Lessons from Archimedes on Leveraging Medical Research Funding in the Post-COVID-19 Era

Wolfram A. Bosbach[1,2], Milena Mitrakovic[2], Keivan Daneshvar[2]

[1] Clinic of Nuclear Medicine, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland

[2] Department of Diagnostic, Interventional and Paediatric Radiology (DIPR), Inselspital, Bern University Hospital, University of Bern, Switzerland

Corresponding author: Wolfram A. Bosbach · WolframAndreas.Bosbach@Insel.ch

Wolfram A. Bosbach · https://orcid.org/0000-0003-4182-3516

Milena Mitrakovic · https://orcid.org/0009-0003-8990-7855

Keivan Daneshvar · https://orcid.org/0000-0002-0345-0379

Received: 6 August 2024 · Accepted and published: 18 August 2024

Swiss Journal of Radiology and Nuclear Medicine · https://www.sjoranm.com · SJORANM GmbH · Switzerland

Abstract

The COVID-19 pandemic has further increased pre-existing financial pressure on universities. Universities will face closure as a realistic scenario in the future, and need to compete for research success. Medical faculties are at a particular risk of being the subject of cost-cutting measures. In this challenging environment, using the concept of financial leverage is key for maximising financial possibilities.

Keywords: Archimedes; leverage of medical research funding; post-COVID-19 era; COVID-19; cost-cutting measures; financial possibilities

Introduction

Besides the loss of life [1], the COVID-19 pandemic has also had a substantial impact on the acceleration or slowing down of social developments. It is by now clear that changes to social policies which were considered impossible before the event will be less unlikely in the post- COVID-19 era. Ideally, the pandemic will have served as a catalyst for reforms to improve data reporting and, e.g., humanitarian responses [2]. For universities, the pandemic can mean that trends existing before will accelerate and affect each individual institution at greater scale sooner. The spreading use of virtual teaching will increase mobility of students and by that the competition for student talent between institutions. Financial outlook was challenging already before Corona; and in cases an existential threat to institutions [3, 4]. With not increasing revenues from student tuition, uncertain financial revenues from endowments, and uncertain future public subsidies from states burdened by COVID-19-related debt, research institutions must maximise their efficiency in using their available funds. Institutions that don't will face the risk of falling behind in worldwide competition, and the risk of eventual closure. In this context, the teachings handed down from Archimedes provide an important lesson.

Archimedes of Syracuse and Modern Financial Leverage

In the classical literature, Archimedes of Syracuse (Sicily) is a historical figure credited with truly ground-breaking work about the mechanics of levers and their equilibrium conditions [5]. None of his original writings have survived. It is disputable whether he actually lived, or whether he was a fictional character invented during later centuries. What is not disputable is that the ideas in his work have found their way into modern mechanics textbooks [6, 7]. Eq. 1 gives the equilibrium condition of Archimedes (Proposition 3) for 2 unequal weights attaching to a lever supported by a middle hinge. Fig. 1 provides the corresponding sketch with 2 forces (resulting from the 2 weights) and distances along the lever to the supporting middle hinge.

Open Access · CC BY 4.0 · © 2024 The Author(s) · Published by SJORANM GmbH, Switzerland
ISSN 2813-7221 · Swiss J. Radiol. Nucl. Med. 2024 11(1):6-10 · DOI 10.59667/sjoranm.v11i1.17

Equilibrium and Financial Leverage

$F_1 \times L_1 = F_2 \times L_2$ (Equation 1)

The lesser force F1 can balance the greater force F2 by using the leverage of the greater length L1. Archimedes writes further that, if F1 or F2 is increased under this equilibrium condition, the lever will tip towards the side of the increased force.

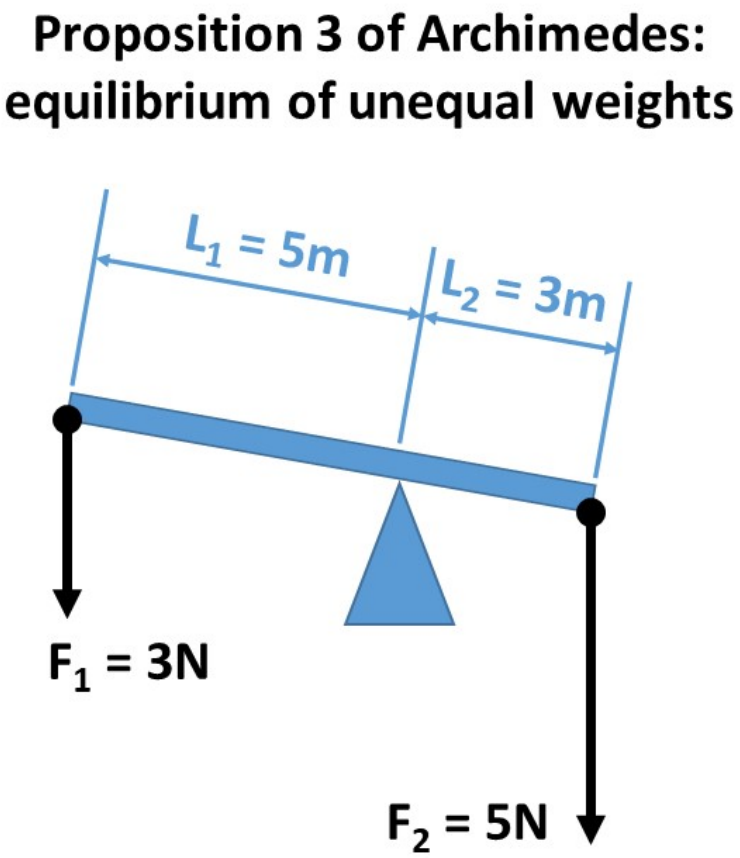


Figure 1. Classical Proposition 3 of Archimedes on the equilibrium of unequal weights attaching to a lever [5], confirmed by modern science, e.g., in [6].

This concept from classical mechanics has found its way into modern financial and business terminology. Business literature knows terms such as financial leverage, operating leverage, purchasing leverage, or cost leverage. In each case, a business variable is increased in its impact for the business's advantage by a certain leveraging factor. In finance, the idea of financial leverage θ (Equation 2) is to increase the business's deployable assets α (materials, staff, machines etc) by not using exclusively equity ε but also external funds [8]. When the idea of financial leverage originated is not entirely clear. It is found already in texts authored by Victorian writers in the 19th century [9].

$\theta = \alpha / \varepsilon$ (Equation 2)

θ: Financial leverage [-] · α: Assets deployable [$] · ε: Shareholder's equity [$]

Open Access · CC BY 4.0 · © 2024 The Author(s) · Published by SJORANM GmbH, Switzerland
ISSN 2813-7221 · Swiss J. Radiol. Nucl. Med. 2024 11(1):6-10 · DOI 10.59667/sjoranm.v11i1.17

Financial Leverage in Medical Research Funding – Short Case Study

How is the above related to research funding budgets in modern medical research? We want to demonstrate how to use successfully Equation 2 in medical research by a short case study.

A number of national funding bodies have established calls for proposals where if approved material costs, for example, may be only partially covered [10, 11]. A project's funding gap must be provided for by the host institution. The US National Science Foundation (NSF) pays through its postdoctoral fellowship, for example, an annual personal allowance of USD 54,000 to the fellow and provides material funds capped annually at USD 15,000. The fellowship runs for the duration of 3 years [10]. There are projects where annual material funding of the mentioned amount will suffice. Other projects might realistically require greater material funds. Examples of expensive medical research today are work on Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) or projects with new imaging equipment. In such a situation of non-self-sufficient project budgeting, the principal investigator (PI) or the faculty must decide whether they want to refrain from submitting to the NSF call, or submit and accept that they will have to subsidise the project if approved. In the following, we assume that an additional USD 20,000 will be necessary annually for funding the project's material cost. Figure 2 shows the 2 action options which a PI has in the current business case. He or she has to decide how to spend USD 60,000 of funds, provided these funds are at his or her disposal.



Figure 2. Action options for a PI who considers submitting to the NSF call [10] under a constellation that a project would require additional annual material funds of USD 20,000 for 3 years.

Table 1 calculates the obtainable financial leverage for the decision-making problem defined for the PI in Figure 2, Equation 2 [8]. It can be seen that under scenario-1 (no submission to the NSF call), a spending of USD 60,000 (own assets, and equity) leads to the lowest leverage possible 1.00. If under scenario-2 an approval is obtained from the NSF, the combination of own assets (USD 60,000) with NSF-assets (USD 207,000) increases the total deployable assets to USD 267,000; the financial leverage taking values > 1, to be precise 4.45.

Table 1. Financial leverage as defined in Equation 2 for the decision-making problem in Figure 2 and for RELX Group plc 2020 balance sheet [12].

	Scenario-1 Not applying for NSF funds USD in thousand	**Scenario-2 Applying for NSF funds USD in thousand**	**RELX Group 2020 Elsevier holding company GBP in million**
NSF-assets	$ –	$ 207	na
Own assets	$ 60	$ 60	na
Total deployable assets	$ 60	$ 267	£ 14,145
Equity	$ 60	$ 60	£ 2,101
Financial leverage	**1.00**	**4.45**	**6.73**

Open Access · CC BY 4.0 · © 2024 The Author(s) · Published by SJORANM GmbH, Switzerland
ISSN 2813-7221 · Swiss J. Radiol. Nucl. Med. 2024 11(1):6-10 · DOI 10.59667/sjoranm.v11i1.17

Financial Analysis and Research Funding

From the viewpoint of financial leverage, idea-1 in Figure 2 (saving USD 60,000) is short-sighted and does not maximise financial possibilities. The International Financial Reporting Standards Foundation (IFRS) requires for more in-depth analyses of business finances specific consolidated statements. These are a balance sheet (assets, liabilities, and equity), a cash flow statement and a statement of profit or loss (income less expenses) [13]. Scenario 2 would not influence negatively the IFRS cash flow statement; NSF funds of USD 207,000 flow in and the same funds flow out. Scenario-2 does not lead to financial loss; income and expenses both increase by USD 207,000. The IFRS balance sheet sees a so-called balance sheet extension; assets increase by USD 207,000 which increases total balance sheet sum. By due diligence following IFRS rules, scenario-2 and participation in the NSF call does not influence negatively a PI's finances. It must be mentioned that the external funds from the NSF do not lead to interest payments of the PI as would a bank loan taken up by a business.

Most readers will be familiar with the products and services of the RELX Group plc. It is the holding company of the Elsevier Corporation from Amsterdam (Netherlands). In the RELX Group's 2020 annual report, its statement of profit or loss is found on p. 132 and its cash flow statement on p 134, and the balance sheet on p 135 [12]. With the information from the 2020 balance sheet, the group's 2020 financial leverage can be calculated (Table 1). The group wide financial leverage in 2020 totalled at 6.73. Financial leverage of individual projects or investments the group undertook (eg the investment into the Elsevier Corporation) can be higher or lower than the group-wide value.

In a more complex business case where a PI can choose from multiple funding calls, it is useful to calculate financial leverage for each call. The PI can then allocate funds available for subsidising projects first to projects with greatest leverage.

Using Financial Leverage Mandatory for Successful Medical Research

In the post-COVID-19 era, with financial income under pressure, research institutions must leverage their finances through external sources [10, 11]. Competition between universities realistically will increase [3]. Universities will have even more to distinguish themselves through research success. Researchers, and in particular the ambitious ones, are mobile. Universities are not; they must compete against other universities in attracting the brightest minds. Faculty funds for subsidising a PI's budget when winning the mentioned NSF call [10] (or one of many other calls) is one chance for faculties to accentuate their thriving for excellence. A lever as in Fig. 1 [5] requires a supporting hinge. Jean-Jacques Rousseau made the analogy that very large levers require the shoulders of Heracles as support [14]. In research funding, the faculties need to assume that role of Heracles. The closure of outstanding institutions is a real-world scenario [4]. Also in states which traditionally provide reliable public funds to universities, divestment of the state occurred in the pre-COVID-19 era [15]. Medical faculties are especially at risk of attracting cost-cutting measures. The cost of maintaining a faculty for medical research is far greater than the cost of, e.g., an arts faculty.

Conclusion

The question will not be whether to work on financial leverage following the concept of Archimedes; rather, the question is how best to use it.

Open Access · CC BY 4.0 · © 2024 The Author(s) · Published by SJORANM GmbH, Switzerland
ISSN 2813-7221 · Swiss J. Radiol. Nucl. Med. 2024 11(1):6-10 · DOI 10.59667/sjoranm.v11i1.17

Correspondence

Wolfram A. Bosbach, MD PhD · Clinic of Nuclear Medicine, Inselspital · Bern University Hospital · University of Bern · CH-3010 Bern · Switzerland · WolframAndreas.Bosbach@Insel.ch



Wolfram A. Bosbach

Conflict of Interest

The authors declare that there were no conflicts of interest within the meaning of the recommendations of the International Committee of Medical Journal Editors when the article was written.

Disclaimer and Publisher's Note

The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of Swiss J. Radiol. Nucl. Med. and/or the editor(s). Swiss J. Radiol. Nucl. Med. and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

References

1. Pifarre i Arolas H, Acosta E, Lopez-Casasnovas G, Lo A, Nicodemo C, Riffe T, et al. Years of life lost to COVID-19 in 81 countries. Sci Rep. 2021;11:3504. https://doi.org/10.1038/s41598-021-83040-3
2. Spiegel PB. Will this pandemic be the catalyst to finally reform humanitarian responses? Nat Med. 2021;27:365. https://doi.org/10.1038/s41591-021-01249-1
3. Witze A. Universities will never be the same after the coronavirus crisis. Nature. 2020;582:162-164. https://doi.org/10.1038/d41586-020-01518-y
4. Small Z. San Francisco's Top Art School Plans Closing After Almost 150 Years. The New York Times [Internet]. 2020 Mar 24. https://www.nytimes.com/2020/03/24/arts/design/san-francisco-art-institute-coronavirus.html
5. Archimedes of Syracuse. On the equilibrium of planes or the centres of gravity of planes - Book I. In: Heath TL, editor. The Works of Archimedes [Internet]. Cambridge (UK); 1897 [cited 2021 Mar 20]. https://archive.org/details/worksofarchimede029517mbp/page/n377/mode/2up
6. Gross D, Hauger W, Schröder J, Wall WA, Rajapakse N. Engineering Mechanics 1: Statics. Heidelberg (Germany); 2009. https://doi.org/10.1007/978-3-540-89937-2
7. Reddy JN. An Introduction to the Finite Element Method. 3rd ed. New York (NY): McGraw-Hill Higher Education; 2006. ISBN 978-0-07-246685-0. https://search.worldcat.org/title/An-introduction-to-the-finite-element-method/oclc/56387129
8. Palepu KG, Healy PM. Business Analysis & Valuation: Using Financial Statements. 5th ed. Mason (OH): South-Western Cengage Learning; 2013. ISBN 978-1-111-97230-1. https://ndlsearch.ndl.go.jp/books/R100000136-I1970867909775189761
9. Lyall A. The Rise and Expansion of the British Dominion in India. 3rd and enlarged ed. London (UK): John Murray; 1894. https://search.worldcat.org/title/The-rise-and-expansion-of-the-British-Dominion-in-India/oclc/13718869
10. National Science Foundation. Postdoctoral Research Fellowships in Biology (PRFB). Program Solicitation NSF 20-602 [Internet]. Alexandria (VA); 2020 [cited 2021 Mar 20]. https://www.nsf.gov/funding/opportunities/prfb-postdoctoral-research-fellowships-biology/503622/nsf20-602/solicitation
11. Alexander von Humboldt Foundation. Humboldt Research Fellowships for postdoctoral researchers [Internet]. Programme information. Berlin (Germany); 2019 [cited 2021 Mar 20]. https://www.humboldt-foundation.de/fileadmin/Bewerben/Programme/Humboldt-Forschungsstipendium/humboldt-fellowship_programme_information.pdf
12. RELX Group plc. RELX Annual Report and Financial Statements 2020 [Internet]. London (UK); 2021 [cited 2021 Mar 21]. https://www.relx.com/investors/annual-reports/2020
13. International Financial Reporting Standards Foundation. IFRS Standards Issued at 1 January 2021. London (UK); 2021. ISBN 978-1-911629-90-0. https://www.ifrs.org/issued-standards/
14. Rousseau J-J. Du contrat social ou principes du droit politique. Amsterdam: Marc-Michel Rey; 1762. https://catalogue.bnf.fr/ark:/12148/cb12026984n
15. Maisch B. A paradigm change in German academic medicine: merger and privatisation as exemplified with the university hospitals in Marburg and Giessen. Herz. 2005;30(2):153-158. https://doi.org/10.1007/s00059-005-2679-4

Open Access · CC BY 4.0 · © 2024 The Author(s) · Published by SJORANM GmbH, Switzerland
ISSN 2813-7221 · Swiss J. Radiol. Nucl. Med. 2024 11(1):6-10 · DOI 10.59667/sjoranm.v11i1.17