

# Learnings from Archimedes on the leverage of medical research funding in the post-Corona era

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## Abstract

The Corona pandemic has increased pre-existing financial pressure on universities further. 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-Corona era, COVID-19, cost-cutting measures, financial possibilities

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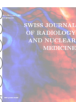
## Introduction

Besides the loss of life (1), the corona pandemic also has had 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-Corona era. In the ideal case, the pandemic will have served as a catalyst for reforms to better data reporting and eg humanitarian response (2). For the university landscape, 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 unsure future public subsidies from Corona-debt plagued states, 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 import 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 hand writings have survived the times. 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.

$$F_1 * L_1 = F_2 * L_2 \quad \text{Eq. 1}$$



The lesser force  $F_1$  can balance out the greater  $F_2$  by using the leverage of the greater length  $L_1$ . Archimedes writes further that if in that equilibrium condition  $F_1$  or  $F_2$  is increased, the lever will tip to the side of the increased force.

### Proposition 3 of Archimedes: equilibrium of unequal weights

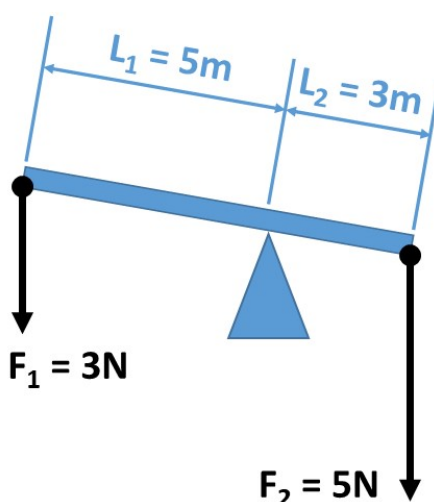


Fig. 1: Classical Proposition 3 of Archimedes on the equilibrium on unequal weights attaching to a lever (5) confirmed by modern science in eg (6)

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**  $\theta$  (Eq. 2) is to increase the business's deployable assets  $\alpha$  (materials, staff, machines etc) by not using exclusively equity  $\varepsilon$  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 19<sup>th</sup> century (9).

$$\theta = \alpha / \varepsilon \quad \text{Eq. 2}$$

$\theta$  : Financial leverage [-]

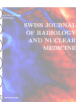
$\alpha$  : Assets deployable [\$]

$\varepsilon$  : Shareholder's equity [\$]

### 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 Eq. 2 in medical research by a short case study.

A number of national funding bodies have established calls for proposals where if approved material cost eg only partially will be 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 eg a personal annual 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. Fig. 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.

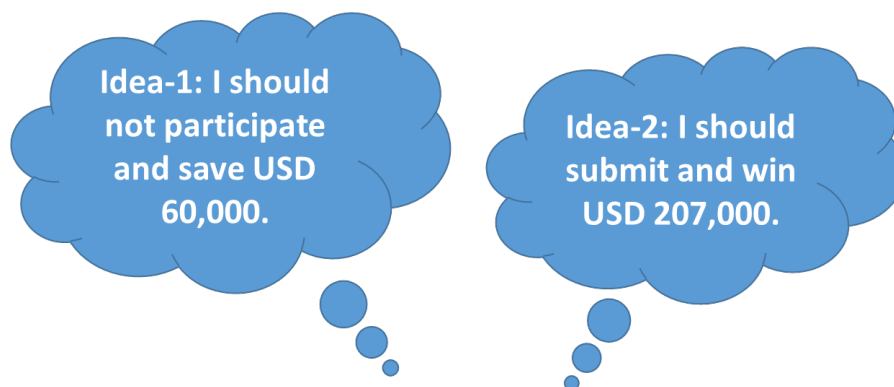


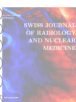
Fig. 2: Action options for a PI who considers submitting to the NSF call (10) under a constellation that a project would require additional annual material funds of USD 20,000 for 3 years

Table a calculates the obtainable financial leverage for the decision making problem defined for the PI in Fig. 2, Eq. 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.

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

Table a: Financial leverage as defined in Eq. 2 calculated for decision making problem of Fig. 2 and for RELX Group plc 2020 balance sheet (12)

From the viewpoint of financial leverage, idea-1 in Fig. 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 consoli-



dated statements. These are a balance sheet (assets, liabilities, and equity), a cash flow statement, and a Profit-Or-Loss statement (income, reduced by 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, the group's Profit-Or-Loss statement is found on p 132, the 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 a. 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 greater/less 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.

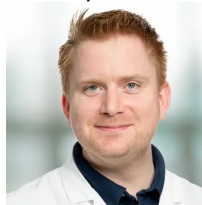
### Using financial leverage mandatory for successful medical research

In the post-Corona future with financial incomes under pressure, research institutes 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 take that Heracles role. 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 has happened in the pre-Corona 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 eg an arts faculty.

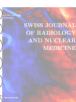
### Conclusion:

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

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**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.

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