3 slides to convince you that it's endogenous TFP

Marco Brianti and Laura Gati

Boston College

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A two-sector model

Final goods firm (GE)

$$\max_{K_t^f(s),L_t^f(s),K_t^{IT}(s)} Y_t(s) = K_t^f(s)^\alpha L_t^f(s)^\beta K_t^{IT}(s)^{1-\alpha-\beta} A_t$$

$$- w_t L_t(s) - R_t K_t^f(s) - P_t^{IT} I_t^{IT}(s)$$

$$\text{s.t. } K_t^{IT}(s) = (1-\delta^{IT})K_{t-1}^{IT} + I_t^{IT}$$

$$\text{but not internalizing } A_t = S_t \Psi_t (K_t^{IT})^\gamma$$

IT-producing firm (Google)

$$\max_{K_t^I(s),L_t^I(s)} I_t^{IT}(s) = P_t^{IT} S_t \lambda_t F(K_t^I(s), L_t^I(s)) - w_t L_t^I(s) - R_t K_t^I(s)$$

A news shock is $S_{t+k} \uparrow$ for some positive k.
An IT productivity shock is $\lambda_t \uparrow$, i.e. an increase in IT productivity today.
Ψ is a final-good-specific exogenous deterministic technology process.

Proposition 1 - the Solow-residual in this model

$$\begin{aligned}\frac{\dot{A}}{A} &= \frac{\dot{Y}}{Y} - \alpha\frac{\dot{K^f}}{K^f} - \beta\frac{\dot{L^f}}{L^f} - (1-\alpha-\beta)\frac{\dot{K^{IT}}}{K^{IT}} \\ &= \frac{\dot{S}}{S} + \frac{\dot{\Psi}}{\Psi} + \gamma\frac{\dot{K^{IT}}}{K^{IT}}\end{aligned}$$

TFP consists of an exogenous, common technology process S, a final-good-specific exogenous technology process Ψ and an endogenous component coming as a spillover from the aggregate stock of IT technology.

Proposition 2 - when a news shock leaves relative prices constant

Since the rate of return on the input factors have to equal in the two sectors, we can set the FOCs from GE and Google equal. Let's do this for capital:

$$
\begin{aligned}
R_t &= \alpha \frac{Y_t(s)}{K_t^f(s)} P_t^C = S_t \lambda_t F_k P_t^{IT} \\
\Leftrightarrow \frac{P_t^{IT}}{P_t^C} &= \alpha \frac{K_t^f(s)^\alpha L_t^f(s)^\beta K_t^{IT}(s)^{1-\alpha-\beta} S_t \Psi_t (K_t^{IT})^\gamma}{K_t^f(s)} \frac{1}{S_t \lambda_t F_k}
\end{aligned}
$$

A news shock doesn't move relative prices if

- the news shock doesn't change the relative marginal productivities of the two inputs in the two sectors, so that labor and capital are not reallocated from one sector to another.

+1 slide: evidence that $\gamma \neq 0$, i.e. that GPTs show up as spillovers

Theoretical evidence

- Brynjolfsson, e.g. in Bloom et al. (2014): theory of IT as a GPT changing management practices.
- Mokyr (1990): an economic history account of how GPTs (electricity, computers) change the organization of production as a whole, so it's not just the firm's individual use of them that matters, but that of the economy as a whole.
- Romer (1986): a production function with spillovers from human capital.

Empirical evidence

- Stiroh (2002 AER): industry-level data show that productivity gains from IT are not confined to industries producing IT.
- Oliner & Sichel (2000 JEP): growth accounting.
- Black & Lynch (2004, EJ), Doms, Dunn & Troske (1997 QJE): plant-level data.