Applying the Pre-Commitment Approach to bottom up stress tests: a new old story

EBA Policy Research Workshop: The future of stress tests in the banking sector

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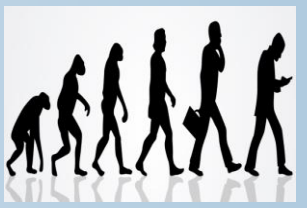

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1. The problem: are stress tests beauty contests?

Bottom-Up vs Top-Down approach

Stress Test: a measure of risk conditional to an extreme but realistic macroeconomic scenario. Need of **statistical models**.

The bottom up approach is considered not fully trustworthy since it relies on banks' models, which could be less conservative given the banks' different **incentives**. If the results are publicly disclosed there is a further incentive for banks to provide the most reassuring estimates of the impact.

Dowd (2015): banks want **bad models** because they understate their risks. Most risk modelling is then just a game: banks pretend to model risks, but they are really **gaming** the risk numbers'.

The bank-supervisor relationship can be seen as a **principal-agent problem**: the bank (the agent) develops a model and provides its outcome to the supervisor (the principal). The supervisor makes decisions relying on the bank's model under asymmetric information.

NOW	1Y FROM NOW
true opinion $E_t(D_{t+1}) = M(\Omega_t, E_t(y_{t+1}))$	OUTPUT GAP: y_{t+1} DEFAULT RATE: $D_{t+1}(y_{t+1})$
	forecast error $\eta_{t+1} = D_{t+1} - E_t(D_{t+1})$
opinion provided $E_t(\widehat{D_{t+1}})$	
banks game $b = E_t(D_{t+1}) - E_t(\widehat{D_{t+1}})$	observed forecast error $\epsilon_{t+1} = D_{t+1} - E_t(\widehat{D_{t+1}}) = b + \eta_{t+1}$

2. The FED Pre-Commitment Approach

The FED Pre-Commitment Approach

The Pre-Commitment Approach (PCA) was developed by FED's economists Kupiec and O'Brien in 1995. In that period, the BCBS had agreed to provide a regime for min. capital requirements for the trading book based on VaR models. The debate at that time was on whether supervisors should set model parameters or rather allow banks to use their estimates → **Top Down vs Bottom Up**

The proposal:

- banks set the amount of capital needed to back the trading book over a period
- are penalised (fine) if losses > capital for that period.

→ **rather than meeting the capital requirements set by the regulator, the bank sets itself the capital requirement with the awareness that it will face penalties should its trading activities generate losses exceeding the pre-committed capital**.

The FED decided to run an experiment involving 10 banks.

PRE-COMMITMENT PILOT EXERCISE: AGGREGATE DATA REPORT

Bank	Fourth-Quarter 1996 P&L:PCA Ratio	First-Quarter 1997 P&L:PCA Ratio	Second-Quarter 1997 P&L:PCA Ratio	Third-Quarter 1997 P&L:PCA Ratio
1	0.56	1.21	1.39	1.09
2	2.27	1.20	2.18	0.96
3	3.56	3.79	3.25	3.61
4	0.44	0.59	0.74	0.84
5	1.84	2.92	1.89	1.81
6	0.42	0.68	0.75	0.54
7	0.81	1.01	1.12	1.12
8	0.77	0.42	1.15	0.91
9	5.43	5.89	5.11	6.60
10	1.46	1.99	1.36	1.88

Notes: P&L is trading profit and loss on consolidated trading activities for the Measurement Period. PCA is the pre-committed capital amount for market risk for the Measurement Period.

FRBNY ECONOMIC POLICY REVIEW / OCTOBER 1998

The PCA uses market-like incentives to reward and encourage improvements in internal risk measurement and management practices. Greenspan (1998)

The consultation seemed ill-timed from the outset, insofar as the other Basel Committee countries had just agreed to the value-at-risk (VaR) approach to market risk. Notwithstanding its abandonment of formal consideration of the pre-commitment approach, the Fed continued to support intellectual work on the idea. Tarullo (2008)

de Finetti's penalty criterion (also, the Brier - 1950 Score)

The dominant Bayesian school is the subjective Bayesianism of de Finetti and Savage. Efron (1986)

For de Finetti, the problem is not to know the "true" probability of the realisation of an uncertain event, but to get the best evaluation of such probability that a subject can provide. The tricky aspect is that the subject could have incentives to not reveal its true belief about the probability of the event. The revelation of true beliefs **requires to correct the incentives through penalties.**

The easiest example: an uncertain event, only two values: $E = \{0,1\}$.

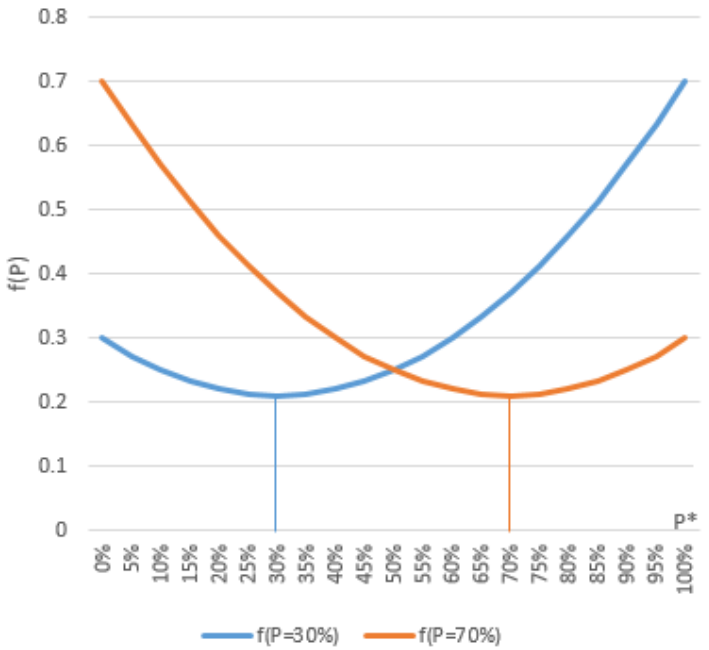
- A subject is asked to provide an evaluation of the probability that the case 1 occurs. His true opinion is *P*
- Penalty criterion: monetary fine proportional to $(1 - P^*)^2$ if the event occurs and P^{*2} if the event does not occur.
- $P^*$is the probability value provided by the subject.

The true evaluation of the probability is equal to P but the subject may decide to provide $P^* \neq P$.

He can anticipate that the fine f he will pay is:

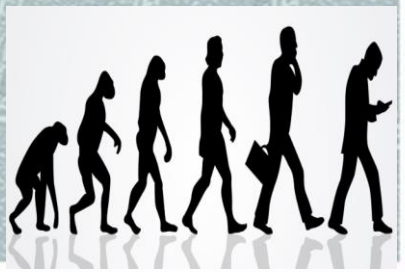
$$E(f) = (1 - P^*)^2 * \Pr(E = 1) + (P^*)^2 * \Pr(E = 0)$$

$$E(f|P) = (1 - P^*)^2 * P + (P^*)^2 * (1 - P)$$



$$min_{P*} E(f|P) \rightarrow \frac{\partial E(f|P)}{\partial P^*} = 2P^* * -2P = 0$$

3. Adapting the PCA to Bottom Up STs



Adapting the PCA to Bottom Up STs

A critical assumption we make:

models used by the banks for internal purposes are the same used to provide the risk measures in the stress test.

→ it is possible to define the bank's better forecast for next year as the one obtained through the internal model fed with the bank's own expected scenario. In this case, **the comparison between the expectation and the error is acceptable**.

Under the new accounting standards (IFRS9), banks are required to compute provisions under different future scenarios.

Guidance on credit risk and accounting for expected credit losses

Reasonable and supportable information

19. The Committee notes that banks are required to consider a wide range of information when applying ECL accounting models. Information considered should be relevant to the assessment and measurement of credit risk to the particular lending exposure being assessed and should include information about past events, current conditions and forecasts of future economic conditions. Information which is ultimately included in the assessment of credit risk and measurement of ECL should also be reasonable and supportable. Banks should use their experienced credit judgment in determining the range of relevant information that should be considered and in determining whether information is considered to be reasonable and supportable.

Consideration of forward-looking information

20. Consideration of forward-looking information, including macroeconomic factors, is a distinctive feature of ECL accounting frameworks and is critical to the timely recognition of ECL. Banks will have to employ sound judgment consistent with generally accepted methods for economic analysis and forecasting. As credit risk management is a core competence of banks, the Committee expects that a

22. As noted in paragraph 19, all information considered should be relevant to the assessment and measurement of credit risk and reasonable and supportable. Banks should be able to demonstrate how they have considered such information in the ECL assessment and measurement process. Information should not be excluded from that process simply because an event has a low likelihood of occurring or the effect of that event on the credit risk or the amount of expected credit losses is uncertain. The

2020 EU-WIDE STRESS TEST – METHODOLOGICAL NOTE

2.4 Impact on P&L

2.4.1 Starting point-in-time risk parameters (a hierarchy of approaches)

113. The following paragraphs describe a hierarchy of methods that banks are required to adhere to when they set the starting (unstressed) point-in-time risk parameters. As a general principle, banks should resort to data from models rather than from accounting approximations:

- Banks are required in the first instance to extract the relevant parameters from the models that they use to compute provisions according to the relevant accounting standard.
- For IRB portfolios where there is no model to produce IFRS 9/nGAAP provisions, banks are required to base their estimation of starting level point-in-time values on their approved internal parameter estimation models.
- For portfolios for which starting level point-in-time parameters cannot be extracted from approved internal models, banks should use non-approved models to extract point-in-time parameters, provided that those models are regularly used in internal risk management and stress testing, and that the competent authority agrees with using them for the purpose of the EU-wide stress test.
- For portfolios where no appropriate internal models are in use for estimating the starting TRs, LGDs or LRs, banks are expected to approximate these values using historically observed equivalents (e.g. the S3 transition and loss rates from S1 for TR[1-3]

Adapting the PCA to Bottom Up STs: a practical example

the default rate generated each year by a bank credit portfolio obeys to a well-defined model like the following.

$$DR_t = d + \rho DR_{t-1} + \theta y_t + \varepsilon_{1,t} \qquad (1)$$

Where:

DR_t default rate of the portfolio at time t

y_t macroeconomic variable, for example the GDP growth rate

The macroeconomic variable y_t follows a simple AR(1) stochastic process.

$$y_t = \beta_0 + \beta_1 y_{t-1} + \varepsilon_{2,t} \qquad (2)$$

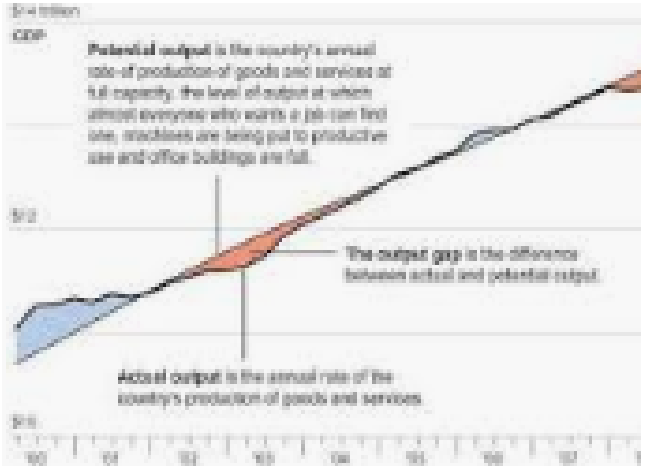
$$\varepsilon_{2,t} \sim N(0, \sigma_i^2)$$

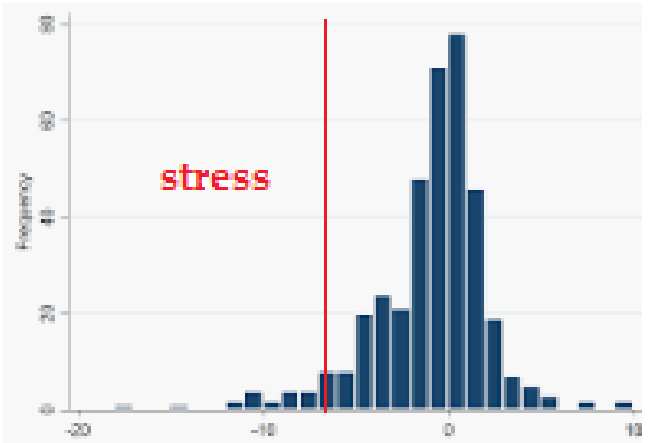
Then being:

$$y_t \sim N\left(\frac{\beta_0}{1-\beta_1}, \frac{\sigma_2^2}{1-\beta_1^2}\right)$$

We have: $E_t^{AUT}(y_{t+1}) = q_\alpha(y_{t+1}) = y^* | P(y_{t+1} < y^*) = 1 - \alpha$

$$E_t^{AUT}(y_{t+1}) = y^* = \frac{\beta_0}{1-\beta_1} + \Phi^{-1}(\alpha)\sqrt{\frac{\sigma_2^2}{1-\beta_1^2}}$$





Adapting the PCA to Bottom Up STs: a practical example

The bank knows the true model given by (1) and (2) so that its best forecast is:

$$E_t^{bank}(DR_{t+1}) = d + \rho DR_t + \theta E_t^{bank}(y_{t+1}) = d + \rho DR_t + \theta(\beta_0 + \beta_1 y_t)$$

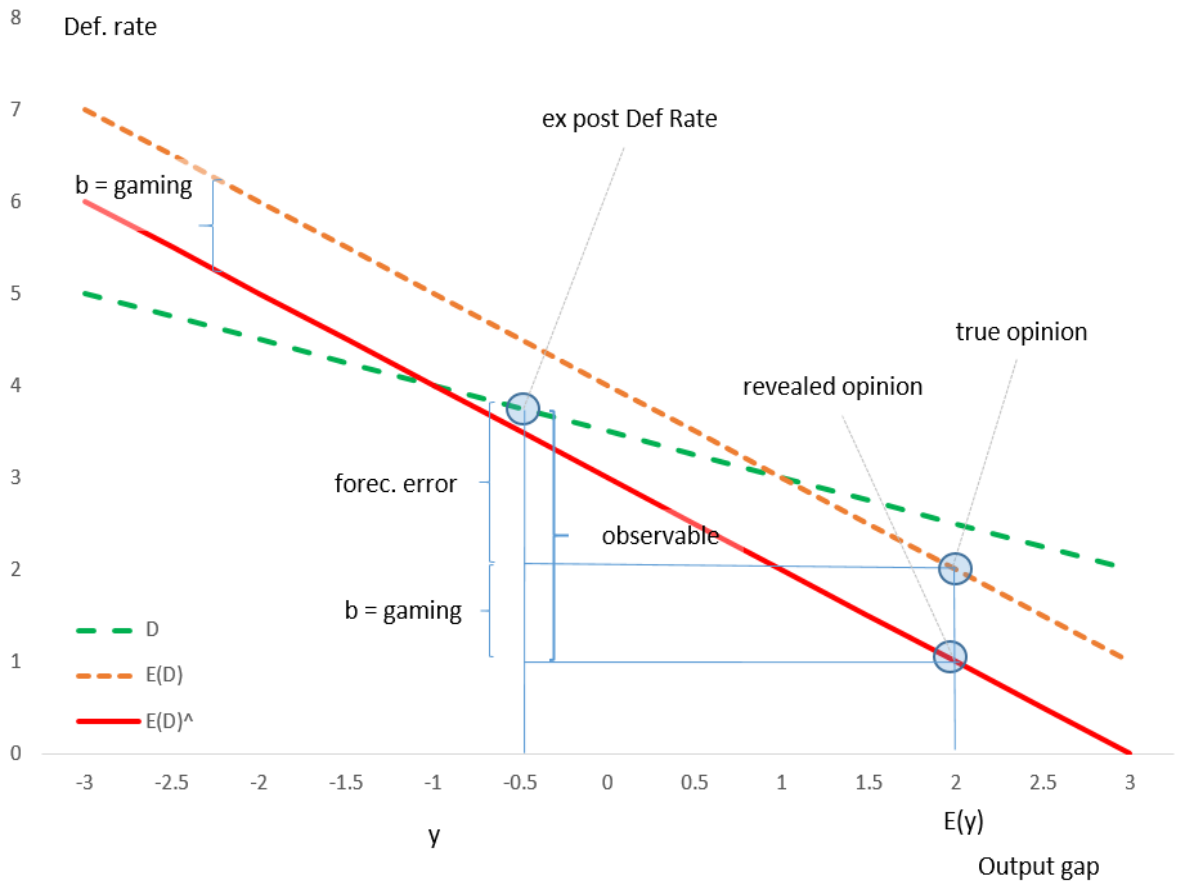
The bank decides then to provide the result of the following model where the internally estimated default rate is systematically reduced by a quantity equal to b:

$$\widehat{E_t^{bank}(DR_{t+1})} = E_t^{bank}(DR_{t+1}) - b = d - b + \rho DR_t + \theta(\beta_0 + \beta_1 y_t)$$

principle of minimum credibility from which the bank derives the lien $d - b \geq 0$.

Given the stress scenario set forth by the authorities i.e. $E_t^{AUT}(y_{t+1}) = y^*$, the model provided by the bank produces the following stressed default rate:

$$\widehat{E_t^{bank,AUT}(DR_{t+1})} = d - b + \rho DR_t + \theta y^*$$



The bank forecast would have been $d + \rho DR_t + \theta y^*$ had the bank provided its best model.

Adapting the PCA to Bottom Up STs: a practical example

define the return on capital as follows:

$$R_t = \frac{P_t r - CRA_t}{C + k} = \frac{P_t\left(r - E_t^{bank}\widehat{(DR}_{t+1}) * LGD\right)}{C + k}$$

The quantity k is meant to ensure that provisions and the additional capital buffer are able to cover losses under the stress scenario.

$$max_b R_t = \frac{A}{B} + \frac{LGD}{B} b$$

$$-b \geq -d$$

$$LGD > 0$$

the optimal solution is $b = d$ that is the bank optimises its position by pushing the level of cheating to the maximum.

Now let's introduce a charge proportional to the forecast error and to the portfolio value:

$$f_{t+1} = \delta * \left(L_{t+1} - E_t(L_{t+1})\right)^2 = \delta * \epsilon_{t+1}^2$$

$$= \delta * (P_t * LGD)^2 * \left(DR_{t+1} - E_t^{bank}\widehat{(DR}_{t+1})\right)^2$$

The charge level will be known only in t+1 when DR_{t+1} is observable.

the bank will try to estimate in advance its value and to include it in its decisional process.

the best forecast for DR_{t+1} is its true model i.e. $E_t^{bank}(DR_{t+1})$

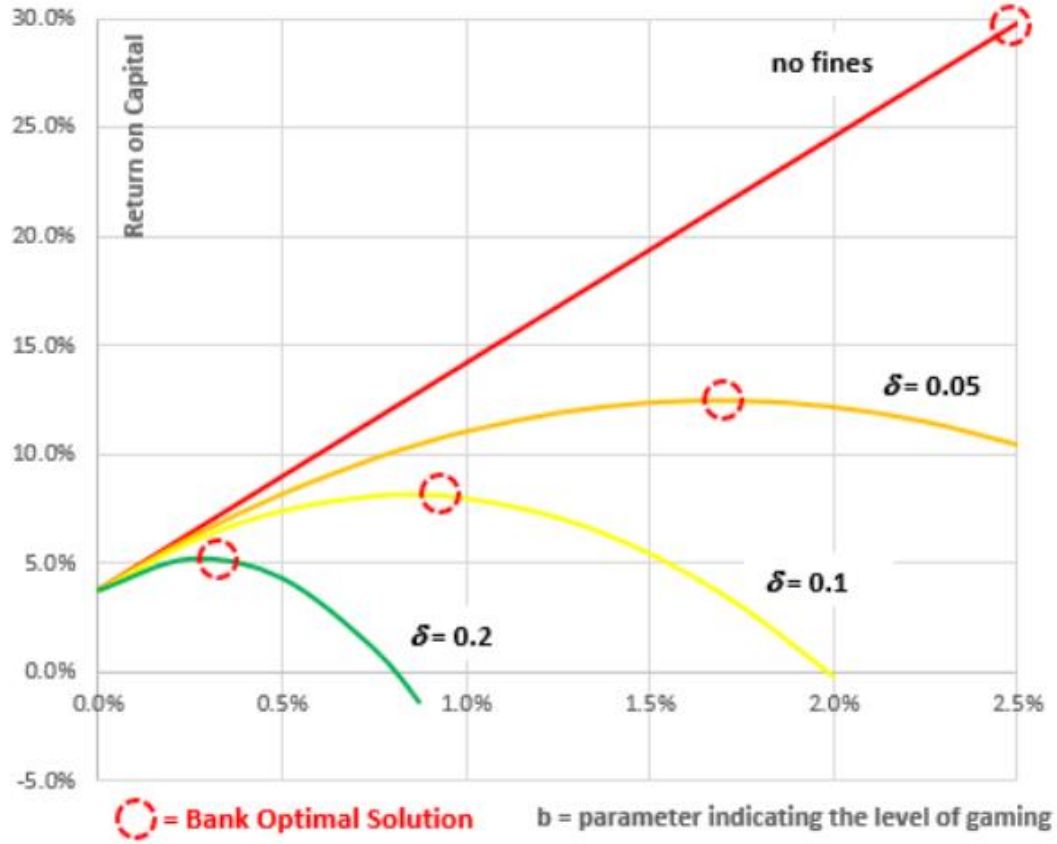
$$E_t\left(f_{t+1} | E_t^{bank}(DR_{t+1})\right) = \delta * (P_t * LGD)^2 * (b)^2$$

Adapting the PCA to Bottom Up STs: a practical example

R_t^f is the return on equity net of the fine evaluated considering (1) the best bank's forecast for the default rate i.e. the (1) and the level of cheating set by the bank i.e. b.

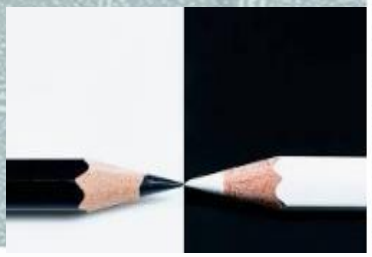
$$R_t^f = \frac{A}{B} + \frac{LGD}{B} b - \frac{C}{B} b^2$$

Now the target function is a parabola in respect to b. This means that as b increase the return is affected by a positive component LGD/B proportional to b but also to a negative element C/B proportional to b squared.



The level of gaming depends also on the parameter δ that is under the control of the authorities. In other words, the presence of the charges makes the bank control variable dependent on the control variable of the authorities.

4. Differences from the PCA



Differences from the PCA

1) The threat of penalties would have a significant impact on portfolio decisions while for "dead walking" banks, the incentives would be ineffective. Milne (2002)

→ In general. Stress tests are not meant for setting minimum capital requirements. Our proposal does not directly affect any measure of the Stress Tests.

2) A key feature of large modern banks is the separation of owners from day-to-day decision-making. Varotto (1997)

→ We believe that the penalisation should hit the person directly responsible for the models' development. The charge could be proportional to a share of the Chief Risk Officer annual bonus for example $f \leq$ x%*bonus.

3) The PCA is more prone to a time consistency problems because it applies penalties ex-post. Regulators, for example, would be pressured to waive the penalty in case it were to lead to bankruptcy. Santos (2000)

→ The penalty must be adequate to offset the incentive of bank managers to set the capital level quite low, but it cannot undermine the bank's economic situation.

4) The "opaqueness of credit losses" is a possible obstacle to the application of the PCA to credit risk. Tarullo (2008)

→ The "opaqueness of credit losses" is more connected with the severity since recovery procedures can take many years. In practice, we propose to make use of the PCA to induce banks to reveal their best forecast models for the probabilities of default.

5. Calibration

Calibration

A proper use of PCA may minimise the distortions to capital holdings caused by private information. It can be beneficial provided that fines are appropriately calibrated. Prescott (1997)

Following de Finetti, the penalty needs to be symmetric, otherwise, a distortion would be introduced and the provided evaluation would not be equal to the true belief. The difference would depend on the level of risk aversion of the subject, which is idiosyncratic and is not predictable.

This can be counterintuitive for stress test practitioners who expect conservatism to be rewarded. The point, however, is to incentivise banks to provide accurate rather than conservative estimates.

- To provide banks with incentives to develop accurate models and to reveal them. Producing a prudent evaluation is a simpler task compared to producing an unbiased measure
- Does not prevent supervisory authorities from monitoring over time the gap between realised and expected losses and to take actions if a systematic underestimation is observed:

  reviewing the calibration of the charges

  substituting the bank's models with external ones.

A last point: In case of publication, it should be clear that the charge itself does not represent a judgment, but it is rather a device for making the bottom-up stress test incentive-compatible.

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Thank you

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