ICT-Specific Investment Shocks and Economic Fluctuations

Evidence and Theory of a General-Purpose Technology

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Motivation

Empirical Fact. U.S. output has expanded only slowly in the aftermath of the financial crisis

Fernald, Hall, Stock and Watson (2017) empirically show that two components explain nearly all this growth gap

1. Slow growth in total factor productivity (TFP)
2. Falling labor force participation

In this paper we focus on the **slowdown in TFP**,

$\Rightarrow$ Which variable boosted productivity in the last three decades?

$\Rightarrow$ Can this variable explain its recent slowdown?

An alternative to R&D Investment

Several papers endogenize TFP through **R&D investment**

- Financial crisis $\Rightarrow \downarrow Y \Rightarrow \downarrow$ R&D $\Rightarrow \downarrow$ TFP

However, as showed by Oliner et al. (2007) and Jorgenson et al. (2008), TFP has started slowing down **before** the crisis.

$\Rightarrow$ R&D cannot be the full story

We follow an alternative avenue and focus on the relation between **Information and Communication Technology Investment** (ICTI) and total factor productivity

- *Acquisition of equipment and computer software meant to be used in production for more than a year.*

This Paper

1. We identify ICT investment shocks using **SVAR** techniques
   - A contemporaneous increase in ICT investment leads to a delayed, persistent, and large rise in productivity
   - Historical decomposition confirms that the dot-com crash explains most of the slowdown in TFP since 2006

2. We analyze a **general equilibrium model** to rationalize our empirical findings
   - Our identified shocks can be interpreted as supply shocks specific to the ICT sector
   - ICT capital boosts productivity of ICT users through a positive externality

     $\Rightarrow$ The effectiveness of ICT depends on its own level of diffusion

Empirical Analysis

We estimate a structural VAR using aggregate quarterly US data from 1989Q1 to 2017Q2.

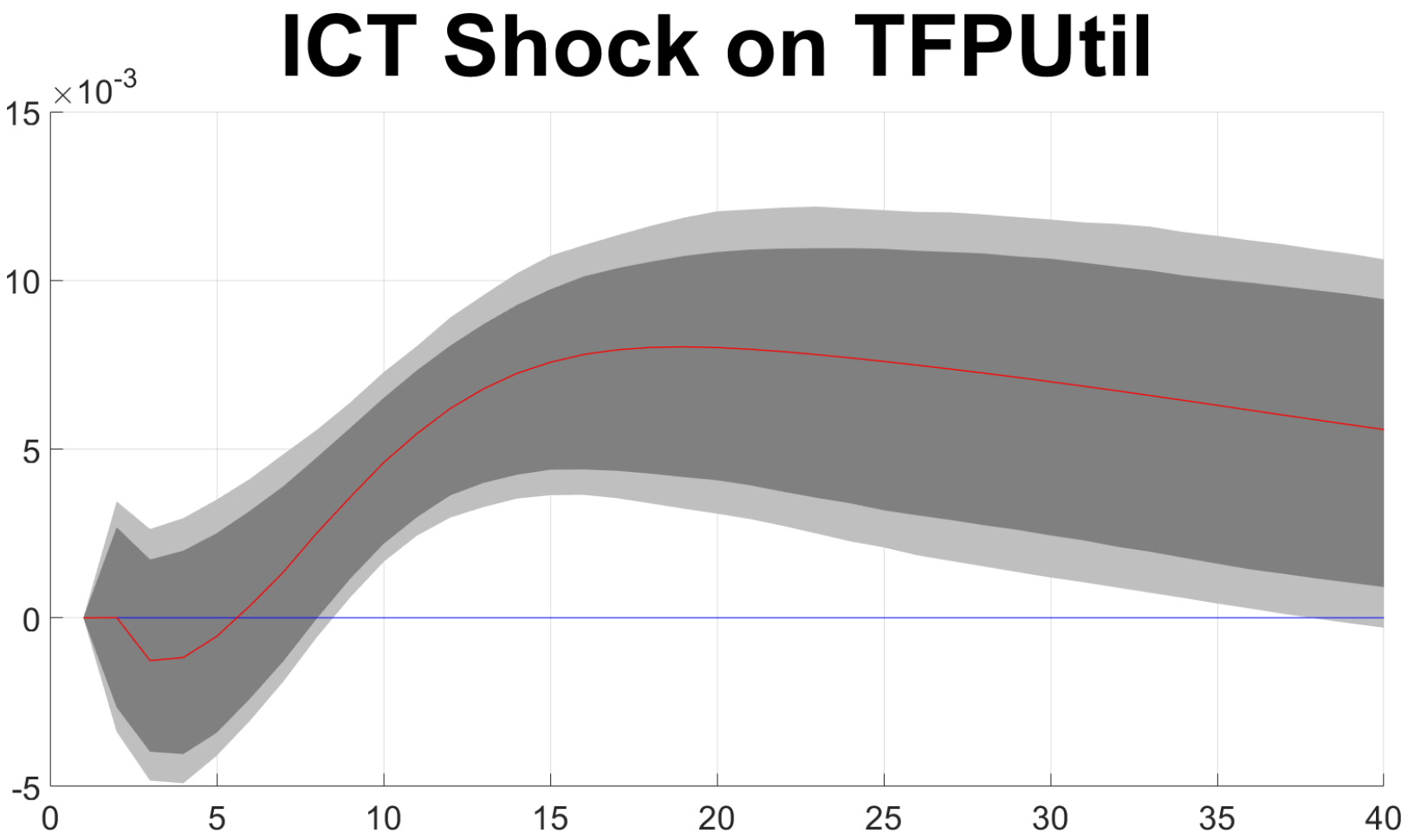
$$X_t = B(L)X_{t-1} + \underbrace{A\varepsilon_t}_{u_t} \tag{1}$$

- $X_t = [TFP_t \quad ICTI_t \quad RP_t \quad Y_t]$ where $RP_t = \pi_t^{IT}/\pi_t^{CPI}$
- Y_t represents the log transformations of endogenous variables
- A is Cholesky decomposition of $\Sigma_u = u_t' u_t$

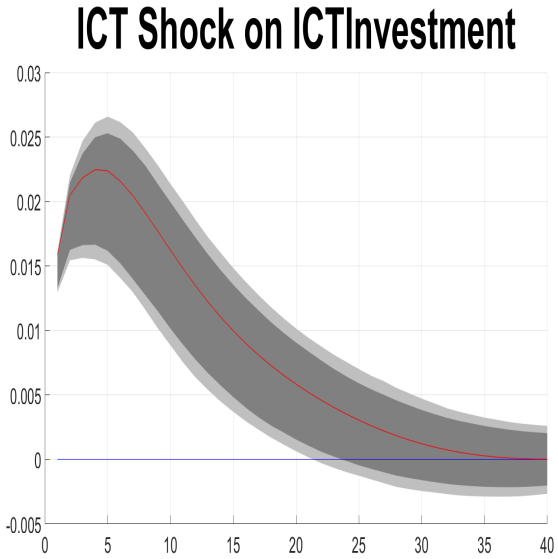
Focus is on the second structural shock $\varepsilon_{2,t}$

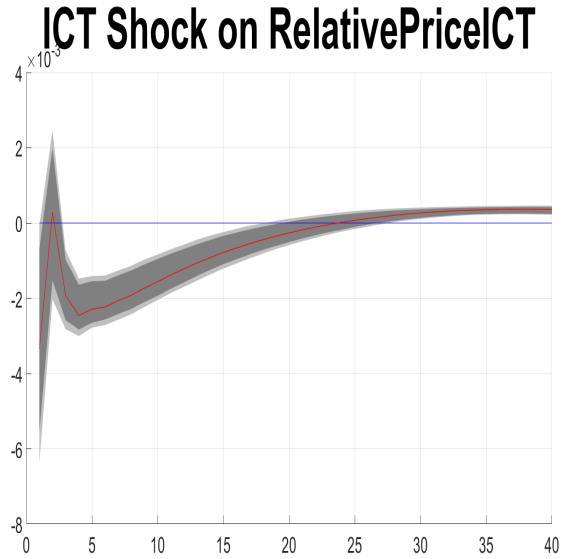
$\Rightarrow$ $\varepsilon_{2,t}$ maximizes the impact effect on $ICTI_t$ and is orthogonal to contemporaneous innovations in TFP

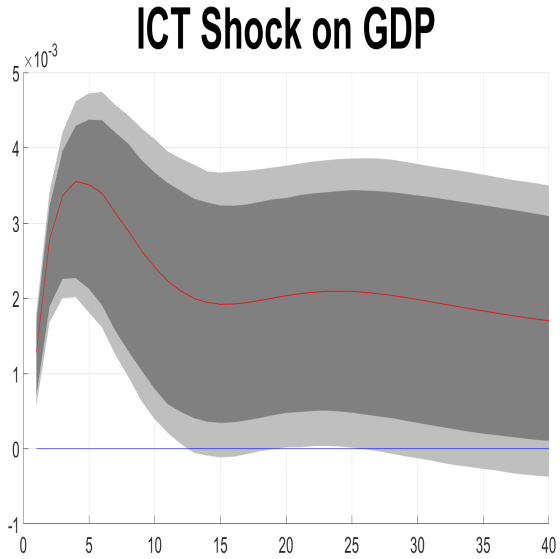
Impulse Response of TFP to $\varepsilon_{2,t}$

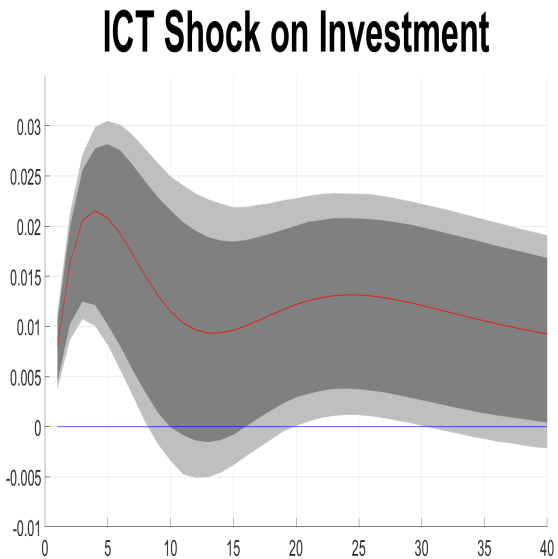


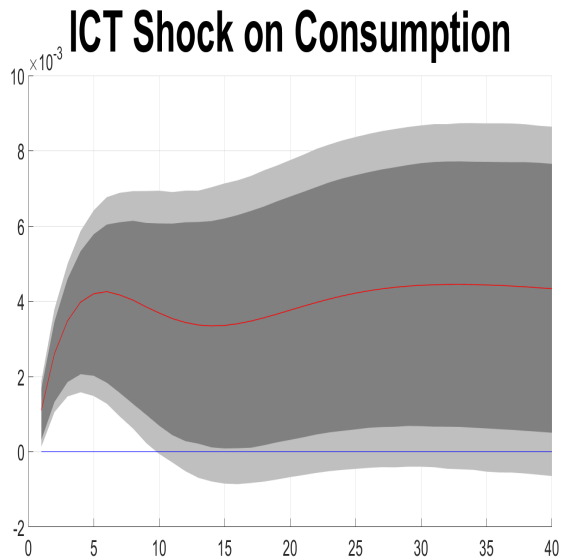
Impulse Responses of X_t to $\varepsilon_{2,t}$

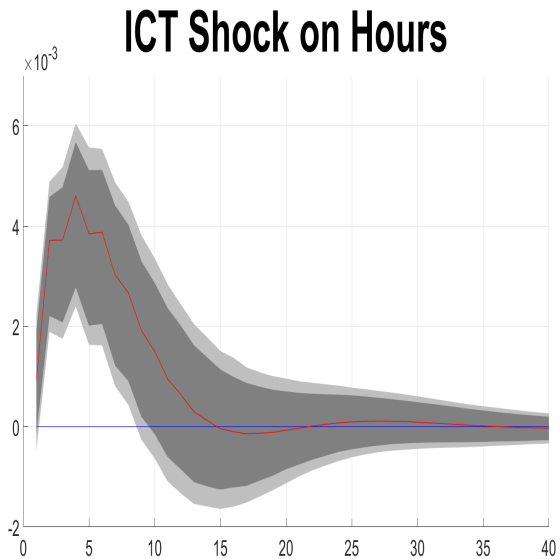












Related Exercises and Robustness Checks

- **Variance Decomposition Analysis**
  - Around 30% of TFP fluctuations over 10-year horizon
  - Almost 40% of GDP fluctuations over BC frequencies

$\Rightarrow$ ICT shocks are an **important driver** of economic fluctuations

- **Historical Decomposition Analysis**
  - Large negative shocks in 2000-2001 (dot-com crash) explain the slowdown in TFP since 2006

$\Rightarrow$ ICT shocks **rationalize** the facts by Fernald et al. (2017)

- **Rebustness Checks**
  - Controlling for news shocks à la Barsky and Sims
  - Controlling for other shocks estimated via narrative approach

$\Rightarrow$ ICT shocks are **not confounded** with other shocks

Model

Main objectives of theoretical analysis

1. Providing structural interpretation to the identified shocks
   $\Rightarrow$ ICT shocks move price and quantities in different directions
2. Rationalize the relation between current ICT investment and future TFP
   $\Rightarrow$ Why current ICT investment drives future TFP?

We extend and analyze a 2-sector GE model in the spirit of Greenwood et al. (2000). Two main assumptions are in place,

1. Second sector specifically produces ICT durable goods to be used as inputs in both sectors' production function
2. Agents fail to internalize that productivity of both sectors positively depends of the overall ICT diffusion in the economy

Main Equations

Consumption-good sector

$$y_t^c(j) = A_t^c \ \left(k_t^c(j)\right)^a \ \left(k_t^i(j)\right)^b \ \left(l_t(j)\right)^{1-a-b} \tag{2}$$

ICT-good sector

$$y_t^i(q) = A_t^i \ \left(k_t^c(q)\right)^a \ \left(k_t^i(q)\right)^b \ \left(l_t(q)\right)^{1-a-b} \tag{3}$$

where

$$A_t^c = \eta_t \ \theta_t^c \ (k_t^i)^\gamma \quad \text{and} \quad A_t^i = \eta_t \ \theta_t^i \ (k_t^i)^\gamma$$

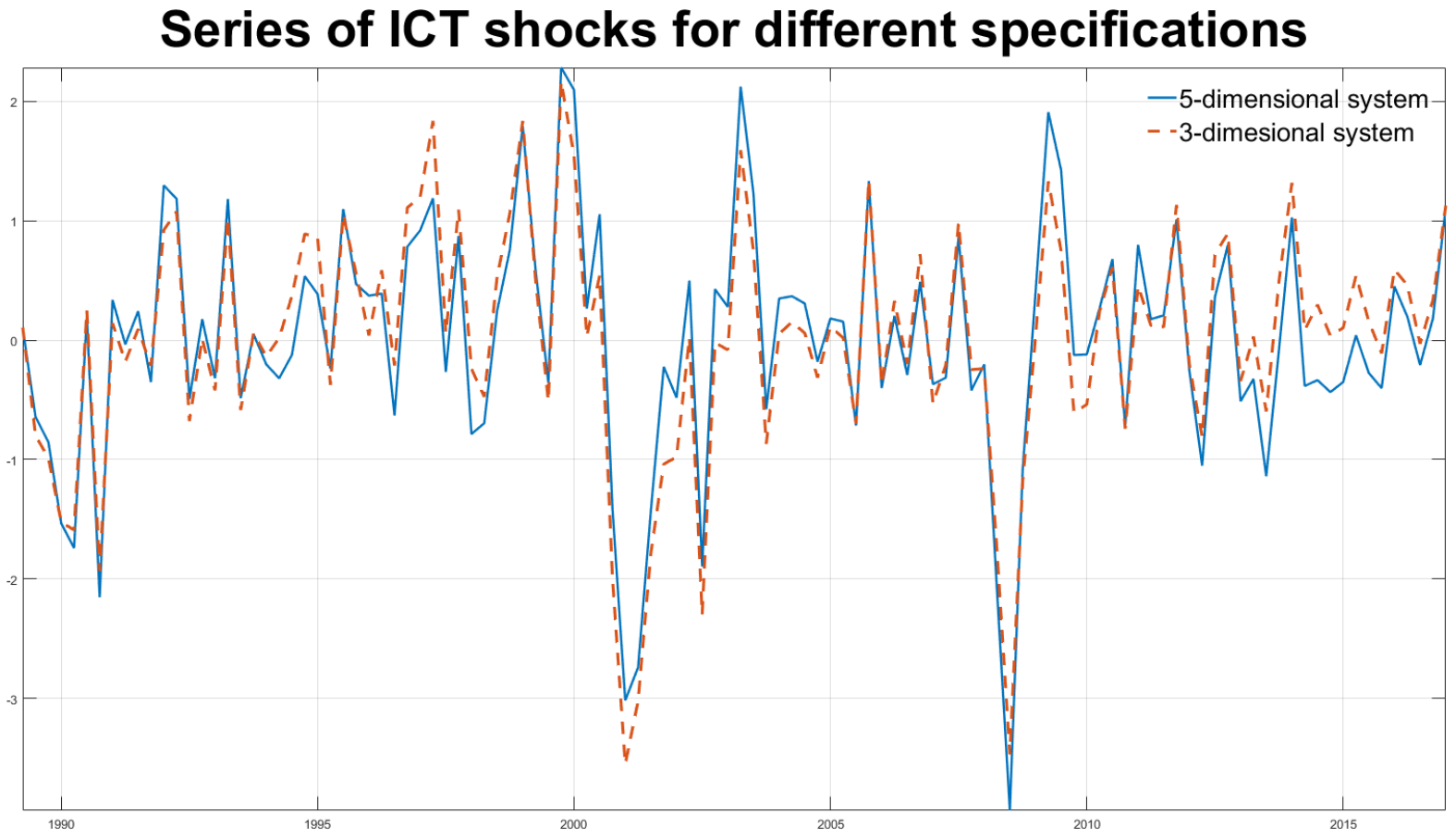
Conclusions

- Structural VAR analysis unfolds a novel relation between current ICT investment and future TFP
  - Unexpected jumps of ICT investment leads to delayed and persistent rise in productivity

- Theoretical analysis suggests to interpret ICT capital as the general purpose technology of the last three decades
  - ICT diffusions increases the productivity of both ICT users and producers

- The fall in ICT investment during the dot-com crash has the right timing to rationalize the structural break in TFP

Estimated Shocks



IRF Matching