Sectoral Economies and the International Transmission of the Business Cycle

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Preliminary and incomplete

Facts:

	BKK95	CZ95
$\mathrm{corr}(y, y^*)$	0.66	0.24
$\mathrm{corr}(c, c^*)$	0.51	0.14
$\mathrm{corr}(z, z^*)$	0.56	0.06
$\mathrm{corr}(i, i^*)$	0.53	0.16
$\mathrm{corr}(n, n^*)$	0.33	0.21

BKK95: $y > z, i, c > n$

CZ95: $y > n > i, c > z$

$y > i, c$

$y > n$

$y > z$

Standard model prediction:

$c >$	$z >$	$y >$	$n,$	i	
0.88	0.25	-0.21	-0.94	-0.94	(1 good)
0.77	0.24	0.02	-0.54	-0.58	(2 good)

quantity anomaly

The problem:

Positive technology shock in the home country:

$c \nearrow, i \nearrow, n \nearrow, y \nearrow$

$c^* \nearrow, i^* \searrow, n \searrow, y \searrow$

"Productivity differentials"

What has been done?

- incomplete markets: Kollmann(1992), Baxter-Crucini(1995), Kehoe-Perri(1996)
- money + trend productivity growth differentials: McCurdy-Ricketts(1995)
- nonseparability of consumption and leisure: Devereux-Gregory-Smith(1992)
- non-traded goods and taste shocks: Stockman-Tesar(1995)
- home production: Canova-Ubide(1995)
- intermediate and final goods: Costello-Praschnik(1993)

Why sectors and intermediate goods?

- 60-70% of international trade
- generate demand effects

$\Longrightarrow$ Sectoral shocks

Costello-Praschnik(1993):

- $2 \times [1 + 1]$
- log utility
- infinite elasticity of substitution
- results: corr(c, c^*)=1, corr$(tb, y) > 0$

This paper:

- 2×2, $S \times H$ (input-output)
- Cobb-Douglas utility
- finite elasticity of substitution

The model economy:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t U(c_{ut}, 1 - n_{ut}) \right], \;\; 0 > \beta > 1$$

$$U\left(C_{ut}, 1 - N_{ut}\right) = \left[C_{ut}^{\mu_u} \left(1 - N_{ut}\right)^{(1-\mu_u)} \right]^{1-\varepsilon_u} / \left(1 - \varepsilon_u\right). \tag{1}$$

$$Y_{pst} = z_{pst} N_{pst}^{\alpha_s} K_{pst}^{\gamma_s} \prod_{m=1}^{S} M_{psmt}^{\zeta_{sm}}, \tag{2}$$

with

$$\alpha_s + \gamma_s + \sum_{m=1}^{S} \zeta_{sm} = 1$$

$$F_{ust} = \phi_{us}\left(X_{1sut}, ..., X_{Hsut}\right), \tag{3}$$

$$\phi_{us}\left(X_{1sut}, ..., X_{Hsut}\right) = \left[\sum_{p=1}^{H} \omega_{psu} X_{psut}^{(1-\rho_{su})} \right]^{1/(1-\rho_{su})}. \tag{4}$$

$$\sum_{u=1}^{H} \pi_u X_{psut} = \pi_i Y_{ist}, \tag{5}$$

$$Y_{ut} = \psi_u \left(F_{u1t} - \sum_{s=1}^{S} M_{us1t}, ..., F_{uSt} - \sum_{s=1}^{S} M_{usSt} \right), \quad (6)$$

$$\psi_u (\circ) = \left[\sum_{s=1}^{S} \varpi_{us} \left(F_{ust} - \sum_{m=1}^{S} M_{umst} \right)^{(1-\lambda_u)} \right]^{1/(1-\lambda_u)}. \quad (7)$$

$$Y_{ut} = C_{ut} + \sum_{s=1}^{S} I_{ust} \left(1 + \theta \frac{(K_{ust} - K_{us,t+1})^2}{K_{ust}} \right), \quad (8)$$

$$K_{ust+1} = (1 - \delta) K_{ust} + I_{ust}, \quad (9)$$

$$\begin{bmatrix} z_{11t+1} \\ z_{12t+1} \\ z_{21t+1} \\ z_{22t+1} \end{bmatrix} = \begin{bmatrix} a & b & c & d \\ b & a & d & c \\ c & d & a & b \\ d & c & b & a \end{bmatrix} \begin{bmatrix} z_{11t} \\ z_{12t} \\ z_{21t} \\ z_{22t} \end{bmatrix} + \begin{bmatrix} \xi_{11t+1} \\ \xi_{12t+1} \\ \xi_{21t+1} \\ \xi_{22t+1} \end{bmatrix},$$

$$V\left(\left\{z_u\right\},\left\{K_u\right\}\right)$$

$$=\max_{D}\left\{\sum_{u=1}^{H}\pi_u U\left(C_u,1-N_u\right)+EV\left(\left\{z_u'\right\},\left\{K_u'\right\}\right)\right\}, \quad (10)$$

plus resource constraint, import brokers, domestic brokers.

$$D=\left\{I,N,M,X\right\}, \quad (11)$$

Calibration

4 types of agents in each country:

Households:

$$\max E_t \left(\sum_{j=0}^{\infty} \beta^j \left[C_{ut+j}^{\mu_u} \left(1 - N_{ut+j}\right)^{(1-\mu_u)} \right]^{1-\varepsilon_u} / \left(1 - \varepsilon_u\right) \right), \tag{12}$$

subject to the sequence of constraints

$$C_{ut} + \sum_{s=1}^{S} I_{ust} \left(1 + \theta \frac{\left(K_{ust} - K_{us,t+1}\right)^2}{K_{ust}} \right) = w_{ut} N_{ut} + \sum_{s=1}^{S} \left(r_{ust} + \delta\right) K_{ust}, \tag{13}$$

$$K_{us,t+1} = \left(1 - \delta\right) K_{ust} + I_{ust}, \quad \forall s. \tag{14}$$

Firms:

$$\max P_{ust} Y_{ust} - w_{ut} N_{ust} - \left(r_{ust} + \delta\right) K_{ust} - \sum_{m=1}^{S} P_{umt} M_{umst}, \tag{15}$$

Import brokers (for each sector):

$$\max V_{ust} \left[\sum_{p=1}^{H} \omega_{psu} X_{psut}^{(1-\rho_{su})} \right]^{1/(1-\rho_{su})} - \sum_{p=1}^{H} P_{pst} X_{psut}, \quad (16)$$

Final good (domestic) brokers:

$$\max \left[\sum_{s=1}^{S} \varpi_{us} Q_{ust}^{(1-\lambda_u)} \right]^{1/(1-\lambda_u)} - \sum_{s=1}^{S} V_{ust} Q_{ust}, \quad (17)$$

where

$$Q_{ust} \equiv F_{ust} - \sum_{m=1}^{S} M_{umst}. \quad (18)$$

Parameter	Value
β	0.9926
π_i	1.0000
α_i	0.3200
γ_i	0.1800
ζ_{ij}	0.2500
θ	0.0250
δ	0.0201
μ	0.3655
ϵ	2.0000
ρ	0.6667
ω_{ijl}	0.6300
λ	0.6667
ϖ_{ij}	0.6300
ϕ	0.9470
ψ^d	0.0500
ψ^f	0.0000
$\sigma(\xi)$	0.0126
$\mathrm{corr}(\xi_{i1}, \xi_{i2})$	0.1750

Statistic	Mean	S.D.	Data[a]	Data[b]
σ_y	0.0205	0.0026	0.0192	0.0162
σ_c	0.0134	0.0018	0.0144	
σ_i	0.1305	0.0132	0.0628	0.0485
σ_n	0.0054	0.0006	0.0117	
σ_{tb}	0.0300	0.0019	0.0052	0.0105
Corr(y,c)	0.95	0.02	0.82	
Corr(y,i)	0.32	0.07	0.94	
Corr(y,n)	0.96	0.01	0.88	
Corr(y,tb)	-0.06	0.09	-0.37	-0.32
Corr(y,y*)	0.92	0.03	0.66	0.24
Corr(c,c*)	0.88	0.05	0.51	0.14
Corr(i,i*)	-0.78	0.05	0.53	0.16
Corr(n,n*)	0.66	0.10	0.33	0.21

a From Backus, Kehoe & Kydland (1995), Tables 11.1 and 11.2.
Standard deviations and domestic correlations are for the U.S.
International correlations are between the U.S. and Europe.

b From Zimmermann (1995), Tables 1, 7 and 15 to 17.
Average correlations across all pairs of countries in sample.

Statistic	Benchmark	$\theta = 0$	$\zeta_{i1} + \zeta_{i2}$ $= .01$
σ_y	0.0205	0.0206	0.0110
σ_c	0.0134	0.0137	0.0068
σ_i	0.1305	0.1613	0.1014
σ_n	0.0054	0.0054	0.0033
σ_{tb}	0.0300	0.0381	0.0240
Corr(y,c)	0.95	0.95	0.94
Corr(y,i)	0.32	0.32	0.35
Corr(y,n)	0.96	0.96	0.93
Corr(y,tb)	-0.06	-0.05	-0.12
Corr(y,y*)	0.92	0.92	0.78
Corr(c,c*)	0.88	0.88	0.93
Corr(i,i*)	-0.78	-0.83	-0.90
Corr(n,n*)	0.66	0.64	0.19

Statistic	Benchmark	$\phi = 0.8$	$\psi^d = 0$ corr = 0	$\phi = 0.847$ $\psi^f = 0.5$
σ_y	0.0205	0.0249	0.0225	0.0206
σ_c	0.0134	0.0063	0.0080	0.0132
σ_i	0.1305	0.1373	0.1296	0.1126
σ_n	0.0054	0.0129	0.0102	0.0054
σ_{tb}	0.0300	0.0267	0.0268	0.0247
Corr(y,c)	0.95	0.91	0.93	0.97
Corr(y,i)	0.32	0.63	0.55	0.46
Corr(y,n)	0.96	0.99	0.99	0.97
Corr(y,tb)	-0.06	-0.06	-0.04	-0.08
Corr(y,y*)	0.92	0.95	0.95	0.94
Corr(c,c*)	0.88	0.89	0.88	0.94
Corr(i,i*)	-0.78	-0.31	-0.46	-0.71
Corr(n,n*)	0.66	0.94	0.91	0.69

Statistic	Benchmark	$\lambda = 0.4$	$\rho = 0.4$
σ_y	0.0205	0.0207	0.0228
σ_c	0.0134	0.0134	0.0166
σ_i	0.1305	0.1336	0.3897
σ_n	0.0054	0.0054	0.0075
σ_{tb}	0.0300	0.0305	0.0785
Corr(y,c)	0.95	0.96	0.81
Corr(y,i)	0.32	0.38	0.29
Corr(y,n)	0.96	0.96	0.91
Corr(y,tb)	-0.06	-0.06	-0.14
Corr(y,y*)	0.92	0.93	0.61
Corr(c,c*)	0.88	0.90	0.62
Corr(i,i*)	-0.78	-0.78	-0.80
Corr(n,n*)	0.66	0.65	-0.12

What is next?

- $H \times S$, $H = 4$, $S = 6$
- "real" calibration data from input-output matrices