

# Frequently Asked Questions About [“Commercializing Biomedical Research Through Securitization Techniques”](#)

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Since the publication of our [article](#) in *Nature Biotech* (doi:10.1038/nbt.2374) on using securitization techniques to raise funds from the private sector to support biomedical research, we have received a number of stimulating comments and questions that we would like to address. Rather than replying to each inquiry individually, we thought it might be more useful to respond via this “frequently asked questions” document so as to stimulate broader dialogue among those with an interest in this subject.

As financial economists, we are not experts in biomedicine or the biopharma business, and it would be foolish and arrogant for us to opine on the problems facing the industry and how to solve them. Our article focuses on a very narrow topic: financing biomedical innovation through portfolio theory and securitization. However, turning our theoretical analysis into practice does require deep knowledge of the life sciences industry. Accordingly, one of the main reasons we chose to publish our research in *Nature Biotech* instead of a finance journal was to stimulate dialogue and collaboration between financial economists, biomedical researchers, practitioners, and other stakeholders that could lead to new methods of funding biomedical research.

We plan to update this FAQ on a regular basis in response to new feedback as well as our own research, so please revisit this list from time to time because our answers may very well change as our thinking evolves. And thank you for your thoughtful comments and constructive criticism—please keep them coming!

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## 1. What is the basic idea of the paper?

We propose using financial engineering techniques to design a new investment structure that would fund a large number of biomedical research programs for cancer treatments while at the same time providing attractive returns for its investors.

These types of biomedical research projects have three key characteristics: the research is expensive, it takes a long time, and it's very risky (i.e., the probability of success for an investment in any single candidate drug compound is very low) but potentially very profitable. To date, private and public equity have been able to provide only a fraction of the financing required in this domain.

By combining many risky projects into a single financial entity, the risk can be reduced dramatically, and such “de-risking” makes it possible for the single entity to raise capital to fund the projects through debt securities, i.e., bonds. Access to debt financing is important

because there is a much larger pool of capital willing and able to invest in debt than in equity due to the relative sizes of the public debt and equity markets. For example, in 2010 the entire venture capital (VC) industry had \$176 billion of investable assets, whereas the size of the U.S. bond market in that year was \$35 trillion.

Our paper proposes to use financial engineering techniques to structure new securities to fund cancer research. These securities can be designed to have different risk levels and maturities than the underlying collateral assets (the drugs being developed in preclinical and clinical phases) and, as a result, may appeal to a much broader range of investors than would typically be the case with venture-capital financing.

Our approach is a general one, suitable for a variety of domains that are characterized by long development cycles, high probabilities of failure, and large financial payoffs for success. Other areas that might benefit include: alternative energy research, climate change, sustainable food production, and so forth. [List of FAQs](#)

## **2. What is new about this proposal?**

Our proposal differs from existing business structures and practices in several important ways. It is not equivalent to creating a large venture-capital fund, a new pharmaceutical company, or a biopharma mutual fund.

First, neither the biopharma industry nor their venture-capital investors currently use securitization to finance preclinical or early-stage drug development. Of course, the industry has long recognized the benefits of diversification, as demonstrated by the increasing number of biopharma mergers, acquisitions, consolidations, and licensing deals over the past decade. Moreover, debt financing has also been embraced. For example, the \$46.8-billion acquisition of Genentech by Roche Holdings in March 2009 was partly financed by Roche's \$16.5-billion bond issue a month before. This was the second-largest corporate-bond offering of all time. However, both Roche and Genentech are well-established companies with clear and easily valued revenue streams. In the current climate of uncertainty, biopharma companies seem more focused on reducing risk and increasing operating efficiency—by engaging in mergers, acquisitions, licensing deals and joint ventures to produce more reliable revenue streams—than on investing in early-stage projects that are even riskier than their existing business lines.

Second, our proposal is to create a single financial entity that invests in multiple biomedical projects at various stages of their development cycles financed by securitized debt and equity, not to create another large publicly traded pharmaceutical company. Although big pharma companies are central to the later stages of drug development and the marketing and distribution of approved drugs, they do not currently play as active a role at the riskier preclinical and early stages of development for the reasons described in our article. Megafunds can fill this gap by funding more speculative early-stage R&D in exchange for a percentage of future royalties or proceeds from any subsequent sale of the intellectual property. Such speculative investments require a much broader set of assets to achieve sufficient risk reduction, which is precisely what a megafund is designed to do.

Also, at earlier stages of development, the required resources per project are smaller and the ability to change direction by discontinuing less promising projects and redeploying capital to more productive assets is considerably easier. Compared with the plethora of small pharmaceutical companies currently pursuing just one or two projects, these savings are especially important for a megafund. It is considerably harder to cull compounds efficiently in a small company because the livelihoods of the employees and management depend on the continued development of the company's few compounds—in these cases, development tends to continue until the money runs out. With a megafund, this conflict can be greatly reduced—capital can be more efficiently allocated to projects that are likely to succeed, and failing projects and compounds can be abandoned rapidly. In fact, for megafunds that have invested in a sufficient number of early-stage projects, it may be worthwhile to build and operate shared facilities for conducting preclinical studies motivated by the megafund's projects. Such a 'preclinical incubator' could provide the megafund with valuable economies of scale as well as reduce duplicative costs in the industry.

Third, our proposed megafund is not a biopharma mutual fund, which is simply a pooled vehicle for equity investors and therefore restricted to investing in companies that are already publicly traded. A megafund may invest in such companies, but it can also invest in startups, existing private companies, royalty streams, intellectual property, and other assets. Moreover, a megafund will issue both debt and equity, making its capital structure materially different from that of a mutual fund; the business pressures, priorities, and horizons it faces are correspondingly different. A megafund's portfolio manager is likely to be much more actively engaged in the scientific and engineering aspects of the portfolio assets, not unlike a traditional venture capitalist; in contrast, a biopharma mutual fund manager is essentially a stock picker whose only involvement in the management of the portfolio companies is through proxy voting decisions. [List of FAQs](#)

### **3. Are there any existing businesses that look similar to what you're proposing?**

The existing business entities that are closest to our proposed megafund are drug-royalty investment companies. While their similarities provide a "proof-of-concept" for the basic premise of our portfolio approach to financing biomedical innovation, there are also important differences that imply greater challenges for creating biomedical megafunds.

Companies like Royalty Pharma (New York), Cowen Healthcare (Stamford, CT, USA), and DRI Capital (Toronto) are investment vehicles that acquire ownership interests in the royalty streams of approved drugs, rather than the equity of biopharma companies. By combining these ownership interests into a single portfolio, these vehicles are able to provide more attractive risk-reward profiles for their investors and can issue debt to finance their acquisitions. The largest of these drug-royalty investment companies, Royalty Pharma, currently manages \$8 billion.

The key difference between drug-royalty investment companies and our proposed megafund is the investment mandate. Royalty Pharma invests only in FDA-approved drugs

and late-stage (Phase III) products, not in preclinical or early-stage projects. As the investment focus shifts to earlier parts of the drug-approval process, the uncertainty becomes greater, calling for larger portfolios and more sophisticated financing and risk-management techniques to generate the same level of diversification and risk reduction. This inverted financing pyramid in which the biggest portfolios correspond to the earliest stages of translational medicine underscores the value of the megafund vehicle.

This difference means that megafunds cannot be operated in the same way as drug-royalty investment companies, and will likely require greater infrastructure, many more employees, new analytics, and new organizational processes that go well beyond current industry practices. We discuss some of practical challenges to launching biomedical megafunds below (see Question 14). [List of FAQs](#)

#### 4. What are the advantages of financing biomedical innovation through Research-Backed Obligations (RBOs)?

RBO structures provide an alternative funding mechanism for projects characterized by long development cycles, high probabilities of failure, and large financial payoffs for success. These structures provide new and differentiated securities for a broad and diverse community of investors. The main advantages of RBOs are:

- **Size and diversification:** By virtue of their large size, biomedical megafunds can provide a diversified exposure to investors and consequently a more attractive risk/return profile to investors. Investing in many projects may reduce the average return of the combined investment, but it also reduces the risk which, for some investors, is a pre-requisite for investing. For such investors, betting on whether a single company or technology will be the winner is unacceptable, but betting on whether the entire industry or some broad segment will be successful in reducing the burden of disease is perfectly reasonable.
- **The use of debt:** Under other financing schemes (venture capital, public markets, and investment funds) it is typically not feasible to use debt at scale to finance the development of new drugs.
- **Lower cost of capital for science:** The cost of debt is lower than the cost of equity and thus, the cost of capital borne by drugs funded by the megafund would be lower than those drugs financed by traditional equity-like structures.
- **A menu of options for investors:** By virtue of the tranching of the capital structure of the megafund, investors are able to choose the risk and return profile of the assets that best suits them. The debt could also potentially be rated by rating agencies.
- **New funding brought to this market:** The cost of developing new drugs is very high and the existing financing sources for drug development are facing growing constraints. This situation has created a so-called “valley of death” in available funding for translational medical research despite the growing number of promising

new medical technologies. The initial public offering (IPO) market is currently weak and the number of venture-capital firms active in biotech has declined by more than 20% in the last 5 years.<sup>1</sup>

- **More patient capital:** Financing biomedical innovation through private and public equity imposes significant time pressure on researchers to reach revenue milestones, which can affect the kind of research they conduct (shorter-horizon, less-risky projects). Long-term debt is, by definition, more patient, allowing the megafund manager to invest in projects that may not yield revenues for a decade or longer by issuing debt with distant maturity dates. An extreme example of long-term debt is the \$750 million of 100-year bonds issued by MIT in May 2011 at an interest rate of 5.623%.

Of course, even long-term debt will require making regular interest payments, which means that the megafund does need to impose a certain degree of financial discipline on its investments at all times. In our simulation of an oncology megafund, we assume that the debt securities have tenors of four and six years (with the portfolio liquidating fully in seven and a half years), but it is possible to design RBOs with much longer tenors (it is not uncommon in debt markets to find bonds with tenors of 30 years or longer).

Also, the decision to continue funding certain compounds or technologies is often based on the likelihood of exiting the investment at a later date. If capital market conditions are unfavorable, or if the economy is not robust, pharma companies and venture capitalists may postpone or withdraw funding until the market environment improves, irrespective of the scientific merits of the project. Megafunds can avoid the short-termism that impedes the development of certain scientific projects by supporting drugs in development to the point where their value does not depend on macroeconomic or financial market considerations but rather on the efficacy of the drug.

- **A new platform:** Industry insiders are proposing new models to develop cures such as the Distributive Partnering model<sup>2</sup> or the Biopontis alliance.<sup>3</sup> The megafund has the potential to fund these new models as a complement to existing business practices. At the same time, the pooled projects may benefit from economies of scope and scale that come from being developed under the same umbrella organization.

## List of FAQs

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<sup>1</sup> Brady Huggett. Biotech's wellspring: a survey of the health of the private sector. *Nature Biotechnology*. May 2012.

<sup>2</sup> Roth, Duane and Cuatrecasas, Pedro. *The distributive partnering model for drug development*. The Kauffman Foundation for Entrepreneurship. October 2011.

<sup>3</sup> Milken Institute. *Fixes in financing: Financial innovations for translational research*. A Financial Innovations Lab Report. Faster Cures. April 2012.

## 5. What do megafunds invest in?

The assets held by a megafund are ownership interests in the research projects and associated intellectual property of biomedical researchers at universities, hospitals, biotech companies, and pharmaceutical companies. They may take the form of patents on approved drugs or interests in therapeutics under development such as anti-cancer compounds, vaccines, or diagnostics that have yet to be approved. They may even take the form of blanket royalty-sharing agreements between the megafund and the technology-licensing offices of academic research centers purchased by the megafund for a pre-specified level of annual research funding. [List of FAQs](#)

## 6. Can RBOs fund more innovative drugs?

The large size of the megafund would spread the investment risk across a wider pool of projects, thus increasing the diversity and decreasing the risk associated with any single project. Depending on the investment strategy and investors' risk appetites, the management team of the megafund can elect to build portfolios in which some of the assets are lower-risk lower-impact opportunities while other assets are riskier but potentially more transformative innovations.

However, a key investment mandate that provides an incentive for the megafund manager to support more innovative therapeutics is diversification. For a megafund to achieve its goal of providing its investors with an attractive risk-adjusted rate of return, it must invest in assets that are not highly correlated with each other. For example, if an oncology megafund already owns products based on blocking angiogenesis in tumors, additional investments in similar research programs will offer less diversification than investing in stem-cell or immunological therapies. This feature reduces the incentive for the megafund to invest in "me-too" drugs, and the sheer size of a megafund will enable the fund to take on truly innovative projects. [List of FAQs](#)

## 7. Is it better to have megafunds focused on a single disease or to have more diverse assets as collateral?

Other things equal, more diversification is better than less, so including multiple diseases or even completely unrelated cashflows (e.g., biomedicine and clean-energy technologies) would provide greater risk reduction. However, the benefits of diversification must be balanced against the cost of managing a complex portfolio of investments and the ability of investors to accurately assess the risks and rewards of megafund portfolios. We chose oncology to illustrate the megafund concept because it provides an ideal balance of diversification (cancer is, in fact, not one disease but over 200 distinct diseases) and an over-arching theme that investors can quickly understand and evaluate.

Disease-specific megafunds have the added advantage of focusing attention on a particular area of need which may help mobilize capital toward a well-defined scientific and social objective. Moreover, thanks to their size, megafunds offer investors exposure not just to

one or two experimental approaches to curing a disease, but rather to a broader cross-section of the entire industry.

Also, “pure-play” funds may offer attractive hedging opportunities for investors with exposure to the financial impacts of the target disease or technology. For example, life insurance firms may wish to own equity of a cancer RBO to offset the longevity risk of their annuity business in case policyholders live longer due to improved cancer therapeutics.

On the other hand, some investors might instead prefer megafunds that cover multiple diseases as these may offer even greater diversification and therefore even more attractive risk-adjusted returns. The choice will ultimately depend on the institution or consortium designing and marketing the megafund. [List of FAQs](#)

**8. In the paper you present simulations A and B that only cover part of the drug development process. Can RBOs finance the development of compounds from preclinical phase to market approval?**

Yes. We chose to break up the drug-development cycle into the two stages typically associated with distinct investor populations: biotech VCs versus publicly traded pharma companies. If you consider our two simulations back to back, i.e., if the compounds sold at the end of Simulation A were sold to Simulation B at its launch, this would cover the full lifecycle of the drug-development process. [List of FAQs](#)

**9. Can RBOs finance projects in phases earlier than the preclinical phase?**

Yes. In principle, the model can be applied to any type of research project, including earlier phases of medical research and research in other fields of science. However, the nature of research implies that earlier stages will be more speculative, hence more projects will be required to generate the same number of successes as later-stage investments. This may imply that much larger pools of assets are required to fund early-stage research, however, an offsetting effect is that early-stage research such as animal studies are typically much less costly than human clinical trials. [List of FAQs](#)

**10. Are megafunds a substitute for biotech venture capital or pharmaceutical R&D programs?**

No. We believe that the biotech and pharma industries play complementary roles that are critical to the success of biomedical megafunds.

Our research focuses solely on the financial engineering methods for funding biomedical innovation—as financial economists, we have nothing to say about the practical business challenges of operating a megafund. The required expertise for managing biomedical megafunds, which is substantial, resides in the biotech and pharma communities, but because the scale of investment is unprecedented, new business practices will have to be invented to manage such complex organizations. While financial engineers can support biopharma professionals in creating these new business models, this daunting challenge

requires deep knowledge of both the science of disease and the practicalities of developing commercially successful therapeutics.

Moreover, the ability to produce, market, and distribute approved drugs is the domain of the pharma industry, while basic biomedical research is supported by universities, medical centers, and government and non-profit granting agencies. Therefore, all of these stakeholders must necessarily collaborate closely with financial experts if megafund financing is to become a reality. [List of FAQs](#)

### **11. Are RBO securities targeted at institutional or retail investors?**

Both. Initially, institutional investors may be obvious candidates to invest because of the required size of megafunds and the expertise needed to evaluate their risk/reward profile. However, as these sophisticated investors develop experience with megafunds, creating retail versions can follow soon thereafter (e.g., mutual funds that invest in RBOs, or direct-purchase programs). Retail investors may have strong personal motives to support biomedical megafunds because of loved ones afflicted with diseases targeted by such funds, so prudent supervision and regulation are required to prevent abuses and to ensure timely and accurate disclosure of the properties and risks of RBO investments. [List of FAQs](#)

### **12. How realistic are the assumptions in the simulations?**

Because we are financial economists, not oncologists, we had to rely on published papers in peer-reviewed biomedical journals to calibrate the probabilities, costs, revenues, and other parameters of our simulation. Under these calibrations our simulations produced reasonable results. However, we recognize that not all experts may agree on these parameter values, and rather than attempting to adjudicate among competing experts, we have made our simulation software freely available to the public with an open-source license to use, modify, and distribute it so as to encourage others to experiment with all of the parameter values and to extend the software.<sup>4</sup> [List of FAQs](#)

### **13. Does the success of biomedical megafunds and RBO financing hinge on the “blockbuster-drug” revenue model?**

No. Our analytical example is based on the blockbuster revenue model purely for expositional simplicity, but we construct a non-blockbuster example in our Supplemental Information document. Moreover, in our more realistic oncology simulations, we employ an economic model that reflects current market conditions and a more realistic drug development lifecycle.

However, this question touches upon an important issue with respect to any simulation of biopharma investments: the revenue model of the pharmaceutical industry is changing

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<sup>4</sup> See [http://web.mit.edu/alo/www/RBOtoolbox\\_final.zip](http://web.mit.edu/alo/www/RBOtoolbox_final.zip)

rapidly because of scientific advances in personalized medicine as well as changes in healthcare laws and insurance reimbursement policies. More sophisticated pharmacoeconomic analyses of these potential changes are necessary ingredients to modeling the financial risks and rewards of biomedical megafunds. [List of FAQs](#)

#### 14. What are the biggest challenges to implementing RBOs in practice?

The practical implementation of the RBO model would require addressing some important challenges:

- **Size.** Managing large portfolios of complex R&D projects may require new management and governance structures.
- **Centralization.** Centralizing knowledge and decision making is critical for managing large complex organizations, but too much centralization may stifle creativity and diversification.
- **Capacity.** Is the talent pool of biomedical researchers and the number of potential projects deep enough to match the scale of this venture?
- **Liability.** A single entity may imply a single point of legal liability, depending on how involved a megafund becomes in marketing and distributing drugs.
- **Complexity.** Can investors fully understand the risks and rewards of RBOs? We hope our analysis provides a useful starting point, but is it sufficient?
- **Execution.** As therapeutics pass through the distinct phases of the clinical trials process, their economic value increases but the monetization of that value through a sale or licensing agreement is subject to implementation risks. Will an active secondary market develop for drug compounds in various stages of development (as it has in other asset classes when investment has increased) to allow megafunds to meet their debt-servicing obligations?
- **Excesses.** If successful, the potential for abuse and fraud in future megafunds will also increase; can they be contained, or are these excesses a necessary evil?

We have our own responses to each of these concerns, some of which we outline in the article and Supplementary Information, and we are cautiously optimistic that in the specific case of oncology, megafund financing is achievable.

However, because we are industry outsiders, our optimism is based on information and opinions of experts in the field, and we do not yet know whether our sampling of experts is truly representative or biased in some important ways. To address this issue, we plan to convene a conference at MIT in 2013 where leaders from all the relevant stakeholder communities will be invited to explore these challenges together and in greater depth. [List of FAQs](#)

**15. How will the SPV management team make decisions about which compounds in the portfolio to finance if there are insufficient funds to fund trials for all compounds as they proceed through the approval process?**

In our article, we do not address this issue. Instead, our simulations employ the simplest possible allocation strategy in which we select compounds purely based on their stage of development. We use this “shotgun” approach to avoid making assumptions about the investment and scientific acumen of the management team. However, in practice, these skills will be critical in determining the success or failure of any given megafund and could greatly improve investment returns and scientific progress.

We believe that top scientific advisers can work collaboratively with megafund business executives to determine which projects to fund and, more importantly, which projects to terminate so as to produce the best long-term return for investors. [List of FAQs](#)

**16. Can RBOs lead to a new financial crisis?**

Our proposal is clearly motivated by financial innovations that played a role in the recent financial crisis; hence, it is natural to question the wisdom of this approach. As we explain in our article, a full accounting of the causes of the crisis has yet to be written and many mutually contradictory narratives have emerged. Nevertheless, the analogy between megafunds and the mortgage companies of the financial crisis does point to some potential pitfalls that should be avoided:

1. Statistical models of the biomedical portfolio returns should be based on a detailed understanding of the science and engineering underlying the individual projects in addition to (and sometimes instead of) an analysis of historical returns.
2. Portfolio valuations should reflect current market realities at all times rather than hypothetical expectations; otherwise, sharp declines and panic selling may easily be triggered when the market’s valuation differs greatly from the portfolio manager’s.
3. Regulations surrounding the sale of megafund securities—including proper risk disclosure by issuers, suitability requirements for investors, and detailed credit analysis—should be strictly enforced.

Securitization is a powerful tool for raising capital, but like most powerful technologies, it can be abused when proper controls are not imposed. [List of FAQs](#)

**17. Can RBOs solve the problems of the pharmaceutical industry and increase the productivity of biomedical R&D?**

As financial economists and outsiders to the biopharma industry, we are in no position to comment on either the problems of the pharmaceutical industry or whether megafunds will solve them. Our intention in writing this article is to address a clear and present need for greater funding in translational medical science through financial engineering. There is a

large body of literature—and a number of experts in academia and industry—focused on explaining the dynamics of the biopharma industry, and we continue to learn about how our work relates to the broader context from these sources. We hope that our article will stimulate collaboration between scientists and financial engineers so that together we can address some of these challenges. [List of FAQs](#)

## **18. Shouldn't the government be taking on such a large and ambitious initiative?**

There are at least three perspectives from which to answer to this question: philosophical, historical, and practical.

The philosophical arguments for and against government involvement in cancer drug development are beyond our purview. Therefore, we will not address this aspect of the question other than to acknowledge that there are significant differences of opinion driven by ideology and ethics (e.g., libertarianism vs. utilitarianism).

From a historical perspective, a number of government agencies have been involved in cancer research since at least December 23, 1971 when President Nixon declared a “War on Cancer” with the passage of the National Cancer Act. This law strengthened the National Cancer Institute by giving it broader responsibilities, greater oversight by a presidential panel, and a more streamlined budget approval process. Four decades later, there is some disagreement as to whether the War on Cancer has been a success or failure. While we have made great progress in our understanding of cancer and how to treat it, we have also learned that cancer is not just one disease but many diseases that can evolve quickly and often unpredictably. However, there is little disagreement that much more needs to be done before we can claim victory in the War on Cancer.

From a practical perspective, given the current state of the economy, the size of the national deficit, and the polarized political climate, it is unlikely that government funding for cancer therapeutics will increase dramatically in the next few years (in fact, NIH funding has been declining in real terms since 2003). Therefore, if we want to make significant progress in the War on Cancer in the near term, the private sector will have to participate in some manner. Instead of using the metaphor of war—which is based on fear, an emotion that can be difficult to sustain over decades—we propose to use the metaphor of greed by putting a price tag on cancer’s head. However, even in this case the government can play a valuable role by providing tax incentives for cancer therapeutics, lengthening the patent life of inventions addressing social priorities like cancer, and providing loan guarantees for biomedical ventures (Israel’s Life Sciences Fund is a proof-of-concept of this mechanism). [List of FAQs](#)

## **19. Are you planning to launch a megafund yourselves?**

No. We have neither the expertise nor the credibility among the various stakeholders to launch a biomedical megafund. However, we would very much like to help facilitate the process of getting more funding for translational medical research, and we believe that

private-sector funding is currently the most effective means for doing so, which is what motivated our research.

The three of us are engaged in different activities to promote the use of financial engineering for social priorities like cancer research. As director of the MIT Laboratory for Financial Engineering and a finance professor at the MIT Sloan School of Management, Andrew Lo is continuing to do research on financial engineering and the biopharma industry, and is planning to organize a conference at MIT sometime in 2013 to bring together academics, industry leaders, regulators, and granting agencies to explore these ideas in more depth. Jose-Maria Fernandez is planning to enter the private sector to pursue these ideas more directly. And Roger Stein is the managing director of Research and Academic Relations at Moody's Corporation<sup>5</sup> and currently conducting academic and industry research on the applications of financial engineering in a number of areas, including to the biopharma industry. The following are our biographical sketches:

- **Jose-Maria Fernandez** is a Research Affiliate of the MIT Sloan Laboratory for Financial Engineering. Prior to MIT he worked in the debt capital markets for over ten years. Between 2006 and 2008 he was a Managing Director for Credit Agricole CIB in London where he ran the Debt Capital Markets Global Origination department for Sovereigns, Supranational, and Development Agencies. Previously, since late 1997 Jose-Maria worked in the Spanish Ministry of Finance where between November of 2002 and December of 2005 he was Head of the Public Debt Department. Jose-Maria holds an MBA degree from the MIT Sloan School of Management (the Sloan Fellows Program in Innovation and Global Leadership), a Masters in Finance degree from the London Business School, and a Bachelor's Degree in Economics and Business from CUNEF in Madrid. He was appointed State Economist and Trade Expert of the Spanish General Government in 1997.
- **Roger M. Stein** is Managing Director of Research and Academic Relations globally at Moody's Corporation, as well as a Research Affiliate at the MIT Sloan School of Management. He received his Ph.D. from the Stern School of Business, New York University in 1999 and has taught at NYU. Previously, he held positions as president of Moody's Research Labs, co-head of Moody's KMV's research and product development, and head of Moody's Risk Management Services research group. He has authored dozens of professional and academic articles and serves on the editorial boards of several finance-related journals. His most recent book is *Active Credit Portfolio Management in Practice*, in which he and his co-author provide a handbook for practitioners on applied corporate credit risk management. He is also a member of the board of PlaNet Finance, USA; a member of the Advisory Council for the Museum of Mathematics; and the President of the Consortium for Systemic Risk Analytics.
- **Andrew W. Lo** is the Charles E. and Susan T. Harris Professor at the MIT Sloan School of Management, the director of MIT's Laboratory for Financial Engineering, and a principal investigator at MIT's Computer Science and Artificial Intelligence Lab. He received his

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<sup>5</sup> The research described in this article was done independently of Moody's.

Ph.D. in economics from Harvard University in 1984, and taught at the University of Pennsylvania's Wharton School from 1984 to 1988. He has published numerous articles in finance and economics journals, and has authored several books including *The Econometrics of Financial Markets*, *A Non-Random Walk Down Wall Street*, and *Hedge Funds: An Analytic Perspective*. He is currently a co-editor of the *Annual Review of Financial Economics* and an associate editor of the *Financial Analysts Journal*, the *Journal of Portfolio Management*, and the *Journal of Computational Finance*. He is also a research associate of the National Bureau of Economic Research, a consultant to the Office of Financial Research, a member of FINRA's Economic Advisory Committee, the New York Fed's Financial Advisory Roundtable, the academic advisory board of the Consortium for Systemic Risk Analysis, and founder and chief investment strategist of AlphaSimplex Group, LLC, an investment advisory firm based in Cambridge, Massachusetts. [List of FAQs](#)

**20. Do you have any existing commercial incentives or conflicting interests in promoting biomedical megafunds that should be disclosed?**

No. Our motivation for conducting this research and publishing our paper is to solve a problem that the biopharma industry seems to be facing—a shortage of funding—using the tools of financial engineering which is our stock and trade as financial economists.

No funding bodies had any role in study design, data collection and analysis, decision to publish, or preparation of this article. No direct funding was received for this study; general research support was provided by the MIT Laboratory for Financial Engineering and its sponsors. The authors were personally salaried by their institutions during the period of writing (though no specific salary was set aside or given for the writing of this paper).

Andrew Lo does have an affiliation with an asset management company, AlphaSimplex Group, which he founded in 1999 and with which he is still involved as Chairman and Chief Investment Strategist. AlphaSimplex manages a systematic global macro hedge fund and several mutual funds; it does not engage in any biopharma-related investments and has no intention to do so in the foreseeable future. But it was through his experience at AlphaSimplex that Professor Lo became convinced that institutions such as pension funds, sovereign wealth funds, insurance companies, and endowments would be natural investors in a biomedical megafund and that the enormous pool of assets in this community could be channeled into translational medical research via financial engineering methods. Professor Lo has other professional affiliations, all of which are fully disclosed on his website <http://web.mit.edu/alo/www>.

Mr. Fernandez does plan to enter the private sector now that this research project is completed, and may pursue some of these ideas commercially.

Dr. Stein is currently in the private sector, and for the past two decades has focused on developing a variety of quantitative financial models and risk-management tools for fixed-income securities and other credit-sensitive financial instruments. [List of FAQs](#)