Innovation and the Productivity Growth Slowdown

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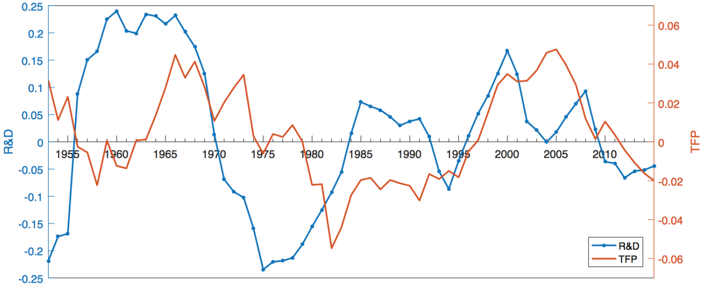
Motivational Fact (I)

Figure 1: U.S. TFP Growth

Note: 5-year moving average (two-sided) of U.S. TFP growth.

Motivational Fact (II)

Figure 3: U.S. Business-Sector R&D and TFP, Medium-Term Cycle



Variables detrended by bandpass filter.

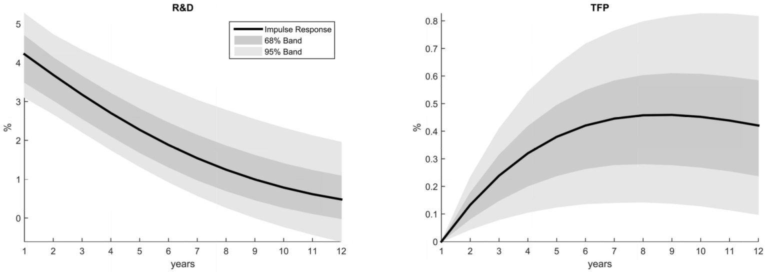
Empirical Estimation

$$\begin{pmatrix} GDP_t^{US} \\ TFP_t^{US} \\ R\&D_t^{US} \end{pmatrix} = C^{US} + B^{US} \begin{pmatrix} GDP_{t-1}^{US} \\ TFP_{t-1}^{US} \\ R\&D_{t-1}^{US} \end{pmatrix} + u_t^{US} \tag{1}$$

- annual variables in log-levels
- standard Choleski identification
- identification assumptions: R&D does not contemporaneously affect fundamentals

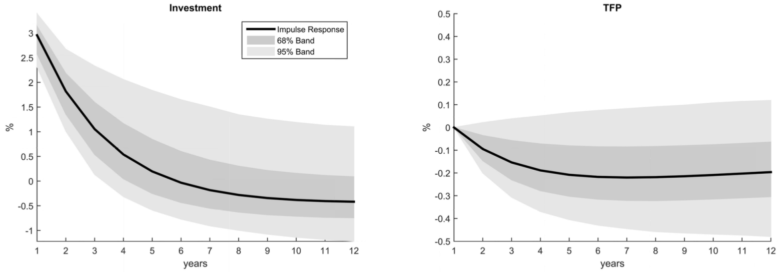
Main Empirical Results

Figure 4: Identified R&D Shock in the U.S.



Check Reverse Causality

Figure 5: Identified Shock to Investment in the U.S.



Robustness Checks

- Panel VAR for advanced economies
- Spillovers from U.S. R&D to foreign TFP
- A larger-scale U.S. VAR
- Sectoral TFP

Theoretical Model

Standard New Keynesian model augmented to include endogenous technology innovation adoption, as in Comin and Gertler (2006)

$$Y_t^W = A_t^{\frac{1}{\theta-1}} \Psi_t K_t^{\alpha} L_t^{1-\alpha} \tag{2}$$

$$Y_t = C_t + \left[1 + f\left(\frac{I_t}{I_{t-1}}\right)\right] I_t + \left[1 + f\left(\frac{I_t^m}{I_{t-1}^m}\right)\right] I_t^m + S_t \tag{3}$$

Innovators

Competitive innovators spend resources in R&D to develop new ideas that eventually will end up as new intermediate goods (measured by A_t)

$$V_{i,t} = \zeta Z_t \frac{1}{K_t^{\eta} S_t^{1-\eta}} S_{i,t} \tag{4}$$

Under this formulation, in equilibrium the R&D elasticity of aggregate new technology creation is given by parameter $\eta \in (0,\ 1)$

$$\max_{S_{i,t}} E_t(\Omega_{t,t+1} J_{t+1}) \zeta Z_t \frac{1}{K_t^{\eta} S_t^{1-\eta}} S_{i,t} - (1 + \Delta_t^s) S_{i,t} \tag{5}$$

LOM of total innovations: $Z_{t+1} = \phi Z_t + V_t$

Adopters

Adopters spend resources ($M_{i,t}$) attempting to transform new inventions into usable technologies with the following probability

$$\lambda_t = \kappa \left(\frac{S_t}{A_t} \right)^{\nu} M_{i,t}^{\rho_\lambda} \tag{6}$$

The problem of an adopter is

$$J_t = \max_{M_{i,t}} \phi E_t \left[\Omega_{t,t+1} \left(\lambda_t H_{t+1} + (1 - \lambda_t) J_{t+1} \right) \right] - Q_t^m M_{i,t} \tag{7}$$

LOM of endogenous TFP: $A_{t+1} = \lambda_t \phi (Z_t - A_t) + \phi A_t$

Additional Features

- There is a retailer sector which faces nominal frictions
- Household supplies labor and exhibits habit formation in consumption
- Euler equation allows for a wedge shock to analyze the ZLB
- Monetary policy is characterized by a simple Taylor rule with interest-rate smoothing and a monetary policy shock

Parameter Estimations

$$\text{parameter space} \;=\; \begin{cases} \text{calibrated (22)} \\ \text{estimated } \epsilon = (\eta \;\; \nu \;\; \rho_s \;\; \sigma_s) \end{cases} \tag{8}$$

Estimation of ϵ by

$$\min_{\epsilon} \left[\hat{\Psi} - \Psi(\epsilon)\right]' \mathcal{V}^{-1} \left[\hat{\Psi} - \Psi(\epsilon)\right] \tag{9}$$

Model vs Data

Figure 12: Impulse response to R&D shock, model v. data

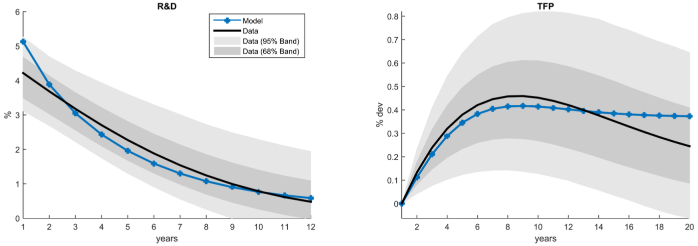
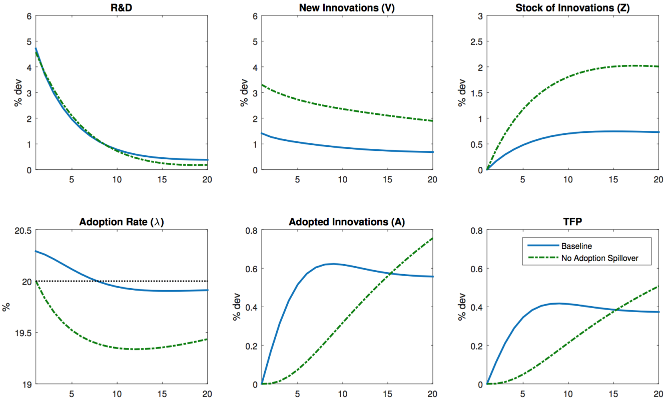


Table 2: Estimated Parameters

Symbol	Value	Description
η	0.30	Elasticity of technology creation to R&D
ν	0.18	R&D spillover to adoption
ρ_s	0.78	Persistence coefficient of Δ_t^s
σ_s	0.037	Size of impulse to Δ_t^s

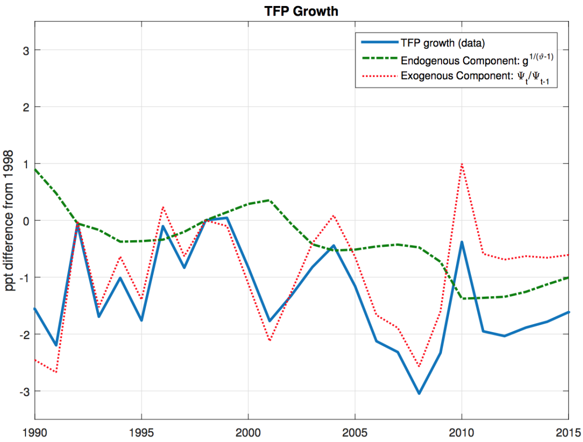
Model vs Data ($\nu = 0$)

Figure 15: R&D shock, baseline v. no adoption spillover



Drivers to Productivity Slowdown

Figure 21: Decomposition of TFP growth

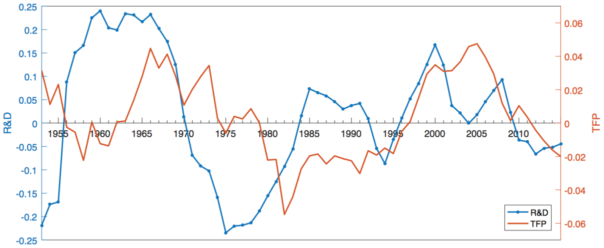


This paper

- Empirical estimation of the causal effect of R&D on TFP
- Model-based evaluation of the role of the endogenous TFP
  - Quantitative role of the R&D spillover on adoption
- In particular, shows the role of endogenous TFP for the Great Recession

What we like about this paper

Figure 3: U.S. Business-Sector R&D and TFP, Medium-Term Cycle



- Compelling story: R&D expenditure and endogenous TFP
- Providing a **correlation** between current R&D and future TFP

What we don't like about this paper (I)

Figure 4: Identified R&D Shock in the U.S.

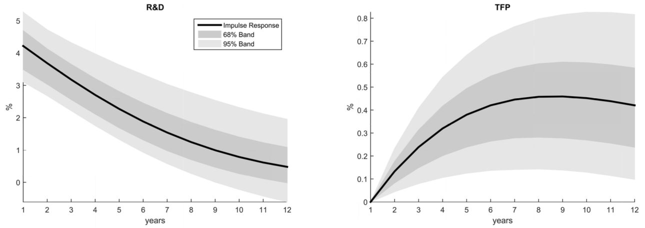
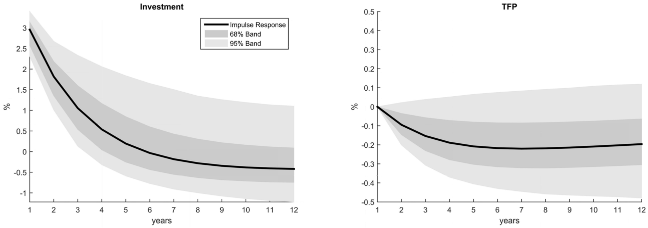


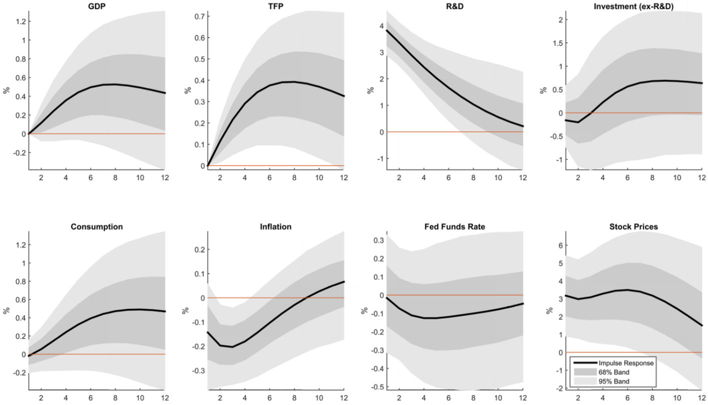
Figure 5: Identified Shock to Investment in the U.S.



What we don't like about this paper (II)

Not surprisingly...

Figure 9: Identified R&D Shock in the U.S., Larger-Scale VAR



Our takeaway

Two literatures

1. News about future TFP
2. R&D triggers future TFP

What we want: a synthesis of the two literatures.

$$\begin{cases} \text{News Shocks} \\ \\ \text{R\&D efficiency shocks} \end{cases}$$

Our takeaway

Two literatures

1. News about future TFP
2. R&D triggers future TFP

What we want: a synthesis of the two literatures.

$$\begin{cases} \text{News Shocks} \\ \\ \text{R\&D efficiency shocks} \quad \begin{cases} \text{Fundamental} \\ \text{Noise-Beliefs} \end{cases} \end{cases}$$

Noise-Belief $\Rightarrow$ R&D expenditure $\Rightarrow$ Fundamentals

Research Project

Step 1 - Structural VAR

- Disentangling the anticipated component from the causal one
- Within the causal component disentangling fundamental versus noise

Step 2 - Theoretical Model

- Providing a theoretical argument where pure belief-noise shocks can trigger future fundamentals persistently
- Relying on framework of Comin and Gertler (2006) and Lorenzoni (2009)

Calibrated Parameters

Table 1: Calibrated Parameters

Symbol	Value	Description
β	0.9978	Discount factor
α	0.33	Capital Share
δ	0.1	Capital depreciation
ϵ^{-1}	2	Frisch labor supply elasticity
h	0.50	Habit
ϑ	2.4925	Intermediates producers' elasticity of substitution
ϕ	0.90	Obsolescence of technologies
ρ_λ	0.95	Adoption elasticity
$\overline{L}$	1	Steady-state labor
$\overline{g}^{\frac{1}{\vartheta-1}}$	1.0120	Steady-state TFP growth (gross)
$\overline{\lambda}$	0.20	Steady-state adoption probability
$\overline{\omega}$	4.167	Retailers' average elasticity of substitution
θ	0.65	Probability of keeping prices fixed
ι_p	0.20	Degree of indexation to pat inflation
π	1.02	Steady-state inflation (gross)
γ_r	0.32	Smoothing parameter of the Taylor rule
γ_π	1.5	Inflation coefficient of the Taylor rule
γ_y	0.5	Output gap coefficient of the Taylor rule
ρ_Ψ	0.9	Exogenous TFP shock persistence
ρ_b	0.65	Consumption wedge persistence
ρ_ω	0.33	Markup shock persistence
ρ_Ψ	0.10	Monetary shock persistence