

Quantitative Risk analysis (QRA) and risk management: can it be used to inform spectrum policy decisions?

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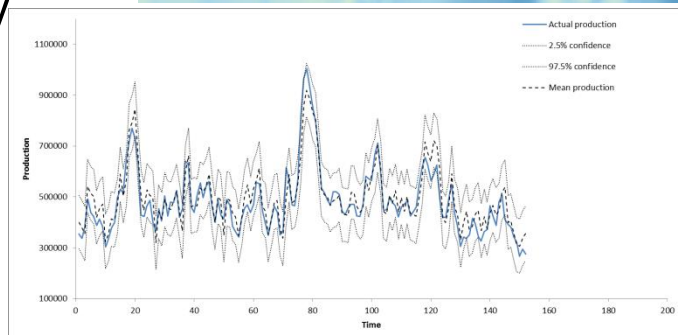
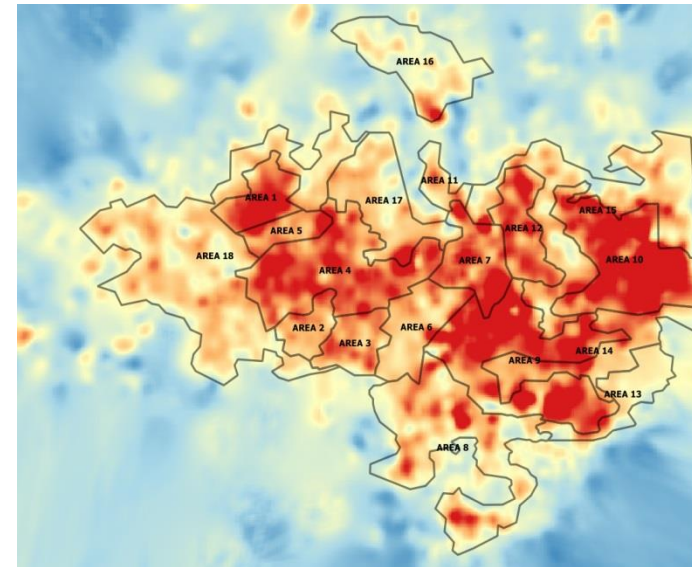
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Agenda

- Introduction by Robert Pavlak - growing need for quantitative/statistical analysis to:
 - Inform trade-offs between stakeholder interests
 - Make more productive use of spectrum authorizations
- Introduction to QRA for decision support
 - What are risks and opportunities
 - How QRA works
 - QRA vs worst-case scenarios
- Experiences in other industries/agencies
 - Why do they do QRA? Regulatory background
 - What can be learned from them
- Discussion
 - How can QRA be used in spectrum policy by the FCC?
 - How do we get there? Short and long-term goals, attainable steps

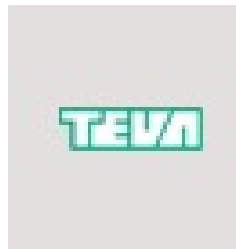
Who is this guy and his company?

1. Managing partner at EpiX Analytics - specialized risk analytics and decision-modeling company
2. *Focus:* Quantitative risk analysis & modeling to improve decision-making
3. Experience in a wide range of industries:
 - Pharmaceuticals
 - Mining
 - Manufacturing
 - Transportation
 - Insurance
 - Outcomes research / pharmacoconomics
 - Financial industry
 - Health / Food safety
 - Energy, oil & gas
 - Many others....





Some of the institutions we have helped



What is risk analysis?

- Risk is usually defined as a triplet:
 1. What can go wrong (event)?
 2. How likely is it (probability)?
 3. How big is the impact?



From: <http://goo.gl/0COq7T>

- Provides informative assessment of probability -> more informative than simply “possible” events/impacts
- **Opportunities** (risks that we would like to happen) or **benefits** can also be quantified
- Quantitatively balancing risk and benefits requires a **common “currency”**

Key to consider

- Provides method to make **decisions** under **uncertainty** - is a **decision** tool
- Uses what is **currently known** about the risk issue
- It makes no scientific judgment, i.e. keeps neutral
- It has to respond to decision questions - often has to make approximations and assumptions
- Has to **deal with data available**
 - Not a wish list
 - So analyses need to be constructed around available data
 - The impact of uncertainty in the decision must be assessed
- Quantification requires a model – typically Monte Carlo simulation

A motivational example

- We would like to estimate the time to complete a new R&D project
- Several steps, some of them are conditional (sequential) and some are parallel
- There is a **20%** chance that the **first pilot fails**, creating delays
- Experts provide estimates below for completion of each step
- Decision question: **how long will it take to finish the project?**

Task	Duration (weeks)		
	Min	M L	Max
Design prototype	3	4	6
Seek internal approval	3	6	21
Get supplies	2	4	12
Build pilot	10	13	16
Test	2.5	3	6
Rebuild?	10	13	16
Test again?	2.5	3	6
Write report	4	5	8

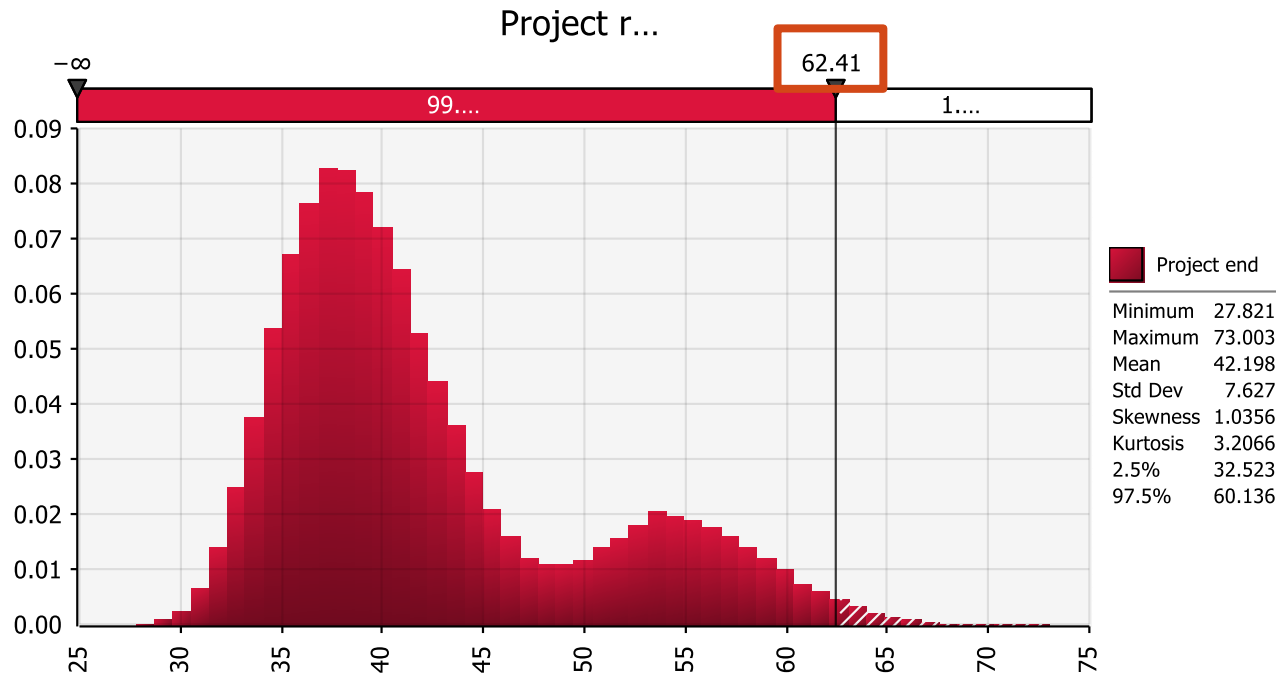
Using **stats** we can say

- Min: 27 weeks
- ML: 38.2
- Mean: 42
- Max: 73.4
- **Probabilities of making it on time?**

a.k.a. Worst-case scenario

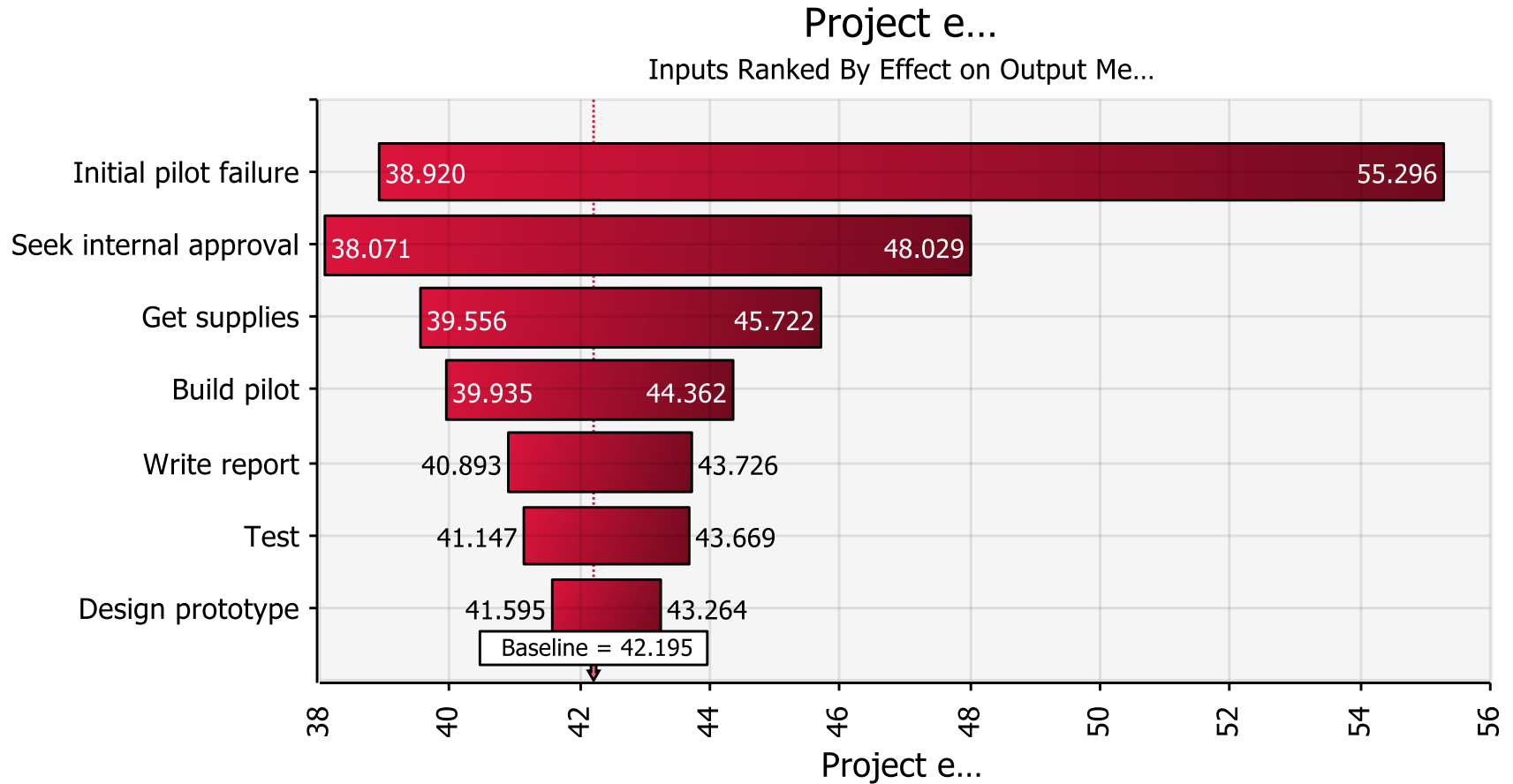
Using QRA we can also calculate probabilities and confidence

- Min, ML, mean, and max same as for stats
- We are **95% sure** that it will take **from 32 to 60 weeks**
- How do our results compare to the max, worst-case scenario of **73**?
 - “Feasible” max: e.g. **99%=62.4** “Only 1 out of 100 projects would last more than 62.4 weeks”
 - **99.9=66.5** - Only **1 out of 1,000** would last more than **66.5** weeks. Still far from 73 weeks!



[ProjectQRA.xlsx](#)

What variable affects our results the most?



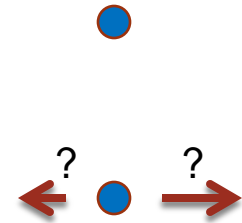
Methods to predict effect of future options/interventions

Single-point estimates:

One set of inputs, one output

Sensitivity analysis:

Change in outcome by varying one (or more) variable(s) at a time



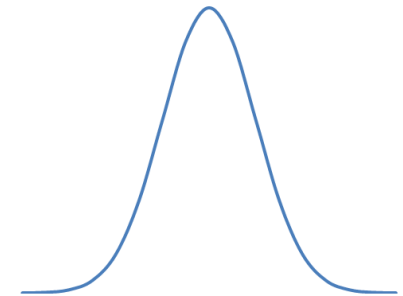
Scenario analysis:

Base-case, best-case, **worst-case**. No sense of likelihood



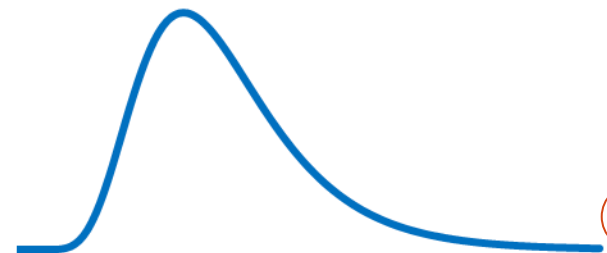
Statistics:

Probabilistic, can only *predict* based on observed (past) events. Can't predict structural changes.



RA and simulation modeling:

**Prediction of future changes, with probabilities.
Quantification of risk drivers**



Why do a risk analysis anyways? (in government)

Because they said so....



<https://sasoc.files.wordpress.com/2010/10/billclinton3.jpg>



<https://d39ya49a1fwv14.cloudfront.net/wp-content/uploads/2012/03/Barrack-Obama-smile.jpg>



<https://http://www.history.com/images/media/slideshow/george-w-bush/george-w-bush-41bush.jpg>

Relevant executive orders (EOs)

Executive order 12866 – 1993 (Clinton)

- “Significant regulatory actions” be submitted for review to the Office of Information and Regulatory Affairs (OIRA).
- What is “significant”?
 - Annual effect on Economy of >\$100M, or
 - Adversely affect economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities
- Thus, **risk analysis** and **cost/benefit analysis** needed
https://www.whitehouse.gov/omb/inforeg_riaguide/

Circular A-4 2003 (Bush)

- Requires use of both **benefit-cost analysis (BCA)** and **cost-effectiveness analysis (CEA)** to evaluate regulatory choices. CEA preferred when benefit not quantifiable
- https://www.whitehouse.gov/sites/default/files/omb/assets/OMB/circulars/a004/a-4_FAQ.pdf

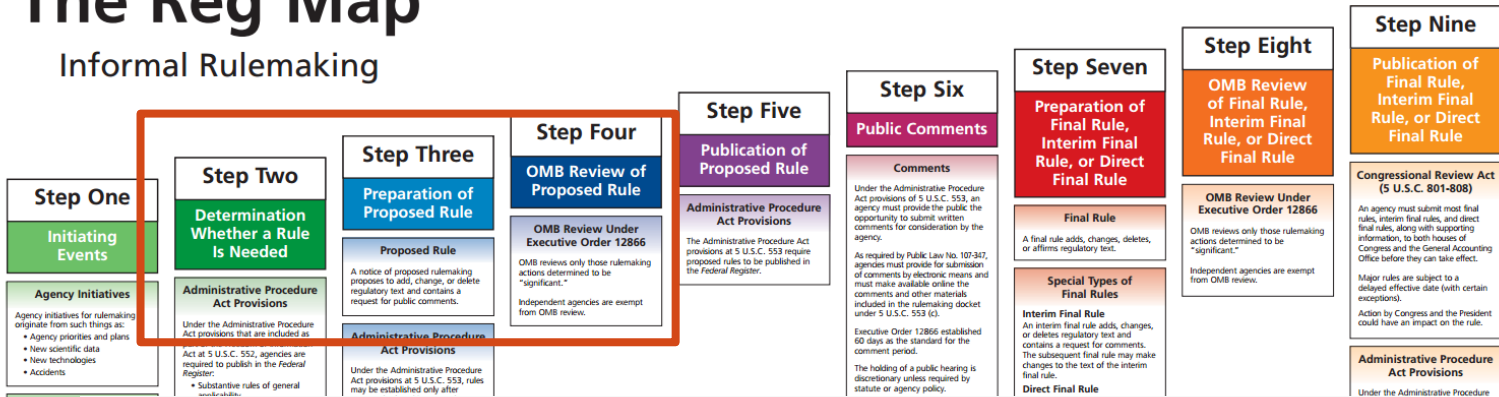
Executive Order 13563 – 2011 (Obama)

- Encourages agencies to consider regulatory approaches that reduce the burden of regulation while maintaining flexibility and freedom of choice for the public
- Requires agencies to **quantify** anticipated **benefits** and **costs** of proposed rulemakings as accurately as possible using the “best available techniques”

Rulemaking

The Reg Map

Informal Rulemaking



Required	Specific Analyses for Steps Three and Seven
Statutory	
Recommend Other Agen Groups/Sta Advisory C	Regulatory Planning and Review (E.O. 12866)
Law	
Peti	<p>Would the rule have a \$100 million annual impact, raise novel issues, and/or have other significant impacts? → If yes Prepare economic impact analysis.</p>
OMB Prop	<p style="text-align: center;">Regulatory Flexibility Act (5 U.S.C. 601-612)</p> <p>Is a notice of proposed rulemaking required by law? → If yes</p> <p>Would the rule "have a significant economic impact on a substantial number of small entities"? → and yes Prepare regulatory flexibility analysis.</p> <p><i>Note: Under limited circumstances analyses also are required for certain interpretive rules involving internal revenue laws (5 U.S.C. 603, 604).</i></p>

The Reg In some requirer that are Also, in are imp In a typ proceed propose Howeve the proj Adminis explain statutor • prom, throu • prom, three period Also, if would r agency omittin duty to

All great but... Executive Order 12866 and circular A-4 **don't apply to independent agencies**

e.g. Congressional Research Service, review of analysis requirements in rulemaking (2014) <https://www.fas.org/sgp/crs/misc/R41974.pdf>

The most extensive and broadly applicable of the requirements are in Executive Order 12866 and OMB Circular A-4, but they **do not apply to independent regulatory agencies.** The statutes that provide rulemaking authority to **independent regulatory agencies** often require them to “consider” regulatory costs and benefits, and they **often have less explicit requirements for cost-benefit analysis, if any.** An OMB report indicated that **independent regulatory agencies** provided some **information and costs and benefits in 76 of the 118 major rules** they issued from FY2003 to FY2012. Cabinet departments and other agencies estimated monetary costs and benefits for some, but not all, of their rules.

Several bills have been introduced in the 113th Congress that would codify and/or expand the current requirements for cost-benefit analysis. Congress could decide to keep the existing analytical framework in place, or could enact one or more of these reform proposals. Another more comprehensive approach could be to consolidate all of the analytical requirements in one place, and perhaps expand those requirements to include more agencies or rules, or to require **different types of analysis. To do so, or to simply cover independent regulatory agencies by the executive order, the President could arguably amend Executive Order 12866 and OMB Circular A-4, or Congress could enact legislation. Any such changes must be cognizant of the state of existing law and practice in this area, and the resources and data required for agencies to carry out the analyses.**



MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES: Updated Principles for Risk Analysis (2007)

*“While many of the principles presented in this Memorandum **may be relevant to other fields, such as financial or information technology risk analyses**, the focus of this Memorandum is on those risk analyses related to environmental, health, and safety risks”* Page 2 of M-07-24

https://www.whitehouse.gov/sites/default/files/omb/assets/regulatory_matters_pdf/m07-24.pdf

In summary, risk analysis in government is usually “health-oriented” because:

- Independent agencies not required to do it (EPA is the exception)
- Term “risk assessment” or “risk analysis” historically associated with “harm”, but methods are similar for “regulatory impact analysis” or “Impact assessment”
 - E.g BCA/CEA analysis require a measure of the “harm” or “benefits”, so risk analysis is often done without being called QRA.

What are others doing in the US?

It started with EPA (so under the “health” umbrella):

- History of QRA at EPA (since 80s): http://www.epa.gov/risk_assessment/history.htm
 - 1983: “Red Book”: Risk Assessment in the Federal Government: Managing the Process (NAS)
 - 2009: Science & Decisions: Advancing Risk Assessment (NAS)
http://www.nap.edu/catalog.php?record_id=12209
- Friendly description of EPA’s human health risk assessment process
http://www.epa.gov/risk_assessment/health-risk.htm
 - Applications: assess health hazards from environment and water.
- Several other agencies actively use it: e.g.
 - USDA –establish policies based on predicted benefits, allocate inspection resources, assess import risks, assess effectiveness of policy changes, quantify performance in achieving standards, identify data gaps
 - FDA – food safety, risk/benefits assessments of interventions/pharma, net clinical-benefits of drugs, etc.
 - Even the fed reserve! Financial risk models (e.g. VaR) , and “stress testing” (Dodd-Frank act)

And in Europe – many cases, but the European Food Safety Authority (EFSA) is a good case study

- **Independent** European agency funded in 2002 to provide food risk assessments to EU – separate from EU commission, EU parliament, and EU member states
- Funded with large emphasis on **separation of risk assessment and risk management**
- However, such drastic separation may not provide most informative answer to decision makers
- Emphasis **evolving to independence with interdependence** with decision makers/risk management

What can we learn from others?

- **“One size fits all”** models typically **don’t work** – but perhaps this approach might be feasible in interference assessment?
- Well defined risk management questions are key to the success of a QRA
- Independence of risk assessors is important, but **iterative dialog** with risk managers and stakeholders is necessary for success/relevance of modeling
- Methods are still not very standardized – QRA requires **skill AND practice**

The way forward

- Key to a good start
 - Awareness of QRA methods and limitations - training
 - Start with a small, self contained project that can show the value of the approach, then consider a bigger scope
- Learn from other's experiences, but perhaps not too much
 - Historical evolution from older agencies not necessarily good to replicate (e.g. EPA vs FSIS)
 - Consider early on how to establish standards and consistency among involved parties

Thanks for your time!



<http://www.bertibenis.it>



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Please feel free to contact me if you have any questions

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