

**Aggregate Shocks or Aggregate Information?  
Costly information and business cycle  
comovement**

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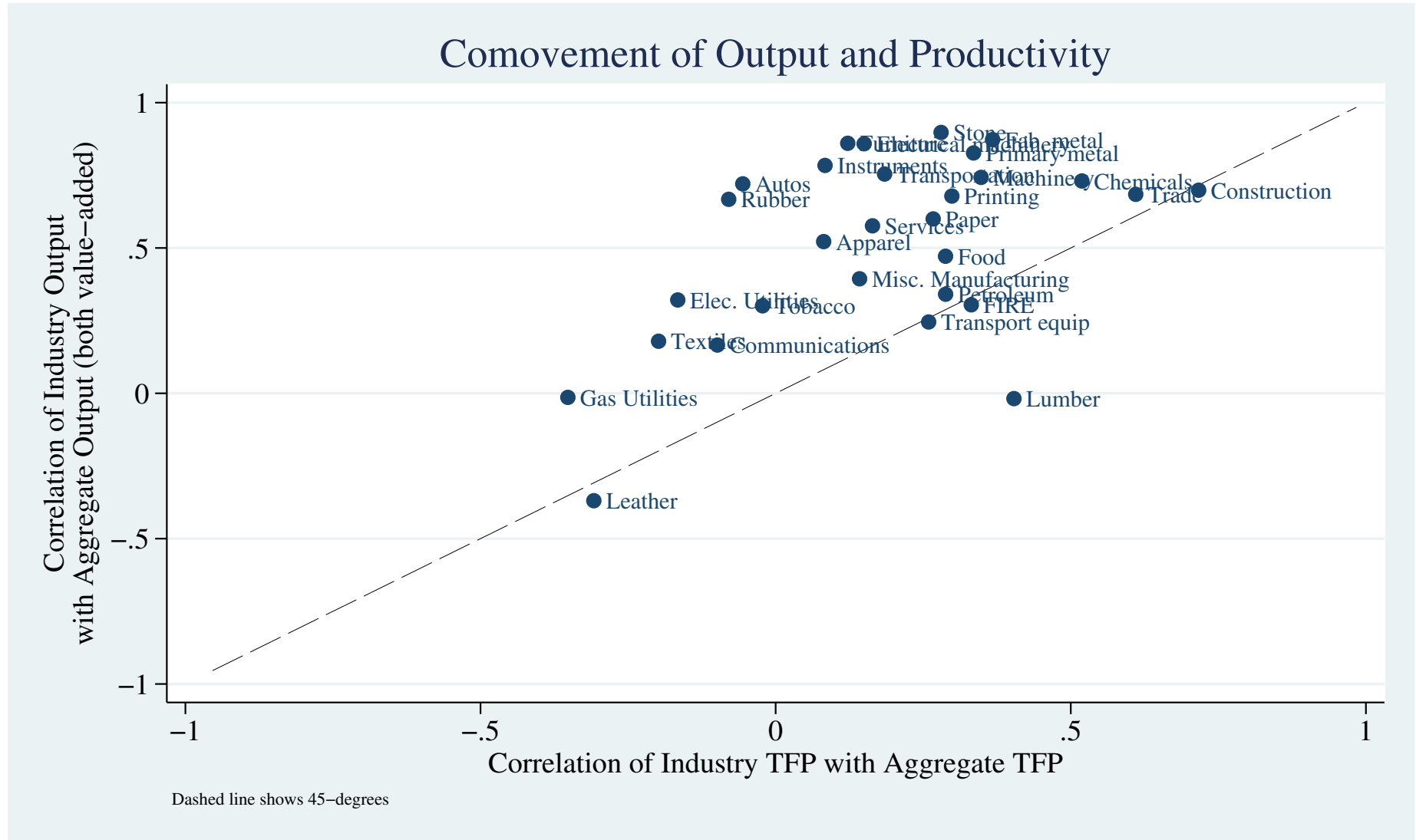
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## What Drives Business Cycles?

- Lucas (1977): A central feature of business cycles is that sectors grow and contract together → aggregate shocks
- 2 problems:
  1. Even with an aggregate shock, consumption and investment sectors covary negatively (Christiano and Fitzgerald 1998).
    - Possible solutions: Home production, habit persistence and limits on labor mobility  
Benhabib, Rogerson and Wright (91), Christiano and Fisher (98)
  2. What is the aggregate shock? Sectoral TFP is not highly correlated. Other shocks not big enough. Cochrane (94)
- We propose an answer to the second question.

# Comovement Facts



## Comovement Facts

- Output is more correlated than technology:  $\text{avg corr}(GDP_i, GDP_a) = 0.51$ ,  $\text{avg corr}(TFP_i, TFP_a) = 0.17$ .
- Shea (2002) decomposes aggregate variances as  $w'Vw$ .
  - Output: industry variance (diagonal of  $V$ ) is 17% of aggregate variance and covariance accounts for 83%.
  - Productivity: industry variance is 86%, covariance is 14%.
- Similar patterns documented by: Rebelo (2006), Hornstein (2000), Christiano & Fitzgerald (1998)

## Related Work

- Could there be large aggregate shocks?  
Blanchard (93), Hall (93), Hansen and Prescott (93)
- Are there production complementarities?
  - Input-output linkages: Long and Plosser (83), Hornstein & Praschnik (97), Horvath (98), Dupor (99).
  - Strategic complementarity: Cooper and Haltiwanger (1996)
  - Scale economies: Baxter and King (91)

This model: Complementarities in information acquisition mimic production complementarities.

**Main idea**

**Aggregate information is cheap because its discovery cost is shared among many purchasers.** Idiosyncratic information is expensive because its discovery cost must be borne alone.

**Agents who observe common information have similar beliefs and make similar decisions.** A firm that only observes 1 aggregate shock only reacts to 1 aggregate shock.

How are aggregate information costs shared?

- Information suppliers go after high-demand information:  
If everyone wants to know it, it's on the evening news.
- Government provides statistics with high social value.

## Outline

- Island economies with industry-specific shocks share only a common information market.
  - $corr(output) > corr(TFP)$ .
- Typical problem: Market undoes information asymmetry.
  - We add a labor market where the wage *reveals all signals*.
- Labor market creates Labor trade-off problem
  - Solution: Add a home production sector.  
(As in Benhabib, Rogerson Wright, 1991)
- Empirical support.

## Island Economies with an Information Market

- Objective is exponential (CARA):  $-E[\exp(-\rho(c_i - \psi n_i))]$ .
- Consume output of island-specific labor:  $c_i = z_i n_i$ .
- Productivity has aggregate and idiosyncratic, learnable and unlearnable components:  $z_i = \mu_z + \beta_i \bar{z} + \eta_i + e_i$ .
- 2 types of signals:
  - Aggregate:  $s_0 = \bar{z} + e_0$ ,
  - Island-specific:  $s_i = \beta_i(\bar{z} + e_0) + \eta_i$ .
- Information production: Fixed cost  $\chi$  for discovery. Zero cost to replicate.



## Equilibrium

Agents choose the following to maximize their objective, taking others' actions as given.

1. **Info production** - Agents announce signal prices  $\tilde{\tau}_j$ . Then they choose whether to produce each signal at cost  $\chi$ . Profit on signal  $j = \pi_j$
2. **Info purchase** - Each agent chooses what signals to purchase.
3. **Goods production** - Agents choose  $c$  and  $n$ , given all observed signals, s.t. budget constraint:

$$c_i = z_i n_i + \sum_j (\pi_j - \tau_j L_{ij}). \quad (1)$$

where  $L_{ij} = 1$  if agent  $i$  buys signal  $j$  and 0 otherwise.

**Result: Market Filters Out Industry Information**

- Equilibrium information price is

$$\tau_j = \chi / \lambda_j$$

where  $\lambda_j$  is the number of agents who buy signal  $j$ .

- For industry-specific information, industry must pay  $\chi$ .
- Aggregate information is cheaper if others buy it (if  $\lambda_a > 1$ ).
- Market supplies lots of aggregate information at a low price, and little industry-specific information.

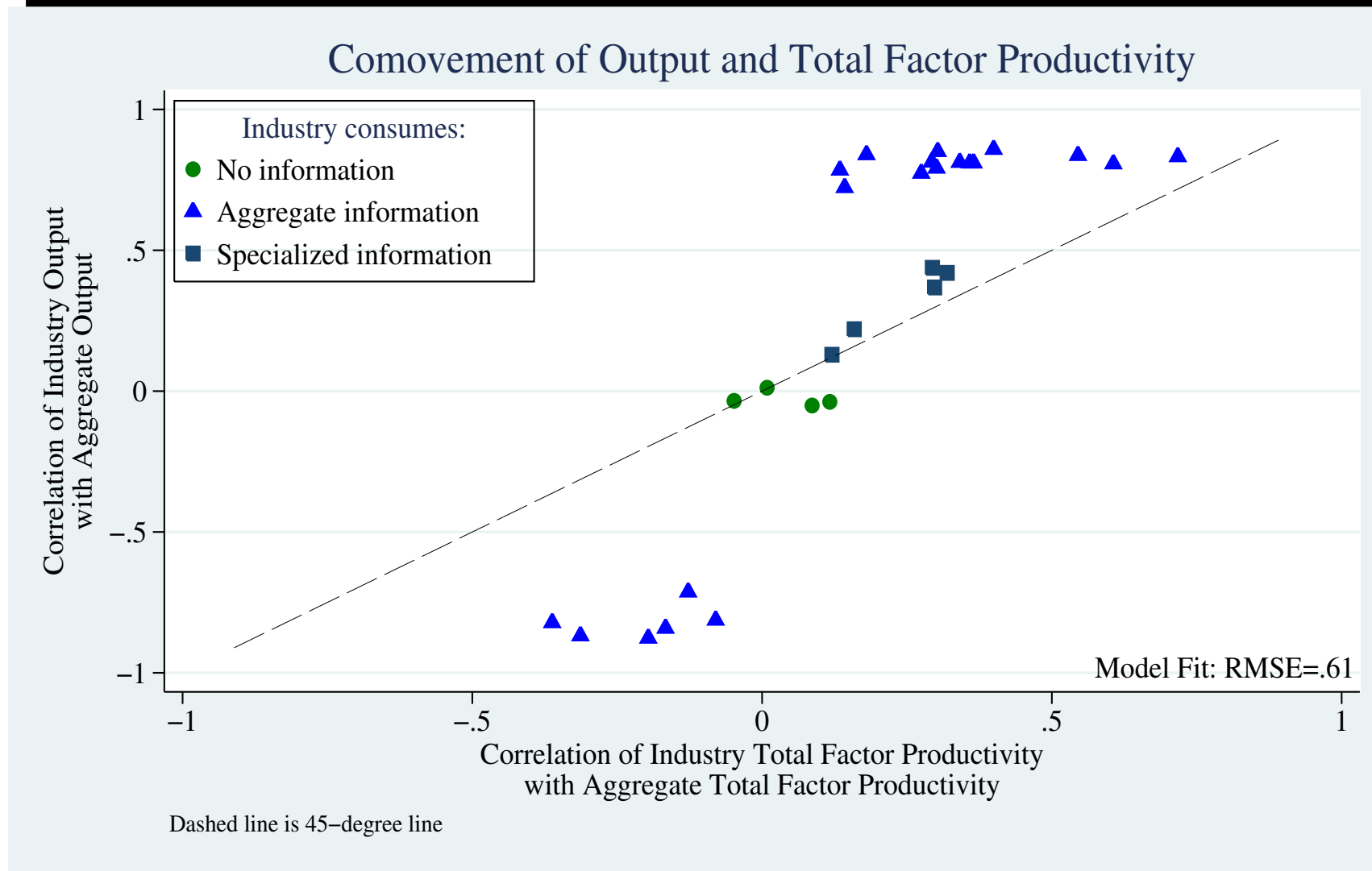
## Result: Aggregate Shocks to Choice Variables

- Firms that observe the aggregate signal (common info) have perfectly correlated beliefs  $E[z_i|s_0]$ .
- Labor is linear in  $E[z_i|s_0] \rightarrow \text{corr}(n_i(s_0), n_j(s_0)) = 1$  or  $-1$ .
  - Cochrane (94): “Shocks to consumption, output, or other endogenous variables... account for the bulk of business cycle variations.”
  - This raises correlation of output .
- For firms that observe industry-specific signal (heterogeneous info),  $\text{corr}(\text{labor input}) \approx \text{corr}(TFP)$ .
  - No excess comovement

## Calibration

- $z_i$  and  $\bar{z}$  processes match std and corr of industry and aggregate TFP.
- Of each  $z_i$ ,  $\bar{z}$  shock, 1/2 is (un)observable:  $\sigma_\eta = \sigma_e$  and  $\sigma_{e0} = \sigma_z$ .
- Disutility of labor:  $\psi = 0.96$  matches  $\text{std}(n)/\text{std}(y)=0.8$  in data.
- Risk aversion and information cost ensure that all 3 possible information choices are made by  $\geq 1$  industry:  $\rho = 4$ ,  $\chi = 0.2$ .
- Normalization:  $\mu_z = 1$

# Result: Information Markets → Aggregate Shocks



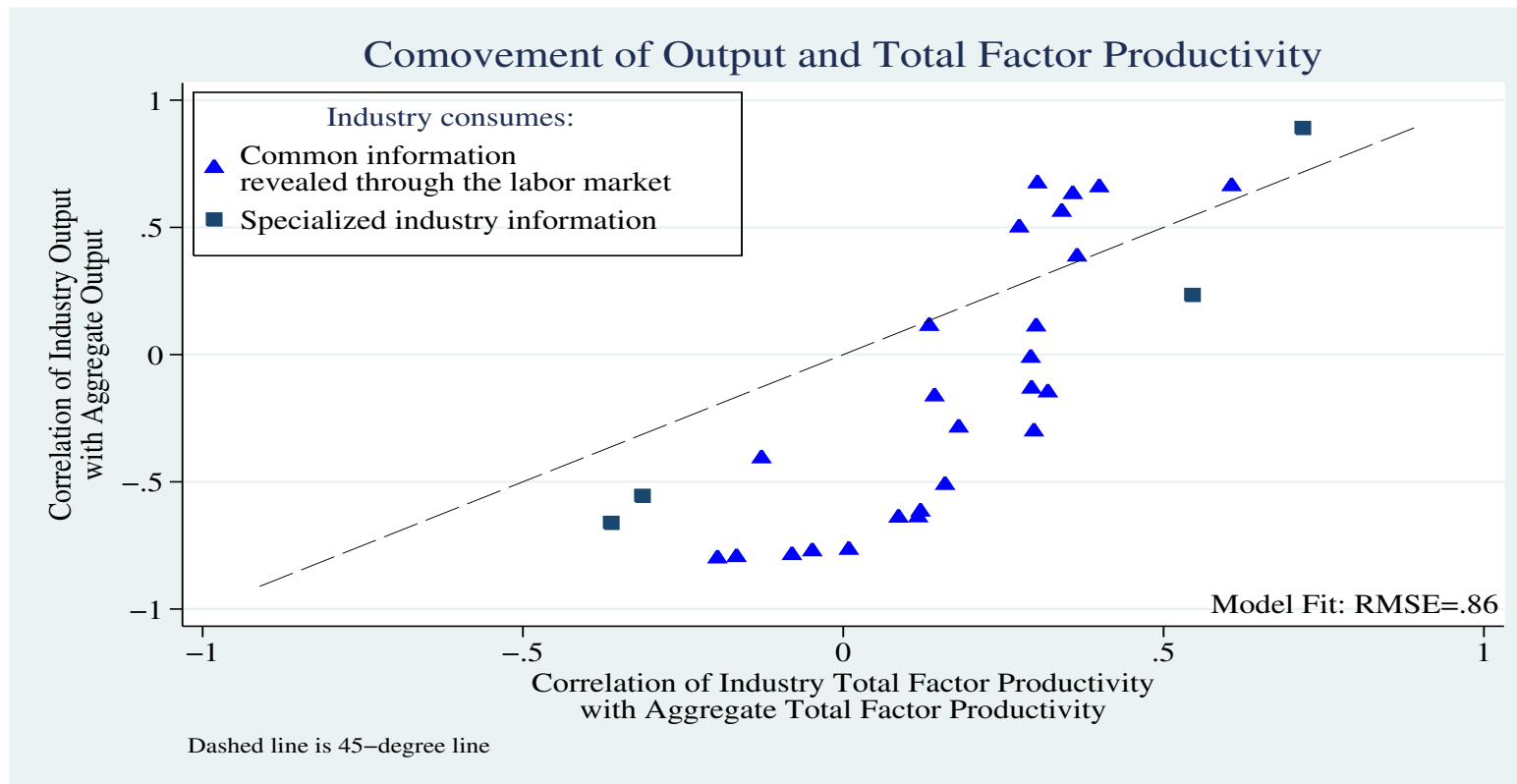
## Labor Markets: Price and Information Effects

- Change the model: Make labor not island-specific and tradeable.
- Input prices reveal ALL information.
  - Free-riding collapses the information market. All info purchased is firm-specific.
  - Few firms pay for information. Non-learners can make inference from others' signals.

## Labor Markets: Belief comovement persists

- Others' signals reveal aggregate information that is observed by all firms. It introduces common shocks to beliefs.
- Firms that do not learn observe  $S$  signals  $\{s_1, \dots, s_S\}$ . They form identical beliefs about aggregate:  $E[\bar{z}|s_1, \dots, s_S]$ .
- Firms that do not learn have no sector-specific information, thus  $E[z_i] = \beta_i E[\bar{z}]$ . Beliefs are perfectly correlated.
- Non-learners' labor depends on  $E[z_i|s_1, \dots, s_S]$ , and the wage.  $\text{corr}(n_i(s_0), n_j(s_0)) = 1$  is  $\beta_i = \beta_j$ . Otherwise, correlation is high, but not perfect.

# Comovement with Labor Market (No home prodn)



**Success:** Looks like the 1-shock multi-sector RBC model.

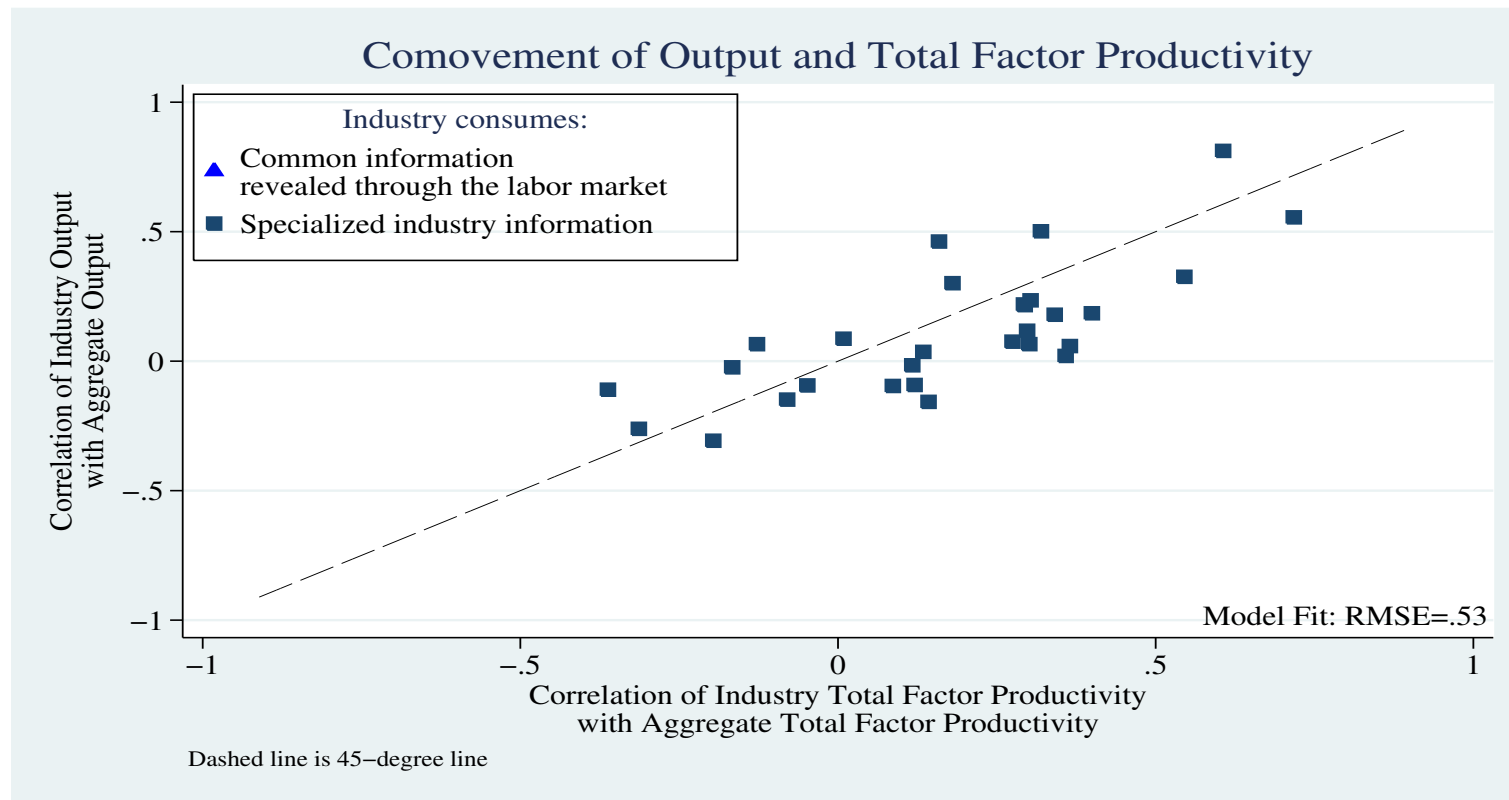
**Failure:** 1-shock RBC → no comovement (labor trade-off).



## A Model with Home Production

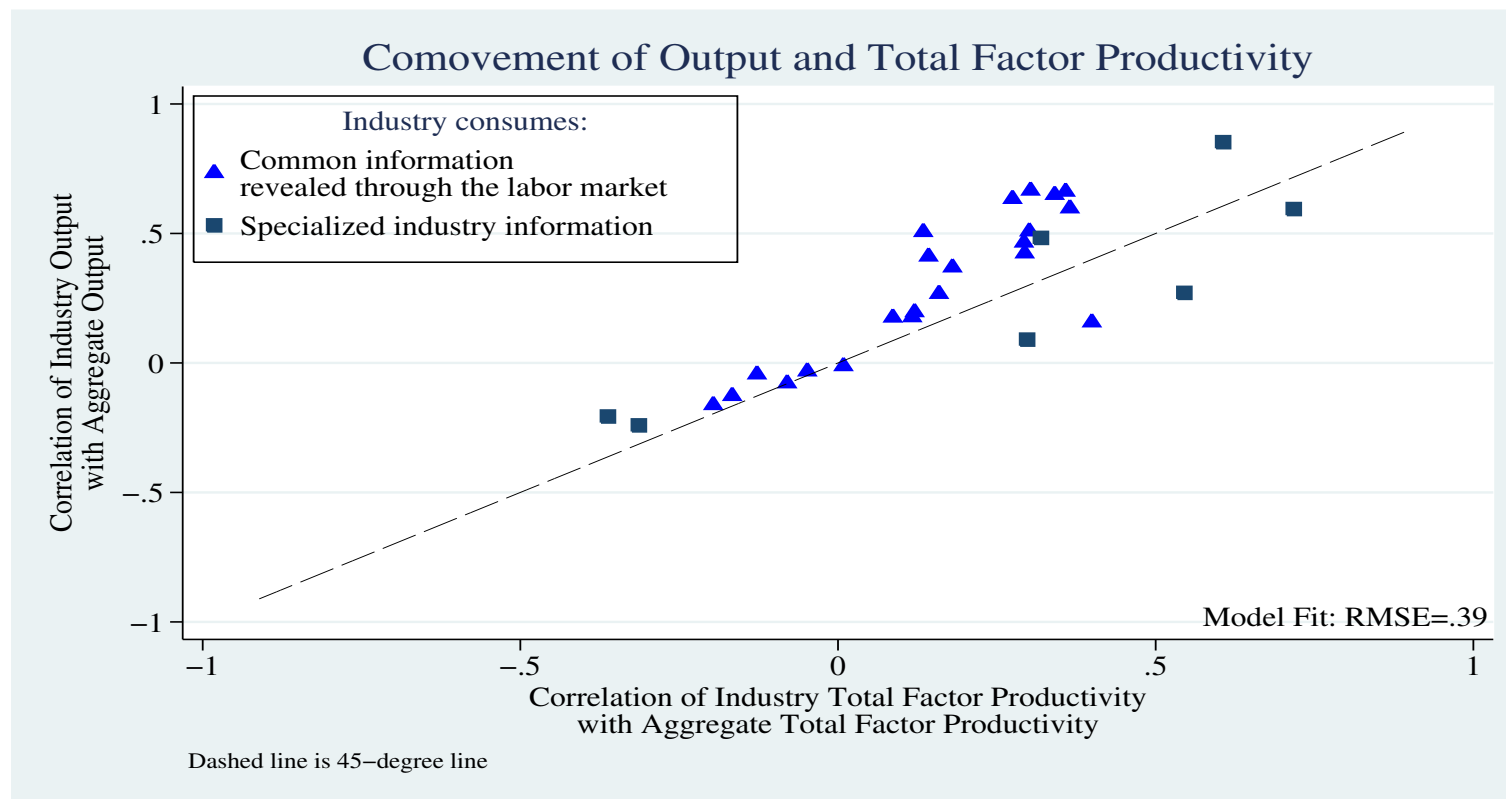
- We apply Benhabib, Rogerson and Wright's (1991) solution to the labor-trade-off problem: a home production sector.
- This sector is modelled like all the others.
  - It is nearly acyclical:  $\beta_h = 0.05$ .
  - It is large: We choose the industry-specific productivity variance  $\phi_h^2$  to match BRW's finding that hours in home production and in market work are about equal.

# Home Production & No Information Friction



Conclusion: To get  $\text{corr}(\text{GDP}) > \text{corr}(\text{TFP})$ , you need to solve both ‘labor trade-off’ and ‘aggregate shock’ problems.

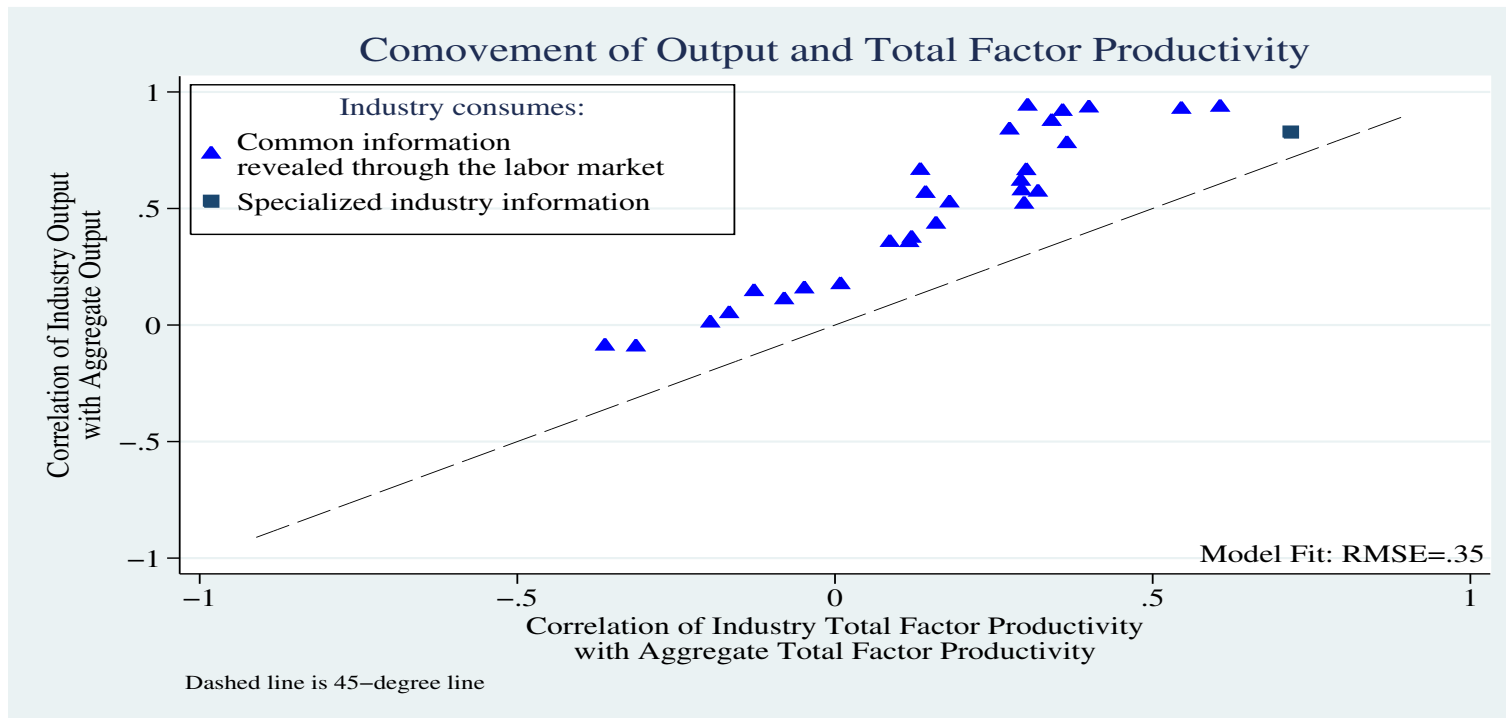
# Home Production & Costly Information



Our sector-specific shocks produce same effect as BWR's aggregate shock.

## A Second Aggregate Shock

A second aggregate shock is already present: home prod TFP.  
 Raising info cost makes it more dominant. Solves  $\beta < 0$  problem.



Punchline: Costly information can amplify other aggregate shocks.

## Evidence from Financial Markets

- Equity prices summarize available information. Most of this information is aggregate → prices comove more than earnings. (Pindyck and Rotemberg, 93)
- Worse information has more aggregate content: Prices that are worse predictors of future earnings covary more. (Durnev et.al. '03)
- More informed firms make more informed choices: If prices have more firm-specific variation, firms make more efficient investments.

## Evidence from Manufacturing Data

- Firms with large sector-specific productivity shocks ( $\phi_i^2$ ) value sector-specific information more.
- Buying sector specific information reduces output comovement.
- Prediction: High  $\phi_i^2$  predicts low comovement, after controlling for productivity correlation.
- The NBER-CES manufacturing industry database tells us:

$$\text{corr}(\text{output}_{ind}, \text{output}_{agg}) - \text{corr}(\text{TFP}_{ind}, \text{TFP}_{agg})$$

$$= \begin{matrix} 0.048 & - & 5.46 \cdot \text{Var}(\text{TFP}_{ind} | \text{TFP}_{agg}) \\ (0.006) & & (2.89) \end{matrix}$$

## The Decline of Comovement

- Over the last 30 years, firm-level volatility increased and aggregate volatility decreased → decrease in firm comovement (Comin and Philippon, 05).
- Falling information cost → industry-specific signals become more abundant. Economy moves closer to full-information economy, which exhibits no excess comovement.
- Small changes in information cost can dramatically change information equilibrium and resulting comovement.

## Conclusions

- Information is costly to discover but cheap to replicate.  
→ Learning aggregate information, but not industry-specific information is efficient (minimizes cost).
- Transmitting aggregate information generates aggregate shocks to choice variables.
- Works even when markets fully reveal private information.
- The model can generate  $\text{corr}(\text{GDP}) > \text{corr}(\text{TFP})$ .
- Suggestive evidence supports our explanation.



## Future work: International comovement

- Fact: Countries that trade more comove more.  
Frankel and Rose (98), Clark and van Wincoop (01)
- Problem: In standard models, trade has little or opposite effect on output comovement. Kose and Yi (06)
- Hypothesis: Countries that trade more goods also trade more information.
  - Common information market → common shocks.
  - Open question: What is the link between goods trade and information trade?