

# Antibiotic R&D Economic Model

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# Provisos

- This work will be published in a peer-reviewed article, so please do not publish it before I do
- This is academic work as a Professor at Boston University. It does not necessarily represent the positions of CARB-X or any CARB-X Funder
- All results today are still tentative

# Objective

*Data that can be used by everyone to determine the magnitude and optimal balance of economic incentives for antibacterial R&D*

# Tools

- A public, transparent, peer-review published **Model** of antibiotic R&D expenses
  - NPV decision-tree model, based on ERG 2014
  - No hidden data; all assumptions explicit
  - Looking for critiques to improve the model
- A **Dashboard** that allows policy makers to vary key assumptions in the Model (such as Peak Year Sales, Preclinical Cost Sharing, Market Entry Rewards, and Probability of Technical & Regulatory Success) to perform sensitivity analyses and validate the Model outputs

# Process

- Project led by Professor Outtersen as PI
- Based on model & parameters in ERG 2014 (for ASPE & FDA)
- Any departures from ERG 2014 are based on explicit rationales & data. For example:
  - ERG used 11% cost of capital; large companies are now using 10% (reduces size of required MER and PYS)
  - ERG data on costs are from 2012; now updated for inflation
  - ERG included only \$10M as post-award costs; now updated for information from Achaogen and others
  - Clinical development times now updated to reflect actual times for the last 14 FDA-approved NME antibiotics
  - Full parameter list will be published, together with data

# Support

- At this stage, the Model and Dashboard have received in-kind support (data, Excel files) from Pfizer and BIO (and other companies), with input and comments from Pew Charitable Trusts and many individuals
- Full control of the project is with the PI, who is alone responsible for the project (and its conclusions)
- No financial support for the writing process
- Co-authorship not yet decided

# Abbreviations

- Probability of Technical & Regulatory Success (PTRS)
- Market Entry Reward (MER)
- Preclinical Cost Sharing (PCCS)
- Peak Year Sales (PYS)
- Expected Internal Rate of Return (eIRR)
- Boston Consulting Group (BCG)
- Eastern Research Group (ERG)

**AMR Dashboard**

Owner Kevin Outterson Adjustable Cells Calculation Cells

*This model is intended to support efforts to understand R&D incentives that may support development of novel Anti-Infectives. It is not intended to be used to make investment decisions.*

**MODEL INPUTS**

Select Desired Scenario:  Select the variable you desire to solve from the drop down menu

Select POTS benchmark:  Select the probability of success benchmark from the drop down menu

Select Start Year:  Select the year to start product development

Peak Year Sales (PYS):  Enter peak year sales amount in millions

Preclinical Cost Sharing (%):  Enter preclinical cost sharing percentage

Please use the drop down in Cell E8 to select one of the three scenarios outlined below. Then, click the button to solve for the Peak Year Sales (PYS), Market Entry Reward (MER), or Cost Sharing (%) based on the model inputs you desire.

Occasionally, the macro will incorrectly say that there is a circular reference in the sheet. Also, if you put a value out of range of a normal scenario, solver might seem to crash. Switch to another scenario and input a normal value and it will correct the code.

- 1) PYS needed  
Enter: MER  
Enter: Cost Sharing % @ PreClinical  
Click Button to derive the PYS needed to hit a 0%, 5% and 10% IRR (so this would output three Peak Year Sales figures, the lowest of which hits 0% IRR, the middle 5% IRR, the highest 10% IRR)
- 2) MER needed  
Enter: PYS  
Enter: Cost Sharing % @ PreClinical  
Click Button to derive the MER needed to hit a 0%, 5% and 10% IRR (so this would output three MER figures, the lowest of which hits 0% IRR, the middle 5% IRR, the highest 10% IRR)
- 3) Cost Sharing (%) needed  
Enter: PYS  
Enter: MER  
Click Button to derive the Cost Sharing % @ PreClinical needed to hit a 0%, 5% and 10% IRR (so this would output three % cost sharing figures at PC, the lowest of which hits 0% IRR, the middle 5% IRR, the highest 10% IRR)

**MODEL OUTPUT DASHBOARD** CLICK THIS BUTTON TO SOLVE FOR MODEL INPUTS

	NO VALUE SCENARIO	MIDPOINT SCENARIO	TARGET SCENARIO
Assuming peak year sales of... Results in an eIRR of	\$200 million 0%	\$200 million 5%	\$200 million 10%
With the support of... Pre-clinical cost sharing amounting to Market entry award amounting to	\$19 million (75%) \$421 million	\$19 million (75%) \$1,041 million	\$19 million (75%) \$1,694 million
Key risk adjusted metrics Total Expected Development Costs Total Expected Commercial Costs Total Expected Lifetime Revenue excluding MER	\$40 million \$28 million \$55 million	\$40 million \$28 million \$55 million	\$40 million \$28 million \$55 million

**MODEL ASSUMPTIONS**

**RESEARCH AND DEVELOPMENT ASSUMPTIONS (LOCKED)**

	Total Preclinical	Total Phase 1	Total Phase 2	Total Phase 3	Regulatory Submission	Post Launch Costs
Original per project costs (ERG):	\$21.10	\$24.00	\$24.55	\$62.60	\$88.35	\$290.46
Inflation Adjustment:	1.205	1.205	1.205	1.205	1.205	1.205
Adjusted per project costs:	\$25.43	\$28.92	\$29.58	\$75.43	\$106.46	\$350.00
Length of phase (Months):	66	24	36	36	12	60
Length of phase (Years):	5.5	2.0	3.0	3.0	1.0	5.0

*<- Adjusted from ERG/DRIVE-AB by KO analysis of last 14 antibacterial drugs approved by US FDA*

	Preclinical	Phase 1	Phase 2	Phase 3	Submission	Approval
Probability of Success (%):	35%	33%	50%	67%	85%	3.3%
Probability of Cost (%):	100.0%	35.2%	11.6%	5.8%	3.9%	3.3%
Probability of Failure (%):	64.8%	23.6%	5.8%	1.9%	0.6%	3.3%

*<- This assumes a large Pharma Co is undertaking the p/c; if they incense for a fee + royalty at IND, lower MER is required*

Start Year:  Development Time (Years):

Launch Year:

**COMMERCIAL ASSUMPTIONS (LOCKED)**

**Main Commercial Assumptions:**

Cost of Goods Sold (% of Sales):  <- See COGS SG&A Tab

SG&A (% of Sales):  <- See COGS SG&A Tab

Time to Peak (Years):  <- \$400M is a lower peak sales target than daptomicin, current numbers are likely to be lower unless DISARM passes

Patent Life Post-Launch (Years):

**Other Key Assumptions:**

Royalty Payments (%)

Plus: Depreciation & Amortization

Less: Capital Expenditure

Less: Working Capital (+/-)

Less: Taxes

Weighted Average Cost of Capital (WACC):

**Sales Curve:**

Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19
2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	
0%	4%	9%	16%	25%	35%	43%	49%	58%	69%	77%	85%	100%	93%	40%	38%	31%	28%	23%	

Dashboard allows user to assume key inputs (level of PCCS, PTRS, PYS, or MER) and then to solve for the remaining variable, to achieve three levels of economic success (eIRR of 10%, 5%, or 0%)



## Sample dashboard output

- *PCCS reduces needed MER*
- *Estimated PTRS has large effect*

MER to achieve 10% eIRR	With ~75% PCCS	Without PCCS
BCG's PTRS	\$1.6b	\$3.4b
ERG's PTRS	\$1.3b	\$2.5b

## Sample MER dashboard output

- *MER should be in the \$1.4-2.1b range*
- *More data on BCG/ERG PTRS would reduce the model's uncertainty*

MER to achieve 10% eIRR	\$200m PYS	\$400m PYS
BCG's PTRS	\$2.1b	\$1.8b
ERG's PTRS	\$1.7b	\$1.4b

All cases here assume 75% PCCS

## Sample 5% eIRR dashboard output

- *“Public utility” with 5% eIRR expectations could function with a smaller MER*

MER to achieve 5% eIRR	\$200m PYS	\$400m PYS
BCG's PTRS	\$1.3b	\$819m
ERG's PTRS	\$1b	\$561m

All cases here assume 75% PCCS

## Next steps

- If you would like an embargoed copy of the Dashboard and Model for the sole purpose of testing the assumptions and providing positive or negative feedback, please email [mko@bu.edu](mailto:mko@bu.edu). I will require a promise that you won't do anything that would prevent publication in a peer-reviewed journal. Critical comments and better data are entirely welcome.
- Plan to write manuscript beginning in early summer, for publication 1Q 2021.