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The correlation of productivity growth across regions and industries in the United States

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Abstract

This paper shows that productivity growth is more strongly correlated across U.S. regions than across the G7 countries. Cross-region correlations of productivity growth within a given industry are typically stronger than cross-sector correlations of productivity growth within the same region.

Keywords: Productivity growth; U.S. regions; G7 countries

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1. Introduction

This paper describes the covariation of productivity growth across broad regions and industries in the United States. This research is motivated by much recent work in macroeconomics which views productivity shocks as an important source of economic fluctuations (see the literature on Real Business Cycles, e.g. Kydland and Prescott, 1982; Backus et al., 1992; and Baxter and Crucini, 1993). It complements recent research on cross-country and cross-country productivity comovements (e.g. Kollmann, 1991; Backus et al., 1992; Hickman, 1992; Bernard and Jones, 1993; Costello, 1993; and Dollar and Wolff, 1993) and it contributes to the growing literature on regional aspects of growth and economic fluctuations (e.g. Barro and Sala-i-Martin, 1991; Blanchard and Katz, 1992; Atkeson and Bayoumi, 1992; and Crucini, 1993).

Within the broad industries considered in this study, annual productivity growth tends to be strongly correlated across regions. Correlations of productivity growth across sectors, within a given region, tend to be weaker. Productivity growth is generally more strongly correlated across the regions of the United States than across the G7 countries.

Section 2 of the paper describes the data used in this study. Section 3 presents the results.

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2. The data

All data used in this study are annual. Three data sets are considered. (i) The Hulten and Schwab (1984) data on capital and labor inputs and on value added in manufacturing during the period 1951–78 in the 9 U.S. census divisions. (ii) Regional and sectoral value added and employment data for the period 1969–86 from the Regional Economic Information System of the U.S. Bureau of Economic Analysis (BEA) (see Bureau of Economic Analysis, 1985, and Renshaw et al., 1988). (iii) Sectoral value added and employment data for the G7 countries during the period 1970–85 taken from the International Sectoral Data Base (ISDB) compiled by the OECD (see Meyer-zu-Schlochtern, 1988).

The Hulten–Schwab data are used to construct Solow residuals (Solow, 1957; Hulten and Schwab, 1984) for manufacturing using the formula

$$S_t = \Delta \ln(Y_t) - \pi_t \Delta \ln(P_t) - \nu_t \Delta \ln(N_t) - (1 - \pi_t - \nu_t)\Delta \ln(K_t)\,, \tag{1}$$

where Δ is the difference operator ($\Delta x_t = x_t - x_{t-1}$), while Y_t, P_t, N_t and K_t denote real value added, the labor input of production workers (in hours), hours provided by non-production workers and the capital stock (structures, equipment, land plus inventories) in period t, respectively. π_t and ν_t are averages of the shares in value added of wage payments made to production workers and to non-production workers, respectively, in periods t and $t-1$.

As no capital stock series are available which can be matched to the BEA regional and sectoral data, my analysis of these data focuses on the growth rate of labor productivity:

$$\mathcal{S}_t = \Delta \ln(Y_t) - \Delta \ln(L_t)\,, \tag{2}$$

where L_t is total employment. Note that employment (not hours) is used in (2) because regional data on hours worked are not available for the United States (except for manufacturing). An alternative to this measure of productivity growth would be $\Delta \ln(Y_t) - \alpha \Delta \ln(L_t)$, where α is the factor share of labor. However, it appears that the results for this alternative measure are quite similar to those reported below for the $\mathcal{S}$ measure, and hence results are only presented for the latter measure.

For the sake of comparability with the BEA data, the analysis of international productivity data (based on ISDB) too focuses on the growth rate of labor productivity.

The analysis of BEA and of ISDB data presented below concentrates on the following five broad sectors which account for close to 90% of U.S. private sector value added: manufacturing (MFG); transportation, communication and public utilities (TCP); wholesale and retail trade (TR); finance, insurance and real estate (FIR); and services (SER).[1]

3. Results

Table 1 shows cross-region correlations of Solow residuals based on the Hulten–Schwab manufacturing data. The correlations are all positive and they are almost all significant (at the

[1] I also considered a finer sectoral disaggregation (using manufacturing industries defined at the two-digit level of the International Standard Industrial Code). For that finer disaggregation, the key qualitative findings reported in the present paper hold as well.

Table 1
U.S. manufacturing: Cross-region correlations of Solow residuals (Hulten–Schwab data)

	MA	ENC	WNC	SA	ESC	WSC	MT	PA
NE	0.74*	0.88*	0.83*	0.51*	0.74*	0.21	0.68*	0.79*
MA		0.81*	0.78*	0.49*	0.71*	0.03	0.43*	0.76*
ENC			0.90*	0.70*	0.76*	0.23	0.60*	0.82*
WNC				0.57*	0.79*	0.10	0.46*	0.86*
SA					0.68*	0.43*	0.50*	0.51*
ESC						0.37	0.57*	0.80*
WSC							0.32	0.18
MT								0.60*

Note: Period: 1952–78. NE: New England; MA: Middle Atlantic; ENC: East North Central; WNC: West North Central; SA: South Atlantic; ESC: East South Central; WSC: West South Central; MT: Mountain; PA: Pacific.
* Significant at 10% level (test based on Generalized Method of Moments).

10% level). The average of the correlations for all pairs of regions is 0.59; when the oil-producing West South Central region (Arkansas, Louisiana, Oklahoma and Texas) is excluded from the sample, the average correlation increases to 0.69.

Tables 2 and 3 use the second data set (BEA). In these two tables the United States is partitioned into eight regions. Table 2 reports cross-region correlations of labor productivity growth within each sector, whereas Table 3 reports cross-sector correlations of labor productivity growth within each region.

Table 2 shows that cross-region correlations of labor productivity growth rates are generally quite strong. Within the MFG, TCP, TR and SER sectors, the averages (over all pairs of regions) of cross-region correlations of productivity growth rates are 0.84, 0.73, 0.91 and 0.55, respectively (in FIR, however, the average cross-region productivity correlation is much lower: 0.18). Table 3 shows that cross-sector productivity correlations within a given region are mostly positive and statistically significant; overall, however, these correlations tend to be lower than cross-region correlations within the same sector (the average value of all cross-sector correlations of labor productivity growth reported in Table 3 is 0.23, while the average cross-region correlation in Table 2 is 0.64).

Costello (1993) has recently studied cross-country, cross-industry correlations of productivity growth in six of the G7 countries. Her study shows that, for an aggregate sector which comprises manufacturing, mining, electricity and gas, the average cross-country correlation of annual Solow residuals equals 0.45; this average correlation is lower than the average cross-region correlation of U.S. manufacturing Solow residuals in Table 1 of the present paper.

In order to draw further comparisons between cross-region and cross-country productivity comovements, time series on labor productivity in the G7 countries were constructed using the OECD International Sectoral Data Base. For each of the five sectors considered in Tables 2 and 3, panel (a) of Table 4 shows the average (over all pairs of G7 countries) of the cross-country correlations of labor productivity growth within that sector; for each G7 country, panel (b) of the table reports the average (over all pairs of sectors) of the cross-sector correlations of labor productivity growth within that country.

A comparison of Tables 2 and 4 confirms that productivity growth tends to be more strongly

Table 2
Cross-region correlations of labor productivity growth rates within a given sector (BEA data)

	ME	GL	PL	SE	SW	RM	FW
(a) Manufacturing (average correlation: 0.84)							
NE	0.91*	0.83*	0.79*	0.74*	0.71*	0.95*	0.90*
ME		0.93*	0.93*	0.90*	0.75*	0.89*	0.88*
GL			0.90*	0.90*	0.80*	0.83*	0.80*
PL				0.96*	0.76*	0.84*	0.83*
SE					0.78*	0.79*	0.80*
SW						0.77*	0.72*
RM							0.87*
(b) Transportation, communic. and public util. (average correlation: 0.73)							
NE	0.83*	0.90*	0.79*	0.85*	0.81*	0.35*	0.90*
ME		0.90*	0.78*	0.79*	0.65*	0.28*	0.79*
GL			0.86*	0.96*	0.76*	0.44*	0.87*
PL				0.89*	0.73*	0.61*	0.87*
SE					0.75*	0.53*	0.86*
SW						0.60*	0.78*
RM							0.46*
(c) Trade (average correlation: 0.91)							
NE	0.95*	0.92*	0.89*	0.93*	0.72*	0.87*	0.95*
ME		0.95*	0.91*	0.96*	0.84*	0.91*	0.94*
GL			0.96*	0.97*	0.89*	0.95*	0.96*
PL				0.95*	0.81*	0.94*	0.91*
SE					0.87*	0.96*	0.94*
SW						0.88*	0.86*
RM							0.91*
(d) Finance, insurance and real estate (average correlation: 0.18)							
NE	0.83*	0.70*	0.29*	0.032*	−0.43*	−0.38*	−0.49*
ME		0.037*	0.00	0.13	−0.22	−0.23	−0.11
GL			0.64*	0.65*	−0.37*	−0.17	−0.56*
PL				0.74*	0.32*	0.41*	−0.12
SE					0.27*	0.38*	−0.08
SW						0.84*	0.72*
RM							0.74*
(e) Services (average correlation: 0.55)							
NE	0.84*	0.59*	0.15	0.31*	−0.06	−0.04	0.49*
ME		0.71*	0.32	0.58*	0.17	0.19	0.56*
GL			0.76*	0.80*	0.59*	0.58*	0.83*
PL				0.74*	0.80*	0.78*	0.68*
SE					0.76*	0.81*	0.58*
SW						0.86*	0.48*
RM							0.46*

Note: Period: 1970–86. NE: New England; ME: Mideast; GL: Great Lakes; PL: Plains; SE: Southeast; SW: Southwest; RM: Rocky Mountains; FW: Far West.

The average correlation (in parentheses) is average (over all pairs of regions) of the cross-region correlations within a given sector.

* Significant at 10% level (test based on Generalized Method of Moments).

Table 3
Cross-sector correlations of labor productivity growth rates within a given U.S. region (BEA data)

	TCP	TR	FIR	SER
(a) New England (average correlation: 0.39)				
MFG	0.35*	0.90*	0.15*	0.60*
TCP		0.41*	0.14	0.30
TR			0.14	0.62*
FIR				0.31*
(b) Mideast (average correlation: 0.43)				
MFG	0.55*	0.86*	0.49*	0.45*
TCP		0.46*	0.31*	0.29*
TR			0.38*	0.38*
FIR				0.16*
(c) Great Lakes (average correlation: 0.33)				
MFG	0.65*	0.83*	0.13	0.42*
TCP		0.44*	−0.09	0.50*
TR			0.05	0.25*
FIR				0.08
(d) Plains (average correlation: 0.11)				
MFG	0.64*	0.79*	−0.29*	−0.07
TCP		0.65*	−0.14	0.02
TR			−0.46*	−0.09
FIR				0.13
(e) Southeast (average correlation: 0.19)				
MFG	0.58*	0.83*	−0.03	0.03
TCP		0.42*	−0.05	0.43*
TR			−0.24	0.00
FIR				0.00
(f) Southwest (average correlation: 0.11)				
MFG	0.70*	0.52*	−0.39*	−0.05
TCP		0.30*	−0.05	0.17
TR			−0.24*	−0.16*
FIR				0.31*
(g) Rocky Mountains (average correlation: 0.08)				
MFG	0.34*	0.83*	−0.47*	−0.25*
TCP		0.30*	−0.22*	0.30
TR			−0.23*	−0.05
FIR				0.27*
(h) Far West (average correlation: 0.23)				
MFG	0.50*	0.93*	0.02	0.08*
TCP		0.47*	0.25*	0.29*
TR			−0.03	0.26*
FIR				−0.38*

Note: Period: 1970–86. In parentheses: average of cross-sector correlations within a given region.
* Significant at 10% level (test based on Generalized Method of Moments).

Table 4
Average correlations of labor productivity growth rates for the G7 countries (ISDB, 1971–85)

(a) Average (over all pairs of G7 countries) of cross-country correlations of labor productivity growth within a given sector

Sector:	MFG	TCP	TR	FIR	SER
Average cross-country correlation:	0.55	0.23	0.30	0.30	0.01

(b) Average (over all pairs of sectors) of cross-sector correlations of labor productivity growth within a given G7 country

Country:	US	JA	GE	FR	UK	IT	CA
Average cross-sector correlation:	0.41	0.19	0.54	0.38	0.51	0.51	0.23

Note: ISDB does not provide value added and employment data for the Italian FIR sector. Hence the average cross-country correlation reported for FIR excludes Italy and the average cross-sector correlation reported for Italy excludes FIR.

US: United States; JA: Japan; GE: Germany; FR: France; UK: United Kingdom; IT: Italy; CA: Canada. Key to sector abbreviations: see text.

correlated across the regions of the United States than across the G7 countries (the average of all cross-country correlations in Table 4 is 0.27; recall that the average cross-region productivity correlation in Table 2 is 0.64).

Table 4 shows also that (on average) cross-sector correlations of productivity growth within the same country tend to be somewhat stronger than cross-country correlations of productivity growth within a given sector;[2] it seems interesting that this is the reverse of the pattern observed for the regional data.

A possible explanation for the findings described in this paper is that, because of the close integration of the regions of the United States, industry-specific technological innovations spread more rapidly across these regions than across independent nations. Note also that changes in measured productivity can be caused by demand shocks (particularly when there exists labor hoarding and when goods markets are imperfectly competitive), i.e. such changes do not necessarily reflect true changes in the technology of an economy (see, for example, Burnside et al., 1993; Hall, 1988; and Rotemberg and Woodford, 1992). Hence the strong cross-region correlations of productivity growth within the same industry which were documented in this paper might also reflect common demand shocks which affect the same industry in all regions. Future research should further explore these possible explanations.

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[2] Costello (1993) reaches a similar finding.

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