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Production Sharing and Business Cycle Synchronization in the Accession Countries

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4.1 Introduction

One of the issues currently confronting Europe is the proposed expansion of the eurozone to include a number of countries in Central and Eastern Europe (CEECs). The potential benefits of expanding the euro area include greater trade linkages between Eastern and Western Europe and, for the euro-adopting countries, the elimination of exchange rate risk and the stabilization of prices. The potential costs of euro adoption, however, are the loss of independent monetary policy in the CEECs, and for the core EU countries, potential pressure on EU policy to meet the needs of a larger and more diverse set of constituents.

According to Mundell's (1961) classic argument, a region constitutes an optimum currency area if the benefits of sharing a currency exceed the costs. Two types of yardsticks are often applied to assess the cost-benefit ratio of a common currency. The first is whether countries experience similar business cycle fluctuations. To the extent countries are exposed to the same shocks, the argument goes, the easier it is for a shared monetary authority to accommodate those shocks. A second, and related, metric is the extent to which goods and factor markets are flexible enough to respond to shocks, reducing the need for adjustments in monetary policy.

This paper focuses on the first of these criteria. In particular, the purpose of this paper is to quantitatively assess the role of trade in the transmission of business cycles within and between the regions of Eastern and Western Europe. In theory, the impact of trade flows on business cycles is ambiguous. If trade induces countries to specialize according to comparative advantage, increased trade could result in more asynchronous cycles. On the other hand, if trade involves vertically integrated networks in which production chains extend across national borders, trade could lead to more correlated cycles. Thus it is not obvious whether increased trade linkages between Eastern and Western Europe will generate more correlated cycles and therefore reinforce efforts to coordinate monetary policy, or whether trade could cause business cycles to diverge.

To study this issue I develop a framework that captures trading patterns in Europe. The model is calibrated to data in order to obtain a quantitative assessment of the impact of increased trade on business cycle transmission. I extend the basic international business cycle model proposed by Backus, Kehoe, and Kydland (1995; henceforth BKK), to a multicountry setting. As in BKK, trade occurs at the level of intermediate goods, and business cycles are driven by shocks to total factor productivity that change relative marginal costs across countries. In the standard BKK setup, an aggregate shock to productivity lowers the relative marginal cost of production in the home country. This induces firms and households in both countries to substitute toward the lower-price good, resulting in a negative transmission of the business cycle from the home to the foreign country. In recent work, Burstein, Kurz, and Tesar (2005) show that when intermediate inputs are complements in production, as would be the case if firms engage in production sharing across international borders, a decline in the relative marginal cost in the home country will increase demand for the intermediate good from other countries in the production chain, leading to a positive transmission of the business cycle. Therefore, depending on the nature of a country's trade, and its use of intermediate inputs, the model can generate positive or negative comovements.[1]

Section 2 documents the volume of trade, foreign direct investment (FDI) flows, and production sharing in a sample of four Western European and four Eastern European countries. These data are used in the calibration of the model, so that the model approximates the direction and volume of trade and trade's share of economic activity in a typical Western and Eastern European country. The data suggest that trade with West Europe accounts for the lion's share of Eastern European exports and imports and that Eastern European trade in manufactured goods is substantially larger than local manufacturing value added. The paper also presents evidence that trade in manufactured goods for further processing accounts for a significant share of total East-West trade flow.

The theoretical model used to describe trade and business cycle transmission is developed in section 3. The model assumes that there are two kinds of trade between East and West—trade in intermediate goods that are complements (standard trade flow) and trade in intermediate goods that are substitutes (production sharing). West-West trade involves only standard trade flow. Production of intermediate goods in each country is subject to a country-specific productivity shock. A calibrated version of the model produces correlations within and between East-West regions under different scenarios. Given the observed volume of trade and the extent of production sharing, the model suggests that East-West trade generates positive bilateral output correlations between trading partners in Eastern and Western Europe of about 0.13. If the creation of a common currency area increases the volume of East-West trade by 50 percent—a modest increase relative to that predicted by Rose (2000)—the model predicts an increase in the average bilateral output correlation for all of Europe from 0.06 to 0.32.

4.2 Trade and European Business Cycle Fluctuations

A large number of studies have examined the synchronization of business cycles within and between the countries of Eastern and Western Europe, using a number of different methodologies and datasets.[2] Fidrmuc and Korhonen (2006) provide a meta-analysis of business cycle correlations, compiling results from a large number of papers. While there is some evidence that business cycle comovements between a subset of Eastern European countries and the core EU countries have increased over time, the shortness of the sample raises issues of robustness. Since the process of integration between East and West is still underway, it is difficult to use past data to assess the impact of trade and other market linkages on business cycles. Adding to the difficulty is the problem of disentangling transition dynamics after the collapse of the Soviet Union from the more traditional notion of a cycle as a deviation from a long-run trend. The perspective adopted here is to take information on business cycles and trade in the two regions in the 1990–2005 period as a snapshot of the current situation and to ask whether increased trade flows could have an important impact on cycles going forward. In that spirit, table 4.1 provides cross-country correlations between output, total industrial production, industrial production of manufactures, and investment for eight European countries, with the length of the time series varying depending on data availability. The four EU countries are Austria, France, Germany, and Italy, chosen for their large size within the EU and for the extent of their trade linkages with Eastern Europe.

Table 4.1
Correlations of output and industrial production for selected countries

A. GDP (hp-filtered, seasonally adjusted, raw data in local currency): 1993.1–2005.3

	Austria	France	Germany	Italy	Czech	Hungary	Poland	Slovakia	EU aggregate
Austria	1.00	0.75	0.53	0.41	0.10	0.56	0.47	(0.34)	0.75
France		1.00	0.74	0.70	(0.11)	0.50	0.24	(0.62)	0.94
Germany			1.00	0.66	0.21	0.57	0.17	(0.43)	0.89
Italy				1.00	(0.06)	0.29	0.05	(0.41)	0.76
Czech					1.00	0.83	0.14	0.25	0.01
Hungary						1.00	0.26	0.28	0.51
Poland							1.00	0.16	0.28
Slovakia								1.00	(0.57)

Average correlations:	Within W. Eur.:	0.63 excluding EU aggregate
	Within E. Eur.:	0.32
	Between W. Eur/E. Eur:	0.07 excluding EU aggregate
	Between EU/E. Eur:	0.06

(Czech and Poland's time series: 1995: 1–2005:3)
(Hungary's time series: 2000.1–2005.3)

B. Industrial production (hp-filtered, seasonally adjusted): 1990.1–2005.4

	Austria	France	Germany	Italy	Czech	Hungary	Poland	Slovakia	EU aggregate
Austria	1.00	0.77	0.74	0.52	0.03	0.52	0.27	(0.03)	0.75
France		1.00	0.76	0.75	0.14	0.49	0.30	0.16	0.91
Germany			1.00	0.54	0.01	0.28	0.17	(0.06)	0.81
Italy				1.00	0.42	0.54	0.45	0.47	0.84
Czech					1.00	0.48	0.67	0.84	0.27
Hungary						1.00	0.64	0.53	0.54
Poland							1.00	0.58	0.39
Slovakia								1.00	0.25

Average correlations:	Within W. Eur.:	0.68 excluding EU aggregate
	Within E. Eur.:	0.62
	Between W. Eur/E. Eur:	0.26 excluding EU aggregate
	Between EU/E. Eur:	0.36

The four Eastern European countries include the Czech Republic, Hungary, Poland, and Slovakia, countries that have the largest trading relationships with Western Europe and are the largest recipients of cumulated FDI inflows from the West. All data are quarterly, in real terms, seasonally adjusted and detrended using the HP filter. At the bottom of

Table 4.1
Continued

C. Industrial production: Manufacturing (hp-filtered, seasonally adjusted): 1990.1–2005.4

	Austria	France	Germany	Italy	Czech	Hungary	Poland	Slovakia	EU aggregate
Austria	1.00	0.77	0.81	0.61	0.12	0.73	0.34	(0.04)	
France		1.00	0.70	0.69	0.17	0.63	0.32	0.02	
Germany			1.00	0.57	0.24	0.65	0.12	0.22	
Italy				1.00	0.33	0.40	0.40	0.43	
Czech					1.00	(0.25)	0.37	0.50	
Hungary						1.00	0.28	(0.13)	
Poland							1.00	(0.01)	
Slovakia								1.00	

Average correlations:	Within W. Eur.:	0.69
	Within E. Eur.:	0.13
	Between W. Eur/E. Eur:	0.32

(Czech time series: 1991.1–2005.4)
(Hungary and Slovakia's time series: 1992.1–2005.4)
(IP manufacturing does not have an EU aggregate series.)

D. Investment (hp-filtered, seasonally adjusted, raw data in local currency): 1993.1–2005.3

	Austria	France	Germany	Italy	Czech	Hungary	Poland	Slovakia	EU aggregate
Austria	1.00	0.78	0.84	0.22	(0.26)	0.03	0.65	(0.38)	0.78
France		1.00	0.78	0.50	(0.38)	0.09	0.38	(0.54)	0.88
Germany			1.00	0.28	(0.40)	0.07	0.56	(0.45)	0.87
Italy				1.00	(0.04)	0.11	0.04	(0.33)	0.51
Czech					1.00	0.04	(0.37)	0.36	(0.47)
Hungary						1.00	0.09	0.09	0.15
Poland							1.00	0.07	0.64
Slovakia								1.00	(0.32)

Average correlations:	Within W. Eur.:	0.57 excluding EU aggregate
	Within E. Eur.:	0.05
	Between W. Eur/E. Eur:	(0.05) excluding EU aggregate
	Between EU/E. Eur:	(0.00)

(Czech and Poland's time series: 1995:1–2005:3)
(Hungary's time series: 2000.1–2005.3)

each panel is the average of the bilateral correlations of the four West European countries, the four East European countries, the average bilateral correlation across the two regions, and the average correlation between each of the East European countries and the EU aggregate.

Starting with the top panel, the data indicate that GDP correlations within Western Europe are large and positive, ranging between 0.41 and 0.75, with an average of 0.63. Correlations within Eastern Europe are also positive but have a wider range, from 0.14 between Poland and the Czech Republic to 0.83 between Hungary and the Czech Republic. The average within-CEEC correlation is 0.32. The lowest correlations are between the East and the West, with an average cross-region correlation of 0.07.[3] The following model will use the correlations in table 4.1 as a starting point for the numerical experiments, rather than as a target for matching moments.

Panels B and C report the cross-country correlations for total industrial production and industrial production in manufacturing. The cross-country correlations of industrial production are somewhat larger than for aggregate GDP, but the ranking remains the same, with the largest correlations between Western European countries, somewhat lower correlations among the CEECs, and the lowest comovements between the East and West. In the case of cross-country correlations of industrial production of manufactures, comovements within the East are the lowest. Panel D of table 4.1 repeats the exercise for investment. Interestingly, investment is positively correlated in the sample of Western European countries. In the numerical examples in section 5, I will assume productivity shocks are positively correlated in the Western European countries, consistent with the observed comovements in investment.[4]

Turning to the trade data, table 4.2 reports bilateral trade flows for the eight countries in the sample for the 2000–2004 period. Panel A shows imports from (other) Western European countries, from (other) Eastern European countries, North America, Asia, and other regions. In general, Western European countries tend to trade with other Western European countries while Eastern European countries tend to trade with Western Europe and trade little with each other. Looking down the first column of the table, the data suggest that trade with other Western European countries accounts for 49–66 percent of the total volume of imports of the four Western European countries in the sample, and accounts for 53–62 percent of their total volume of exports. Eastern European countries tend to source about 50–60 percent of their imports from Western Europe and export a slightly larger share to Western Europe. On average,

Table 4.2
Bilateral trade shares of manufactured goods (average shares 2000–2004)

	West Europe	East Europe	North America	Asia	Other
	A. Imports by source as a share of total imports				
Austria	0.66	0.09	0.05	0.10	0.10
France	0.59	0.02	0.08	0.16	0.15
Germany	0.49	0.09	0.08	0.18	0.16
Italy	0.55	0.03	0.05	0.15	0.22
Czech Rep	0.60	0.11	0.04	0.18	0.07
Hungary	0.58	0.07	0.04	0.25	0.06
Poland	0.60	0.07	0.04	0.21	0.08
Slovakia	0.49	0.21	0.02	0.22	0.06
	B. Exports by destination as a share of total exports				
Austria	0.60	0.10	0.06	0.08	0.16
France	0.62	0.03	0.09	0.11	0.15
Germany	0.54	0.07	0.11	0.13	0.15
Italy	0.53	0.04	0.11	0.13	0.19
Czech Rep	0.69	0.15	0.03	0.06	0.07
Hungary	0.74	0.06	0.04	0.06	0.10
Poland	0.68	0.08	0.03	0.09	0.12
Slovakia	0.60	0.26	0.03	0.04	0.07

Source: OECD, *ITCS International Trade by Commodity Database.*
Notes: Western Europe includes: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.
Eastern Europe includes: Czech Republic, Hungary, Poland, and Slovakia.

trade with Eastern Europe accounts for 6 percent of the trade of Western European countries. Trade with other Eastern European countries accounts for about 13 percent of total Eastern European trade. Trade with North America accounts for less than 10 percent of trade for both Eastern and Western European countries, while trade with Asia accounts for between 5 and 25 percent of trade flows. The simulation model will focus on the intra-European trade flows and will abstract from flows to North America and Asia.

The impact of trade on the transmission of business cycles depends not just on the direction of trade, but also on the importance of trade in total economic activity. The first panel in table 4.3 shows trade (measured as the sum of exports and imports of goods and services) as a share of GDP. In 2004, trade accounted for 52 to 97 percent of GDP in the four Western European countries, and a larger share—ranging from 80

Table 4.3
Trade and manufacturing shares of GDP

	1990	1995	2000	2004
	A. (Exports + Imports)/GDP			
Austria	0.72	0.70	0.89	0.97
France	0.45	0.44	0.56	0.52
Germany	0.49	0.47	0.66	0.71
Italy	0.39	0.50	0.56	0.52
Czech Republic	0.83	1.06	1.32	1.44
Hungary	0.67	0.89	1.53	1.33
Poland	0.47	0.45	0.62	0.80
Slovakia	0.60	1.14	1.44	1.56
	B. (Exports + Imports of manufactured goods)/manufacturing valued added			
Austria	2.92	2.98	3.67	4.11
France	2.22	2.39	3.15	3.32
Germany	1.77	1.89	2.68	2.92
Italy	1.39	1.90	2.34	2.38
Czech Republic		3.14	4.56	5.43
Hungary		3.20	6.16	5.65[b]
Poland		1.98	2.81	3.81
Slovakia		4.85[a]	5.78	7.12
	C. Manufacturing valued added/GDP			
Austria	0.19	0.17	0.18	0.18
France	0.16	0.15	0.14	0.12
Germany	0.25	0.21	0.21	0.20
Italy	0.22	0.21	0.19	0.18
Czech Republic	0.22	0.22	0.24	0.23
Hungary	0.22	0.20	0.21	0.20[b]
Poland	0.31	0.19	0.17	0.18
Slovakia	0.24	0.25	0.21	0.19

Source: United Nations, *National Accounts Main Aggregates Database*, and OECD *ITCS International Trade by Commodity Database*.
[a] Value for 1997.
[b] Value for 2003.

to 156 percent of GDP—in the sample of Eastern European countries. In both regions, the trade share has risen since 1990, and the rate of increase is generally larger in Eastern Europe. Trade in manufactured goods is an even larger share of manufacturing value added, with ratios that exceed five to one in three of the four Eastern European countries. The high volume of trade in manufactures against a relatively low base of manufacturing value added is suggestive that trade involves production sharing, where intermediate goods are shipped internationally and value is added at different stages of the production process. Panel C shows that the share of the manufacturing sector relative to GDP is about the same size across the two regions, so the key difference between Eastern and Western Europe is the high volume of trade in manufactured goods in the East.

The impact of offshoring labor-intensive activities to low-wage countries has been widely documented in the trade literature (see Hanson, Mataloni, and Slaughter [2005], Hummels, Ishii, and Yi [2001], and Yi [2003]). A new term—*nearshoring*—has been coined to describe the offshoring activities of Western European firms in the former Soviet states. While wages in Eastern Europe are not as low as those in Asia, transportation costs are dramatically lower, the Eastern European labor force is better educated, and there are important cultural and institutional ties between Eastern and Western Europe. A recent article in *The Economist* (December 2, 2005) is illustrative of the decision to nearshore. In an interview, a broker in the textile industry notes that production in Eastern Europe is particularly advantageous in the "fast fashion" industry, where garments must get to the market quickly before consumer tastes change. While the manufacturing cost per article of clothing is higher in Eastern Europe than in China, the time from ordering to delivery is reduced from months to weeks. Thus nearshoring is particularly important in industries where brand names matter and product life cycles are short. Currently, about 20 percent of Western European textile imports are produced in Eastern Europe.

It is difficult to obtain a precise estimate of the magnitude of nearshoring activities in Eastern Europe, but the volume of FDI flows to Eastern Europe and transactions between multinationals and their affiliates in Eastern Europe provide some clues. Figure 4.1 shows the flow of FDI into the four Eastern European countries in the sample over the 1985 to 2004 period. Foreign direct investment picked up after the fall of the Soviet Union with the privatization of state-owned enterprises and as restrictions on foreign ownership were lifted. Flows to Hungary (in terms of $US) peaked in 1995, while flows to the Czech Republic, Poland, and Slovakia peaked somewhat later. Figure 4.2 illustrates the number of foreign merger and acquisition transactions in the Czech Republic, Hungary, and Poland. Again, transactions in Hungary tended to peak somewhat earlier than in the Czech Republic and Poland. Table 4.4 shows FDI inflows over the 2000–2004 period decomposed by country

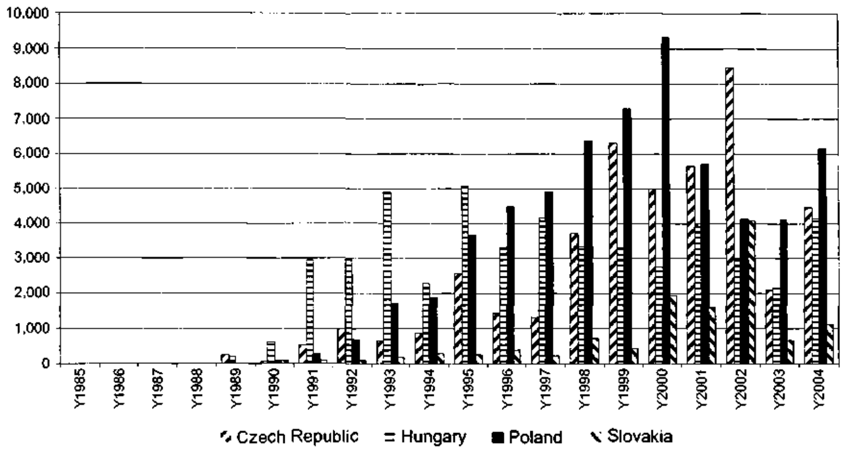

Figure 4.1
FDI Inflows in East Europe (millions of U.S. dollars)
Source: United Nations, *World Investment Report*.

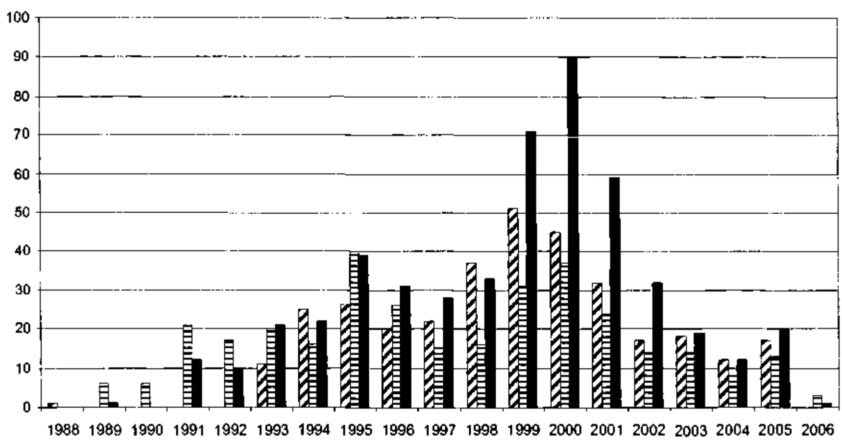

Figure 4.2
Number of foreign M&A transactions in East Europe, 1988–2006
Source: SDC Thompson.

of the investor. The majority of FDI inflows in Eastern Europe originate in the European Union (EU). Germany, in particular, is a major source of foreign direct investment in Hungary and Slovakia.

Of course, the important issue for business cycle transmission is not whether multinationals are present in Eastern Europe—they are present everywhere in Europe—but whether their activities involve production

Table 4.4
Foreign direct investment inflows into Eastern Europe

	Czech Republic	Hungary	Poland	Slovakia
Cumulated FDI inflow, 2000–2004 (in million $US)	25,681	15,363	36,406	9,326
FDI inflow/GDP (average 2000–2004)	0.07	0.05	0.04	0.08
Share of inflow (average 2000–2004) from:				
EU15	0.73	0.78	0.88	0.78
Austria	0.13	0.16	0.06	0.11
France	0.17	0.03	0.23	0.13
Germany	0.19	0.29	0.11	0.23
Italy	0.02	0.01	0.03	0.08

Source: OECD, *International Direct Investment Statistics.*

sharing. The first three rows of table 4.5 provide information on the share of multinational activity as a fraction of domestic economic activity. Value added of foreign affiliates as a percentage of manufacturing value (row A) ranges from 26 percent in the Czech Republic to an astounding 70 percent in Hungary.[5] The employment share of foreign affiliates in manufacturing (row B) ranges from 19 percent in Poland to 47 percent in Hungary. Finally, turnover (i.e., sales) of foreign affiliates as a share of total turnover in the manufacturing sector (row C) ranges from 34 percent in Poland to 73 percent in the Czech Republic and Hungary. These figures suggest that the activity of foreign affiliates constitutes a sizable share of total manufacturing activity in Eastern Europe.

The last two rows in table 4.5 provide information on trade in intermediate inputs between foreign affiliates in Eastern Europe and their parents in Austria and Germany.[6] Unfortunately, this data is not available for transactions by other parent firms in Western Europe, but the data from Austria and Germany are certainly indicative of a significant volume of production sharing. Row D shows the volume of intermediate inputs shipped from a parent firm to its Eastern European affiliate as a fraction of total exports. Fully 20 to 42 percent of Austrian exports to Eastern Europe are intermediate inputs shipped to their Eastern European affiliates for further processing. The figures are slightly smaller for Germany, ranging from 7 percent of total exports to the Czech Republic to 34 percent to Slovakia. Row E captures the flow of goods making the return trip to Austria and Germany, again as a fraction of total imports from

Table 4.5
Activity of foreign affiliates in Eastern Europe

	Czech Republic	Hungary	Poland	Slovakia
A. Value added of foreign affiliates as a share of total manufacturing value added (1)				
	0.26	0.70	n.a.	n.a.
B. Employment of foreign affiliates as a share of total employment, manufacturing sector (1)				
	0.27	0.47	0.19	n.a.
C. Turnover of foreign affiliates as a share of total turnover, manufacturing sector (1)				
	0.73	0.73	0.34	n.a.
D. Intermediate inputs shipped to affiliates as a share of total exports to Eastern Europe (2)				
Exports of Austrian parents	0.20	0.20	0.42	0.26
Exports of German parents	0.07	0.12	0.18	0.34
E. Intermediate and final good shipped from affiliates to parents as a share of total imports from Eastern Europe (3)				
Imports by Austrian parents	0.42	1.36 (4)	0.65	0.55
Imports by German parents	0.16	0.41	0.15	0.65

Sources:
(1) Figures for 1999. Data from OECD, *Measuring Globalisation: The role of multinationals in OECD Economies.*
(2) Marin (2005), Table 2, columns 1 and 3. Shares based on survey of 2,200 investment projects in Eastern Europe undertaken by 660 firms (Statistik Austria).
(3) Marin (2005), Table 2, columns 2 and 4. Shares based on survey of 2,200 investment projects in Eastern Europe undertaken by 660 firms (Statistik Austria).
(4) Figure is likely to be misleading, as sales to Austria and sales to parent in Singapore could not be separated. See Marin (2005).

each Eastern European country. Note that not all production sharing is undertaken by multinationals in conjunction with their foreign affiliates. This activity may be subcontracted out to enterprises not under the control of the contracting firm.[7] Thus, the figures in table 4.5 are likely to be a lower bound on the extent of nearshoring in Eastern Europe.

A critical parameter in the following numerical experiments is the amount of local value added contributed by the Eastern European country in the production-sharing sector. The data in table 4.5 can be used to back out an estimate of this parameter. The numerator in row 5 is the value of the good shipped back to the Western European parent, while the numerator in row 4 is the value of the intermediate inputs shipped from parent to affiliate for further processing. Provided the denominators (exports to and from Eastern Europe are roughly balanced—which is a close approximation to the data), the ratio of row 4 to row 5 is the fraction of local content. This fraction is roughly 0.5 (excluding the

"1.36" entry, which is due to measurement error in Austrian sales to Hungarian affiliates—see the footnotes to the table and Marin [2005]). The figure 0.5 will be used in the following calibration exercises.[8]

4.3 Benchmark Model

The model used to study business cycles in Western and Eastern Europe follows the framework set up in Burstein, Kurz, and Tesar (2005). The location of production and the direction of trade are exogenous to the model, abstracting from the issues of why firms locate where they do and why production sharing occurs where it occurs. One could construct a framework in which firms trade off the advantages of shifting the labor-intensive segments of the production chain to markets with lower wages against the cost of shipping goods at intermediate stages of production and the potential management difficulties of operating facilities in different locations. Production sharing in Eastern Europe could emerge as an attractive production location, given its lower relative wages and its proximity to Western Europe. It is then an open question whether Eastern Europe will remain a profitable location for production sharing if incomes in Eastern Europe converge toward those in the West. While these are interesting issues for future research, the focus here is on the behavior of firms at business cycle frequencies where the location of plant and equipment is already established and the firm's decision is the optimal combination of factor inputs and the amount to produce given relative prices.[9]

The model studied here includes four countries—two Western European countries, denoted 1 and 2, and two Eastern European countries, denoted 3 and 4. Consistent with the bilateral trade data in table 4.2, I assume that the Western European countries engage in trade with each other, and each Western European country has a key trading partner in the East (1 with 3 and 2 with 4). To keep the model relatively simple, I make the extreme assumption that there is no trade between Eastern European countries, or between a Western European country and the other Eastern European country (for example, Germany trades with Austria and with the Czech Republic but not with Hungary, and Austria trades with Germany and Hungary but not with the Czech Republic).[10] Countries are indexed by $i = 1, 2, 3, 4$. Each country i has a population of L_i individuals. Countries 1 and 2 are symmetric, as well as countries 3 and 4. Preferences of the representative agent in country i are characterized by an expected utility function of the form:

$$U_i = \max E_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}, 1 - n_{it})$$

where c_i and n_i denote per capita consumption and employment in country i, and the specific form of period utility is $u(c, 1 - n) = [1/(1 - \sigma)][c^{\mu}(1 - n)^{1-\mu}]^{1-\sigma}$.

Each country produces an intermediate good z_i using inputs of domestic labor n_i and capital k_i. The intermediate-goods sector is subject to a country-specific shock to productivity A_i. The production function has constant returns to scale, and is given by:

$$z_{it} = A_i e^{s_{it}}(n_{it})^{\alpha}(k_{it})^{1-\alpha}.$$

The vector of aggregate productivity shocks $s_t = (s_{1t}, s_{2t}, s_{3t}, s_{4t})$ follows the process $s_{t+1} = Ps_t + \varepsilon_{t+1}$, where ε_t is distributed normally and independently over time, with mean 0 and variance Σ.[11]

International trade occurs at the level of the intermediate good. Figure 4.3 provides a diagram of the location of production and the flow of

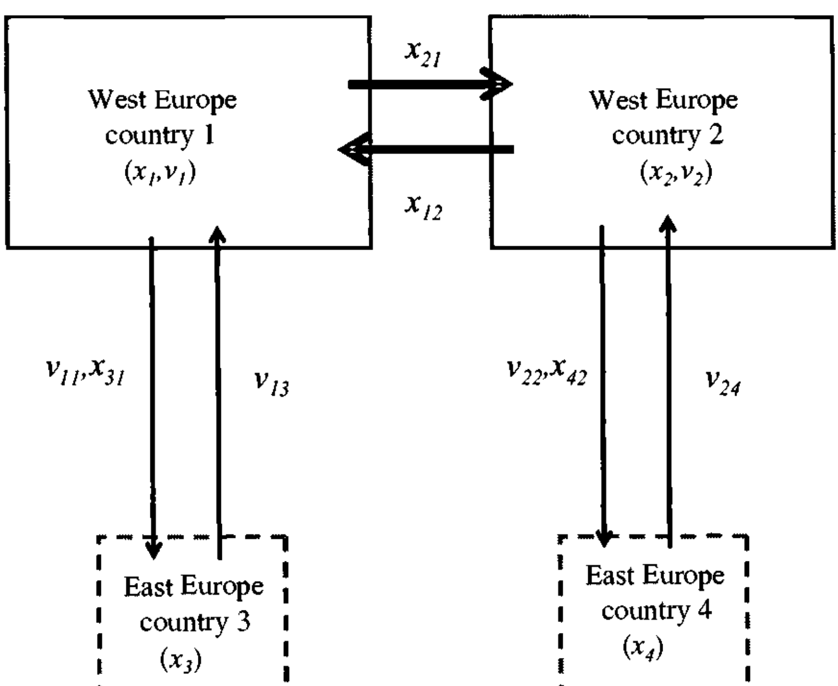

Figure 4.3
Pattern of trade between West and East Europe

trade between countries described in the following equations. Local and imported intermediate goods can be combined to produce two different types of final goods, x and ν. The asymmetric impact of trade on business cycles is due to an assumption about the technology used to create these two goods. I assume that good x is not produced in a vertically integrated production chain, and that firms can readily substitute between local and foreign inputs in response to changes in technology and relative prices. Specifically, production of good x_i combines local and imported intermediate goods according to the following Armington aggregator:

$$x_{1t} = [\theta_1^{1-\rho}(x_{11t})^{\rho} + (1 - \theta_1)^{1-\rho}(x_{12t})^{\rho}]^{1/\rho}$$

$$x_{2t} = [\theta_1^{1-\rho}(x_{22t})^{\rho} + (1 - \theta_1)^{1-\rho}(x_{21t})^{\rho}]^{1/\rho}$$

$$x_{3t} = [\theta_3^{1-\rho}(x_{33t})^{\rho} + (1 - \theta_3)^{1-\rho}(x_{31t})^{\rho}]^{1/\rho}$$

$$x_{4t} = [\theta_3^{1-\rho}(x_{44t})^{\rho} + (1 - \theta_3)^{1-\rho}(x_{42t})^{\rho}]^{1/\rho}.$$

The first subscript denotes the location of production and the second subscript the input's country of origin (i.e., x_{12} is the intermediate input from country 2 used in country 1's production). In the following numerical experiments the elasticity of substitution, $1/(1-\rho)$, between inputs in this sector will be set relatively high, reflecting the assumption that foreign and domestic inputs are close substitutes. The parameter θ_i reflects the importance of domestic intermediate goods in the production of good x_i. Note that the local content in x production in countries 1 and 2 is assumed to be identical, as is local content in countries 3 and 4. Throughout, the model will impose symmetry across Western European countries and across Eastern European countries, but will allow some asymmetries between East and West.

The second good, ν, is produced in a vertical production chain that involves a production-sharing arrangement between firms in the East and the West. The two production-sharing sectors (one between 1 and 3, and the other between 2 and 4) combine local and foreign inputs according to:

$$\nu_{1t} = [\lambda^{1-\zeta}(\nu_{11t})^{\zeta} + (1 - \lambda)^{1-\zeta}(\nu_{13t})^{\zeta}]^{1/\zeta}$$

$$\nu_{2t} = [\lambda^{1-\zeta}(\nu_{22t})^{\zeta} + (1 - \lambda)^{1-\zeta}(\nu_{24t})^{\zeta}]^{1/\zeta}.$$

The parameter λ measures the share of Western European intermediate goods in the production of the good produced through production sharing. One interpretation of good ν is that it is the product of a multinational enterprise (MNE) headquartered in Western Europe in conjunction with its foreign affiliate in Eastern Europe. To capture the flavor of production sharing in a simplified way, I assume that inputs into the production of good ν are complements relative to the production of the good x. So, the elasticity of substitution in the production-sharing sector, $1/(1-\zeta)$ is assumed to be small relative to $1/(1-\rho)$.

Each country produces a nontraded final good, y, that is used for consumption or investment. In Western Europe (countries 1 and 2), the final good is a composite of goods x and ν, combined according to:

$$y_{it} = (x_{it})^{\omega}(\nu_{it})^{1-\omega}.$$

By assumption, countries in Eastern Europe do not engage in outsourcing to other countries, so in countries 3 and 4, $y_{it} = x_{it}$.

The resource constraints for each of the four countries are given by:

$$L_1 z_{1t} = L_1 x_{11t} + L_2 x_{21t} + L_3 x_{31t} + L_1 \nu_{11t}$$

$$L_2 z_{2t} = L_2 x_{22t} + L_1 x_{12t} + L_4 x_{42t} + L_2 \nu_{22t}$$

$$L_3 z_{3t} = L_3 x_{33t} + L_1 \nu_{13}$$

$$L_4 z_{4t} = L_4 x_{44t} + L_2 \nu_{24t}.$$

Intermediate goods produced in Western Europe (countries 1 and 2) are used as local inputs at home, in the other Western European country in the nonproduction-sharing sector, or in Eastern Europe, either in the production-sharing or the non-production-sharing sector. This implies that trade with the West involves goods that are substitutes (different varieties, for example), while trade with the East is a mixture of inputs that are substitutes, and inputs that are used in the production-sharing sector. Intermediate goods produced in the East (countries 3 and 4) are either used at home or in the production-sharing sector. Therefore, all Eastern European exports are inputs in the vertical production chain.

The final good resource constraint in each country ($i = 1, 2, 3, 4$) is given by:

$$y_{it} = c_{it} + i_{it}$$

where $i_{it} = k_{it+1} - (1-\delta)k_{it}$.

I assume that households can trade securities contingent on all states of nature. Under complete markets, the solution to a planner's problem yields allocations that are Pareto optimal and correspond to a competitive equilibrium. The planner maximizes:

$$\max L_1 U_1 + L_2 U_2 + L_3 U_3 + L_4 U_4$$

subject to the technology and resource constraints described previously. By choosing a suitable set of initial wealth levels, the competitive equilibrium allocations are identical to the ones that are obtained by solving this planner's problem. Furthermore, prices can be computed from marginal rates of substitution across goods where the numeraire is the price of the good produced by country 1.

4.4 Parameter Values and Steady-State Solution

Table 4.6 shows the parameter values used in solving the model. The table also compares the steady-state shares generated by the model with the corresponding figures from the data (averages across the four countries in each region). I follow Backus, Kehoe, and Kydland (1995) and

Table 4.6
Parameter values characterizing the model's steady state

A. Parameter value

	Western Europe	CEEC
L1, L3: Size of labor force	2.9	1
σ: Coefficient of risk aversion	2	2
β: Rate of time discount	0.99	0.99
δ: Depreciation rate	0.025	0.025
$\theta 1, \theta 3$: Share of home goods in non-production-sharing sector	0.7	0.7
λ: Share of W. Eur. inputs in production-sharing sector		0.5
ω: Share of non-production-sharing goods in W. Eur. GDP aggregator	0.8	

B. Steady-state ratios

	Western Europe		CEEC	
	Data	Model	Data	Model
Ratio of country sizes (average GDP3/average GDP1)			0.17	0.18
Trade as a share of GDP	0.81	0.89	2.03	1.98
Imports from W. Eur. as a share of total imports	0.58	0.55	0.69	1.00
Exports to W. Eur. as a share of GDP	0.18	0.26	0.50	1.21
Exports to W. Eur. as share of manufacturing value added	0.92	0.26	1.84	1.21

Burstein, Kurz, and Tesar (2005) in choosing the values of β, σ, δ, and α. The period length is one quarter. The rate of time discount β, is set equal to 0.99, so that the quarterly real interest is 1 percent. The coefficient of risk aversion, σ, is set equal to 2. Labor's share of output, α, is set equal to 0.4, and the rate of depreciation, δ, to 0.025. The parameter λ, which reflects the share of local inputs in the production-sharing sector, is set equal to 0.5 (see the discussion in section 2).

The parameters $\{L_1, L_3, \theta_1, \theta_3, \omega\}$ jointly determine the steady-state ratios in part B of Table 4.6: the ratios of country sizes (Eastern Europe to Western Europe), trade as a share of GDP in each region, imports from (other) Western European countries as a share of total imports, exports to (other) Western European countries as a share of GDP, and exports of the production-sharing sector as a share of total exports to CEECs. In measuring trade flows in the model, I assume that ν_{11} is initially shipped to the East and ν_{13} is added to produce good ν_1, which is then shipped back to the West.[12] The ratio of East-to-West country size (measured as the ratio of average real per capita GDP in the East countries relative to average real per capita GDP of the West countries) in the data is 0.16.[13] The model produces a ratio of 0.18. Trade as a share of GDP is 0.81 in Western Europe and 2.03 in Eastern Europe. The steady-state of the model replicates these ratios fairly closely, at 0.89 and 1.98, respectively. Imports from other Western European countries (see table 4.2) account for 58 percent of total imports in the sample from Western Europe—the model generates a value of 55 percent. In Eastern Europe, imports from Western Europe account for about 60 percent of total imports, with Slovakia's share being somewhat lower. Because the model only allows for East-West trade, the percentage of imports from the West as a share of total imports is 100 percent. The next line of Table 4.6 describes bilateral trade flows to Western Europe. If the share is calculated as a fraction of GDP in the two regions, the shares are 0.18 and 0.50, respectively. The model generates values of 0.26 and 1.21. From the perspective of trade as a share of total economic activity, the model clearly overstates the volume of exports from the CEECs to Western Europe.[14] On the other hand, the data in table 4.2 describe trade in manufactured goods, and the model is silent about the role of services, so one interpretation is that one should focus on the importance of trade in manufacturing value added rather than on total economic activity. When the share of exports to Western Europe are calculated relative to manufacturing value added, the shares in the two regions increase to 0.92 and 1.84. Because GDP and manufacturing value added are identical in the model, it is unclear which is the better benchmark for calibrating the size of trade in the economy.

With the steady-state in place, the next step is to set the shocks to productivity, and the elasticities of substitution between domestic and foreign intermediate inputs in the production of good x and the production sharing good, ν. I again follow BKK and set the persistence of the shocks to 0.91. To isolate the effect of trade on the correlation between output in the East and the West, I assume that shocks to productivity in countries 1 and 2 are uncorrelated with the shocks in 3 and 4, and further assume that the shocks between 3 and 4 are uncorrelated. I allow for correlated shocks among Western European countries to match the observed within-Western European output correlations in the data (approximately 0.5). In the non-production-sharing sector, ν, I assume the elasticity of substitution between inputs is 2 ($\rho = 0.5$). In the production-sharing sector, I assume inputs are strong complements ($\zeta = -20$).

The model is solved using standard log-linearization techniques. A matrix of productivity shocks is fed into the model, generating time series for each of the four countries. Moments are computed based on this artificially generated data. The procedure is repeated 1,000 times. The figures reported in subsequent tables are the averages across simulations.

4.5 Results

Table 4.7 reports the results from a number of experiments exploring the impact of trade between the CEECs and Western Europe on output correlations.[15] Four correlations are reported for each experiment: the within-Western European correlation, the within-CEEC correlation, the correlation between CEEC and Western Europe trading partners, and finally, a pan-European correlation that includes all pairwise correlations equally weighted.[16] The results in the first row are based on the assumption that there is no trade between East and West (and hence no nearshoring of production). The positive correlation within Europe of 0.46 is due to positively correlated shocks to productivity within Western Europe.

The second row reports the results for a benchmark case in which there is trade between East and West, but all trade is of the standard form where inputs are assumed to be good substitutes. As East-West trade expands relative to the no-East-West-trade experiment in the first row, the output correlations within Western Europe are largely unaf-

Table 4.7
Numerical results

	Output correlations			
	Within W. Europe	Within CEEC	Between W. Europe CEEC	All Europe (1)
Case 1: Trade within W. Europe only, no trade with CEEC				
ρ = 0.5 (elasticity of 2 in x sector)	0.49	0.00	0.00	0.08
corr(A1,A2) = 0.5, corr(A3,A4) = 0				
Case 2: Trade between all countries in intermediate goods, no production sharing				
ρ = 0.5	0.46	–0.01	–0.02	0.06
ζ = 0.5 (elasticity of 2 in v sector)				
corr(A1,A2) = 0.5, corr(A3,A4) = 0				
Case 3: Production sharing between W. Europe and CEEC				
ρ = 0.5	0.46	–0.01	0.13	0.16
ζ = –20 (elasticity of 0.05 in v sector)				
corr(A1,A2) = 0.5, corr(A3,A4) = 0				
Case 4: Production sharing and positively correlated shocks in CEEC				
ρ = 0.5	0.46	0.23	0.13	0.20
ζ = –20				
corr(A1,A2) = 0.5, corr(A3,A4) = 0.25				
Case 5: 50% increase in W. Europe-CEEC trade, with production sharing				
ρ = 0.5	0.49	–0.01	0.36	0.32
ζ = –20				
corr(A1,A2) = 0.5, corr(A3,A4) = 0				
Case 6: Production sharing between W. Europe and CEEC, uncorrelated shocks in W. Europe				
ρ = 0.5	–0.04	–0.02	0.13	0.08
ζ = –20 (elasticity of 0.05 in v sector)				
corr(A1,A2) = 0, corr(A3,A4) = 0				
Case 7: Production sharing between W. Europe and CEEC, financial autarky				
ρ = 0.5	0.56	0.00	0.13	0.17
ζ = –20 (elasticity of 0.05 in v sector)				
corr(A1,A2) = 0.5, corr(A3,A4) = 0				

Note: (1) All-Europe correlation calculated as the average of the six bilateral correlations in the model.

fected. Substitutability of inputs results in a weak negative transmission of the cycle between the CEECs and Western Europe, with a correlation of –0.02. The third row repeats the experiment with nearshoring to Eastern Europe (i.e., complementarity in the ν-sector), holding all other parameters fixed. This shift leaves the output correlations within each region largely unaffected. However, the correlation between East and West increases from –0.02 to 0.13 and the all-Europe correlation increases from 0.06 to 0.16. In this case, an increase in productivity in country 1 increases demand for inputs from country 3, driving up GDP in both countries. Note that the assumption of no trade between countries 3 and 4 implies that there is no connection between the CEEC economies—therefore, throughout the experiments (in the absence of correlated shocks) the correlation between CEECs is virtually zero and the model will therefore not generate the West-West, East-East, East-West ranking observed in the data.

To better understand how shocks are transmitted through trade, Figures 4.4a through 4.4c show the impulse responses of output, labor, relative prices, and consumption to an increase in country 1 productivity. Each plot contrasts the allocations under substitutability and under complementarity. Turning first to figure 4.4a, the increase in country 1

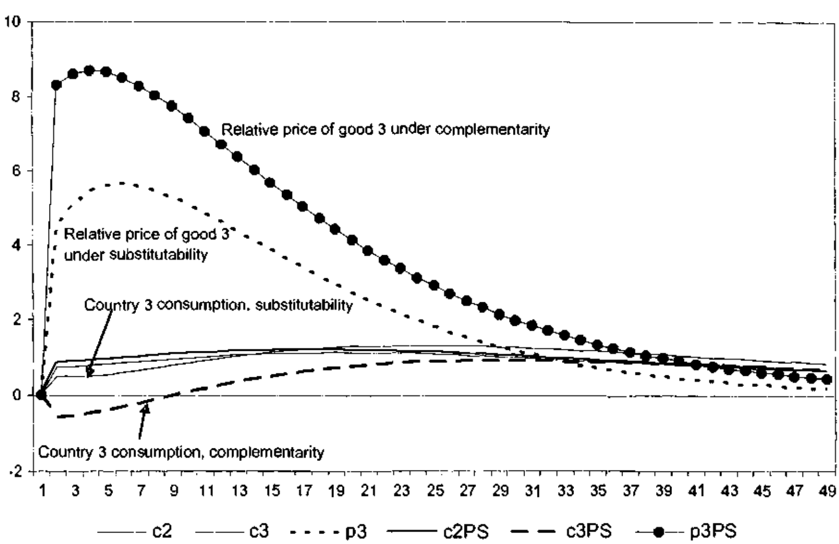

Figure 4.4a
Impulse responses of the relative price of good 3 and consumption in Country 3 in response to a Country 1 productivity shock

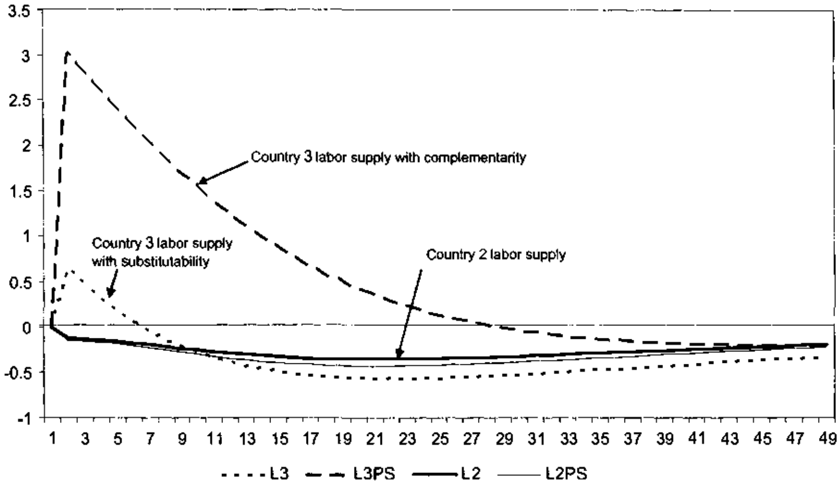

Figure 4.4b
Impulse responses of labor supply in countries 2 and 3 in response to a Country 1 productivity shock

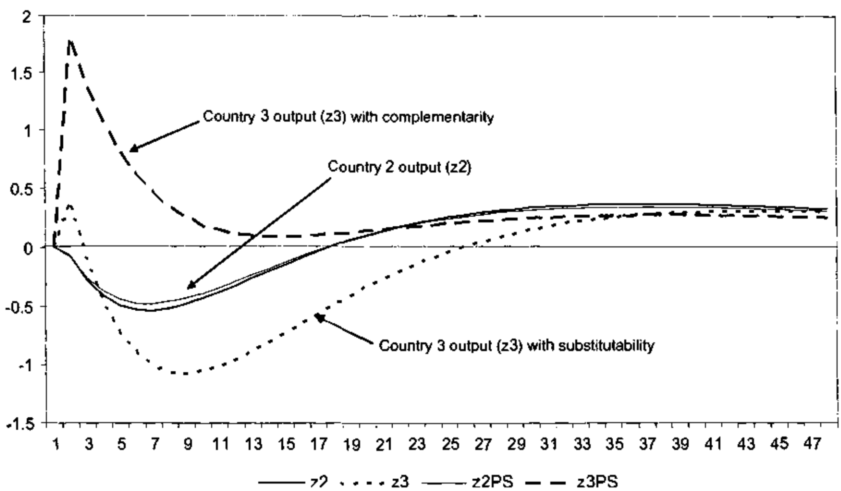

Figure 4.4c
Impulse responses of output in countries 2 and 3 in response to a Country 1 productivity shock

productivity results in an increase in the relative price of country 3's intermediate good relative to country 1's intermediate good under both scenarios. However, the price increase is roughly 30 percent larger under production sharing, reflecting country 1's relatively inelastic demand for ν_{13}. The price increase is large enough that households in country 3 shift inputs out of the x-sector (x_{33} falls), reducing total consumption in country 3. Figure 4.4b shows that, in addition to giving up consumption, households also reduce leisure. The increase in demand for ν_{13} induces country 3 to intertemporally shift labor supply to increase output of the good in the production-sharing sector. Figure 4.4c shows the response of output. Under substitutability, output of good three drops after the initial impact, while under production sharing it increases.

In previous work, Burstein, Kurz, and Tesar (2005) examine a similar kind of model and find that the impact of production sharing on output correlations is minimal. The international transmission mechanisms are stronger here for two reasons. First, trade is a larger share of economic activity for the European countries (East and West) than it is in the context studied by BKT (extra-Europe, U.S., and Mexico). Second, the share of domestic value added in the production-sharing sector is larger in the Eastern European countries than in Mexico's maquila sector. Because more domestic resources are involved in the sector, shocks are more readily transmitted through trade.

Rows 4 through 7 of table 4.7 report the results of additional experiments and robustness checks. The fourth case assumes that there is production sharing between East and West and that shocks within the East are weakly positively correlated (the innovations to productivity are assumed to have a correlation of 0.25). This experiment reveals that the nature of trade, not the underlying correlation of shocks, pins down the correlation between East and West. The only effect of correlated shocks in the CEECs is to increase the within-CEEC correlation, and by definition, the all-Europe correlation. The fifth experiment examines the effect of an increase in East-West trade.[17] Rose (2000) estimates that the eurozone could produce a 200 percent increase in trade flows within Europe. Here I consider a much more modest increase in East-West flow as a share of GDP—50 percent.[18] Comparing these results to the benchmark of case 3, the model produces an East-West correlation of 0.36 and an all-Europe correlation of 0.32.[19]

Could the results be driven by the assumed positive shocks to Western European productivity? Case 6 sets the Western European correlation to zero. This reduces the output correlation within Western Europe, and as a consequence the all-Europe correlations, but leaves the comovements with Eastern Europe largely unaffected. This suggests that trade linkages, not the assumption about productivity shocks, are driving the comovement between East and West. Finally, the last case assumes that there is no risk-sharing between countries by imposing balanced trade for each country. The assumption about financial markets affects consumption correlations but has little impact on output correlations.

Taken together, the simulation results suggest that trade has a sizable impact on output correlations between East and West. The comovement of output is sensitive to the nature of trade (i.e., whether inputs are substitutes or complements) and is less sensitive to the overall volume of trade or to the underlying shocks to productivity.[20] In general, the results suggest that production sharing between East and West works as a strong linkage between the two regions. Whether this linkage makes coordinated monetary and fiscal policy easier or more difficult, however, depends on which feature of the economy policymakers are most concerned about. Table 4.8 reports comovements between output as well as consumption, investment and labor for cases 2 and 3 (intermediates as substitutes or as complements). The main differences between the two cases arise in the correlations between East and West, reported in the last column. Consumption is more strongly correlated in the case of substitutability between inputs. However, output and labor are more correlated in the case of production sharing. Interestingly, Darvas and Sza-

Table 4.8
Correlations between output, consumption, and labor supply

	Correlations		
	Within W. Europe	Within CEEC	Between W. Europe, CEEC
All inputs substitutes			
Output	0.46	–0.01	–0.02
Consumption	0.76	0.04	0.23
Investment	–0.07	–0.07	–0.55
Labor	0.49	–0.02	0.06
Production sharing between W. Europe and CEEC			
Output	0.46	–0.02	0.16
Consumption	0.80	0.01	0.02
Investment	–0.02	–0.09	–0.43
Labor	0.48	0.05	0.54

pary (2004) find that while output correlations between the CEEC countries and core EU countries have increased over time, consumption correlations have not. While not definitive evidence, their finding is consistent with what the model predicts when there is production sharing between East and West.

4.6 Conclusion

This paper explores the implications of an increase in the volume of East-West trade on output correlations in Europe resulting from an expansion of the eurozone to include countries in the former Soviet Union. The volume of nearshoring production by Western European companies in Eastern Europe is shown to play a critical role in the comovement of output, labor, and consumption in the two regions. If production sharing continues to dominate trade flows, output is likely to become more correlated as trade flows expand. On the other hand, if trade shifts toward a more standard type of flow, where intermediate goods produced in different countries are substitutes for each other, the transmission of the business cycle will likely be negative. Given the current magnitudes of trade flow and nearshoring in Eastern Europe, the model generates an East-West output correlation of 0.16 for Europe as a whole. These should be interpreted as lower-bound predictions stemming purely from trade flows. If increased integration between Eastern and Western Europe also entails technology transfer, more readily transmitted supply shocks, or better-coordinated economic policies, the resulting output correlations will likely be larger.

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Notes

1. Other papers that have examined the role of substitutability of intermediate inputs on business cycles include Ambler, Cardia, and Zimmerman (2002), Heathcote and Perri (2003), and Kose and Yi (2006).

2. To list just a subset of these papers: Artis, Marcellino, and Proietti (2003), Boone and Maurel (1998), Darvas and Szapary (2005), Fidrmuc and Korhonen (2006), and Suppel (2003).

3. Gross domestic product correlations are obviously only one measure of business cycle synchronization. See Fidrmuc and Korhonen (2006) and Darvas and Szapary (2005) for a discussion of alternative measures of business cycle comovements in Europe.

4. In standard open-economy business cycle models, trade induces a large negative cross-country correlation in investment unless shocks are strongly positively correlated. As will be seen in section 5, the assumption of a 0.5 correlation in the innovations to productivity produces a weakly negative investment correlations.

5. The OECD is currently in the process of creating a database on the activities of foreign affiliates (foreign affiliate trade statistics [FATS]). Data for some countries is available in *Measuring Globalisation: The Role of Multinationals in OECD Economies,* though the tables in the volume contain as many missing values as data.

6. The data in rows D and E are based on a survey undertaken over the period 1990–2001 of Austrian and German multinationals with operations in Eastern Europe. For details of the survey and how the ratios reported in table 4.5 are constructed, see Marin (2005).

7. For an analysis of outsourcing and control rights, see Feenstra and Hanson (2005).

8. Pavlínek (2005) provides a discussion of the expansion of automobile production in Eastern Europe targeted for the Western European consumer market. Estimates of the local content in various auto plants across Eastern Europe range from 5 percent to 70 percent.

9. For a treatment of the impact of outsourcing on the location of production and the firm's decision at the extensive and intensive margin, see Bergin, Hanson, and Feenstra (2005).

10. The effect of allowing more extensive trade channels, such as East-East trade or cross–East-West trade, is difficult to predict. Given country-specific shocks, the additional channels would increase opportunities for substitution across different types of inputs. This could weaken or strengthen the transmission mechanism, depending on the assumed elasticities.

11. The model here focuses on productivity shocks, which tend to produce negative correlations in output in models of this type. Thus, the finding that trade produces positive comovements is somewhat surprising relative to the larger literature on trade and business cycles. Demand shocks would certainly produce a different set of dynamic responses and different cross-country correlations. An experiment based on demand shocks would have to confront the problem that aggregate demand is likely to be affected by the degree of integration with Western Europe due to constraints on monetary and fiscal policy.

12. An alternative assumption is that ν_{13} is shipped from the East for further processing and distribution in the West. Allocations are identical under the two assumptions, with the exception of the gross volume of trade, which is larger under the first assumption.

13. All figures reported in the calibration section are averages of the four Western European and the four CEEC countries in my sample using the most recent year for which data are available (usually 2004). Thus, the calibration can be thought of as the effects of trade starting from the current situation.

14. In calibrating the model, there is a trade-off between capturing the overall importance of trade in GDP or in matching bilateral trade shares. I opted in favor of matching the

trade-to-GDP ratio at the expense of overstating the share of CEEC flows to Western Europe in total CEEC trade.

15. In reporting the results, I focus on the cross-country correlations. The model produces the usual set of business cycle moments for each country (smooth consumption relative to output, volatile investment relative to output, etc.). These moments are not reported here but are available upon request.

16. This is an average of all bilateral correlations produced by the model [(1,2), (1,3), (1,4), (2,3), (2,4), (3,4)] where each pair receives equal weight.

17. In this experiment, θ_3 is set equal to 0.25. The ratio of trade in GDP in countries 3 and 4 increases from 1.98 in the benchmark case to 3.0.

18. It is not possible to increase trade flows 200 percent in the model without adjusting country sizes. Under the 7:1 ratio assumed here, countries 3 and 4 are not large enough to meet the demands of countries 1 and 2 consistent with such large trade shares.

19. The responsiveness of output correlations to increases in trade shares reported here are much larger than those found by Kose and Yi (2006). The primary difference between the two models is that within-Europe trade shares are much larger than the trade shares of the countries included in their study.

20. One caveat that should be noted is that I have only explored productivity shocks. It is conceivable that demand shocks, either working through preferences or shifts in government spending, would have different effects on the transmission of cycles. Treatment of a broader set of shocks is left for future work.

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Comment

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East-West trade in Europe is indeed a particularly interesting example of internationalized production to study. Compared to other examples, such as Mexico and China, the nearshoring in Eastern Europe represents a notable fraction of value added, and thereby is more likely to affect international comovements of aggregate GDP. Indeed, this chapter finds that when its particular model of nearshoring is stochastically simulated, it does predict a positive East-West correlation in business cycles in response to productivity shocks. Further, the model is useful as a means of predicting effects of future accession to the European Monetary Union (EMU). The chapter predicts that if trade increases in response to monetary union to the degree observed elsewhere, and if this trade continues to take the form of nearshoring, then the international correlation of business cycles between Eastern and Western Europe should increase significantly.

One natural question regarding this last finding is whether it is reasonable to expect future growth in trade to follow the same pattern as that calibrated in the model. Since nearshoring arises in Eastern Europe as a counterpart to large foreign direct investment (FDI) from Western Europe, this type of trade might currently dominate because of Eastern Europe's need for capital. As Eastern European countries gradually converge with the West in terms of capital accumulation and wage rates, nearshoring might be expected to become a smaller share of overall trade. While the question of why nearshoring exists is beyond the scope of the current paper, research by Helpman, Melitz, and Yeaple (2004) show that FDI decisions depend on the nature of trade costs and firm characteristics. As trade costs fall or Eastern Europe moves out of its transitional phase, we might expect to see an increase in more standard types of trade. Further, the existence of other types of internationalized production in other countries, sometimes with very different characteristics from nearshoring, offers examples of what nearshoring might evolve into in the future. For example, since the parties involved in the outsourcing between the United States and Mexico are much more independent of each other, the production-sharing relationship more easily can be severed when conditions change over the business cycle.

A second question involves how sensitive the paper's conclusion is to the fact it only considers productivity shocks. Demand shocks are a clear alternative that could have dramatically different implications. It is true that a positive productivity shock in a Western European country will raise the production of the Eastern European intermediate, provided the two countries' inputs are combined together with a low degree of substitutability. On the other hand, suppose there is a shock that raises demand in a Western country, which drives up the relative price of its home good relative to all foreign goods. Demanders may well substitute most actively toward those goods with the highest degree of substitutability, such as other Western European goods, rather than goods with a low substitutability, like the intermediate input from the East. In this case, demand for imports rises least from the Eastern European country involved in nearshoring activity, limiting conditional comovement between the two countries.

Finally, it is worth considering more carefully a motivation used in the paper's introduction, which builds on Mundell's argument that business cycle comovement favors joining a monetary union. The paper readily admits that its model is limited in what it can say about monetary policy, since it has no money and no role for monetary policy to improve welfare. Nonetheless, one can readily contemplate what the model likely would imply if it were extended to include the frictions needed to motivate a role for policy, such as sticky prices and imperfect risk sharing. If we suppose a positive productivity shock in a Western country, the objective of replicating the flexible price equilibrium would require a monetary expansion, inducing production to rise with productivity. What does this imply for the Eastern European country? The model shows a Pareto optimal allocation, in which the Eastern European country's output does rise with its Western counterpart. So it may be true that the optimal policy, from the perspective of a social planner, is a monetary expansion in the Eastern European country paralleling that in the Western European country. So a monetary union might seem reasonable. However, while the result is optimal from the perspective of a social planner, it may not be optimal from the perspective of the Eastern European country without the transfers implied by the complete as-set markets assumed in the paper. Given that perfect risk sharing is a strong assumption for the EMU, it is problematic to extrapolate from the current model to draw conclusions for optimal monetary policy coordination and the advisability of joining the monetary union.

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Comment

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In her paper, Linda Tesar applies a modified international business cycle model to quantitatively evaluate the importance of trade for business cycle correlation within and between Western and Central and Eastern European (CEE) countries. The main novelty in the model is that it allows for two types of internationally traded intermediate goods and, correspondingly, for two different production sectors that use these goods as inputs. In addition to the sector for which domestically produced and imported intermediates are substitutes, Tesar considers a sector that is part of an internationally integrated production chain and therefore uses domestic and foreign intermediate goods as strong complements. Tesar interprets the latter activity as international production sharing (or nearshoring, in the European context) and argues that trade associated with it plays a key role in the transmission of business cycles between Western European and CEE countries. In particular, she calibrates the model using data for four old and four new EU member states and concludes, on the basis of her baseline calibration, that present trade levels are capable of producing Western-Eastern European output correlation of 13 percent. Tesar also attempts to predict how much this correlation will rise as a result of trade expansion brought about by the future entry of CEE countries to the eurozone. After assuming that the enlargement of the monetary union will increase trade between the old and new members by 50 percent, she obtains that the Western-Eastern European output correlation will rise to 36 percent.

Since both figures—the 13 percent trade-induced output comovement according to the benchmark simulation, and the 23 percentage point rise in the correlation as a result of a 50 percent increase in trade intensity—are high compared to those reported in some other studies that have analyzed the link between international trade and cross-country output comovement, most of my discussion will be focused on highlighting the factors, in many cases assumptions, that make trade relatively more important in this paper. To set a general background for the discussion, I will touch upon what Kose and Yi (2006) call a trade-comovement puzzle: the difficulty that the workhorse international business cycle model has in reproducing a sufficiently strong dependence of the international business cycle correlation on trade. This short account of the related literature will be helpful in three respects. First, it will clarify which aspects of Tesar's model make trade a more potent determinant of cross-country output correlation. Second, it will allow me to consider Tesar's results in the context of other numerical results in the literature. Finally, it will hint at why the assumption of low substitutability in traded intermediate goods has not gained much popularity in previous studies. Next, I find it very useful to refer to Burstein, Kurz, and Tesar (BKT 2005), who consider exactly the same model as in Tesar's present paper but calibrate it using data for Western Europe, the United States, and Mexico. The fact that BKT find the same model to be considerably less successful in explaining empirical output comovement in a different geographical context will further clarify the reasons for the apparent success of the model in its current application. More importantly, it will become clear that the empirical validity of the model has to be evaluated more strictly before the model is used to obtain the sort of quantitative assessment that Tesar is pursuing. In relation to this, I will also draw attention to some aspects of Tesar's calibration exercise, that in my opinion lead to an overstatement of the importance of production sharing in CEE countries. Finally, I conclude my discussion with a short comment on what appears to be a very important presumption underlying the main motivation of Tesar's paper, the idea that future EMU enlargement will result in considerably more trade—in fact, more production sharing between the old and new member states.

Generally, the model adopted by Tesar is in the spirit of the standard international real business cycle model considered, for instance, by Backus et al. (1995). In both cases, international trade is modeled as trade in intermediate goods produced using the Cobb-Douglas technology in labor and capital. Employing a constant elasticity substitution (CES) production function (Armington aggregator), imported and domestically produced intermediate goods are combined to obtain nontraded final goods used for investment and consumption. In both cases, total factor productivity shocks are responsible for generating model business cycle fluctuations. However, the models differ in two key respects. First, Tesar uses a four- rather than two-country framework. In the geographical context she considers, two of the four countries represent more advanced western European economies such as older EMU states, while the remaining two model economies correspond to new member states and future candidates of the eurozone. The second difference stems from the fact that Tesar allows for two final good sectors instead of one. In the first sector, sector x, domestic and imported intermediate goods are good substitutes. The elasticity of substitution in this sector is assumed to be 2. As such, sector x is similar to the (single) final goods sector in Backus et al. (1995) and therefore can be referred to as the *traditional* sector. The second final goods sector, on the other hand, is assumed to use imported and domestic intermediate goods as basically complete complements, since the elasticity of substitution between them is set at 0.05. As noted in the paper, Tesar uses this setup to model international linkages in vertically integrated production networks (hence the label for this sector, v) or, in other words, production sharing in a simplified way. Importantly, Tesar argues that it is the relative importance of this production-sharing sector in the Western-Eastern European trade that is responsible for a relatively high business cycle correlation between the two regions. Moreover, she predicts that an expansion of this sort of trade caused by the entry of CEE countries to the eurozone will further increase output comovement in Europe.

It is useful to consider Tesar's results in the context of previous quantitative assessments of the importance of trade for the international transmission of business cycles. As is well known, the standard international business cycle model, in which countries are assumed to specialize in the production of tradable intermediate goods, has difficulties in generating a sufficiently strong link between trade intensity and international output correlation (Backus et al. 1995; Kose and Yi 2001). The model appears to fall short when it is applied to explain empirical output correlations at observed bilateral trade intensities as well as when it is used to investigate the sensitivity of output comovement to changes in trade intensity. For example, Backus et al. (1995) report that according to their benchmark calibration, theoretical output correlation between the United States and Europe is only 0.02, compared to the actual 0.66. Kose and Yi (2001) also demonstrate that international output correlation is insufficiently sensitive to changes in the volume of trade in the standard model. In general, this contrasts with a statistically significant and economically sizable trade effect found in cross-sectional regressions of cross-country output correlations (Frankel and Rose 1998; Fidrmuc, 2004). For example, Frankel and Rose estimate the (log) trade intensity coefficient to be 0.048 (standard error 0.01), which implies that doubling trade increases output correlation by 0.033. Although this might seem to be a small effect in absolute terms, the fact that trade intensity between any two countries is usually quite low implies that trade expansion of a reasonable size can lead to an economically significant increase in output comovement.

In a recent paper, Kose and Yi (2006) focus specifically on the ability of the standard international business cycle model to explain the relationship between trade intensity and output correlation investigated by Frankel and Rose. To establish an updated benchmark for the trade-comovement effect, Kose and Yi have reestimated the Frankel and Rose (FR) regressions using more recent data and measuring trade intensity in logs (as FR did) as well as levels.[1] According to the estimates of the log and their preferred-level specifications, a doubling of trade intensity increases output correlation by 0.063 and 0.029, respectively (the latter is evaluated at the median bilateral trade elasticity, which is 0.0023 in their sample). Kose and Yi show, however, that their calibrated three-country international business cycle model produces trade-induced changes in output correlations that are very considerably—ten or more times—smaller than these empirical estimates. In light of the magnitude and robustness of this discrepancy (between theory and empirics), Kose and Yi even give it a name, *the trade-comovement puzzle*, or the lack of ability by the workhorse international business cycle model to reproduce sufficiently strong dependence of the business cycle correlation on trade. Since in this context, Tesar's result that a 50 percent increase in trade intensity raises output correlation by 0.23 is strikingly different, it seems worthwhile to discuss in greater detail the features of the Tesar model that magnify the importance of trade.

The numerical results that Tesar reports in tables 6 and 7 show convincingly that the calibrated Western-Eastern European output correlation has very much to do with the production-sharing sector (sector v). However, given that the defining characteristic of the v sector is a very low elasticity of substitution at which it combines domestic and imported intermediate goods, the finding that the presence of this sector increases cross-country output correlation can hardly be surprising. The almost complete complementarity assumed in the v sector locks this part of a CEE economy in with the corresponding sector of its western trading partner, making output in the former move in sync with the productivity developments in the latter. At the aggregate level, the presence of the production-sharing sector lowers the effective elasticity of substitution between Western European and CEE intermediate goods, and this increases output correlation between the two regions.

That lower elasticity of substitution between traded intermediate goods increases international output correlation, thus alleviating the trade-comovement problem, is a well-known result that has been investigated by Backus, Kehoe, and Kydland (1995), Kose and Yi (2001, 2006) and others. However, there are at least three reasons why low elasticity of substitution has not been adopted as a baseline value for this parameter in the literature. As shown by Backus et al. (1995), low substitutability increases cross-country output correlation but worsens the model performance in terms of other moments—for example, consumption correlation. In addition, even such value of this parameter as 0.9 was deemed inconsistent with empirical estimates, as well as difficult to square with large differences in trade across countries and over time (Kose and Yi 2001). Hence, it is quite understandable that in applications dealing with the trade-comovement issues, one might want to modify the model in such a way that the elasticity of substitution would become effectively lower. In the Tesar model, this effect is achieved by introducing the production sharing sector v. Although the modification is appealing and has a clear interpretation, it is not obvious that this change in the setup is immune to the reservations that the abovementioned literature had with regard to low baseline values for the elasticity of substitution parameter.[2]

Of course, given that Tesar identifies the v sector with production sharing, which in principle is observable and measurable, calibration can be used to determine whether the introduction of the v sector is the right modification of the model, that it improves the ability of the model to explain the empirically observed relationship between international trade and output correlation. Tesar calibrates the model using data for selected European economies and obtains that at their current levels, bilateral trade and production sharing between Western European and CEE countries are responsible for West-East output correlation of 13 percent. One of the biggest concerns I have with this part of the paper is that Tesar does not use any formal or informal criterion to assess the quality of this finding. She mentions that matching some level of output correlation is not an objective, but suggests no alternative for evaluating the performance of the model. The absence of any discussion about this makes me feel uneasy because I do not know which quality of the model and/or the calibration exercise shows that, first, the framework provides a reasonably good description of the trade-comovement link in

Europe and, second, that it can be used to tell how much output correlation would change if trade intensity changed by a certain amount.

In this light, I would like to refer to some findings by Burstein, Kurz and Tesar (BKT 2005) who use essentially the same theoretical model but apply it in a different geographical context and therefore calibrate the production sharing part of it on the basis of the U.S. and Mexican data. Their benchmark calibration produces a U.S.-Mexican output correlation of 0.02. In contrast, according to the actual data, correlation between the U.S. and Mexican GDP was 0.19 in 1990Q1–1999Q4 and 0.61 in 2000Q1–2004Q2 (0.37 and 0.51, respectively, on the basis of annual data; see BKT, table 1). As a result, BKT conclude that in spite of the apparent importance of production sharing in U.S.-Mexican trade, the influence of trade on the output comovement of the two countries is minimal. Hence, the same model brings us to two quite different situations. On the one hand, we have the U.S.-Mexico case, when the empirical output correlation is high but the importance of trade and production sharing is found to be trivial. On the other hand, we have the Western Europe—CEE case, when the degree of empirical comovement of output is somewhat uncertain but probably slightly lower than the U.S.-Mexican one,[3] and production sharing is found to generate a significant 0.13 output correlation. And although there are several objective reasons why the model leads to such different implications about the importance of production sharing for business cycle comovement in the two applications, the fact that the model accounts for only a trivial share of the observed output correlation in the U.S.-Mexico case indicates that the framework is not complete enough. In other words, the BKT results can be interpreted as showing that to a very large extent, output correlation between the United States and Mexico has either little to do with trade or that it is related to trade but not in the way described by the model. In either case, it is not clear why one should believe that the model performs better when applied to Europe—in fact, so much better that it could be used to *predict* the effect of a trade expansion on output commovement between Western Europe and CEE countries. Hence, it is very doubtful that the quantitative implications of the model can be used for policy guidance, unless some formal evaluation of the model performance, an assessment of its explanatory power, is provided as well.

Next, I would like to discuss one aspect of Tesar's calibration exercise and argue that it leads to a considerable exaggeration of the importance of production sharing in CEE countries. As duly emphasized by Tesar and BKT, a steady-state characteristic that very strongly influences the importance of production sharing for output comovement in the model is the ratio of local value added in the production-sharing sector to GDP. Since it is the production-sharing sector that largely determines the degree of business cycle correlation between a typical CEE country and its western trading partner, the more important this sector is for the CEE economy, the more closely its output comoves with the output of its western counterpart. We can trace this critical ratio back by considering three other ratios: the share of domestic content in the production-sharing sector, the share of the production-sharing sector's exports in total exports, and, finally, the share of total exports in GDP. The first of these shares is a model parameter that is calibrated to be 50 percent.[4] The production-sharing sector is assumed to be the only exporting sector in the model CEE country, so the second share is 100 percent by construction. Finally, the steady-state exports-to-GDP ratio obtained in calibration is 121 percent, even though the share of exports in GDP is 50 percent, according to the data. That is a critical discrepancy. It implies that in the steady state, as much as 60 percent of the CEE country's GDP is committed to the production-sharing sector. That is unfounded and, given the pivotal role that this ratio plays in the model, unduly exaggerates the importance of production sharing for business cycle correlation between Western European and CEE economies. Even if we assumed that the whole manufacturing of a typical CEE country functioned as a production-sharing sector, so that all of its value added was a complete complement in the production of the final v good abroad, value added created by this sector would constitute only 20 percent of GDP (see table 4.3, which shows that the ratio of manufacturing value added to GDP is about 20 percent in CEE countries). The point made by Tesar, that the steady-state ratio of exports to manufacturing value added is less than the empirical one (1.21 and 1.84, respectively; see Table 6) is not that important. What matters here is the share of domestic value added in exports, not exports per se, as these can be increased by raising the number of times goods are shifted across the border in the production-sharing sector. Therefore, it can hardly be the case that in the context of this model, the calibrated ratio of exports to manufacturing value added of 1.21 is an understatement. This ratio implies that 60 percent of manufacturing value added in the CEE country is created in the production-sharing sector. If anything, even this share might be too high, although perhaps it is not unreasonable, given the information provided in table 4.5, which says that foreign affiliates contribute 70 percent of manufacturing value added in Hungary. In sum, the assumption that 60 percent of manufacturing value added is created by the production sharing sector makes this sector very important, but perhaps this could be some sort of an upper bound for that part of manufacturing that produces intermediate goods—complements for foreign producers. However, neglecting the difference between manufacturing and the whole economy and assuming that 60 percent of GDP is involved in production sharing does not seem appropriate (unless we agree that we are talking exclusively about cross-country correlations of industrial output). This must be particularly so in Case 5 of Table 4.7, which assumes a 50 percent increase in trade and thus allows for an even higher share of GDP constituted by the production sharing sector.

In addition, I would like to discuss one more aspect of the numerical results reported in table 4.7, namely, the role that the assumption of a four-country world plays in this model. To begin, Tesar is not very explicit about the reasons for considering four rather than two countries.[5] Although several asymmetries are introduced concerning the nature of trade and trade flows between and among Western European and CEE countries, it is also assumed that the two West-East country pairs are symmetric. It is therefore not obvious why it is necessary and/or convenient to consider two West-East country pairs rather than one. For example, a comparison of cases 3 and 6 in table 4.7 shows that West-East output correlation is 0.13 regardless of whether output is positively correlated in western Europe (due to the assumed 0.5 correlation in country-specific productivity shocks) or not. This suggests that having two West-East country pairs might be a matter of convenience rather than conceptual necessity. That is, given that the West-West trade is "traditional" while the West-East trade is dominated by production sharing, the four-country structure of the model allows us to see the effects of both types of trade at once.

On the other hand, cases 3 and 6 also imply some interesting cross West-East output correlations that, by construction, would not arise in a two-country setup. For example, from the information provided in table 4.7 it follows that under the scenario named Case 3, the cross West-East output correlation (i.e. correlation between countries 1 and 4 or 2 and 3) is 0.125.[6] Since there are no cross West-East trade flows in the model, the fact that the cross West-East output correlation is basically as high as the West-East output correlation (which refers to the countries that are linked by trade directly) is interesting. Surprisingly, the cross West-East output correlation becomes even higher in Case 6, when productivity shocks in the West are assumed to be uncorrelated and hence output is negatively correlated within Western Europe![7] To reiterate, table 4.7 implies that in spite of the restrictions eliminating cross West-East trade, the model produces relatively strong cross West-East output correlations regardless of whether business cycles between the two western economies are correlated or not. Since the magnitude of these cross correlations is basically the same as that of the direct West-East correlation emphasized by the paper, I find this case of significant cross-correlations to be rather puzzling.

Finally, I would like to make a short comment on what appears to be a very important presumption underlying the main motivation for Tesar's paper, namely, the idea that the future EMU enlargement will result in considerably more trade between the EU old and new member states. In support of this idea, she refers to Rose's (2000) famous finding that joining a monetary union increases bilateral trade intensity by 200 percent. In the calibration exercise, Tesar opts to consider a "much more modest" euro effect of 50 percent and obtains that it would increase West-East output correlation by 0.23. I would like to refer to Baldwin (2006), who provides a very extensive critical account of this literature and argues that the one-money effect is very considerably smaller, in fact, might be as low as 15–30 percent. If that is true, the 50 percent one-money effect on trade may very well be on the high side.[8] What should be more relevant for the present discussion, however, is that if there is a more significant one-money effect on trade, it may take many years, even several decades, to come into effect.[9] If that is the case, then we are talking about the time horizon beyond that normally considered in the business cycle literature and we are talking about changes in trade the microeconomic foundations of which are not yet know. Both of these remarks imply that model simulations based on the current steady-state ratios can be very misleading. For example, in the long run, CEE countries may become less attractive for near shoring due to the catching up process. To deal with such a concern, we need a model with endogenous production sharing. Similarly, if we do not know the microeconomics of the one-money effect, we cannot be sure that it will promote trade via more vertical integration and not by expanding the number of varieties exchanged.

To conclude, I find the idea of introducing production sharing into the standard international real business cycle model very appealing, especially when the model is meant to describe economic interaction between some large developed economy and its less developed trade partners (core and periphery, using the terminology of BKT). On the one hand, such an extension can be used to effectively lower the elasticity of substitution between traded intermediate goods and strengthen the link between trade intensity and cross-country output correlation in the model. On the other, we have evidence that in some regions, production sharing constitutes a non-trivial share of international trade. Since production sharing is in principle observable and measurable, relatively straightforward quantitative techniques can be used to assess whether modeling production sharing in the simple way adopted by BKT and Tesar helps to improve the ability of the model to explain the trade-comovement relationship in the data. For example, would the model successfully capture the differences in business cycle synchronization that we observe across CEE countries? At the same time, it would be interesting to see how far the model would go in terms of other variables and correlations; the behavior of the terms of trade would perhaps be a good particular example.

My main criticism of the paper is that it draws quantitative conclusions about the influence of international trade on output comovement in Europe using a model, whose ability to capture the relationship between trade and output correlation in the data has not been verified using any formal criterion. The baseline calibration of the model is required to match neither output nor any other empirical cross-country correlation, and although some steady-state ratios are shown to reproduce their empirical counterparts reasonably well, the model seems to have enough free parameters to be able to do that. Since it is not known to what degree the model "fits the data" in terms of capturing the relationship between bilateral trade and cross-country output comovement, it is not clear how it can be used to assess changes that depend on the nature of that same relationship.

My second criticism concerns the benchmark calibration exercise, which considerably overstates the importance of production sharing for cross-country GDP correlation between Western European and CEE countries. The problem is reflected in the significantly overstated steady-state export-to-GDP ratio of the typical CEE country. This discrepancy inflates the value added share of the production sharing sector in domestic GDP (recall that the production sharing sector is the only sector that exports in CEE countries), and since this share determines the importance of production sharing for cross-country output correlation, overstating it unduly magnifies the quantitative link between trade and business cycle comovement in the baseline simulation of the model.

One of the central themes in the Tesar paper is her intention to qualitatively assess the effect that trade expansion associated with the future enlargement of the euro area will have on the output correlation between the old and new members of the eurozone. The assumption that joining the eurozone will increase trade intensity between its incumbents and newcomers by 50 percent is exogenous to the model and rather arbitrary as there is considerable uncertainty about the potential size of this effect. The extent to which more trade results in higher cross-country output correlation is of course endogenous in the model, but since this part of the assessment is subject to the two criticisms mentioned above, the overall result should be regarded as highly speculative and of very limited policy relevance. In general, given that we do not know how joining a currency union increases trade while many aspects concerning the nature of trade are exogenous in the model, it is doubtful that the theoretical framework considered here could lead to a credible enough quantitative assessment of the one-money effect on the business cycle synchronization in the enlarged eurozone.

Notes

1. Their measure of the business cycle is HP-filtered GDP.

2. I do not mean to imply that the elasticity of substitution is always found or calibrated to be greater than unity. Interestingly, it is set at 0.5 in the DSGE model of the Czech National Bank (Beneš et al., 2005; to my knowledge, the central banks of the other three CEE countries considered by Tesar do not have operational DSGE models yet). On the other hand, the elasticity of substitution is 0.45 in the Bank of Finland's general equilibrium model (Kilponen and Ripatti, 2006). This illustrates that Tesar's assumptions about the predominance of normal trade in Western Europe and production sharing in CEE may be misleading.

3. According to table 4.1 in Tesar's paper, the average West-East business cycle comovement calculated on the basis of GDP data is 0.07. Because of various data problems and period-specific issues in the case of CEE countries, estimates of business cycle synchronization in CEE countries vary across studies (Fidrmuc and Korhonen, 2004; Darvas and Szapáry, 2005). Still, 0.07 must be on the low side.

4. Although the role of this parameter is very important in the present setup, limited information is available for calibrating it. It is therefore worth mentioning that the import intensity of exports in the DSGE model of the Czech National Bank is 0.59 (Beneš et al., 2005), very similar to the one chosen by Tesar.

5. That is not the case in BKT. They consider two core economies (U.S. and Europe) and their corresponding periphery (Mexico and Canada, and CEE, respectively) to study business cycle synchronization in the case of core-core and core-periphery.

6. Since "All Europe" correlation in table 4.7 is calculated as the average of the six bilateral correlations in the model, the cross West-East correlation in Case 3 is: Cross W.Eur & CEEC = (6*All Europe—Within W.Eur—Within CEEC—2*Between W.Eur & CEEC)/2 = (6*0.16 – 0.46 – [–0.01] – 2*0.13)/2 = 0.125.

7. Analogously to Case 3 in the previous footnote: Cross W.Eur & CEEC = (6*0.08 – [–0.04] – [–0.02] – 2*0.13)/2 = 0.135.

8. It is certainly not my intention to refute the 50 % effect assumed by Tesar. My only (minor) point is that according to some recent estimates, including those based specifically on the euro experience like Mico et al. (2003), the 50 % effect is on the high side. Otherwise, it is all in Baldwin (2006).

9. Baldwin (2006) and Jeffrey A. Frankel in his discussion of Baldwin's paper mention 30 years.

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