**	74.29	−155.33**	75.08
Research Category 3%)	−102.76*	59.02	−266.63***	75.87	−252.54***	78.23
C-upper Staff	−114.53*	67.13	19.11	43.97	37.19	43.37
B-level Staff	−6.73	54.94	68.71	50.98	63.80	50.77
Casual Staff (%)	−14.44	15.66	−18.41	22.25	−15.25	22.53
QLD	30.92	20.90	24.63*	14.97	19.78	14.44
VIC	21.13	16.62	31.98	12.89	24.65*	14.00
NSW	8.95	7.95	12.35	8.94	7.62	8.86
RUN	−72.87***	22.18	−42.00***	15.44	−30.68**	15.11
ATN	−111.13***	19.63	−111.35***	13.30	−107.75***	13.55
IRU	−84.65***	19.42	−64.48***	11.80	−57.40***	11.98
NAU	−86.29***	17.28	−69.22***	9.94	−60.24***	10.14
Constant	91.30	139.62	498.40***	183.56	2829.19**	1219.90
Observations	369		369		369	
F value	13.49***		50***		46.77***	
R^2	0.6909		0.8305		0.8318	

*$p < .1$, **$p < .05$, ***$p < .01$ at the two-tail test. QLD: Queensland State; VIC: Victorian State; NSW: New South Wales State; other states as the reference. RUN: Regional University Network, ATN: Australian Technology Network, IRU: Innovative Research Universities, NAU: Non-aligned Universities; Go8 as the reference. Research category 1: Australian competitive grant R&D, Research category 2: Other public sector R&D, Research category 3: Industry and other R&D and Research category 4: Cooperative Research Centre (CRC) R&D—the reference.

In addition, as we can observe, universities located in QLD, VIC and NSW have a positive relationship with the net operating result and their net operating result was higher than universities in other states (Models 3b and 3c). A recent study by Tran & Dollery (2022) found that QLD and NSW have a higher AI than the other Australian states. This could be due to the fact that student university enrollments in these states were higher than student enrollments of universities in the other states. The time variable has a positive impact on the net operating result in all models in Tables 2 and 3, implying that there was improvement in FS in Australian universities over the reported period. This also underlines the importance of the time trend in empirical research on university financial performance in order to adequately capture changes in financial indicators over time.

As noted earlier, in order to examine the influence of university type on FS, we added four dummy variables including RUN, ATN, IRU and NAU (with Go8 as the reference category) in the regression models and then regressed FS against AI, student size and exogenous variables. The results are presented in Table 4 in terms of the linear and nonlinear impact of AI and student size on the net operating result. The estimated models are significant at the 5% level. As we can see in Table 4, AI negatively affected the net operating result with a U-shaped relationship in the presence of dummy variables of university types. This implies that increasing AI could potentially worsen FS. This result is in line with theoretical arguments that a high degree of AI imposes a "bureaucratic burden" by channeling resources from frontline service delivery to administration and thereby impedes organizational performance (Boon & Verhoest, 2014; Boyne & Meier, 2013; Peters, 2001). In the same vein, student size has a U-shaped relationship with the net operating result. The dummy variables had a significantly negative influence on the net operating result. In essence, universities belonging to the RUN, ATN, IRU and NAU categories exhibited a reduction in FS compared to their counterpart Go8 universities in the reported years.

In order to examine the impact of AI on FS by type of university, we stratified our sample into five university groups and regressed AI and contextual variables against net operating results. As can be seen in Table 5, the influence of AI on FS is significant in a U-shaped form at the 1% level in the G08 group whereas in the other groups, the impact of AI on FS is not significant (albeit the coefficients of the quadratic term (AI^2) are significantly negative). This implies that the impact of AI on FS in the presence of contextual

variables in the G08 has driven the relationship between AI and FS for the whole sample. As we can see from the reported data (DESE, 2022a), total revenue of the G08 is substantial, accounting for 78% of total revenue of the other university groups. It reflects the fact that top-ranked universities enjoy greater latitude to boost their financial indicators and thereby maintain their financial performance because of their prestige and investments. However, from a managerial perspective, administrative efficiency plays a vital role in maintaining the overall performance of every university in a sustainable manner.

The U-shaped relationship between student size and FS is significant only in the IRU group that is dominant in the whole sample. The impacts of external variables vary across five groups. For example, the proportion of international students contributes positively to net operating result in the IRU and RUN groups. Similarly, academic level B has a positive impact on the ATN group. In contrast, research category 3 negatively affects net operating result for the NAU group. Except for the IRU group, the time trend and spatial locations of universities were not statistically significant in presence of AI and other external factors.

Discussion of results

We examined FS of Australian universities proxied by the net operating result as indicated in DESE (2022a). The influence of AI on the financial sustainability indicator was examined in the presence of student size, university type and other exogenous variables. We found that AI significantly and negatively correlated with the net operating result (i.e., H1 is accepted). Put differently, when the proportion of AI rises, greater administrative expenditure becomes ineffective and might even weaken the ability of a university to maintain its financial performance. As indicated in public choice theory, excessive bureaucracy generates a cumbersome organizational structure when the quantity and range of service provision expands (Boyne & Meier, 2013). Consequently, higher administrative intensity would inevitably damage financial sustainability unless an increase in administrative intensity is used efficiently and effectively.

In essence, our finding in Australian higher education of a U-shaped impact of AI on financial performance echoes earlier empirical work on public organizations (Andrews & Boyne, 2014; Tran & Dollery, 2021; Yarramet al., 2022). This result is in line with the empirical literature that a high degree of AI may impede university performance because it imposes "bureaucratic burden" on organizations (Boon & Verhoest, 2014; Peters, 2001). However, if AI continues to increase, then a university may perform better because of superior coordination of its operations (Adler & Borys, 1996; Van Helden & Huijben, 2014; Walker, 2013). In this sense, it is important that universities monitor their administrative efficiency. The interactive influence of AI on other exploratory variables with a bearing on university financial sustainability should be further investigated it since could affect the financial performance of universities.

In addition, we find that university type significantly affects FS with respect to the impact of AI and the presence of exogenous factors (i.e., H2 is supported). Given that the Go8 group represents the base case, universities belonging to RUN, ATN, IRU and NAU are all negatively and significantly associated with FS. Our findings show that the net operating result of these universities is uniformly less than the net operating result of Go8 universities. Specifically, in comparison with Go8, the ATN group has the worst impact on its net operating result, followed by IRU and NAU groups. The RUN group is the least adversely affected. This falls in line with the extant empirical literature that a lower level of AI could reduce the bureaucratic burden. Put differently, AI might generate superior performance due to improved operational coordination (Boon & Verhoest, 2014; Boyne & Meier, 2013; Peters, 2001). In sum, AI affects the financial performance of universities by university category thereby confirming our hypothesis. We stratified the whole sample into five groups to examine the impact of AI on FS for each individual group. Our findings in Table 5 showed that there is a significant difference between the different groups of university with respect to the relationship between administrative intensity and financial sustainability in which the G08 has driven the impact of AI on FS in a U-shaped form for the whole sample whilst in the remaining groups, the impact of AI on FS is unclear (although it is found in the quadratic term). This underlines the dominant influence of the G08 group in the system in terms of the association between AI and FS. Accordingly, H2 is supported.

This finding provides insightful information for policy makers that public policy intervention should be tailored to meet the specific circumstances of different categories of universities.

The time variable was incorporated into the regression models to determine how financial indicators changed over time in relation to AI, student size and the control variables. The time trend had positive effect on FS in Tables 2 and 3 at the 5% level of significance. However, in the presence of university type, the time trend had no influence on the financial indicator at the 5% level of significance in the estimated models. This

Table 5. Financial sustainability and administrative intensity classified by university groups, 2009/10–2018/19 ($n = 37$).

	Go8		NAU		IRU		ATN		RUN	
Dependent variable Net operating result	Coefficient	Robust S. Error	Coefficient	Robust S. Error	Coefficient	Robust S. Error	Coefficient	Robust S. Error	Coefficient	Robust S. Error
Time trend	7.46	4.73	−0.51	1.30	−3.89***	1.13	2.85	2.22	1.16	1.43
Admin intensity	−4887.10***	550.25	74.94	359.79	−64.88	225.79	−612.66	437.03	−325.65	190.94
Admin intensity^2	3363.51***	814.43	−649.65**	257.95	−412.23***	152.64	−381.82**	191.28	−63.33**	29.80
LnStudent	−2752.94	1853.26	−109.11	572.66	−811.67***	201.69	63.92	1679.56	102.42	255.55
(LnStudent)^2	130.44	92.03	7.96	28.77	44.51***	10.04	−0.89	79.56	−4.99	13.21
Student-staff ratio	0.14	2.04	0.13	0.49	0.15	0.90	0.27	1.63	0.94*	0.54
Int'l Students (%)	−485.40*	289.49	−16.61	42.95	158.23***	49.55	82.39	77.11	98.85***	30.68
Indigenous Student (%)	−3140.27	9416.04	306.88	543.41	1451.83***	277.15	1793.77	2543.68	153.03	750.68
Research Category 1%)	80.64	979.27	−38.04	30.44	−122.96*	65.56	−123.27	107.43	−45.61	41.77
Research Category 2%)	353.29	999.87	30.97	33.09	−95.38	73.23	−48.90	76.85	−47.45	45.60
Research Category 3%)	361.19	1060.43	−107.7***	35.32	−126.11*	74.07	−38.65	98.31	−55.04	46.56
C-upper Staff	150.97	106.50	27.11	31.02	17.56	49.97	−53.05	72.54	−27.19	33.05
B-level Staff	39.39	121.52	−58.32	49.97	−20.31	53.49	198.15***	54.97	69.31	45.17
Casual Staff (%)	113.40	87.03	3.18	27.53	22.68	52.20	38.93	116.10	0.49	6.61
QLD[(a)]	108.08	87.60	9.44	16.65	−22.27**	10.23	-	-	24.94	18.90
VIC[(a)]	136.47	120.85	2.90	8.19	−12.40*	7.40	2.88	8.49	-	-
NSW	90.76	95.40	4.99	10.48	−11.38***	12.89	14.23	17.41	23.98	24.94
Constant	15978.74	10010.71	510.21	2870.32	3909.29	1008.30	−141.70	8789.52	−332.27	1240.69
Observations	80.00		100.00		70.00		49		70	
F value	75.33***		651.75***		1663.77***		1603.27***		85651***	
R^2	0.9316		0.9052		0.9409		0.9946		0.9954	

Note *$p < .1$, **$p < .05$, ***$p < .01$ at the two-tail test. QLD: Queensland State; VIC: Victorian State; NSW: New South Wales State; other states as the reference. RUN: Regional University Network, ATN: Australian Technology Network, IRU: Innovative Research Universities, NAU: Non-aligned Universities; Go8 as the reference. Research category 1: Australian competitive grant R&D, Research category 2: Other public sector R&D, Research category 3: Industry and other R&D and Research category 4: Cooperative Research Centre (CRC) R&D—the reference; (a) there are no universities classified as ATN in Queensland state and as RUN in Victoria state.

implies that university type had a dominant influence on FS, thereby overwhelming the impact of the time trend.

Our finding sheds light on how AI modifies university financial performance over time. Intertemporal measures of this kind have not previously been employed in the empirical literature on AI in higher education in the presence of university type. In this respect, our study breaks new ground, especially insofar as we captured changes in university financial performance through time and stratified the whole sample into five separate types of university to generate a clearer picture of the impact of administrative intensity on financial sustainability.

Conclusion

We have investigated whether a causal relationship exists between financial sustainability and AI in the Australian public university system over the financial years 2009/10 to 2018/19. Our findings have contributed to the empirical literature on university financial performance in three main respects. Firstly, our study represents the first attempt to investigate the relationship between university financial sustainability (as proxied by the net operating result index) and administrative intensity in Australian universities. This approach has not been previously attempted in the empirical literature. Moreover, it could assist in developing policies to improve the performance of the Australian public university system. Secondly, the impact of administrative intensity on financial sustainability was examined in terms of university type. Finally, the impact of time was considered on the relationship between the financial sustainability index and administrative intensity in the presence of student size and control variables.

Our findings reveal that there was a significantly negative association between administrative intensity and financial sustainability at the 1% level of significance. Furthermore, we found that variations existed among various types of university and that these groups demonstrated a deterioration in financial sustainability in which the G08 group exerted a dominant influence on the entire sample in the surveyed period. The exogenous factors (i.e., the student-staff ratio, the proportion of international and indigenous students, the proportion of research income categories 1, 2 and 3, the proportion of various staff types and spatial location) have differential and significant effects on financial sustainability in the presence of administrative intensity and student size. Put differently, a divergence in the academic characteristics of universities in the different categories and different locations has a differential impact on the financial performance of universities. This implies that "one size fits all" public university policy settings may be inappropriate.

Our results contribute to the empirical literature in several ways. Firstly, whilst student size has long been recognized as a pivotal determinant of organizational performance in higher education, implying that student size has a differential impact on university financial performance (Andrews et al., 2017; Rutherford, 2016; Ryu & Christensen, 2019), we have established that administrative intensity is also a key factor that should be taken into account in empirical analysis of university performance. In addition, we have demonstrated that the time trend should be also included in regression models to capture changes in financial sustainability over time in a pooled data structure. Furthermore, our findings demonstrate that administrative intensity significantly affects financial sustainability in a U-shaped manner. This suggests that university managers should be wary of increasing administrative intensity given that it can weaken financial sustainability (Tran & Dollery, 2021; Boyne & Meier, 2013). Finally, given the heterogeneity among university types in the Australian public university system, public policymakers should tailor public policy intervention to meet the specific circumstances of the different categories of Australian university.

Whilst our paper has sought to investigate the impact of administrative intensity on financial sustainability (as proxied by the net operating result), we suggest that future empirical work in the area consider exploring the following avenues: (a) Investigate the influence of administrative intensity on other financial indicators representing financial sustainability in the Australian higher education sector that we have not covered in this paper. These financial indicators could potentially be affected by administrative intensity and other external factors. (b) Investigate if the time trend bears a nonlinear relationship with financial sustainability over a longer time span. This is important because university financial indicators can initially improve with additional administrative expenditure, but then decline. (c) Finally, examine the influence of administrative intensity on other exploratory variables with a bearing on university financial sustainability, especially given the interactive impact of administrative intensity on other exploratory variables that can potentially affect university financial performance.

Notes

1. Level B and below are equivalent to Assistant Professor and Instructor under the North American classification system.
2. Level C and above are equivalent to Associate Professor and Professor under the North American classification system (University College Cork, Ireland, 2022).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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