Are Low Interest Rates Deflationary?
A Paradox of Perfect-Foresight Analysis

Mariana Garcia Schmidt  Michael Woodford
Columbia University  Columbia University

Conference on Deflation
Sveriges Riksbank
June 12-13, 2015
First Japan, and now the US, have gone through prolonged periods of ultra-low interest rates, without this leading to high inflation or even very robust growth.

This has lead some to suggest that prolonged low nominal interest rates — and central-bank promises to maintain such policy — may bring about lower inflation (rather than higher).
First Japan, and now the US, have gone through prolonged periods of ultra-low interest rates, without this leading to high inflation or even very robust growth.

This has lead some to suggest that prolonged low nominal interest rates — and central-bank promises to maintain such policy — may bring about lower inflation (rather than higher) — some (e.g., Bullard, 2010) even propose that interest rates should be raised in order to exit from a deflationary slump.
(How) will raising rates affect inflation?

Traditional (Keynesian and Monetarist) view

Instability

ZLB lesson and current theory

A credible peg, with fiscal backing is stable

Standard (Keynesian and Monetarist) View

Higher interest rates lead to lower inflation, both short and long run

Mild Neo-Fisherian View

→Raising rates will (eventually) raise inflation
1. Is it really true that “modern theory” — deriving aggregate demand and supply relations from intertemporal optimization — implies the neo-Fisherian view?
Questions

1. Is it really true that “modern theory” — deriving aggregate demand and supply relations from intertemporal optimization — implies the neo-Fisherian view?

2. Can one maintain the orthodox view — that maintaining a lower nominal rate for longer should cause higher inflation and capacity utilization — while having a view of expectations that implies that central-bank commitments regarding future policy should have any effect?
People are at least somewhat forward-looking; this is why commitments regarding future policy matter
Our View

- People are at least somewhat forward-looking; this is why commitments regarding future policy matter.

- The assumption of **perfect foresight** is nonetheless very strong — especially in the context of a novel policy regime, and the anticipated effects of policies announced for many quarters in future.
People are at least somewhat forward-looking; this is why commitments regarding future policy matter.

The assumption of **perfect foresight** is nonetheless very strong — especially in the context of a novel policy regime, and the anticipated effects of policies announced for many quarters in future.

PFE predictions are relevant only to the extent that

- the PFE is the **limit** of an iterative process of **belief revision** (as in Evans and Ramey, 1992)
- and this process **converges fast enough** for the limit to well approximate the outcome from a finite degree of reflection.
Our View

When the iterative process *fails to converge*, or converges only slowly: no basis to predict *definite paths* for endogenous variables under a given policy commitment.
Our View

When the iterative process **fails to converge**, or converges only slowly: no basis to predict **definite paths** for endogenous variables under a given policy commitment

— nonetheless, robust conclusions may be possible about how the outcome should be **changed** by choosing one policy rather than another

— and these can **differ** from what a study of the **PFE** consistent with each policy would suggest
Temporary equilibrium (Hicks, Grandmont, etc.): endogenous variables determined by optimizing behavior of economic agents, under subjective expectations that are specified as part of the model (and need not be correct)
Temporary equilibrium (Hicks, Grandmont, etc.): endogenous variables determined by optimizing behavior of economic agents, under subjective expectations that are specified as part of the model (and need not be correct)

Except for the specification of expectations, model here is a standard log-linear NK model

- households, firms solve infinite-horizon problems
- log-linear decision rules depend on (subjective) expectations about outcomes arbitrarily far in future
  - crucial for analysis of effects of “forward guidance”
Temporary equilibrium (Hicks, Grandmont, etc.): endogenous variables determined by optimizing behavior of economic agents, under subjective expectations that are specified as part of the model (and need not be correct)

Except for the specification of expectations, model here is a standard log-linear NK model

- Households, firms solve infinite-horizon problems
- Log-linear decision rules depend on (subjective) expectations about outcomes arbitrarily far in future
  - Crucial for analysis of effects of “forward guidance”

[Details of temporary-equilibrium model: Woodford (2013)]
Optimal Expenditure

- Log-linearization of solution for optimal spending by household $i$:

\[ c_t^i = \sum_{T=t}^{\infty} \beta^{T-t} \hat{E}_t \{ (1 - \beta) Y_T - \beta \sigma (i_T - \pi_{T+1}) - \beta \Delta \bar{c}_{T+1} \} \]

where $\sigma > 0$ is IES, and all variables are log deviations from values in deterministic steady state with inflation at target $\pi^*$.
Log-linearization of solution for optimal spending by household $i$:

$$ c_t^i = \sum_{T=t}^{\infty} \beta^{T-t} \hat{E}_t^i \{ (1-\beta) Y_T - \beta \sigma (i_T - \pi_{T+1}) - \beta \Delta \bar{c}_{T+1} \} $$

where $\sigma > 0$ is IES, and all variables are log deviations from values in deterministic steady state with inflation at target $\pi^*$

generalizes PIH to allow for non-constant desired path of spending owing to

(i) real interest-rate variation, or

(ii) transitory variation in urgency of spending $\bar{c}_t$
Optimal Expenditure

- Can summarize relevant expectations of $i$ by a single variable:

\[
c_t^i = \ldots + \beta \hat{E}_t^i v_{t+1}^i
\]

where

\[
v_t^i = \sum_{T=t}^{\infty} \beta^{T-t} \hat{E}_t^i \{ (1 - \beta) Y_T - \sigma (\beta i_T - \pi_T) - (1 - \beta) \bar{c}_T \} + \beta \hat{E}_t^i v_{t+1}^i
\]
Can summarize relevant expectations of $i$ by a single variable:

$$c_i^t = \ldots + \beta \hat{E}_t^i \nu_{t+1}^i$$

where

$$\nu_t^i = \sum_{T=t}^{\infty} \beta^{T-t} \hat{E}_t^i \left\{ (1 - \beta) Y_T - \sigma (\beta i_T - \pi_T) - (1 - \beta) \bar{c}_T \right\}$$

Hence aggregate demand depends on a measure of average subjective expectations

$$e_{1t} \equiv \int \hat{E}_t^i \nu_{t+1}^i di$$
Aggregate Demand ("IS Equation")

Then defining aggregate demand

\[ Y_t = \int_i c_t^i di \]

and output gap \( y_t \equiv Y_t - Y^n_t \), individual decision rules aggregate to AD relation

\[ y_t = \rho_t - \sigma i_t + e_{1t} \]

where \( \rho_t \equiv \bar{c}_t - Y^n_t \) collects exogenous terms
Price Adjustment

- Dixit-Stiglitz monopolistic competitors

- Calvo-Yun model of staggered price adjustment [fraction $\alpha$ of prices not reconsidered each period, automatic price increases at target rate $\pi^*$ between adjustments]
Price Adjustment

- Dixit-Stiglitz monopolistic competitors

- Calvo-Yun model of staggered price adjustment [fraction $\alpha$ of prices not reconsidered each period, automatic price increases at target rate $\pi^*$ between adjustments]

- Log-linear approximation [around steady state with inflation $\pi^*$] to optimal price-setting:

$$p^*_t j = (1 - \alpha \beta) \sum_{T=t}^{\infty} (\alpha \beta)^{T-t} \hat{E}_t^{j} [p_T + \xi y_T - \pi^* (T - t)] - (p_{t-1} + \pi^*)$$

where $p_t$ is (log) price index, $p^*_t j$ is $j$’s estimate of optimal (log) price relative to average unadjusted price $p_{t-1} + \pi^*$
Aggregate Supply ("AS Equation")

Implied AS relation:

\[ \pi_t = \kappa y_t + (1 - \alpha) \beta e_{2t} \]

where \( \pi_t \) is inflation in excess of the target \( \pi^* \),

\[ \kappa \equiv \frac{(1 - \alpha)(1 - \alpha \beta)\xi}{\alpha} > 0, \]

and

\[ e_{2t} \equiv \int \hat{E}_t p^*_t \, dj \]

measures average expectations of another composite variable.
Complete 3-equation TE Model

\[ y_t = \rho_t - \sigma i_t + e_{1t} \]

\[ \pi_t = \kappa y_t + (1 - \alpha) \beta e_{2t} \]

and a monetary policy rule, such as

\[ i_t = \bar{i} + \phi_{\pi} \pi_t + \phi_y y_t \]

- System to determine TE paths of \( \{y_t, \pi_t, i_t\} \) given paths for expectations \( \{e_{1t}, e_{2t}\} \) and exogenous disturbances \( \{\rho_t\} \)

— regardless of how expectations are determined
Perfect Foresight Analysis

Suppose \( \{ \rho_t \} \) and monetary policy are both deterministic, and we impose the further assumption of perfect foresight:

— at any time \( t \), expectations \( e_t \) correspond to the correct values of the variables forecasted
Perfect Foresight Analysis

- Suppose \( \{\rho_t\} \) and monetary policy are both deterministic, and we impose the further assumption of perfect foresight:
  
  — at any time \( t \), expectations \( e_t \) correspond to the correct values of the variables forecasted

- Then eq’m relations can equivalently be written

\[
\begin{align*}
y_t &= y_{t+1} - \sigma (i_t - \pi_{t+1}) - \Delta \rho_{t+1} \\
\pi_t &= \kappa y_t + \beta \pi_{t+1}
\end{align*}
\]

[“NK IS”]

[“NKPC”]
Perfect Foresight Analysis

- Case of monetary policy that fixes interest rate $i_t = \bar{i}$ indefinitely:
  
  - one-parameter family of solutions to PFE equations (indexed, for example, by value of $\pi_0$) with the property that inflation and output gap remain bounded for all $t$
  
  - all of these solutions converge asymptotically to the constant-$\pi$ steady state with nominal interest rate $\bar{i}$
Perfect Foresight Analysis

- Case of monetary policy that fixes interest rate \( i_t = \bar{\bar{i}} \) indefinitely:
  - one-parameter family of solutions to PFE equations (indexed, for example, by value of \( \pi_0 \)) with the property that inflation and output gap remain bounded for all \( t \)
  - all of these solutions converge asymptotically to the constant-\( \pi \) steady state with nominal interest rate \( \bar{\bar{i}} \)

- This long-run inflation rate is lower the lower is \( \bar{\bar{i}} \)

- thus one can argue that permanently maintained low \( i \) must (at least eventually) bring about correspondingly low \( \pi \)
Cochrane (2015a) proposes a particular criterion for selecting one among this continuum of PFE solutions as the prediction of the model: the “backward stable” equilibrium.

But is this a reasonable view of what should follow from intertemporal optimization, and an ability to reason about the implications of the central bank’s policy commitments for future economic outcomes?
Cochrane (2015a) proposes a particular criterion for selecting one among this continuum of PFE solutions as the prediction of the model: the “backward stable” equilibrium.

In the context of an indefinite interest-rate peg, this selects the solution in which variables are immediately at their long-run steady-state values.

So lower $\bar{r}$ should imply **lower inflation immediately** as well as in long run.
Cochrane (2015a) proposes a particular criterion for selecting one among this continuum of PFE solutions as the prediction of the model: the “backward stable” equilibrium

- in the context of an indefinite interest-rate peg, this selects the solution in which variables are immediately at their long-run steady-state values
- so lower $\bar{\bar{i}}$ should imply lower inflation immediately as well as in long run

But is this a reasonable view of what should follow from intertemporal optimization, and an ability to reason about the implications of the central bank’s policy commitments for future economic outcomes?
Bounded Rationality

- Suppose beliefs are revised through an iterative process:
  - given any sequences \( \{e_t\} \) describing the evolution of average expectations, and a specification of monetary policy, the TE relations deliver implied sequences \( \{\pi_t, y_t, i_t\} \)
  - these imply sequences \( \{e^*_t\} \) of correct expectations, the result of a mapping \( e^* = \Psi(e) \)
Bounded Rationality

- Suppose beliefs are revised through an iterative process:

  - given any sequences \( \{e_t\} \) describing the evolution of average expectations, and a specification of monetary policy, the TE relations deliver implied sequences \( \{\pi_t, y_t, i_t\} \)

  - these imply sequences \( \{e_t^*\} \) of correct expectations, the result of a mapping \( e^* = \Psi(e) \)

  - define a continuous updating rule for beliefs

    \[
    \dot{e}_t(n) = e_t^*(n) - e_t(n)
    \]

    where the continuous variable \( n \) indexes how far along the revision process is; \( \dot{e}_t \) is the derivative of \( e_t \) with respect to \( n \); for each \( n \), \( e^*(n) = \Psi(e(n)) \)

    — starting from some (relatively naive) initial specification \( \{e_t(0)\} \) of the evolution of average beliefs
If this process of belief revision converges, it must converge to sequences \( \bar{e} \) such that \( \Psi(\bar{e}) = \bar{e} \)

— which must correspond to a perfect foresight equilibrium
If this process of belief revision converges, it must converge to sequences \( \tilde{e} \) such that \( \Psi(\tilde{e}) = \tilde{e} \)

— which must correspond to a perfect foresight equilibrium

This idea provides a possible justification for interest in the PFE solutions implied by a given policy

and if the process converges, the particular fixed point to which it converges also answers the question about equilibrium selection, left open by the mere conjecture that outcome should be a PFE
If this process of belief revision converges, it must converge to sequences $\bar{e}$ such that $\Psi(\bar{e}) = \bar{e}$ — which must correspond to a perfect foresight equilibrium.

This idea provides a possible justification for interest in the PFE solutions implied by a given policy.

and if the process converges, the particular fixed point to which it converges also answers the question about equilibrium selection, left open by the mere conjecture that outcome should be a PFE.

but if the process doesn’t converge, the PFE prediction may be quite different from what this model of expectation formation would imply, even if the process of reflection is carried quite far.
Even when the process of belief revision converges, if convergence is slow, the PFE prediction may still not be too relevant.

— unless process of reflection is carried very far, may not lead to beliefs too close to PFE.
Bounded Rationality

- Even when the process of belief revision converges, if convergence is slow, the PFE prediction may still not be too relevant.

— unless process of reflection is carried very far, may not lead to beliefs too close to PFE.

- If slow convergence or non-convergence: the relevant model prediction should be the set of possible paths for the economy’s evolution corresponding to some not-too-extreme range of possible specifications of $e(0)$, and a range of possible finite values of $n$. 
Case of Temporary Fixed Interest Rate

- Suppose that for all $0 \leq t < T$, $i_t = \bar{i}$ regardless of inflation or output
  - but reversion to “normal” policy (Taylor rule) for all $t \geq T$

- Case of interest: ZLB prevents any lower interest rate during period of loose policy, so always as low as possible
Case of Temporary Fixed Interest Rate

Suppose that for all $0 \leq t < T$, $i_t = \bar{i}$ regardless of inflation or output

— but reversion to “normal” policy (Taylor rule) for all $t \geq T$

Case of interest: ZLB prevents any lower interest rate during period of loose policy, so always as low as possible

question: to what extent can increasing the length of commitment substitute for possibility of deeper immediate interest-rate cut?
Numerical Illustrations

Parameter values used in numerical illustrations:

- Model parameters are those used in Denes, Eggertsson and Gilbukh (2013), which allow a ZLB episode similar to the US Great Recession, in the case of a suitable exogenous shock:

  \[ \alpha = 0.784, \quad \beta = 0.997, \quad \sigma^{-1} = 1.22, \quad \zeta = 0.125 \]

  [periods = quarters]
Parameter values used in numerical illustrations:

- Model parameters are those used in Denes, Eggertsson and Gilbukh (2013), which allow a ZLB episode similar to the US Great Recession, in the case of a suitable exogenous shock:
  \[
  \alpha = 0.784, \quad \beta = 0.997, \quad \sigma^{-1} = 1.22, \quad \zeta = 0.125
  \]
  [periods = quarters]

- “Normal” policy specified as in Taylor (1993):
  \[
  \pi^* = .02/4, \quad \phi_\pi = 1.5, \quad \phi_y = 0.5/4
  \]
Numerical Illustrations

Parameter values used in numerical illustrations:

- Model parameters are those used in Denes, Eggertsson and Gilbukh (2013), which allow a ZLB episode similar to the US Great Recession, in the case of a suitable exogenous shock:
  \[ \alpha = 0.784, \quad \beta = 0.997, \quad \sigma^{-1} = 1.22, \quad \zeta = 0.125 \]
  [periods = quarters]

- “Normal” policy specified as in Taylor (1993):
  \[ \pi^* = 0.02/4, \quad \phi_\pi = 1.5, \quad \phi_y = 0.5/4 \]

- Temporary policy: \( i_t = \bar{i} \) for dates \( 0 \leq t < T \) corresponds to nominal rate of zero (in un-transformed variables)
Results: Temporary Fixed Interest Rate

1. TE paths converge to the PFE paths for inflation, output and interest rates, as $n \to \infty$

   — specifically, to the unique PFE paths with property that each of these variables remains \textit{bounded} for $t \to \infty$
Results: Temporary Fixed Interest Rate

2 Change to Fixed Interest Rate for a Fixed Period

2.1 Evolution Expectations: Graph 1

Figure 10: Change in $\omega$: $T = 8, n = 0 − 4$

Notes: The dashed blue line is the REE. The updates in expectations are shown from yellow line ($n = 0$, no update) and until the blue ($n = 4$).

TE paths for $n = 0 − 4$, if at ZLB for 8 quarters
TE paths converge to the PFE paths for inflation, output and interest rates, as $n \to \infty$

— specifically, to the unique PFE paths with property that each of these variables remains \textit{bounded} for $t \to \infty$

- so PFE prediction can be justified as approximation to TE outcome
  - for large enough $n$
  - and assuming commitment is not for \textit{too long} a horizon $T$
Results: Temporary Fixed Interest Rate

TE paths converge to the PFE paths for inflation, output and interest rates, as $n \to \infty$

— specifically, to the unique PFE paths with property that each of these variables remains \textit{bounded} for $t \to \infty$

so PFE prediction can be justified as approximation to TE outcome

- for large enough $n$
- and assuming commitment is not for \textit{too long} a horizon $T$

analysis does \textbf{not} support selection of “backward stable” solution (Cochrane, 2015a) as prediction of the model
For longer-horizon commitments, convergence to dynamics near the PFE predictions requires longer process of belief revision — hence more reasonable to expect departure from PFE predictions
For longer-horizon commitments, convergence to dynamics near the PFE predictions requires longer process of belief revision — hence more reasonable to expect departure from PFE predictions.

- In this case, TE analysis implies forward guidance should be less powerful than the PFE analysis (with conventional equilibrium selection) would imply.
  - though still quite powerful (indeed, implausibly so...)
  - and much more powerful than PFE analysis with Cochrane (2015a) equilibrium selection would imply.
Results: Temporary Fixed Interest Rate

TE paths for $n = 0 - 20$, if at ZLB for 20 years
Moreover, in the fixed-\(i\) case, there is no finite \(n\) for which TE dynamics and PFE dynamics are similar for all values of \(T\).

- For any finite \(n\), the TE responses are the same for all large enough \(T\) (and so remain bounded as \(T \to \infty\)).
- Instead, the PFE responses (under the conventional eq’m selection) grow explosively as \(T\) is made large.
Cochrane (2015a) objects to this implication of PFE with standard eq’m selection, and so argues for selection of another PFE ("backward stable" solution).

Instead, TE analysis for finite $n$ avoids the unreasonable prediction.
Cochrane (2015a) objects to this implication of PFE with standard eq’m selection, and so argues for selection of another PFE ("backward stable" solution)

- instead, TE analysis for finite $n$ avoids the unreasonable prediction
- but not because it’s like “backward stable” PFE!
  - the conventional PFE solution is accurate for small $T$
  - and no PFE solution is accurate for large $T$
Permanently Fixed Interest Rate

- What if interest rate is expected to be fixed **indefinitely**?
  - in this case, belief revision dynamics **don’t converge** as $n$ grows
  - instead, diverge explosively
What if interest rate is expected to be fixed indefinitely?

In this case, belief revision dynamics don’t converge as $n$ grows.

Instead, they diverge explosively.

And for no $n$ are they similar to any of the PFE solutions.
If we let $R^n(T)$ be the vector of responses when commitment is for $T$ periods and belief revision continues to level $n$, then

$$\lim_{T \to \infty} R^n(T) = R^n(\text{permanent})$$

for any finite $n$

$$\lim_{n \to \infty} R^n(T) = R^{PF}(T)$$

for any finite $T$.
Permanently Fixed Interest Rate

If we let $R^n(T)$ be the vector of responses when commitment is for $T$ periods and belief revision continues to level $n$, then

$$\lim_{T \to \infty} R^n(T) = R^n(\text{permanent}) \quad \text{for any finite } n$$

$$\lim_{n \to \infty} R^n(T) = R^{PF}(T) \quad \text{for any finite } T$$

But the limits

$$\lim_{n \to \infty} \lim_{T \to \infty} R^n(T), \quad \lim_{T \to \infty} \lim_{n \to \infty} R^n(T)$$

both diverge

— neither converges to any of the PFE solutions under assumption of permanently fixed rate
Hence consideration of the set of PF equilibria is especially misleading in the (somewhat artificial) thought experiment of a permanent interest-rate peg

— a case in which none of the PFE paths approximate TE paths for finite \( n \), even for very large \( n \)
Hence consideration of the set of PF equilibria is especially misleading in the (somewhat artificial) thought experiment of a permanent interest-rate peg

— a case in which none of the PFE paths approximate TE paths for finite $n$, even for very large $n$

So we should not necessarily expect the conclusion above to be correct, that a long-enough lasting commitment to remain at the ZLB must eventually make inflation lower, rather than higher
Hence consideration of the set of PF equilibria is especially misleading in the (somewhat artificial) thought experiment of a permanent interest-rate peg — a case in which none of the PFE paths approximate TE paths for finite $n$, even for very large $n$.

So we should not necessarily expect the conclusion above to be correct, that a long-enough lasting commitment to remain at the ZLB must eventually make inflation lower, rather than higher.

What would we conclude about the consequences of such a commitment if, instead, we use TE analysis for some finite (though possibly high) value of $n$?
Effects of *increasing length of time* at which one expects to remain at ZLB *(by some *finite* amount)*:

- as in the PFE analysis *with conventional eq’m selection* (not Cochrane’s), this should increase output and inflation immediately
Effects of increasing length of time at which one expects to remain at ZLB (by some finite amount):

- as in the PFE analysis with conventional eq’m selection (not Cochrane’s), this should increase output and inflation immediately

- for large enough $n$, predictions of TE analysis are similar to PFE predictions (with this eq’m selection)
Results: Temporary Fixed Interest Rate

Effects of increasing length of time at which one expects to remain at ZLB (by some finite amount):

- as in the PFE analysis with conventional eq’m selection (not Cochrane’s), this should increase output and inflation immediately

- for large enough \( n \), predictions of TE analysis are similar to PFE predictions (with this eq’m selection)

- but even for smaller \( n > 0 \), predictions are qualitatively like PFE predictions (with this eq’m selection)
Effects of Increasing Length of Commitment

varying $T$ from 8-14 quarters; top: $n = 4$, bottom: PFE
2.3 Effects of Increasing $T$ on the output gap: Graph 3

Figure 19: Increasing $T$, from $T = 8$ to $T = 14$, low number of updates $n = 0.5$.

Notes: Each line represents a different end date of the policy, from $T = 8$ (yellow) until $T = 14$ (blue). The first graph shows the solution when $n = 0.5$ and the second shows the PFE.

varying $T$ from 8-14 quarters; top: $n = 0.5$, bottom: PFE

Garcia Schmidt and Woodford
Interest Rates and Deflation
June 2015
Where the conventional PFE analysis of effects of forward guidance is less reliable: in its implication that further lengthening of time expected to remain at ZLB should be able to increase output and inflation effects without bound.
Where the conventional PFE analysis of effects of forward guidance is less reliable: in its implication that further lengthening of time expected to remain at ZLB should be able to increase output and inflation effects \textit{without bound}

- PFE predictions for larger $T$ are progressively less reliable, as the size of $n$ required for them to be approximately correct grows and grows

- in fact, for any finite $n$, TE analysis implies \textit{bounded} effects, no matter how large $T$ is made
Thus the prediction of a **stimulative** effect of commitment to maintain interest rates at the lower bound for longer is robust, regardless of how much $n$ or $T$ may be increased.
Effects of Increasing Length of Commitment

Thus the prediction of a **stimulative** effect of commitment to maintain interest rates at the lower bound for longer is robust, regardless of how much \( n \) or \( T \) may be increased.

- The finite-\( T \) PFE analysis, however, represents an **upper bound** on the size of effect that one can plausibly expect.

- And the larger \( T \) is, the more reason to doubt that the effect should be as large as predicted by the PFE analysis.
Effects of Increasing Length of Commitment

Thus the prediction of a *stimulative* effect of commitment to maintain interest rates at the lower bound for longer is robust, regardless of how much $n$ or $T$ may be increased

- the finite-$T$ PFE analysis, however, represents an *upper bound* on the size of effect that one can plausibly expect
- and the larger $T$ is, the more reason to doubt that the effect should be as large as predicted by the PFE analysis

Especially for larger values of $T$, the approach recommended here leads only to a *set* of possible predictions for a given policy

- but this still allows *qualitative* conclusions that remain very useful for practical policy analysis
- and insisting on PFE analysis simply because it makes more sharply defined predictions may lead to large errors