

Of Models and Cakes

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HANDOUTS

Disclaimer:

The views expressed herein are those of the authors and should not be attributed to the International Monetary Fund, its Executive Board, or its management.

What is Next?

YOU HAVE LEARNED A LOT!

Back home, review all the materials and exercises. . .

take the model and then

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Back home, review all the materials and exercises. . .

take the model and then

DELETE IT ;)

Learn by Doing

- ▶ **Build** the model from scratch (closed, then open)
- ▶ **Compile** the data, transform the data. Do FIGURES!
- ▶ **Explore** many parameter setups, tinker
- ▶ **Write down** the economic narrative for the simulations

Sit down with your team, switch a projector on, and discuss the models properties.

**NO MATTER HOW YOU SLICE IT,
IT'S A PIECE OF CAKE**

Key Modeling Philosophy

Modeling follows a story by J. Čapek: Tales of Doggie and Moggie

Let me share the story with you.

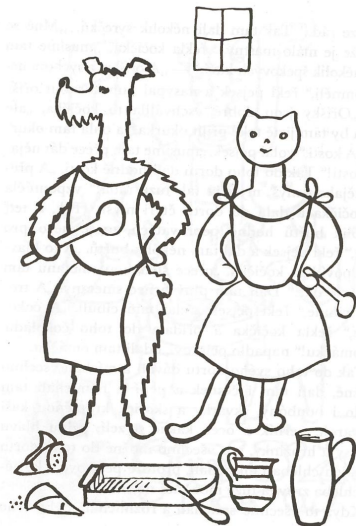
Getting a Cake

The dog and the cat got a cake. . . but they couldn't eat it!



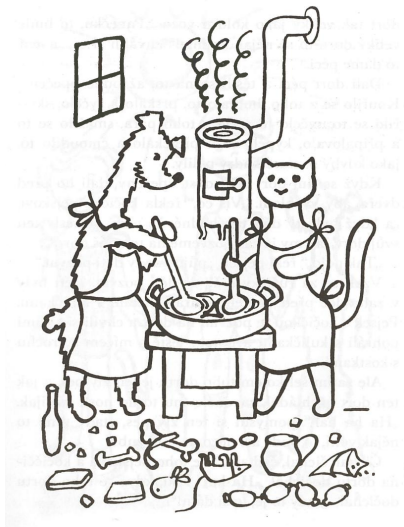
Preparing to Make a Cake

They decided to their own. . . and bought all the right tools.



What Should be in the Cake?

They set out to put all the things they like into the cake. . .

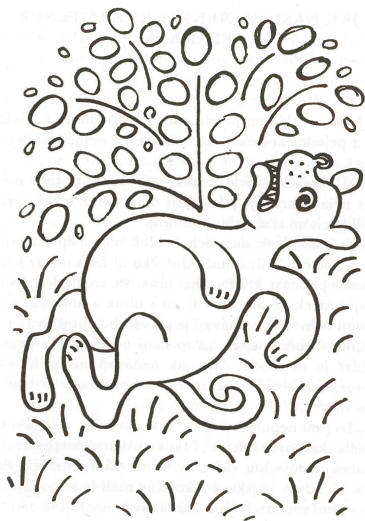


Eating the Cake

They were excited about eating the cake. Yet. . .

Eating the Cake

...before they could, a mean dog ate their cake! And suffered.



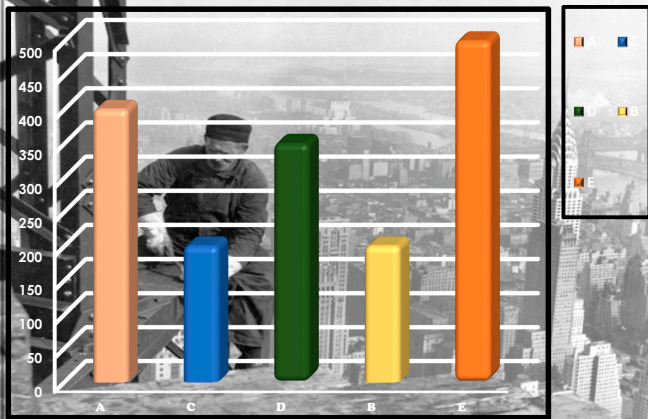
COMMUNICATION OF RESULTS

Visualization of Quantitative Information

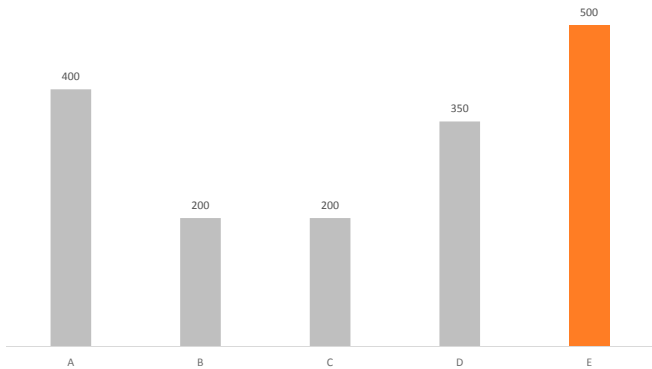
Communicating clearly the message should not be underrated.

- ▶ Learn principles of data visualization
- ▶ Built code base for fast and effective visuals
- ▶ Automation of reports and charts is key

Number of Skyscrapers Built in 2017



Number of Skyscrapers Built in 2017



Real House Prices over the Past Year

Real house prices increased over the past year in most countries.

(2017:Q1 or latest, annual percent change)



Sources: Bank for International Settlements, European Central Bank, Federal Reserve Bank of Dallas, Savills, Sinyi Real Estate Planning and Research, and national sources.



www.imf.org/housing | #HousingWatch

Do Not Underestimate Presentations

- ▶ Don't try to jamm too much into one slide, the slides are not equal to your presentation. Use mostly visuals.
- ▶ Slides are also not your handouts. Be concise, don't write full sentences or paragraphs. It is OK to have both slides and handouts.
- ▶ Think of the audience of your talk. People have different level of technical skills and different emphasis on details.
- ▶ Learning to present your ideas and results well is important and better started sooner than later.
- ▶ Technical experts laughing at people skills is the same as if people thinking anybody who can code is a geek – unproductive and foolish.
- ▶ It is actually really, really hard to fill this page with bulletpoints that make some sense. Very painful.

A FEW COMMENTS

Build a SYSTEM, not a MODEL

Systems last. Models DO NOT.

Forecasting Model:

- ▶ Is not the same as a simulation model
- ▶ Is a very useful calculator
- ▶ Should not be surprising you
- ▶ Better be designed top-down

Slide and Dice...

Think how to decompose all model results and properties.

Think of the model as of

$$Y = F(X, \theta), \quad X = f(Y_{obs}, \theta) \quad (1)$$

Even if you know the intuition, do decomposition reports.

Kalman Smoother = Least Squares (Easy to Slice)

Kalman filter/smoothen is just least squares. Linear operator.

The Model:

$$\mathbf{Y} = \mathbf{A}\mathbf{X} \quad (2)$$

$$\mathbf{X}_{t|T} = \mathbf{A}^{-1}\mathbf{Y} = \mathbf{P}\mathbf{Y}. \quad (3)$$

So you can slice and dice it. . .

Forget about the “tracking” problem ;)

Wonkish

$$\min_{X_0, \{\varepsilon\}} \Lambda = X_0 P^{-1} X_0 + \sum_{t=1}^N [Y_t - Z X_t] (H H')^{-1} [Y_t - Z X_t]' + \sum_{t=1}^N [X_t - T X_{t-1}] (R R')^{-1} [X_t - T X_{t-1}]' .$$

The genius of Kalman was to make the problem recursive!
... and I'm kind of doing the opposite



Super Wonkish

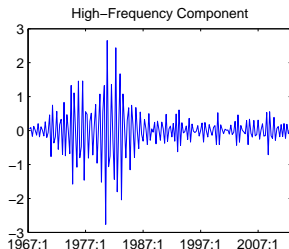
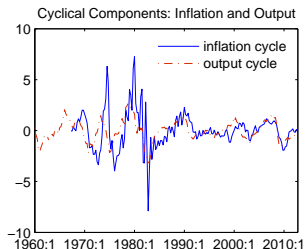
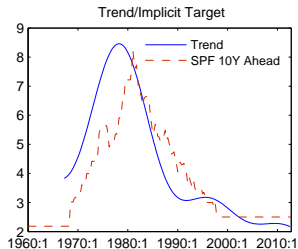
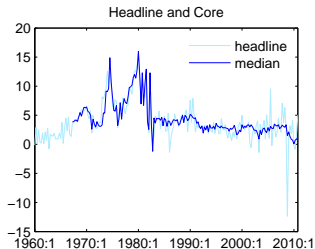
Denoting $\mathbf{Y} = [Y_1 \ Y_2 \ \dots \ Y_N]'$, $\mathbf{E} = [\varepsilon_1 \ \varepsilon_2 \ \dots \ \varepsilon_N]$, and $\mathbf{Z} = [X_0 \ \mathbf{E}]$, the least-squares problem is stated as follows:

$$\mathbf{Z} = \operatorname{argmin} \|\operatorname{vec} \mathbf{Y} - \mathbf{A} \times \operatorname{vec} \mathbf{Z}\|, \quad (4)$$

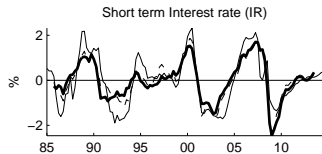
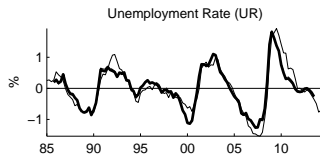
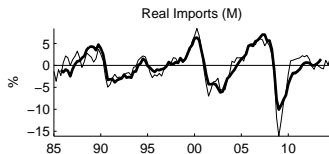
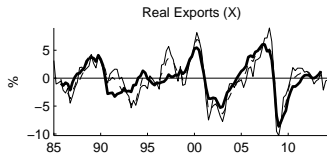
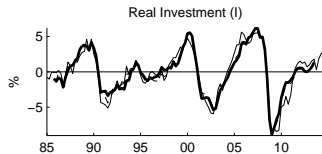
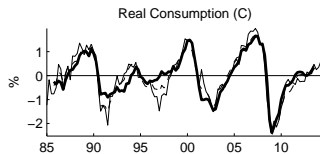
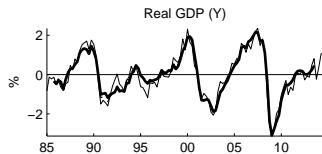
$$\mathbf{A} = \left[\begin{array}{c|cccccc} \mathbf{ZT} & \mathbf{ZR} + \mathbf{H} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \dots & \mathbf{0} \\ \mathbf{ZT}^2 & \mathbf{ZT}^2 \mathbf{R} & \mathbf{ZTR} & \mathbf{ZR} + \mathbf{H} & \mathbf{0} & \dots & \mathbf{0} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ \mathbf{ZT}^N & \mathbf{ZT}^{N-1} \mathbf{R} & \mathbf{ZT}^{N-2} \mathbf{R} & \dots & \dots & \dots & \mathbf{ZR} + \mathbf{H} \end{array} \right] = [\mathcal{O} \ \mathcal{H}]. \quad (5)$$

Trend-Cycle Models: $x_t = \bar{x}_t + \hat{x}_t + \varepsilon_t^x$

Think of each frequency, **model** each component:



Trends and Cycles



— Data
— Fit with the first principal component
- - - Fit with the first two principal components

Trend-Cycle Models: $x_t = \bar{x}_t + \hat{x}_t + \varepsilon_t^x$

- ▶ Applies to QPM, DSGE, and VARs (TC-VARs)
- ▶ MODELS \neq FILTERS
- ▶ A great model can be hurt by a botched filter
- ▶ Example: Long vs. Short Cost-Push Shocks

Trends and Cycles in Real Time

Two interesting tendencies in the economy:

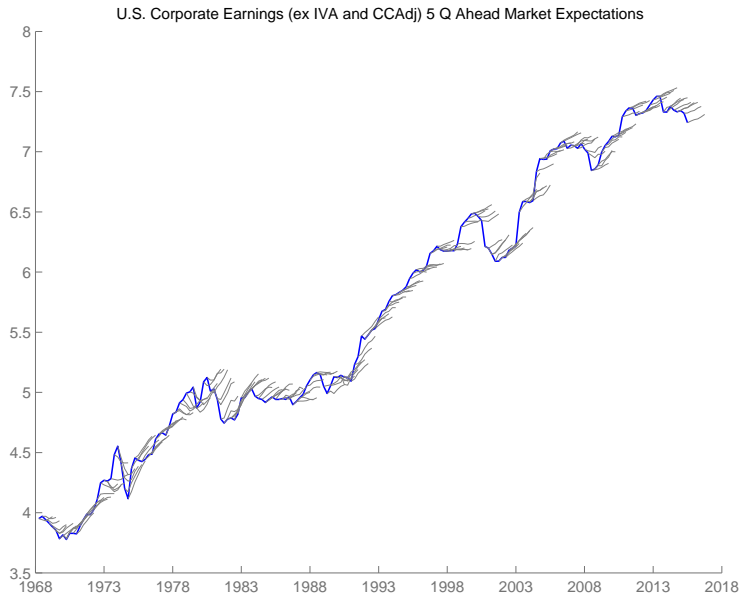
1. **OVERRACTING:**

Thinking everything is permanent

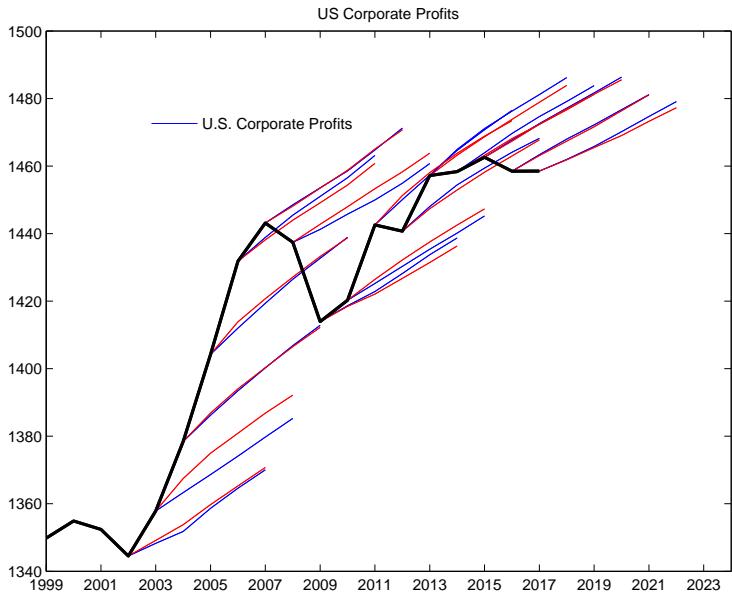
2. **UNDERREACTING:**

Belated reckoning of permanent shocks

Trends and Cycles in Real Time



Trends and Cycles in Real Time



FORECASTING WITH JUDGEMENT

Forecasting with Judgement

“Humility is attainable, even if forecasting accuracy is not”

Philip Tetlock [Superforecasters]

Reading:

Kahneman, Tversky, Ariely, Thaler, Tetlock, Munger, . . .

Forecasting with Judgement

- ▶ **Where do you get your judgement from?**

Other models, empirics, ...

- ▶ **Can you trust your judgement?**

Psychology of human misjudgement

- ▶ **How do you check your judgement?**

Model-based methods of imposing discipline

Judgement. . . Where From?

Judgement... Where From?

READ. READ. READ. And READ SOME MORE...

- ▶ Read papers by other people, broadly
- ▶ Read FT and WSJ, finance journals
- ▶ Study methods of causal inference to be able to interpret empirical research and tell good from bad
- ▶ Study and build structural/DSGE models
- ▶ Talk to sectoral experts, non-modelers, ...
- ▶ *Value experience, value senior talent...*

Semi-Structural vs. DSGE Models

It is much easier to build semi-structural models with solid knowledge and experience of DSGE models!

- ▶ Helps to derive a structure and “simplify” and loosen up restrictions
- ▶ Helps to realize the limitations of semi-structural forms
- ▶ ...

Better yet, have at your disposal a semi-structural model and a structural (simulation) model test, experiment, and learn.

Judgement from a Simulation Model (1)

Example:

The IMF's **GPM** model, a gap/QPM model, uses inputs from simulations based on more structural models:

- ▶ **FSGM** (Flexible System of Global Models) or
- ▶ **GIMF** (Global Integrated Monetary and Fiscal) models

Example:

An immediate and permanent drop in remittances by 35% from the U.S. to 'Country X'.

Simulations based on IMF's FSGM model (Andrle et al. 2015)

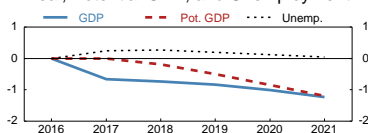
Judgement and a Simulation Model (1)

Country X

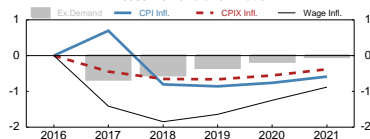
Country X: Drop in Remittances from the USA by 35%

(Percent or percentage point deviations from control)

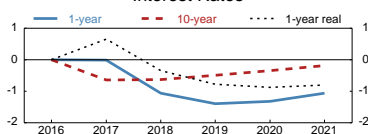
Real, Potential GDP, and Unemployment



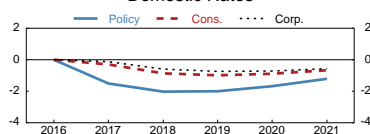
Excess Demand and Inflation



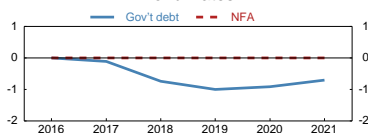
Interest Rates



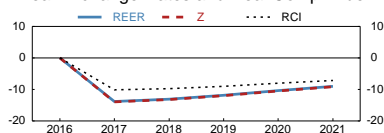
Domestic Rates



Bond Rates

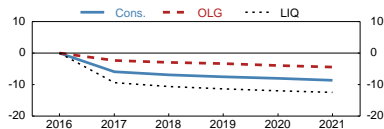


Real Exchange Rates and Real Comp. Index

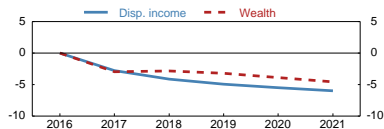


Judgement and a Simulation Model (continued)

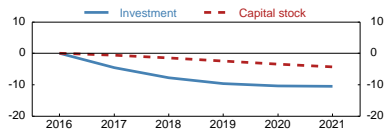
Consumption



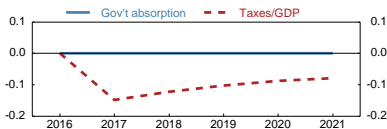
Disposable Income and Wealth



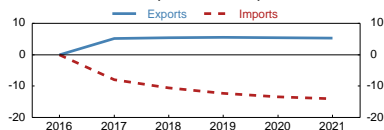
Private Investment and Capital Stock



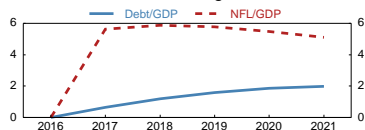
Government Sector



Real Exports and Imports



Debt and Net Foreign Liabilities



Digression: On Specialized Generalist

Focus on your specialization (economic modeling, ...)

But learn key ideas in other fields:

- ▶ History, history, history
- ▶ History of economic thoughts, non-mainstream school of thoughts
- ▶ Behavioral finance/economics (is there any other?)
- ▶ Computer science
- ▶ Math and engineering
- ▶ ...

Can You Trust Your Judgement?

Can You Trust Your Judgement?

Tom W. is of high intelligence. He has need for clarity and order. His writing is rather dull and mechanical, occasionally enlivened by somewhat corny puns and flashes of imagination of the sci-fi type. He has strong drive for competence. He does not enjoy interacting with others. He has a deep moral sense.

What is Tom's W. most likely graduate degree?:

- A) Computer science
- B) Business Administration
- C) Humanities and Education

Source: Kahneman, Thinking—Fast and Slow

Can You Trust Your Judgement?

Linda is a thirty-one years old, single, outspoken, and very bright. she majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations.

Can You Trust Your Judgement?

Which alternative is more probable?

- A) Linda is a bank teller.
- B) Linda is a bank teller and is active in the feminist movement.

Representativeness vs. Probability

Kahneman-Tversky:

“About 85% to 90% of undergraduates at several major universities chose the second option, contrary to logic.”
[Kahneman: Thinking – Fast and Slow]

There are more “difficult” version of Linda/Tom W., ranking whether Linda is more probable to be

- ▶ teacher in elementary school
- ▶ bank teller
- ▶ psychiatric social worker
- ▶ insurance person
- ▶ ...

Base Effects

Tom W., say, may look like a geek, loving computers, etc.

But it's still more probable he studies business administration or liberal arts than computer science

BAYES LAW:

It is important to realize that people are NOT NATURAL at using BAYES LAW.

System I. versus System II.

System I. is your guts. . .

System II. is your logic and reasoning. . . But it is often quite
LAZY! (mine is)

Policy Choices and Trade-Offs

Policy Choices...

There 600 people with a deadly disease.

- ▶ **Treatment A:**

400 people will die.

- ▶ **Treatment B:**

There is a 33% chance nobody will die. 66% chance all 600 will die.

Policy Choices...

There 600 people with a deadly disease.

- ▶ **Treatment A:**

200 people will be saved.

- ▶ **Treatment B:**

There is a 33% of saving all 600 people. 66% chance of saving no one.

The Funny Thing...

In Kahneman and Tversky research in 1981:

- ▶ Treatment A was chosen by 72% with positive framing (saves lives)
- ▶ Treatment A was chosen by 22% with negative framing (400 people die)

Models and Human Biases

We all have tendency to fool ourselves. Seek easy solutions.

Example:

1. Come up with a simulation scenario
2. In writing, describe what will happen in the model
3. Simulate the scenario
4. Compare
5. Describe the scenario the simulation

Conjecture effects of scenarios, forecasts, effects of new data.

Then, slice and dice the results using formal analytical tools.
(shockd decomp, obs. decomp, FEVD, decompose spectrum, ...)

Answering an Easier Question

It's natural (System I) to answer a different, easier question.

The ugly way:

- ▶ **The primacy of conclusion** – you like the policy, you see evidence of its benefits
- ▶ **Substitution and Selection Bias** – A. Wald: Plane hits vs. plane crashes
- ▶ Of course the output gap is negative, the Phillips curve is flat. . .
- ▶ Nominal interest rates and inflation are always negatively correlated. . .

Hammers and Nails...

To a man with a hammer, everything looks like a nail...

1. Tendency to always apply the tool at hand
2. Tendency to reinterpret everything in one way
3. Where do we get our **judgement** from?

Read broadly, read deeply.

Study DSGE models to understand their benefits and problems.

Trusting Your Model

Eventually, some people believe too much in their models...

1. Structural models are internally consistent, logical
2. Understanding model mechanics does not imply understanding reality
3. The tools we use shape our minds (models, even software)

A Few Cognitive Biases for Forecasts

A tip of the proverbial iceberg...

- ▶ We're all pattern seekers
- ▶ Inconsistency-Avoidance and Commitment Tendency
- ▶ Over-influence by Social Proof, Groupthink
- ▶ Hindsight Bias
- ▶ Familiarity (A Guy with a Hammer) Bias
- ▶ Base Effect Bias, Availability-Misweight
- ▶ Denial (Not looking at discomfoting facts. . .)

How to Evaluate Judgement

Let's Use Models

Models Help Testing

- ▶ **Decompose smoothed estimates into observables**

Does inflation affect the output gap estimate? Which period is doing what?

- ▶ **How plausible is your judgement**

Compute your unconditional predictive distribution. How likely is your judgemental forecast? How does it involve over time?

- ▶ **How likely are the estimated shocks given your model?**

Are the shocks correlated? Auto-correlated? Fat tails? How your model compares with DPCA?

- ▶ **Using reduced-form stat. relationships**

E.g. estimated consumption/import equations' residuals evaluated on a forecast. . .

Fighting Cognitive Biases with MODELS

Checks, balances, and openness...

1. Meticulously version code and data
2. Archive all forecasts, analysis, minutes. Regularly review!
3. Decompose the forecasts along many dimensions (shocks, observables, judgement, etc.)
4. Regular forecast-error decomposition and evaluation
5. Foster culture of openness to non-orthodox productive contributions
6. **Own your screw-ups! Allow people to mess up.**

Conclusions

- ▶ Learning by doing
- ▶ Don't be the 'guy with a hammer'
- ▶ Decompose model results into pieces

Thank you for your patience...