Perspectives on Institutional Bridge-Funding Policies and Strategies in the Biomedical Sciences

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Abstract: *Bridge-funding by tertiary-educational institutions allows researchers to continue their research in times of funding loss. With the ever-declining funding rates for major medical research institutions in North America, and the global economic downturn, it is crucial to critically assess institutional policies surrounding the allocation of bridge-funding. We review the theoretical framework of bridge-funding decisions and present theoretical factors that determine the success of bridge-funding. We also report the results of an online survey of bridge-funding policies in major medical research institutions in North America.*

Keywords: *Bridge-funding, research administration, research management, research leadership*

Introduction

With steadily declining funding success rates for academic research by major funding organizations in North America, such as the National Institutes of Health (NIH) and the Canadian Institutes of Health Research (CIHR), academic researchers are facing month-by-month uncertainty with respect to the financial stability and sustainability of their research programs. The NIH funding success rates for first time operating research grants (R01 and equivalent) has dropped from 38% in 1998 to 18% in 2015 (NIH, 2015), and the success rates of CIHR open operating grants have dropped from 33% in 2005 to 18% in 2014 (CIHR, 2014). Significant and unexpected reductions in funding success rates inevitably increase the probability that any academic research program will encounter a period of underfunding or complete lack of funding. This phenomenon is putting pressure on research-intensive tertiary education institutions (TEIs) who historically have financially supported underfunded researchers between grants with bridge-funding. The slow recovery of the global economy from the financial crisis of 2007-8 (IMF, 2014) has eroded the financial stability of most TEIs, causing internal research funding programs to be stretched thin (Glied, Bakken, Formicola, Gebbie, & Larson, 2007; Holbrook & Sanberg, 2013; Neiman, 2013).

Bridge-funding is a mechanism by which institutions can financially support a researcher or research group between external grant funding periods. As the name implies, this is not intended to be a perpetual source of operational funds, but to "bridge" the financial gap between past and future external funding. When executed successfully, it creates a win-win situation: the researcher is able to continue his/her research program and career progression; the institution

retains a productive research asset, while emboldening other researchers in the institution with a sense of security that facilitates their own research decisions (Glied et al., 2007; Neiman, 2013). When executed poorly, the researcher's career is unnecessarily drawn out and internal funds are depleted. Hence, the decision of who or what to bridge-fund, for how much, for how long, and what conditions should accompany bridge-funding is paramount, particularly in these times when other sources of income for institutions are also uncertain. Indeed, Paul Neiman (the first director of the Basic Sciences Division of the Fred Hutchinson Cancer Research Center, Seattle, WA) states in reference to decision-making in bridge-funding management: "*In times of financial stress there may be no other more important need for a research institution to address*" (Neiman, 2013, p. 17).

Despite the importance of institutional bridge-funding mechanisms for the stability of research careers and the global academic research system as a whole, there is surprisingly little literature on the policies, strategies and management of bridge-funding schemes. Given this scarcity of information, much of this paper will draw upon opinion-based literature and personal observation. To address the deficiency of data on the topic, a brief analysis of publicly available policy documents on bridge-funding from medical faculties in North America will be presented. This document does not attempt to critically evaluate the effectiveness of particular bridge-funding strategies—although such studies are particularly warranted. Instead, it attempts to provide a considered perspective on current bridge-funding strategies and the rationale behind these schemes. .

Who, what and how to bridge-fund: application of the principles of cost-benefit analysis

In a perfect world, all researchers who request bridge-funding would be supported at the level and term requested. In reality, the institution is most likely to provide bridge-funding to a proportion of those researchers who are underfunded and at a level that may be suboptimal (Glied et al., 2007). Hence, those in academic leadership positions need to strategically allocate bridge funds to maximize institutional sustainability and do so in a logical and defensible manner (Taylor, 2006). The simplest economic principle that could be theoretically applied to strategic allocation of funds in a business decision would be cost-benefit analysis (CBA). Simply, the objective of the CBA would be to calculate the ratio between the estimated costs and the total anticipated benefit (Scarborough & Bennett, 2012). For determining bridge-funding for individual cases, a simple CBA would ideally identify the lowest bridge-funding amount and the shortest possible time that would give the greatest return (e.g., facilities and administrative (indirect) costs from future external grants). If it were anticipated that the costs outweigh the benefit, bridge-funding—purely from a CBA perspective—is not a sound investment. When establishing priorities to optimally deal with multiple bridge-funding requests and finite funds, applying CBA principles can assist in determining a strategy to reach Pareto optimality (an equilibrium reached through allocation of resources where no one person can be made better off without someone else being made worse off (Scarborough & Bennett, 2012)). While the core principles of CBA and Pareto efficiency are rational approaches, their application to setting bridge-funding priorities becomes more complex, particularly because predicting the benefits of bridge-funding in different cases and quantifying

the non-monetary advantages are at best unreliable (Kern, 2011; Nelson, 2006). While risk can be incorporated into CBA using probability algorithms, the complexity of calculating risk and the vague parameters precludes a strictly analytical approach. Hence, qualitative indicators should be used to guide reasonable predictions of the probabilities and the magnitude of benefit.

Given the topic, it is almost impossible to resist the physical "bridge" analogy. Merriam-Webster defines a bridge as "a structure carrying a pathway or roadway over a depression or obstacle" (Bridge, n.d.). Likewise, bridge-funding is a financial structure that may allow the researcher or research group to survive a downturn in funding. When building a physical bridge, however, the other side of the gap is visible and the decision how and whether to build the bridge is simplified. Deciding the format and whether or not to bridge-fund a researcher is complicated by the uncertainty of what, if anything, does the bridge-building link to in the future? Nonetheless, the analogy illustrates some of the outcomes of bridge-funding in an obvious manner. Three world-renowned bridges will be used to illustrate three bridge-funding scenarios: the Peace Bridge between New York State and Ontario; the Seven Mile Bridge in the Florida Keys; and the Bridge to Nowhere in Whanganui National Park, New Zealand.

Low cost: high benefit —The Peace Bridge

The Peace Bridge was completed in 1927, joining the USA and Canada across the Niagara River (Figure 1). This single bridge allows safe passage from one expansive land mass to another. This example is an optimal outcome of bridge-funding. The researcher with a solid track record uses bridge-funding to allow his/her research team to return to solid, consistent, externally sponsored program funding. Researchers who have a high probability of falling into the "Peace Bridge" category should be obviously prioritized for bridge-funding. Additionally, the level of bridge-funding should be sufficient to allow the researcher to maintain productivity and research personnel during the bridging period (Perkel, 2012). Hence bridge-funding may not be "low cost" (as the subtitle states), but it is "cost-effective" as the researcher does not lose skilled personnel, research models or momentum on key projects that are needed to win future funding. Predictors of researchers that fit into the Peace Bridge category may include:

- Established investigator (mid-career or mid-late-career),
- Consistent funding record through a number of external funding agencies (multiple overlapping grants in a diversified portfolio)*,
- A defined and stable research program that aligns with the funding priorities of major external granting agencies,
- Studying an area that shows an upward or stable trend in funding success*,
- Previously received little or no internal funding support,
- High scores and positive reviews on recent unsuccessful grant applications and the ability to address stated deficits,
- Consistent or increasing publication output of high impact*,
- Good reputation in the field,

- Significant protected time for research,
- Indicators of a high level of enthusiasm, personal effectiveness and dedication to research activities,
- Record of collaboration and willingness to collaborate with other researchers*,
- Highly effective, well-trained research team, and
- State of the art infrastructure/instrumentation and/or unique model systems.

(*adapted from Perkel, 2012)

Figure 1. The Peace Bridge. Photograph by Óðinn. Source: Creative Commons (Óðinn, 2008).

High cost: low benefit — The Seven Mile Bridge

The Seven Mile Bridge connects Knight's Key to the Little Duck Key in Florida (Figure 2). It is one of the middle sections of the Overseas Highway connecting mainland US to the Florida Keys via a series of forty-two bridges. Travelling south on the Ocean Highway, a traveler will spend a significant amount of time on bridges and end up at a quaint, but small land mass, Key West. This type of bridge-funding is less than optimal. The researcher has already received a disproportionate level of internal funds and in the future will require significant bridge-funding to span the multiple gaps between sporadic external grants. In this scenario, researchers may be given low priority for future bridge-funding (or other internal funding schemes). Many TEIs have

strict policies that preclude serial bridge-funding of researchers; however, funding may be allowed under special circumstances (see below) (Lange, Riskin, Brainard, & Denton, 2003). Predictors of researchers that fit into the Seven Mile Bridge category may include:

- Early- or late-stage researcher,
- Inconsistent funding record*,
- A constantly changing project-based or case-based research program,
- Previously held regular internal funding support,
- Inconsistent scores and reviews on previous grant applications,
- Little alignment of area of study with priorities of major external granting agencies,
- Studying an area of low relevance or considered antiquated by funding agencies*,
- Sporadic publication output*,
- Low impact output*,
- No reputation in the field,
- High turnover in research personnel and
- High commitment to teaching or administrative activities

(*adapted from Perkel, 2012)

Figure 2. The Seven Mile Bridge. Photograph by I. Matrek. Source: Creative Commons (Matrek, 2009).

Low cost: no benefit — The Bridge to Nowhere

The "Bridge to Nowhere" is a bridge over the Mangapurua Gorge in the Whanganui National Park in New Zealand (Figure 3). Constructed in 1936, before roads were built in the area, the bridge still stands without roads leading to it in either direction, as the terrain was deemed unsuitable to farm or inhabit. With respect to bridge-funding, this is the lowest possible priority. Even if the level of bridge-funding required is minimal, it does not increase the possibility of future funding success, making the benefit zero. Strictly speaking from a CBA perspective, such bridge-funding is a poor investment and funds would be best spent elsewhere. Predictors of researchers that fit into the Bridge to Nowhere category may include:

- No or outdated funding record*,
- No recognizable research program,
- Low scores and negative reviews on previous grant applications or no previous applications,
- Inability to address stated deficits in previous unsuccessful grant applications,
- No alignment of area of study with priorities of major external granting agencies,
- Studying an area of low relevance or considered antiquated by funding agencies*,
- Low publication output*,
- Low impact output*,
- No reputation in the field,
- Little or no protected time for research and
- Indicators of a low level of enthusiasm, personal effectiveness and a lackadaisical approach to research activities.

(*adapted from Perkel, 2012)

Figure 3. The Bridge to Nowhere. Photograph by J. Ebrey. Source: Creative Commons (Ebrey, 2005).

Other considerations: Special Circumstances

CBA and Pareto efficiency approaches do not recognize social aspects of allocation of funds such as fairness, social justice and contribution or alignment with other strategic objectives of the institution (Scarborough & Bennett, 2012; Sen, 1993). When assigning priority to bridge-funding schemes, consideration of circumstances that fall out of the simple CBA calculations can be essential to build and sustain trust and morale as well as to support diversity within the TEI (Lintz, 2008; Taylor, 2006). Although many policy documents do not specifically list special circumstances, several articles outline the need for prioritizing specific faculty for bridge-funding based on circumstances such as gender, maternity/paternity or health leaves, mid-career scientists and regulatory obstruction of research (Baldwin, DeZure, Shaw, & Moretto, 2008; Chapman & Guay-Woodford, 2008; Dankoski, Palmer, Laird, Ribera, & Bogdewic, 2012; Fried et al., 1996; Gross, 2007; Holleman & Gritz, 2013; Jagsi, Butterton, Starr, & Tarbell, 2007; Powell, 2010; 2011; Whiteside et al., 1997). Other considerations that can be strategically used to retain the vitality and further the mission of the TEI include maintaining graduate education standards, enhancing the teaching-research nexus, promoting innovation and alignment with research priorities of the faculty or institution (Neiman, 2013; Shine, 1997; Wilkerson & Irby, 1998).

Referenced is a case study that examined the outcomes of a targeted bridge-funding program addressing the needs of women and maternity in academic research, highlighting the need for inclusion of special considerations in bridge-funding strategies. In 1997, Massachusetts General Hospital created a bridge-funding program to specifically address the challenges facing women research faculty during their reproductive years (Fried et al., 1996; Jagsi et al., 2007; Jagsi et al., 2006). The bridge-funding "Claflin Awards" aimed to increase retention and long-term productivity of women faculty. Findings from the longitudinal study conducted in 2005-2006 found that the Clafin program increased faculty retention, productivity and academic promotion of the awardees. Furthermore, the cost of the targeted bridge-funding program was dramatically offset by the subsequent external funding attracted by the awardees (Jagsi et al., 2007). Hence, the implementation of a bridge-funding strategy that specially targeted a sub-population of faculty not only was considered socially-responsible and built morale but it also resulted in a favorable cost-benefit ratio. This example highlights the complexity of the CBA related to bridge-funding decisions and the deficiency in many of the bridge-funding policies with respect to special considerations.

Survey of bridge-funding policies from North American medical faculties

Since very little literature is dedicated to the policies and management of bridge-funding schemes, a brief analysis was conducted by the authors of the current bridge-funding policy documents from 28 North American medical faculties. The choice of faculties included in the study was based on the following criteria:

- research-intensive medical faculty,
- accredited by the Association of American Medical Colleges (AAMC), and
- current and comprehensive bridge-funding policy document that was publicly available through the internet (AAMC, 2014).

A list of the 28 medical faculties examined is found in the appendix. Given these criteria, the data are biased towards faculties that have transparent and comprehensive bridge-funding programs. Bridge-funding policy documents for each of the faculties were downloaded for analysis. Following review of a sub-selection of seven documents, a series of criteria/questions were defined and were subsequently used to extract data from all 28 documents. These data were tabulated and categorized according to parameters that addressed: 1) eligibility; 2) factors and process of funding decisions; and 3) the terms of the bridge-funding awards. Although limited in scope, to the authors' knowledge this is the most exhaustive comparison of bridge-funding policies of any medical faculties to date.

Eligibility for bridge-funding

Table 1. Survey of criteria that determined eligibility for faculty bridge-funding.

Eligibility	**Yes**	**No or not specified**	**Not determined**	**Total**
Must have submitted an unsuccessful grant application to a major agency	27 (96%)	1 (4%)	0 (0%)	28 (100%)
Must hold a full-time primary appointment	23 (82%)	5 (18%)	0 (0%)	28 (100%)
Dependent of previous bridge-funding history (terms vary)	19 (68%)	9 (32%)	0 (0%)	28 (100%)
Dependent on matching funds provided by department/school	13 (46%)	15 (54%)	0 (0%)	28 (100%)

Review of the 28 policy documents revealed considerable overlap with respect to the parameters that determined the eligibility of applicants for bridge-funding (Table 1). Almost all institutions (27/28) required that the researcher had applied for and been unsuccessful for grant funding by a major funding organization (e.g., NIH). Parameters of the unsuccessful grant application and reviews were also extensively used to determine the bridge-funding priority. Unsurprisingly, the majority of the institutions (23/28) specified that applicants had to hold a full time primary appointment, with two faculties stipulating that these must be tenured or tenure-track appointments. The majority of institutions also used the previous bridge funding history of potential applicants to determine eligibility (19/28). Terms varied significantly with some institutions excluding all applicants who had received any bridge-funding (11/28), while others restricted new bridge-funding to those with a history of bridge-funding over the prior 1-5 years (5/28). The variation on the requirement for matching funds by departments or schools (13/28) most likely reflects the diversity of institutional-departmental financial relationships.

Factors and process of funding decisions

Table 2. Survey of criteria and process used to determine faculty bridge-funding priority.

Priority determined by	Yes	No or not specified	Not determined	Total
Received a high score/favorable reviews on unsuccessful grant application	20 (71%)	8 (29%)	0 (0%)	28 (100%)
Demonstration of previous continuous funding	20 (71%)	8 (29%)	0 (0%)	28 (100%)
Likelihood of success in next grant application	25 (89%)	3 (11%)	0 (0%)	28 (100%)
Merit of research topic	20 (71%)	8 (29%)	0 (0%)	28 (100%)
Research proposal's ability to increase chance of grant success	20 (71%)	8 (29%)	0 (0%)	28 (100%)
Value of faculty member	8 (29%)	20 (71%)	0 (0%)	28 (100%)
Financial need	7 (25%)	12 (75%)	0 (0%)	28 (100%)
Internal review of unsuccessful grant	3 (11%)	25 (89%)	0 (0%)	28 (100%)
Process involving recommendation by internal committee	20 (71%)	5 (18%)	3 (11%)	28 (100%)
Unilateral decision by the Associate Dean of Research (or equivalent)	5 (18%)	20 (71%)	3 (11%)	28 (100%)

The criteria and process used to rank, prioritize or decide upon applications for bridge-funding displayed minimal variability (Table 2). There was significant commonality between policy documents with respect to prioritizing those applications that have the greatest chance of being awarded grants in the future (25/28), and those that had scored well in the last funding cycle (20/28). Demonstration of previous and continuous funding success was also used to rank applicants by many institutions (20/28). Interestingly, only a few policies prioritized based on the financial need of the applicant (7/28). Anecdotally, several stated that a significant reduction in grant revenue was sufficient to justify bridge-funding in order to maintain research momentum irrespective of the total funds held by the investigator. Much emphasis was also placed on the bridge-funding proposal itself by the majority of institutions and the ability to increase the chance of grant success in the next granting cycle (20/28). Several documents specifically asked applicants to address previous reviews and outline how the proposed work would strengthen the resubmission of the unsuccessful grant. Other, rather ill-defined, criteria used by some institutions to evaluate bridge-funding applications included "value of the faculty member" (8/28) and "merit of the research topic" (20/28). The specific parameters of what determined value and merit were nebulous. The process by which the bridge-funding applications were ranked and awarded also varied. The majority of institutes (20/28) evaluated the applications by committee, whereas 5

out of 28 stipulated that it was entirely at the discretion of the Associate Dean of Research (or equivalent).

Terms and levels of bridge funding awards

Table 3. Survey of term and conditions of faculty bridge funds.

Terms of bridge funding	**Yes**	**No or not specified**	**Not determined**	**Total**
Set maximum on amount awarded (cap)	24 (86%)	4 (14%)	0 (0%)	28 (100%)
Maximum term of one year	24 (86%)	3 (11%)	1 (4%)	28 (100%)
Maximum term of two years	3 (11%)	24 (85%)	1 (4%)	28 (100%)
Requirement to repay	1 (4%)	27 (96%)	0 (0%)	28 (100%)

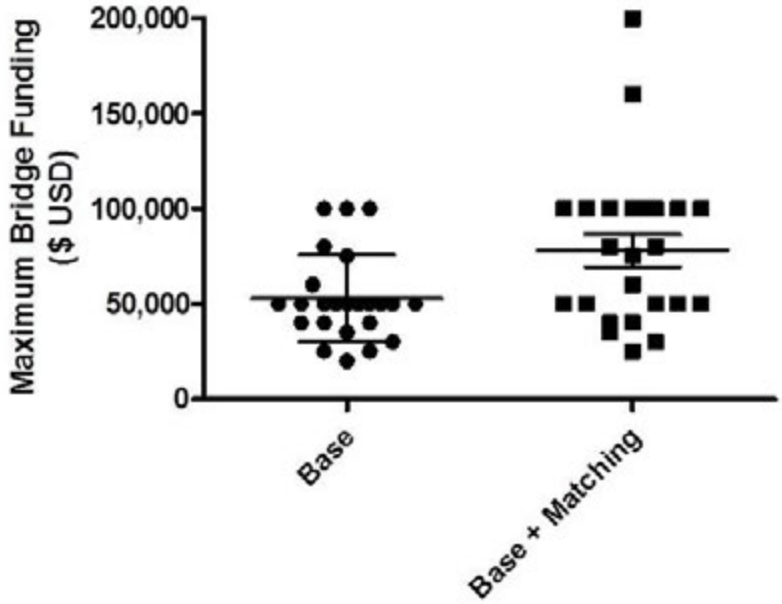

Figure 4. Maximum bridge-funding allowable as stipulated by 24 out of 28 bridge-funding policy documents from North American institutions. As some policies required matching funds from departments or schools, these amounts have been included in the right column

Review of the terms of the bridge-funding polices revealed a high degree of similarity between programs. The vast majority had a limited term of one year (24/28) and a cap on the maximum amount of funds that can be awarded (24/28). The maximum amount varied considerably between institutions (Figure 4). Other conditions of the award included requirements of regular or final progress reports, internal review of future grant submissions and in, one case, a requirement to pay back the bridge funds from the "indirect cost recovery" funds that the department received for future grants from the funded investigator.

Closing Remarks

There are common themes in the allocation of bridge-funding in medical research institutions in North America. In most institutions, eligibility relied on the applicants applying for or previously holding major external grants (most commonly NIH funding), having a full-time and primary appointment in the faculty or department providing the bridge-funding, and not having held bridge-funding in the recent past. Eligible applications were then commonly ranked based on their likelihood of securing funding in the next granting cycle (ensuring the highest "benefit" for institutes in a CBA model). This likelihood was assessed based on favorable review scores in the recently failed grant cycle and on a previous strong history of external funding. Finally, institutions in general required that bridge-funding applicants include a detailed plan of how the investigator would re-establish external funding within a year of the bridge-funding period. Together, these criteria support selecting faculty members that commonly are aligned with the "Peace-Bridge" or low cost: high benefit theoretical model of bridge-funding. These applicants had the highest likelihood of re-establishing independent funding in a short period of time.

In this age of declining grant funding success rates, institutional bridge-funding programs are becoming increasingly critical to the maintenance and progression of academic research (Glied et al., 2007; Holbrook & Sanberg, 2013). Concomitantly, the economic instability of TEIs and oversubscription to bridge-funding programs are forcing academic leaders to make arduous decisions in order to preserve and promote sustainable research within their department or institution (Neiman, 2013). Robust, logical and defensible bridge-funding policies should be the cornerstone of future bridge-funding programs. Moreover, quantitative studies that ascertain the effectiveness of particular bridge-funding policies, particularly with respect to special circumstances, are critically needed to direct effective bridge-funding strategies.

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References

AAMC. (2014). Association of American Medical Colleges. Retrieved September 2014, from www.aamc.org

Baldwin, R., DeZure, D., Shaw, A., & Moretto, K. (2008). Mapping the terrain of mid-career faculty at a research university: Implications for faculty and academic leaders. *Change: The Magazine of Higher Learning*, 40(5), 46-55. doi:10.3200/CHNG.40.5.46-55

Bridge. (n.d.). Retrieved October 18, 2016, from https://www.merriamwebster.com/dictionary/bridge

Canadian Institutes of Health Research [CIHR]. (2014). Application and funding statistics OOGP and related programs. *CIHR Reports*. Retrieved from http://www.cihr-irsc.gc.ca/e/47960.html#fig1

Chapman, A. B., & Guay-Woodford, L. M. (2008). Nurturing passion in a time of academic climate change: The modern-day challenge of junior faculty development. *Clinical Journal of the American Society of Nephrology*, 3(6), 1878-1883. doi:10.2215/CJN.04240808

Dankoski, M. E., Palmer, M. M., Laird, T. F. N., Ribera, A. K., & Bogdewic, S. P. (2012). An expanded model of faculty vitality in academic medicine. *Advances in Health Sciences Education*, 17(5), 633-649. doi:10.1007/s10459-011-9339-7

Ebrey, J. (2005, January 5). The Bridge to Nowhere in Whanganui National Park [Digital image]. Retrieved from *Creative Commons,* https://commons.wikimedia.org/w/ index.php?curid=3691701

Fried, L. P., Francomano, C. A., MacDonald, S. M., Wagner, E. M., Stokes, E. J., Carbone, K. M., & Stobo, J. D. (1996). Career development for women in academic medicine: Multiple interventions in a department of medicine. *JAMA, 276*(11), 898-905. doi:10.1001/jama.1996.03540110052031

Glied, S., Bakken, S., Formicola, A., Gebbie, K., & Larson, E. L. (2007). Institutional challenges of interdisciplinary research centers. *Journal of Research Administration*, 38(2), 28-36. Retrieved from http://files.eric.ed.gov/fulltext/EJ902222.pdf

Gross, L. (2007). Stem cell promise, interrupted: How long do US researchers have to wait? *PLoS Biology*, 5(1), e32. doi:10.1371/journal.pbio.0050032

Holbrook, K. A., & Sanberg, P. R. (2013). Understanding the high cost of success in university research. *Technology and innovation,* 15(3), 269. doi:10.3727/194982413X13790020922068

Holleman, W., & Gritz, E. R. (2013). Biomedical burnout. *Nature, 500*(7464), 613-614. doi:10.1038/nj7464-613a

International Monetary Fund [IMF]. (2014, April 2). Global economy turning corner of Great Recession, but obstacles ahead. *IMFSurvey Magazine*. Retrieved from http://www.imf.org/external/pubs/ft/survey/so/2014/new040214a.htm

Jagsi, R., Butterton, J. R., Starr, R., & Tarbell, N. J. (2007). A targeted intervention for the career development of women in academic medicine. *Archives of internal medicine*, 167(4), 343-345. doi:10.1001/archinte.167.4.343

Jagsi, R., Guancial, E. A., Worobey, C. C., Henault, L. E., Chang, Y., Starr, R., & Hylek, E. M. (2006). The "gender gap" in authorship of academic medical literature—a 35-year perspective. *New England Journal of Medicine, 355*(3), 281-287. doi:10.1056/NEJMsa053910

Kern, S. (2011). Analytic model for academic research productivity having factors, interactions and implications. *Cancer Biology & Therapy, 12*(11), 949-956. doi:10.4161/cbt.12.11.18368

Lange, S. E., Riskin, E. A., Brainard, S. G., & Denton, D. D. (2003). Implementing a transitional support program. Paper presented at WEPAN Conference, June 8-11, 2003, Chicago. *Women in Engineering ProActive Network.* Retrieved from https://advance.washington.edu/apps/resources/docs/Lange,%20Riskin,%20etc_TransSupportPgm.pdf

Lintz, E. M. (2008). A conceptual framework for the future of successful research administration. *Journal of Research Administration*, 39(2), 68-80. Retrieved from http://files.eric.ed.gov/fulltext/EJ888527.pdf

Matrek, I. (2009, September 9). The Seven Mile Bridge [Digital image]. Retrieved from *Creative Commons*, https://commons.wikimedia.org/w/index.php?curid=2451826

National Institutes of Health [NIH]. (2015). Research project and R01-equivalent grants: Success rates, 1970 to present. *NIH Reports*. Retrieved August 15, 2016, from https://report.nih.gov/success_rates/

Neiman, P. E. (2013). T*he biomedical research institute: a perspective on alternative paradigms for research development* (2nd ed.). Retrieved from http://authors.fhcrc.org/id/eprint/1101

Nelson, R. R. (2006). Reflections on "The simple economics of basic scientific research": Looking back and looking forward. *Industrial and Corporate Change*, 15(6), 903-917. doi:10.1093/icc/dtl022

Óðinn. (2008, February 24). The Peace Bridge [Digital image]. Retrieved from *Creative Commons*, https://commons.wikimedia.org/w/index.php?curid=3621392

Perkel, J. (2012). Bridge funding: How to stay afloat. *Nature*, *481*(7380), 225-226. doi:10.1038/nj7380-225a

Powell, K. (2010). Research funding: Making the cut. *Nature, 467*(7314), 383-385. doi:10.1038/467383a467383a [pii]

Powell, K. (2011). Mid-career crunch. *Nature, 471*(7338), 399-399. doi:10.1038/nj7338-399a

Scarborough, H., & Bennett, J. (2012). *Cost-benefit analysis and distributional preferences: A choice modelling approach.* Cheltenham, Glos, GBR: Edward Elgar Publishing.

Sen, A. (1993). Markets and freedoms: Achievements and limitations of the market mechanism in promoting individual freedoms. *Oxford Economic Papers, 45*(4), 519-541. Retrieved from http://www.jstor.org/stable/2663703

Shine, K. I. (1997). Some imperatives for clinical research. *JAMA, 278*(3), 245-246. doi:10.1001/jama.1997.03550030085040

Taylor, J. (2006). Managing the unmanageable: The management of research in research-intensive universities. *Higher Education Management and Policy, 18*(2), 1-25. doi:10.1787/hemp-v18-art8-en

Whiteside, C., Dessureault, S., Dickstein, J., Tibbles, L. A., Torrance, S., Boynton, E., & Stewart, D. (1997). Women in biomedical research--addressing the challenges. *Clinical and Investigative Medicine, 20*(4), 268-272.

Wilkerson, L., & Irby, D. M. (1998). Strategies for improving teaching practices: A comprehensive approach to faculty development. *Academic Medicine, 73*(4), 387-396. Retrieved from http://journals.lww.com/academicmedicine/Abstract/1998/04000/Strategies_for_improving_teaching_practices__a.11.aspx

Appendix

List of Faculty/Schools of Medicine used for analysis of bridge-funding policies.

1	Boston University School of Medicine
2	Case Western Reserve University School of Medicine
3	Duke University School of Medicine
4	Emory University School of Medicine
5	Johns Hopkins University School of Medicine
6	Northwestern University The Feinberg School of Medicine
7	Ohio State University College of Medicine
8	Perelman School of Medicine at the University of Pennsylvania
9	Stanford University School of Medicine
10	State University of New York Upstate Medical University
11	Tulane University School of Medicine
12	University of South Florida Health Morsani College of Medicine
13	University of California, Davis, School of Medicine
14	University of California, Irvine, School of Medicine
15	University of California, San Francisco, School of Medicine
16	University of Cincinnati College of Medicine
17	University of Colorado School of Medicine
18	University of Illinois College of Medicine
19	University of Kentucky College of Medicine
20	University of Louisville School of Medicine
21	University of Medicine and Dentistry of New Jersey - New Jersey Medical School
22	University of Medicine and Dentistry of New Jersey - Robert Wood Johnson Medical School
23	University of Michigan Medical School
24	University of Oklahoma College of Medicine
25	University of Rochester School of Medicine and Dentistry
26	University of Vermont College of Medicine
27	University of Washington School of Medicine
28	Virginia Commonwealth University School of Medicine