Title

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A very big question

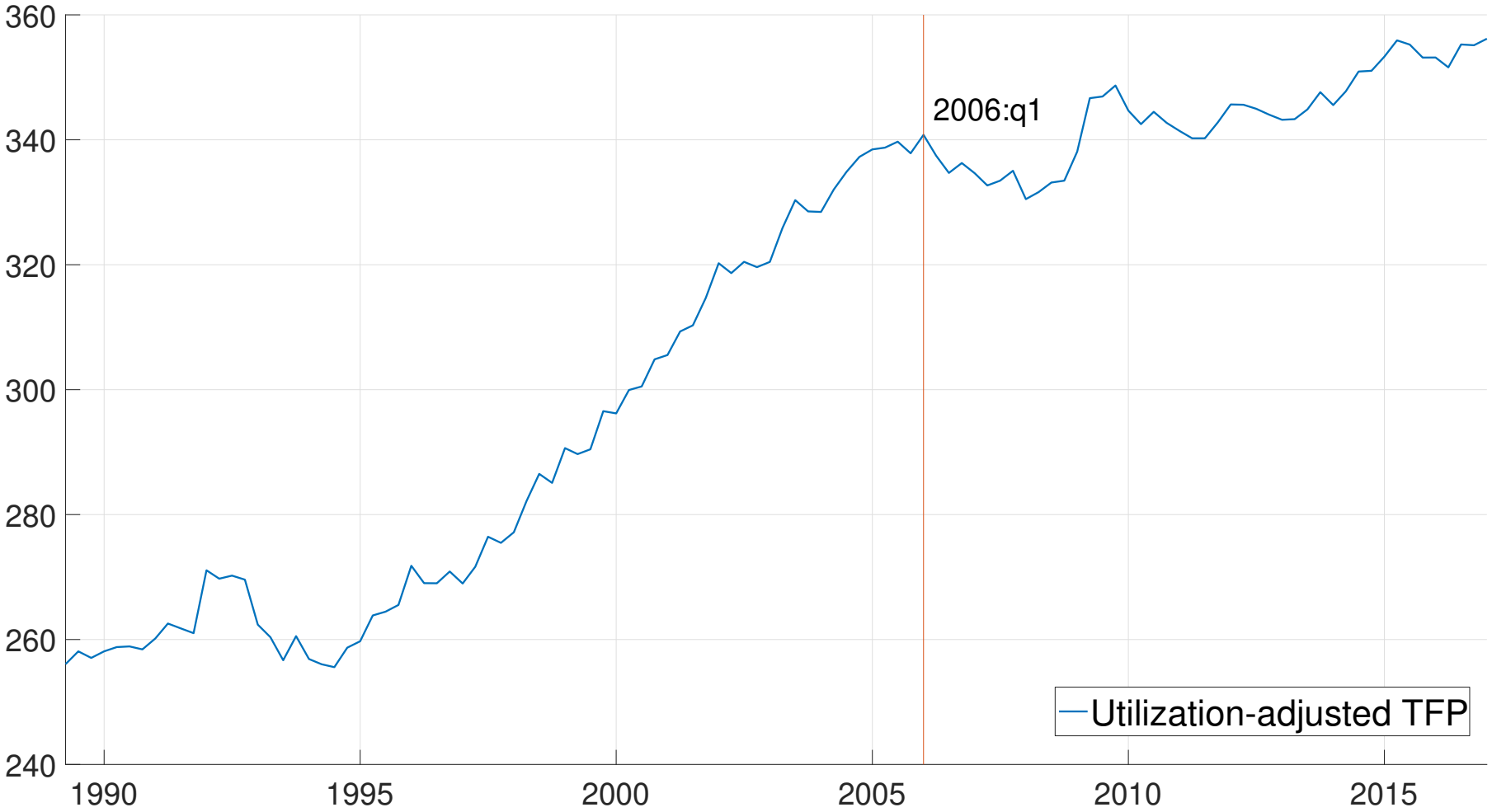
Broad consensus on secular stagnation.

The literature has agreed that there are two main factors driving this:

- decreasing labor force participation
- decreasing TFP growth

A smaller, but still big question

Why has TFP slowed down?



Two possible mechanisms

- a permanent, or very persistent exogenous shock to TFP
- an endogenous mechanism

$\rightarrow$ What we do in a nutshell: test for the endogenous mechanism (main analysis will be a SVAR)

Related literatures

- One strand of literature: Exogenous TFP and news shocks
  - Beaudry & Portier (2006)
  - Barsky & Sims (2011)

  Our contribution: allow in this setting the existence of an endogenous mechanism that affects future TFP

  ▸ Barsky & Sims quote

- Another strand of literature: Endogenous TFP with R&D investment as the key variable
  - Comin & Gertler (2006)
  - Moran & Queralto (2017)

  Our contribution: provide what we think is a more convincing test for the endogenous mechanism

Why more convincing?

Because the endogenous TFP literature faces a big problem: The endogenous mechanism is rationalized entirely using R&D investment.

1. But R&D in the data is almost acyclical.... $\rightarrow$ hard to rationalize as a driver of business cycle fluctuations ▸ Graph of acyclical R&D
2. Timing issue: the TFP slowdown begins around 2006, i.e. *before* the Great Recession and thus *before* the marked drop in R&D ▸ Graph of timing

$\Rightarrow$ Following the suggestion of Fernald, Hall, Stock & Watson (2009), we propose to use investment in information technology (IT) ▸ Graph of IT investment

Empirical analysis

We run a SVAR using aggregate, quarterly US data. The data vector is:

$$\mathbf{X_t} = \begin{bmatrix} TFP_t \\ SP_t \\ IT_t \\ GDP_t \\ C_t \\ RP_t \end{bmatrix} \tag{1}$$

- $RP = \pi^{IT} / \pi^{CPI}$.
- All variables are real (except price indexes) and in log levels (except for RP, which is in growth rates).
- The dataset ranges from 1989:q1 - 2017:q1.

From reduced form to structural form

Structural Form

$$(\mathbf{AD})^{-1}\mathbf{X_t} = \mathbf{C(L)X_{t-1}} + \mathbf{s_t} \tag{2}$$

Reduced Form

$$\mathbf{X_t} = \underbrace{\mathbf{ADC(L)}}_{\mathbf{B(L)}}\mathbf{X_{t-1}} + \underbrace{\mathbf{AD_t}}_{\mathbf{i_t}} \tag{3}$$

- AD is the impact matrix
- A is s.t. $As_t s_t' A' = i_t i_t' = \Sigma$ and $s_t s_t' = I$
- D is a rotation matrix s.t. $DD' = I \Rightarrow AD(AD)' = \Sigma$

D will be a tool to impose our identification assumptions ▸ Technicalities

Identified shocks

- We impose restrictions on D in order to identify two shocks:
  1. News Shock
  2. IT Productivity Shock

- Econometric challenge is to disentangle two shocks with very similar features
  1. No impact effect on TFP
  2. Persistent positive effect over time on TFP
  3. Most likely both shocks have positive impact effects on forward-looking variables

- Barsky & Sims' identification strategy is not sufficient to disentangle the two
  - We need a further assumption (restriction) to find a dimension of difference between the shocks

Additional restriction

- We rely on simple demand and supply theory

  1. The IT shock is a *sectoral* shock $\rightarrow$ we expect it to move relative prices
  2. The news shock is *not* a sectoral shock $\rightarrow$ we have no a priori sense of what it should do to relative prices on impact, but after some time relative prices should go back to their initial value

$\rightarrow$ add the restriction that a news shock should have no effect on relative prices after a reasonable time

$\hookrightarrow$ enough for prices to adjust, so between 6-12 quarters

Identification strategy overall

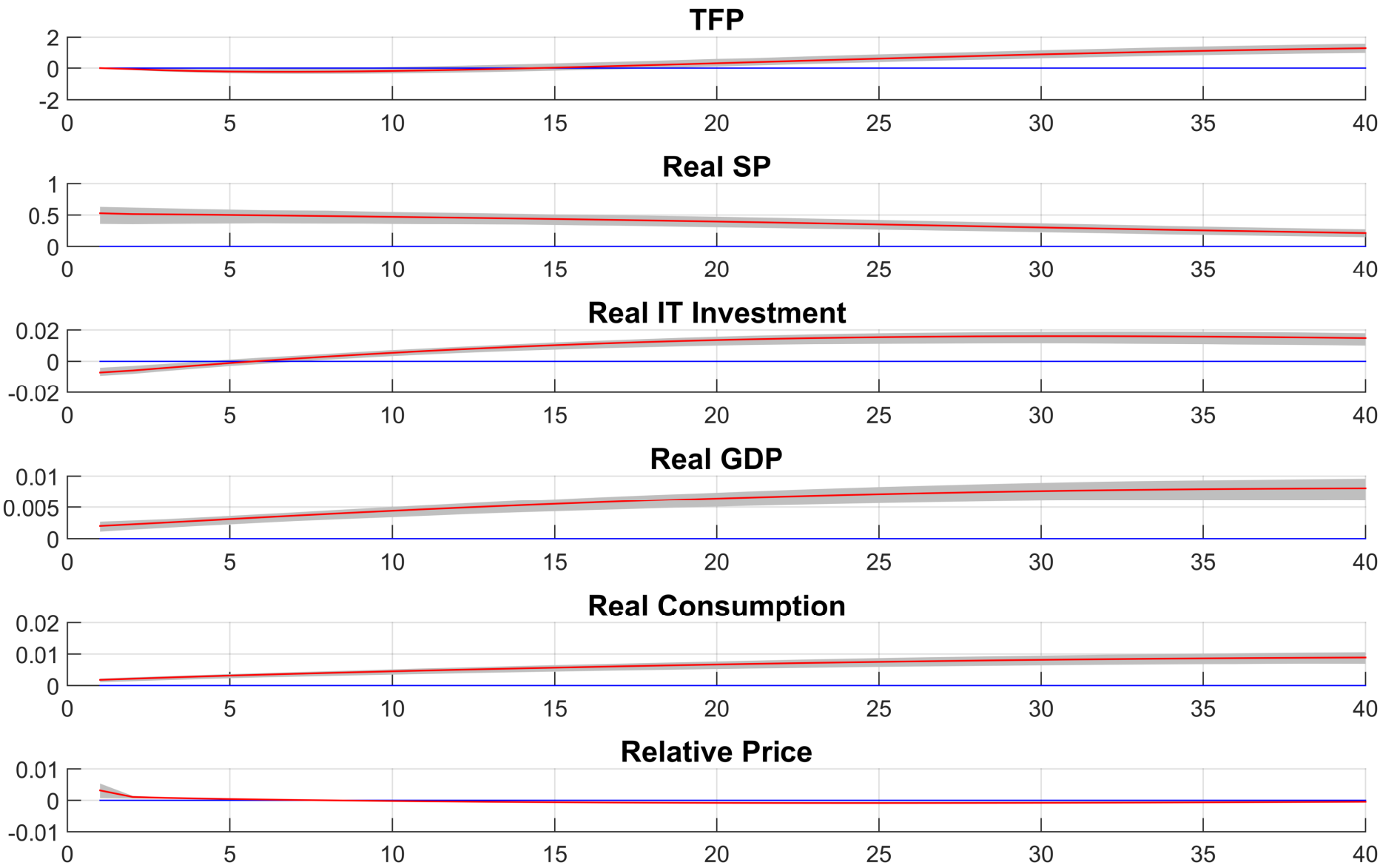
$$TFP_t = \underbrace{\varepsilon_t}_{\text{surprise tech shock}} + \underbrace{V_{t-k}}_{\text{news shock}} + \underbrace{IT_{t-k}}_{\text{IT shock}} \quad (4)$$

1. The news shock V_{t-k} maximizes the FEV of future TFP subject to the restriction that it has no effect on the relative price RP at a small number of quarters;
2. The IT shock maximizes the remaining FEV of future TFP;
3. The tech shock ε_t is considered as a residual shock and is left unrestricted (unidentified).

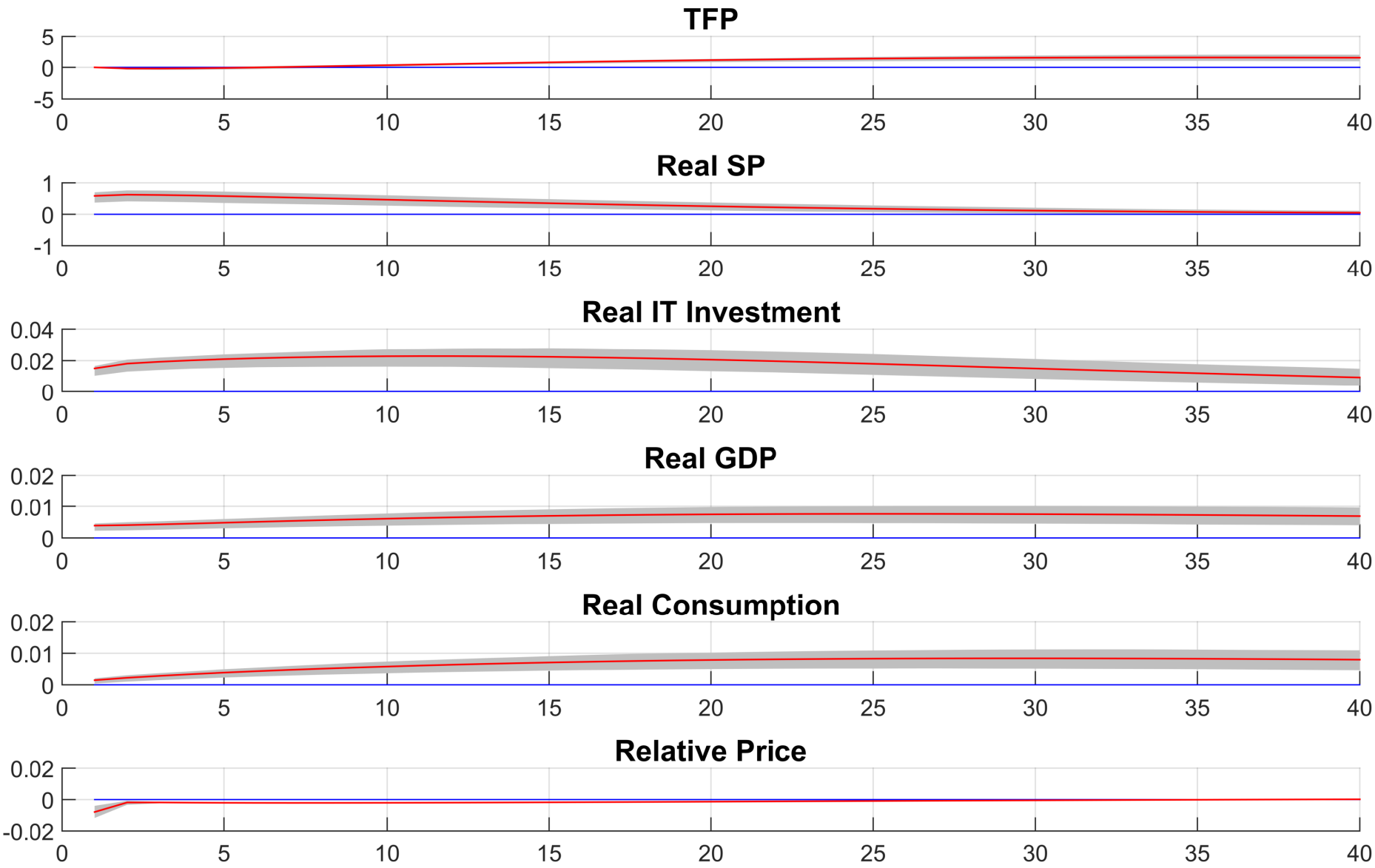
Our favorite specification

- Recall: dataset is quarterly and covers 1989:q1-2017-q1.
- One lag (as suggested by BIC and HQ).
- Horizon of FEV-maximization: 100 quarters.
- Restriction on relative prices after a news shock is imposed at 8 quarters.

Impulse responses to a news shock



Impulse responses to an IT shock



FEV explained by the two shocks at 40 periods

	News	IT	Total
TFP	0.4081	0.4026	0.8107
GDP			
Cons			

Interpretation

1. Shape and timing of the responses reflect ...
   - both the Barsky & Sims result ...
   - ... as well as the the conjecture that the IT shock looks similar to news along certain dimensions,
   - ... but relative prices do indeed introduce a margin of difference between the two shocks.
2. Shares of FEV of TFP explained ...
   - ... are also in line with the Barsky & Sims result ...
     For BS, news explains around 45%, compared to 37% here
   - ... yet suggest that the IT shock plays an important role as well

Robustness checks

- Different variables
  - Add the Michigan index of consumer confidence (expected business conditions 5 years ahead)
  - Replace IT prices with capital prices (following Comin & Gertler)
- Different horizons at which we impose the restriction on relative prices for the news shock

  $\rightarrow$ ran 6, 8, 10, 12 and 16 quarters.
- Increase the number of lags (2)

Conclusion

- Provided what we think (and we hope you do too) a careful and more general test for the endogenous mechanism in TFP.
  - While the literature focuses exclusively on R&D, we show that IT is a better variable to focus on.

- The results show that by controlling for the presence of news shocks, the endogenous component of TFP is an important driver of TFP fluctuations at long horizons.

- This result does not contrast however with the findings of the news shock literature since we still find that news also play a significant role in explaining TFP.

Work ahead

- Rationalize this setting using a theoretical model

  $\hookrightarrow$ what we have in mind: an endogenous TFP model (in the vein of Comin & Gertler) augmented with news shocks

- Estimate the model (IR-matching)

- Perform a counterfactual for the Great Recession *and* the period prior, shutting down the negative IT shocks around 2000

- See if we can find interesting interactions between the two shocks?

  $\hookrightarrow$ In particular, we're thinking of noise shocks on IT productivity

  news shock: shock to expected future value
  noise shock: shock to expected current value ("perceptions")

Barsky & Sims say:

A more general objection to our empirical approach would be that a number of structural shocks, which are not really "news" in the sense defined by the literature, might affect a measure of TFP in the future without impacting it immediately. Among these shocks might be research and development shocks, investment specific shocks, and reallocative shocks. Our identification (and any other existing VAR identifications) would obviously confound any true news shock with these shocks.

Barsky & Sims (2011), p. 278.

◂ Return | Barsky & Sims' FEV-table

Barsky & Sims FEV of TFP explained

Table 1
Forecast error variance decomposition.

	$h=1$	$h=4$	$h=8$	$h=16$	$h=24$	$h=40$
TFP	0.000	0.062	0.126	0.269	0.366	0.454
	(0.00)	(0.06)	(0.11)	(0.14)	(0.15)	(0.16)
Consumption	0.050	0.234	0.377	0.493	0.524	0.507
	(0.09)	(0.18)	(0.24)	(0.27)	(0.27)	(0.26)
Output	0.111	0.091	0.242	0.382	0.429	0.431
	(0.07)	(0.10)	(0.18)	(0.23)	(0.24)	(0.24)
Hours	0.622	0.200	0.105	0.092	0.094	0.089
	(0.23)	(0.16)	(0.13)	(0.15)	(0.16)	(0.15)
Stock price	0.140	0.200	0.185	0.189	0.193	0.181
	(0.17)	(0.20)	(0.20)	(0.21)	(0.22)	(0.21)
Confidence	0.245	0.343	0.353	0.333	0.310	0.286
	(0.21)	(0.22)	(0.22)	(0.22)	(0.20)	(0.18)
Inflation	0.138	0.220	0.226	0.205	0.191	0.180
	(0.18)	(0.18)	(0.15)	(0.15)	(0.14)	(0.14)
Total TFP	1.000	0.948	0.943	0.951	0.948	0.910
Total output	0.731	0.282	0.364	0.451	0.491	0.520

The letter h refers to the forecast horizon. The numbers denote the fraction of the forecast error variance of each variable at various forecast horizons to our identified news shock. Standard errors, from a bootstrap simulation, are in parentheses. "Total TFP" shows the total variance of TFP explained by our news shock and the TFP innovation combined. "Total output" shows the total variance of output explained by the news shock and the TFP innovation combined.

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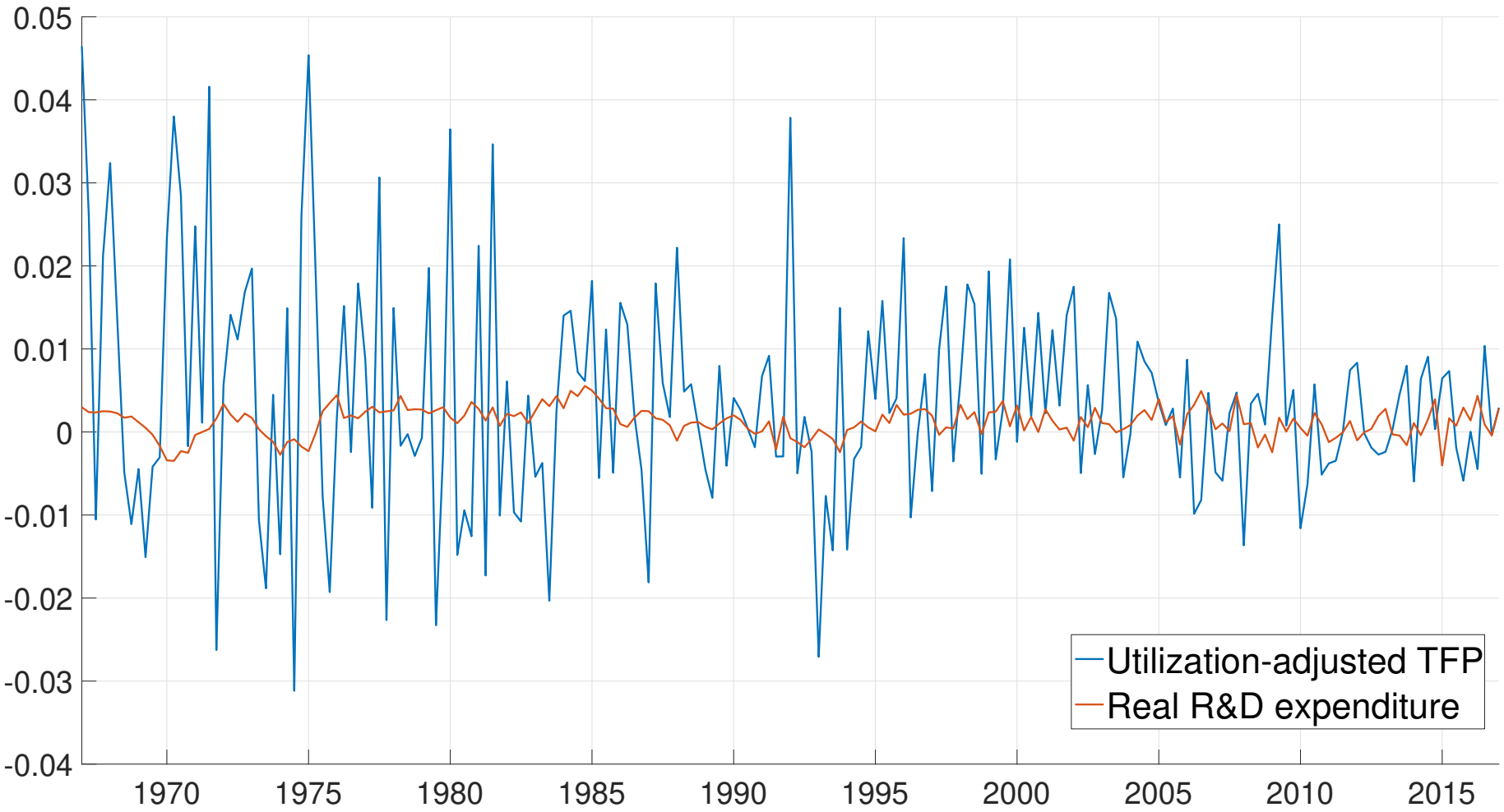
Growth rate of RD vs growth rate of TFP



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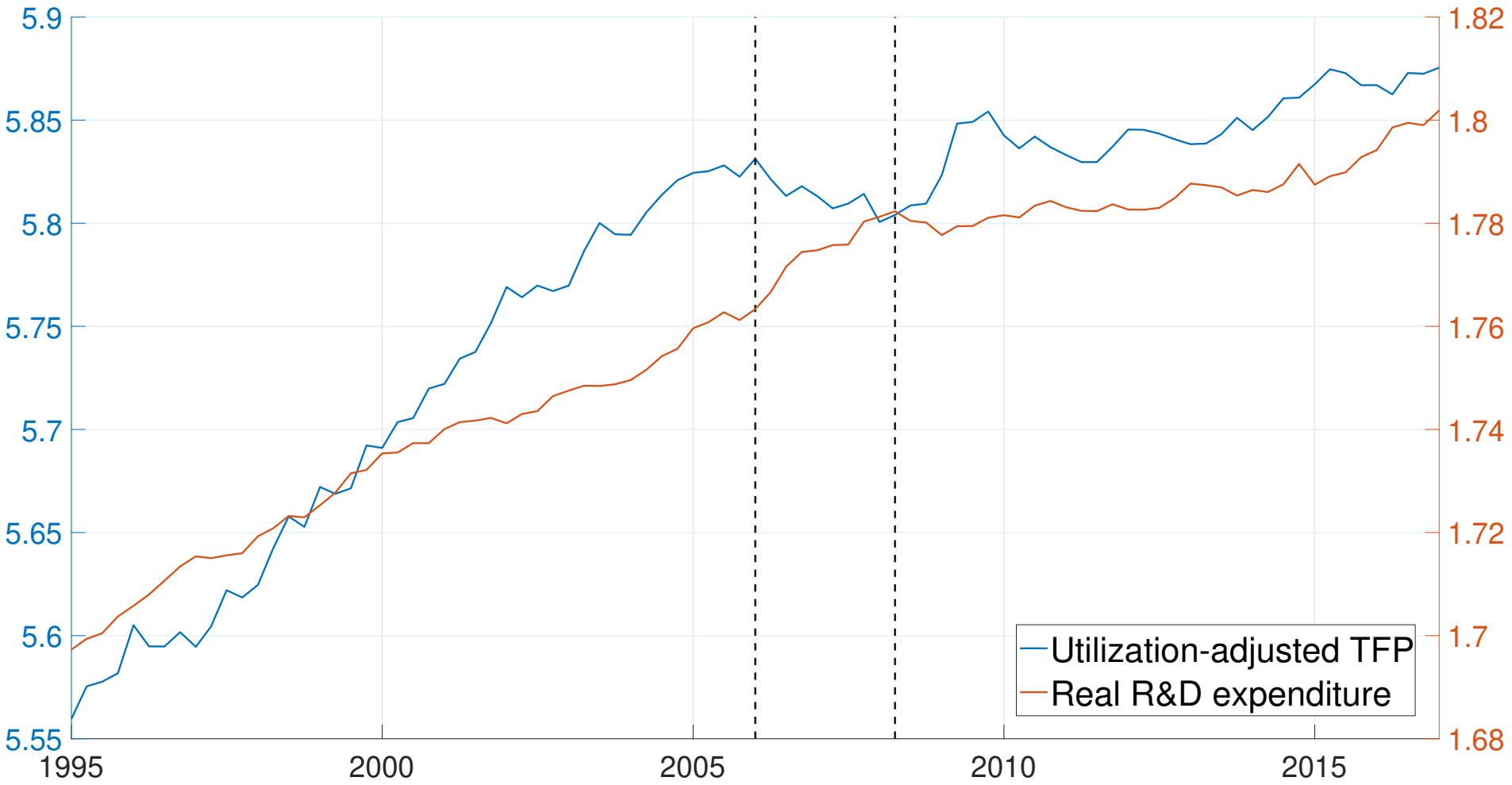
Timing: RD drop vs TFP drop



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IT investment: a break at the right time

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Identification Strategy

$$D = \begin{bmatrix} d_{11} & \gamma_{12} & \gamma_{13} & d_{14} & \cdots \\ d_{21} & \gamma_{22} & \gamma_{23} & d_{24} & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \end{bmatrix} \tag{5}$$

- Indifferent over d_{ij} as long as D is orthogonal
- $A\gamma_2$ is the impact response to a news shock
- $A\gamma_3$ is the impact response to a IT productivity shock
- First element of both $A\gamma_2$ and $A\gamma_3$ is zero due to the no-contemporaneous effect of both shocks on TFP
- $A\gamma_2$ is such that the FEV of TFP is maximized subject to zero long-run effect on RP
- $A\gamma_3$ is maximizing the remaining FEV of TFP

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