Trade and Transmission of Endogenous Growth Effects: Japanese Economic Reform as an Externality for East Asian Economies

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The Japanese economy has fallen well below its potential output path over the last decade. The cost of this economic stagnation has been borne in significant part by Japan's trading partners, East Asian countries in particular, as they have seen withering export markets and attenuated inflows of innovative imports, technology, and investment capital. Using a dynamic calibrated general equilibrium (CGE) model, we examine the implications of externalities like this turning positive: how structural reform and greater productivity growth in Japan would induce economic benefits elsewhere in the region. Our preliminary findings suggest that, while Japanese growth appears to be neither necessary nor sufficient for aggregate expansion among its regional trading partners, very different trade patterns would prevail for most of them if Japanese reforms are effective, and there will also be significant positive spillovers. The precise nature of these effects, however, depends critically upon the microeconomics of the structural reform and recovery in Japan and on the composition of trade with each partner country.

1. Introduction

It is generally agreed that the Japanese economy has fallen well below its potential over the last decade. While this shortfall has important implications for living standards within the Japan, its neighbors are also keenly aware of how different things might have been. The opportunity cost of Japanese economic stagnation has been shared with its trading partners, as they see withering export markets and attenuated inflows of innovative imports, technology, and foreign capital. While there may not be much satisfaction in reminding ourselves of opportunities lost, it is reasonable to ask what kind of regional adjustments might be expected to ensue from a reform-induced Japanese recovery.

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Using a calibrated general equilibrium (CGE) model, we attempt to elucidate these issues by simulating the regional economic effects of higher rates of productivity growth in Japan, taking explicit account of how these endogenous growth effects might be propagated to trading partners. This model then gives detailed information about induced adjustments in productivity, as well as the level and composition of demand, supply, trade, and factor use in each of 10 countries and/or regions globally. Our general results indicate that, while most regional economies would not experience significant aggregate stimulus from accelerated faster Japanese productivity growth, some would and most can expect to see substantial shifts in their patterns of trade and domestic resource allocation. Thus Japanese growth or recovery may not be sufficient to "make or break" any of its neighbors economically, but the nature of their trade and production patterns can change dramatically and these changes depend upon the microeconomics of the adjustment process in Japan. Thus, Japanese recovery should not be viewed by trading partners as a business-as-usual increase in absorption, inflating their export demand in its traditional composition. Structural adjustments in Japan, particularly those induced by productivity changes, will alter trade patterns in ways that create new market opportunities and attenuate old ones and, more profoundly, alter productive relationships within partner economies.

In order to specify what we mean by a counterfactual to Japanese economic recovery, it is important to identify or at least characterize a central cause of the current stagnation. Since we have neither the time nor the expertise to undertake a thorough analysis of Japanese institutional imperfections, we focus instead upon those consequences that are discernable from the perspective of neoclassical economic theory. Many institutional features have been blamed for Japanese economic problems over the last decade, but most authoritative authors will agree that these diverse imperfections have manifested themselves prominently in one economic phenomenon, low factor productivity growth.

Consider labor and capital in turn. It could be argued, for example, that the Japanese education system was well-suited to training a large and productive blue-collar labor force for rapid industrial mobilization, but has been less adept at developing a more elaborated and flexible human capital base like that needed for a modern, information-based economy that derives more than 60 percent of its GDP from tertiary activities.

Indeed, some have argued that even this argument is too generous, and that high Japanese labor productivity growth era was simply inflated by massive capital accumulation and technology transfer from abroad. The institutional side of labor markets in the country may or may not have functioned efficiently over the last ten years, but the manifest result today is low growth of labor productivity. Ultimately, and sooner rather than later in the era of globalization, this will translate in low (or even negative) growth of real wages, particularly in foreign currency.

In an analogous way, many financial and monetary experts have questioned the efficiency of capital markets in Japan. For example, it can be argued that oligopolistic banking practices have led to excessive lending and investment to over-capitalized large firms, starving small innovators. This institutional reality may be difficult to model, but it manifests itself in low capital productivity, something we can measure and incorporate in a counterfactual scenario.

Other authors have examined these issues from related perspectives. Ando (1999) suggests that the main cause of the Japanese recession in the 1990s is inefficiently allocated and excessive investment by both private and public sectors. Using a static CGE model, Noland et al. (1998) attempt to assess the impact of the economic crisis and possible recovery in Japan by real exchange rate and factor productivity shocks. Their main findings are that the impact of the real depreciation of the yen experienced in 1998 would predominate productivity shocks and that the former would lead to significant adverse effects on the current account of Asian developing countries and the United States. Englander and Mittelstädt (1988) estimated average annual growth rates of output, factor inputs, and factor productivities for 21 OECD countries from the 1960s to 1986. They suggest that structural factors, such as the end of postwar reconstruction, the reduced scope for catch-up, less rapid expansion of international trade, and slowdown of technological advances were likely to be the initial cause of the productivity slowdown in the early 1970s. Subsequently, a reduction in the capital formation rate exacerbated the slowdown.

A number of studies have investigated the extent to which rapid output growth in postwar Japan resulted from increases in capital inputs, labor inputs, and total factor productivity (TFP). The relative importance of each component varies across studies, however. For example, Denison and Chung (1976) found that 22, 20, and 59 percent of the Japanese real output growth during 1953-71 was attributable to real capital input, real labor input, and TFP, respectively, whereas Nishimizu and Hulten (1978) found these contributions to be 58, 17, and 25 percent (respectively) during 1955-71. Most studies have found, however, that TFP and capital input were the two most important factors contributing to postwar economic growth in Japan.

For the purposes of discussion and model calibration, we have collected estimates of real GDP, labor input, capital stock, and TFP in Table 1. The declining trend in factor inputs and total factor productivity is plain enough, and these combined effects are prime suspects in the search for an explanation of low real GDP growth in the economy, even if they fail to reveal their institutional origins.

Table 1. Average Annual Growth Rates of Real Output, Factor Inputs, and TFP in Japan (percent)

	Real GDP	Labor input	Capital stock	Total factor productivity
1960-1965	9.5	6.0	12.8	1.5
1965-1970	11.2	2.9	13.5	4.3
1970-1975	4.4	-1.2	10.4	0.6
1975-1980	4.6	1.4	5.7	1.3
1980-1985	3.7	1.0	3.7	1.5
1985-1990	4.5	1.2	5.1	1.4
1990-1995	1.5	-0.3	4.1	-0.5
1995-2000[a]	1.0	-0.2	3.6	-0.9
2000-2005[a]	1.9	-0.5	3.4	0.1

[a] Growth rates of real GDP and labor input for the 1995-2000 and 2000-2005 periods are based on the World Bank projections. Growth rates of capital stock and total factor productivity during these periods are based on the baseline simulation.

Source: Nikkei database and the authors' calculations.

2. Model

2.1 The Dynamic General Equilibrium Model and Database

A CGE model is an empirical tool that is well suited to evaluating the impact of structural reform on both a domestic economy and its trading partners. The model used in this study is a ten-region, twelve-sector dynamic CGE model of the global economy.[1] It is to a large extent based upon OECD's LINKAGE model (OECD, 1997). One of the key features of the model is that goods are differentiated by region of origin and are modeled as imperfect substitutes. On the import side, this is reflected by the implementation of the so-called Armington assumption where a constant elasticity of substitution (CES) specification is used to incorporate imperfect substitution of imported goods with respect to domestically produced goods. A symmetric specification is used to model export supply, the latter being implemented with constant elasticity of transformation (CET) functions.

The model is calibrated to social accounting matrices (SAMs) of the 10 regions, as well as to various parameter values. The SAMs are constructed from the GTAP database, version 4, which provides 1995 data on input-output, value added, final demand, bilateral trade, tax and subsidy data for 45 regions and 50 sectors.[2] This has been aggregated into a ten-region, twelve-sector data set for the implementation of the present model.

The model solves for eleven years from 1995 to 2005. While it relies on sequential static computation of equilibria, intertemporal trends are specified for factor growth (labor) and accumulation (capital), as well as changes in factor productivity. Land is assumed to be price-responsive, however, with no time trend on the supply curve.

All sectors are assumed to be perfectly competitive and operate under constant returns to scale. Production technology is modeled mainly by a nesting of CES functions. The model has four primary factors of production: labor, capital, agricultural land, and

[1] The regions in the model are Japan, China (including Hong Kong), South Korea, Taiwan, Singapore, ASEAN-4, Australasia, the United States, the European Union, and the rest of the world. The sectors are agriculture, energy and natural resources, processed food, textiles and apparel, chemicals, metal and products, nonelectric machinery, electric machinery, transportation equipment, other manufactures, trade and transport, and other services.

sector-specific fixed factors. Supply of labor is specified as an increasing function of the wage rate and a decreasing function of the marginal budget share for leisure.[3] While we assume no international migration, labor is free to move across all sectors of the economy. Thus, there is a single equilibrium wage rate in each region.

Within each period, capital is classified as being either *old* or *new*. New capital is generated by the previous period's investment. This vintage structure of capital allows for differentiating the substitution possibilities across inputs by the age of capital. Similar to labor, *new* capital is assumed to be perfectly mobile across sectors and there is a single economywide rate of return on capital.

All income generated by economic activity is assumed to be distributed to consumers. A single representative consumer (or household) allocates optimally his/her disposable income among the consumer goods and saving. The consumption/saving decision is static: saving is treated as a good and its amount is determined simultaneously with the demands for the other goods. The price of saving is set arbitrarily equal to the average price of consumer goods. Investment is driven by aggregate saving, or the sum of household, government, and foreign savings. We assume that foreign saving is exogenous and that the ratio of government expenditures to GDP remains constant in each region during the 1995-2005 period.

The model is calibrated on exogenous growth rates of real GDP, population, labor productivity, and an autonomous energy efficiency improvement in energy use.[4] In the baseline scenario, the dynamics are calibrated in each region by imposing the assumption of a balanced growth path. This implies that the ratio between labor and the capital/fixed-factor bundle (in efficiency units) is held constant over time.[5] When the Japanese

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[2] See Gehlhar et al. (1997) and McDougall et al. (1998) for detailed descriptions of the GTAP database.

[3] While the total supply of labor is assumed to be fixed in a given period in most of the CGE models, we have chosen instead to specify it endogenously to capture the positive income and employment effects of productivity change on aggregate employment.

[4] Real GDP and population growth rates are based on the World Bank's latest projections (as of May 1999).

[5] This involves computing in each period a measure of Harrod-neutral technical progress in the capital/fixed-factor bundle as a residual, given that the growth of the labor force (in efficiency units) is pre-determined. This is a standard calibration procedure in dynamic CGE modeling.

structural reform scenarios are simulated, the growth of capital is endogenously determined by the saving-investment relation.

2.2 Modeling Technology Linkages Between Trading Partners

Technological spillovers between trading partners occur in many ways, including direct transfers, emulation of import technologies, export market research, domestic operations of foreign-owned subsidiaries, and scientific, educational, and cultural exchanges. For the sake of tractability and transparency, we have chosen to aggregate all these effects in a relatively parsimonious specification based on the work of van Meijl and van Tongeren (1999). In particular, for each commodity, we assume that TFP growth in Japan's trading partners is determined by the following transmission equation:

$$a_r = f(T_{r,J}) \cdot a_J \qquad 0 \le T_{r,J} \le 1 \tag{1}$$

where a_J and a_r denote productivity growth rates for Japan and trading partner r, respectively, $T_{r,J}$ is the ratio of r's imports of product i from Japan to r's total imports of product i.[6] This can be captured with the following specific functional form for $f(T_{r,J})$:

$$f(T_{r,J}) = T_{r,J}^{1-H_{r,J} \cdot D_{r,J}} \qquad 0 \le H_{r,J} \le 1 \quad 0 \le D_{r,J} \le 1 \tag{2}$$

where $H_{r,J}$ and $D_{r,J}$ denote absorptive capacity and structural similarity, respectively, between Japan and trading partner r. The absorptive capacity index ($H_{r,J}$) provides the absorptive capacity of a trading partner (h_r) relative to that of Japan (h_J), which may be approximated by

$$H_{r,J} = \min\left[\frac{h_r}{h_J}, \frac{h_J}{h_r}\right] \tag{3}$$

where h_r and h_J are the level of human capital (average year of schooling) in region r and Japan, respectively. The idea behind this equation is that, the lower is the education level in a trading partner relative to Japan, the more difficult it is to assimilate new technology. If trading partner r has a larger amount of human capital than Japan (e.g., the United

[6] While van Meijl and van Tongeren (1999) assume that the initial productivity growth results from an R&D process that is taken to be exogenous, we assume that the productivity growth in Japan results from structural reform.

States), however, some of the new technology in Japan is redundant in *r* and may not be assimilated. Thus, $H_{r,J}$ takes a maximum value of one when the trading partner's average year of schooling is equal to Japan's.[7]

We assume that the more similar the relative factor endowments of two countries, the more easily the new technology will be transmitted between them. The structural similarity index ($D_{r,J}$) may be computed using the equation:

$$D_{r,J} = \exp\left\{ - \left| \frac{k_r - k_J}{D^{\max}} \right| \right\} \qquad (4)$$

where k_r and k_J are capital/labor ratios of region *r* and Japan, and $D^{\max}$ is the largest absolute difference in the capital/labor ratio between all pairs of regions.[8] Actual computed values of these coefficients are given in Table 2.

Instead of limiting consideration of technology spillovers to a linear specification of the kind set forth in equation (2), we evaluated two alternative forms of technology spillover functions:

$$f(T_{r,J}) = H_{r,J} \cdot D_{r,J} \cdot T_{r,J} \qquad (5)$$

and

$$f(T_{r,J}) = \frac{D_{r,J}}{1 + 100 \cdot e^{-H_{r,J} \cdot T_{r,J}}} \qquad (6)$$

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[7] van Meijl and van Tongeren (1999) assume a slightly different absorption capacity index

$$H_{r,J} = \min\left[\frac{h_r}{h_J}, 1\right]$$

[8] van Meijl and van Tongeren (1999) use the land/labor ratios instead of capital/labor ratio because they focus on technical change in the agricultural sector.

Table 2: Import Shares, Absorption Parameter, and Similarity Index

	China	Korea	Taiwan	Singap.	ASEAN4	Aus-NZ	U.S.	EU	ROW
Ratio of r's imports from Japan to its total imports ($T_{r,J}$)									
Agriculture	.020	.008	.022	.007	.006	.032	.003	.001	.002
Energy and resources	.055	.047	.068	.012	.014	.007	.004	.002	.003
Processed food	.036	.059	.093	.040	.025	.019	.015	.001	.002
Textiles and apparel	.109	.120	.178	.066	.103	.026	.010	.006	.017
Chemicals	.162	.330	.362	.161	.218	.089	.121	.023	.028
Metal and products	.272	.260	.340	.229	.277	.150	.095	.011	.048
Nonelec. machinery	.310	.433	.452	.297	.358	.159	.272	.075	.079
Electric machinery	.242	.235	.341	.182	.170	.130	.241	.091	.082
Transport equip.	.214	.173	.240	.211	.504	.428	.292	.068	.135
Other manufac.	.220	.188	.243	.204	.230	.066	.089	.024	.026
Trade and transp.	.095	.351	.320	.152	.053	.225	.137	.056	.065
Other services	.087	.146	.105	.199	.029	.114	.061	.011	.032
Absorption para. ($H_{r,J}$)	.636	.925	.876	.579	.584	.859	.788	.882	.624
Structural similarity index ($D_{r,J}$)									
Agriculture	.809	.883	.857	.455	.814	.935	.993	.896	.812
Energy and resources	.490	.601	.584	.751	.501	.808	.877	.696	.505
Processed food	.510	.604	.583	.904	.544	.659	.721	.724	.552
Textiles and apparel	.441	.637	.610	.673	.551	.596	.834	.767	.468
Chemicals	.368	.462	.437	.821	.396	.486	.776	.450	.390
Metal and products	.368	.572	.487	.655	.419	.534	.516	.436	.381
Nonelec. machinery	.368	.479	.439	.675	.554	.489	.637	.464	.383
Electric machinery	.368	.478	.424	.675	.447	.528	.631	.473	.387
Transport equip.	.368	.458	.443	.590	.488	.427	.534	.446	.374
Other manufac.	.368	.519	.468	.741	.444	.552	.938	.526	.404
Trade and transp.	.521	.819	.796	.706	.552	.920	.865	.900	.537
Other services	.368	.431	.505	.509	.382	.513	.567	.559	.382

Sources: GTAP database (version 4), Barro and Lee (1993), and the authors' calculations.

Since $H_{r,J}$ and $D_{r,J}$ are fixed coefficients, equation (5) provides a linear relationship between productivity growth rates of Japan and trading partner *r*. Equation (6) is a logistic function incorporating increasing returns when *r*'s trade with Japan is small and decreasing returns when its trade becomes larger. Technology transmission coefficients under three alternative functional forms are computed using equations (2), (5), and (6) and summarized in Table 3 In general, they are significantly smaller when the technology spillover function is linear.

Generally speaking, the technology transfer model used here has the usual virtue of parsimony, but the usual vice of restrictive assumptions. For example, we have assumed that structural reform in Japan will lead to an increase in TFP growth in every sector. It might be more realistic to limit this to the manufacturing and service sectors, since it is unlikely that the agricultural or resource sectors will be affected very much in an OECD country. We have also assumed that technology will transfer with equal facility to from Japan to developing and other industrial countries. It might be more realistic to limit the extent of technology transfer from Japan to the U.S. and EU because Japanese technology is not as essential to U.S. or EU productivity growth as it might be to Asian developing countries. These are the kind of simplifications that could be expanded upon in a more extended research exercise, but we feel they to not bear substantially on our current results.

It should also be noted that, in this paper, we only model spillovers embodied in final products. By comparison, van Meijl and van Tongeren (1999) assume that imports of improved final products lead to Hicks-neutral productivity improvements in the production of that particular commodity in the importing country.[9] This is another area of extension for the current framework.

[9] Coe, Helpman, and Hoffmaister (1995) find that the ratio of developing country's imports from industrial countries to its GDP has a positive and significant impact on domestic TFP. Industrial country's R&D stock and developing country's education level also have significant impact on developing country's TFP.

Table 3. Technology Transmission Coefficients under Alternative Functional Forms

	China	Korea	Taiwan	Singap.	ASEAN4	Aus-NZ	U.S.	EU	ROW
A. Linear technology spillover function: $f(T_{r,J}) = H_{r,J} \cdot D_{r,J} \cdot T_{r,J}$									
Agriculture	0.010	0.006	0.017	0.002	0.003	0.026	0.003	0.001	0.001
Energy and resources	0.017	0.026	0.035	0.005	0.004	0.005	0.003	0.001	0.001
Processed food	0.012	0.033	0.047	0.021	0.008	0.011	0.008	0.000	0.001
Textiles and apparel	0.031	0.071	0.095	0.026	0.033	0.013	0.007	0.004	0.005
Chemicals	0.038	0.141	0.139	0.076	0.050	0.037	0.074	0.009	0.007
Metal and products	0.063	0.138	0.145	0.087	0.068	0.069	0.039	0.004	0.011
Nonelec. machinery	0.073	0.192	0.174	0.116	0.116	0.067	0.137	0.031	0.019
Electric machinery	0.057	0.104	0.127	0.071	0.044	0.059	0.120	0.038	0.020
Transport equip.	0.050	0.073	0.093	0.072	0.144	0.157	0.123	0.027	0.032
Other manufac.	0.051	0.090	0.100	0.088	0.060	0.031	0.066	0.011	0.006
Trade and transp.	0.031	0.266	0.223	0.062	0.017	0.177	0.093	0.044	0.022
Other services	0.020	0.058	0.046	0.059	0.006	0.050	0.027	0.005	0.008
B. Logistic technology spillover function: $f(T_{r,J}) = \dfrac{D_{r,J}}{1+100 \cdot e^{-H_{r,J} \cdot T_{r,J}}}$									
Agriculture	0.027	0.018	0.055	0.007	0.011	0.128	0.013	0.009	0.009
Energy and resources	0.119	0.255	0.464	0.015	0.011	0.014	0.012	0.008	0.006
Processed food	0.045	0.422	0.566	0.085	0.022	0.033	0.022	0.008	0.006
Textiles and apparel	0.402	0.636	0.610	0.211	0.444	0.051	0.018	0.013	0.013
Chemicals	0.367	0.462	0.437	0.813	0.396	0.464	0.770	0.031	0.021
Metal and products	0.368	0.572	0.487	0.655	0.419	0.534	0.489	0.011	0.063
Nonelec. machinery	0.368	0.479	0.439	0.675	0.554	0.489	0.637	0.411	0.221
Electric machinery	0.368	0.478	0.424	0.673	0.445	0.527	0.631	0.459	0.242
Transport equip.	0.368	0.458	0.443	0.589	0.488	0.427	0.534	0.357	0.366
Other manufac.	0.368	0.519	0.468	0.741	0.444	0.412	0.861	0.041	0.019
Trade and transp.	0.421	0.819	0.796	0.696	0.099	0.920	0.864	0.515	0.194
Other services	0.262	0.431	0.500	0.508	0.019	0.510	0.314	0.014	0.025
C. Concave technology spillover function: $f(T_{r,J}) = T_{r,J}^{1-H_{r,J} \cdot D_{r,J}}$									
Agriculture	0.149	0.409	0.386	0.027	0.068	0.508	0.289	0.217	0.040
Energy and resources	0.135	0.256	0.269	0.082	0.050	0.215	0.186	0.085	0.019
Processed food	0.105	0.287	0.312	0.217	0.080	0.181	0.161	0.072	0.019
Textiles and apparel	0.203	0.418	0.448	0.190	0.214	0.169	0.208	0.192	0.056
Chemicals	0.248	0.529	0.534	0.383	0.310	0.244	0.441	0.102	0.066
Metal and products	0.368	0.530	0.538	0.401	0.379	0.358	0.248	0.063	0.099
Nonelec. machinery	0.408	0.627	0.613	0.477	0.499	0.344	0.523	0.217	0.145
Electric machinery	0.337	0.446	0.509	0.354	0.270	0.328	0.489	0.248	0.150
Transport equip.	0.307	0.363	0.417	0.359	0.612	0.584	0.490	0.196	0.216
Other manufac.	0.313	0.419	0.434	0.404	0.336	0.240	0.533	0.136	0.065
Trade and transp.	0.207	0.775	0.708	0.329	0.136	0.731	0.531	0.551	0.162
Other services	0.153	0.314	0.285	0.320	0.063	0.296	0.213	0.102	0.072

3. Results

To elucidate the effects of more dynamic Japanese economic growth on other economies, we present a baseline simulation scenario for TFP growth and calculate induced effects on Japan's trading partners. As Table 1 indicated, Japan experienced a serious slowdown in these trends after the first oil crisis of 1973-74 and this worsened dramatically in the 1990s. Our counterfactual is based on the assumption that, if the Japanese government had carried out structural reform in the 1990s with determination and vigorous institutional discipline, TFP growth rate could have been at least 1 percent per annum over the past decade. Thus, we conducted simulation experiments assuming Japanese TFP growth to increase by 2 percentage points per annum during 1995-2000 and by 1 percentage point per annum during 2000-2005 compared with the baseline trends (Table 1).

The results of this exercise are presented in Table 4, detailing percentage changes in real GDP in 2000 and 2005 relative to the baseline values for the ten countries/regions in the model. We present results for no technology spillovers and for each of three different specifications of technology spillover, as explained in the previous section. These results clearly indicate that positive technical externalities for trading partners do result from Japanese structural reform, but that the magnitude of this tonic effect depends upon the trading partner and, especially, on how the spillover function is specified. Part of these results are of course simply a result of macro and sectoral trade linkages, as can be seen by the positive numbers in the no spillover scenario.

When explicit account is taken of technology links, however, some trading partners enjoy annual increases in real GDP of more than 1 percent because of endogenous growth factors transmitted from Japan. The most intensive transmission, as would be expected, is to Asian growth economies, since these have large trade shares with Japan, and a high level of readiness to assimilate technology and other endogenous growth influences. Strong growth externalities for Australia are probably a result of factor complementarity that has often been observed between Japan and this country. The high U.S. numbers may be somewhat unrealistic for reasons already discussed. In any case, it is remarkable that, under the nonlinear spillover functions, Japan can transmit as much as half its domestic TFP growth (in aggregate real GDP terms) to several of its trading partners.

Table 4. Deviations in Real GDP from the Baseline (percentages)

	No spillovers		Linear spillovers		Logistic spillovers		Concave spillovers	
Country/Region	2000	2005	2000	2005	2000	2005	2000	2005
Japan	10.64	17.28	10.64	17.29	10.65	17.31	10.66	17.32
China	0.19	0.47	0.53	1.06	3.24	5.75	2.46	4.40
Korea	0.09	0.31	1.14	1.99	5.08	8.47	4.61	7.62
Taiwan	0.21	0.62	1.27	2.30	5.86	9.77	4.75	7.94
Singapore	0.33	1.10	0.95	2.02	5.93	9.38	3.55	6.00
ASEAN-4	0.22	0.66	0.49	1.12	1.85	3.52	1.89	3.51
Australasia	0.06	0.15	0.83	1.34	5.61	8.89	4.16	6.54
United States	0.02	0.04	0.55	0.88	4.90	7.75	3.39	5.34
European Union	0.01	0.02	0.16	0.26	1.44	2.26	2.03	3.15
Rest of World	0.02	0.06	0.13	0.24	0.76	1.34	0.92	1.56

In a related piece of work (Lee and Roland-Holst, 1999), we examined a larger variety of Japanese growth scenarios in the absence of spillovers, but including flows of foreign capital. The results in those cases suggested that Japanese recovery would be neither necessary nor sufficient to promote significant aggregate growth within other economies, even in the Asia-Pacific region. When we take account of the possibility of growth externalities, however, a very different picture emerges. The no spillover scenarios give small comfort to those waiting for Japanese recovery to put wind in their sails. In light of the above results, however, it can be argued that trade and capital flows have weak linkages, while the trans-boundary endogenous growth processes, including regional externalities and spillovers, have strong linkages in regional development.

The next set of results presented in Table 5 details percentage changes in exports to Japan for three trading partners (China, ASEAN-4, and Australasia) resulting from the four simulation scenarios. Evidently, Japanese and other induced productivity growth will change the composition of regional trade, and the magnitude of the adjustments depends again on the specification of the growth externalities.

Table 5. Exports to Japan for Selected Trading Partners (percentage changes)

		No spillovers		Linear spillovers		Logistic spillovers		Concave spillovers	
	Country and sector	2000	2005	2000	2005	2000	2005	2000	2005
	China								
1	Agriculture	3.8	6.5	3.8	6.5	3.9	6.7	4.1	6.9
2	Energy and resources	2.9	4.3	3.1	4.7	4.9	7.8	4.5	7.1
3	Processed food	1.8	3.1	1.8	3.2	2.3	4.0	2.4	4.1
4	Textiles and apparel	4.0	6.6	4.1	6.8	5.4	8.9	4.9	8.0
5	Chemicals	4.6	7.1	4.7	7.4	6.3	10.2	5.9	9.3
6	Metal and products	3.5	5.5	3.6	5.8	5.3	8.8	5.1	8.3
7	Nonelec. machinery	2.5	4.2	2.7	4.5	4.1	6.9	4.0	6.7
8	Electric machinery	2.2	3.5	2.4	3.8	3.9	6.5	3.7	6.0
9	Transport equip.	4.2	6.6	4.4	7.0	6.0	9.8	5.7	9.2
10	Other manufac.	4.8	7.7	5.0	8.0	6.5	10.8	6.2	10.1
11	Trade and transp.	5.5	9.0	5.7	9.2	7.7	12.8	6.8	11.3
12	Other services	5.8	9.1	5.9	9.3	7.1	11.3	6.8	10.7
	All sectors	4.0	6.4	4.1	6.7	5.5	9.2	5.1	8.4
	ASEAN-4								
1	Agriculture	3.6	6.2	3.5	6.2	3.4	5.9	3.5	6.2
2	Energy and resources	2.7	4.0	2.6	4.0	2.4	3.8	2.9	4.6
3	Processed food	1.6	2.8	1.6	2.8	1.5	2.7	1.8	3.2
4	Textiles and apparel	3.7	6.1	3.8	6.3	5.6	9.3	4.7	7.8
5	Chemicals	4.3	6.6	4.4	6.9	5.8	9.0	5.7	8.9
6	Metal and products	3.3	5.2	3.5	5.6	5.0	8.1	5.1	8.2
7	Nonelec. machinery	2.8	4.7	3.1	5.3	4.9	8.1	4.8	7.8
8	Electric machinery	2.0	3.3	2.2	3.6	4.1	6.6	3.5	5.7
9	Transport equip.	4.1	6.6	4.7	7.6	6.3	10.2	7.0	11.1
10	Other manufac.	4.7	7.6	4.9	7.9	6.2	10.0	6.1	9.9
11	Trade and transp.	5.4	8.8	5.4	8.8	5.6	9.5	6.1	10.1
12	Other services	5.8	9.1	5.9	9.2	6.3	10.1	6.4	10.2
	All sectors	3.5	5.7	3.6	5.8	4.2	7.0	4.4	7.2
	Australasia								
1	Agriculture	3.8	6.5	3.9	6.7	4.9	8.2	5.3	8.9
2	Energy and resources	2.7	3.9	2.7	3.9	3.1	4.8	4.2	6.3
3	Processed food	1.7	2.9	1.8	3.1	2.8	4.6	3.0	4.9
4	Textiles and apparel	3.7	6.0	3.8	6.2	4.4	7.0	4.8	7.6
5	Chemicals	4.4	6.7	4.6	7.0	7.1	10.9	5.9	9.0
6	Metal and products	3.2	5.0	3.4	5.4	5.7	9.0	4.9	7.6
7	Nonelec. machinery	2.2	3.6	2.4	3.9	4.4	6.9	3.5	5.6
8	Electric machinery	1.8	2.8	2.1	3.2	4.5	7.0	3.4	5.3
9	Transport equip.	3.8	5.9	4.3	6.6	6.2	9.6	5.9	9.2
10	Other manufac.	4.6	7.4	4.8	7.7	7.2	11.4	6.2	9.9
11	Trade and transp.	5.4	8.6	6.2	9.9	10.2	16.3	9.0	14.4
12	Other services	5.7	8.8	5.9	9.1	7.7	12.0	6.9	10.8
	All sectors	3.7	5.8	3.9	6.2	5.8	9.3	5.7	9.0

Structural change and dynamic recovery in Japan significantly alters the patterns of economic interaction with its trading partners. Table 6 reports the values of estimated "general equilibrium elasticities," i.e. the annual percent change in sectoral exports resulting from a one percent annual change in Japanese TFP in a general equilibrium framework, for selected trading partners.[10] That these are all less than unity is not surprising, and the differences across countries are not nearly as great as differences across sectors or across scenarios. This is because the Armington assumption used in these scenarios assumes that exports from all these countries are close substitutes from a Japanese perspective, so there is very little in the way of differences in bilateral terms-of-trade adjustments, and new exports of a given commodity to Japan are essentially apportioned according to base year market shares for the exporting countries. These results are by definition demand-driven, and therefore best reveal the market opportunities that will arise across sectors as Japanese economic structure changes. The extent to which a given trading partner is ultimately able to capture part of these export opportunities will depend on considerations endogenous to the exporting economy and only here are country-specific productivity differences likely to assert themselves.

4. Conclusions and Extensions

While the Japanese themselves have paid the greatest price for their disappointing economic performance over the last decade, their many trading partners have also suffered. This is particularly the case for trading partners in the Asia-Pacific region, many of whom directed large shares of their exports to the Japanese market and saw these sales slide with the recession. Beyond the basic absorption shortfall for business cycle linkage, these countries have also suffered from a deeper attribute of Japan's economic stagnation, i.e. attenuated productivity growth. To better ascertain the opportunity cost of the recession for Japan's trading partners, we used a global CGE model to simulate the effects on trade and productivity of a more dynamic Japanese economy.

[10] These should be distinguished from conventional elasticities where all other variables are being held constant.

Table 6. Export Elasticities for Selected Trading Partners with respect to Japanese Total Factor Productivity

	Country and sector	No spillovers 2000	No spillovers 2005	Linear spillovers 2000	Linear spillovers 2005	Logistic spillovers 2000	Logistic spillovers 2005	Concave spillovers 2000	Concave spillovers 2005
	China								
1	Agriculture	0.36	0.41	0.36	0.41	0.37	0.42	0.39	0.43
2	Energy and resources	0.28	0.27	0.30	0.29	0.47	0.49	0.43	0.44
3	Processed food	0.17	0.19	0.18	0.20	0.22	0.25	0.23	0.25
4	Textiles and apparel	0.38	0.41	0.39	0.42	0.52	0.56	0.47	0.50
5	Chemicals	0.44	0.44	0.46	0.46	0.61	0.64	0.56	0.58
6	Metal and products	0.33	0.34	0.35	0.36	0.51	0.55	0.49	0.52
7	Nonelec. machinery	0.24	0.26	0.26	0.28	0.39	0.43	0.38	0.42
8	Electric machinery	0.21	0.22	0.23	0.24	0.38	0.40	0.36	0.38
9	Transport equip.	0.41	0.42	0.42	0.44	0.57	0.61	0.54	0.57
10	Other manufac.	0.46	0.48	0.48	0.50	0.63	0.67	0.59	0.63
11	Trade and transp.	0.53	0.56	0.54	0.58	0.74	0.80	0.66	0.71
12	Other services	0.56	0.57	0.57	0.58	0.68	0.71	0.65	0.67
	All sectors	0.38	0.40	0.39	0.42	0.53	0.57	0.49	0.53
	ASEAN-4								
1	Agriculture	0.34	0.39	0.34	0.38	0.32	0.37	0.34	0.39
2	Energy and resources	0.26	0.25	0.25	0.25	0.23	0.23	0.28	0.29
3	Processed food	0.15	0.18	0.15	0.17	0.14	0.17	0.18	0.20
4	Textiles and apparel	0.35	0.38	0.36	0.40	0.54	0.58	0.45	0.49
5	Chemicals	0.41	0.41	0.42	0.43	0.55	0.56	0.54	0.55
6	Metal and products	0.31	0.33	0.34	0.35	0.48	0.51	0.49	0.51
7	Nonelec. machinery	0.27	0.29	0.30	0.33	0.47	0.50	0.46	0.49
8	Electric machinery	0.20	0.21	0.21	0.22	0.39	0.41	0.34	0.36
9	Transport equip.	0.40	0.42	0.45	0.47	0.60	0.63	0.67	0.70
10	Other manufac.	0.45	0.47	0.47	0.49	0.59	0.63	0.58	0.62
11	Trade and transp.	0.51	0.55	0.52	0.55	0.54	0.59	0.58	0.63
12	Other services	0.56	0.57	0.56	0.57	0.61	0.63	0.62	0.64
	All sectors	0.34	0.35	0.34	0.36	0.41	0.44	0.42	0.45
	Australasia								
1	Agriculture	0.36	0.41	0.37	0.42	0.47	0.51	0.51	0.56
2	Energy and resources	0.26	0.24	0.26	0.24	0.30	0.30	0.40	0.40
3	Processed food	0.17	0.18	0.18	0.19	0.27	0.29	0.29	0.31
4	Textiles and apparel	0.35	0.38	0.36	0.38	0.42	0.44	0.46	0.48
5	Chemicals	0.42	0.42	0.44	0.44	0.68	0.68	0.56	0.56
6	Metal and products	0.31	0.31	0.33	0.34	0.55	0.56	0.47	0.48
7	Nonelec. machinery	0.21	0.23	0.23	0.24	0.42	0.43	0.34	0.35
8	Electric machinery	0.18	0.18	0.20	0.20	0.44	0.44	0.33	0.33
9	Transport equip.	0.37	0.37	0.41	0.42	0.59	0.60	0.57	0.58
10	Other manufac.	0.44	0.46	0.46	0.48	0.69	0.71	0.60	0.62
11	Trade and transp.	0.52	0.54	0.59	0.62	0.98	1.02	0.87	0.90
12	Other services	0.55	0.55	0.56	0.57	0.74	0.75	0.67	0.68
	All sectors	0.35	0.36	0.38	0.39	0.56	0.58	0.55	0.56

Our main results indicate that the aggregate macroeconomic linkages between Japan and its major trading partners are relatively weak. When recovery is accompanied by rising Japanese factor productivity, but this productivity is not transmitted to partner economies, most experience less than five percent of the added real GDP growth rate Japan itself experiences. Thus a Japanese real GDP growth alone is not sufficient for dynamic growth elsewhere. On the other hand, when account is taken of growth externalities in the form of productivity spillovers from Japan, partner economies can experience much more substantial induced growth.

At a more detailed level, adjustment patterns are at once more dramatic and complex. Japan's aggregate productivity growth strongly influences the sectoral composition of adjustment in trade patterns. Moreover, the ultimate magnitude and composition of bilateral trade adjustments depend critically on the functional nature of technology spillovers. This implies the evolution of export opportunities for Japan's trading partners hinge upon on the detailed economic properties of the recovery, and in particular on the exact nature of productivity spillovers.

The qualitative results we obtain are consistent with common intuition: growth with trade begets growth. The importance of specification choice to our quantitative estimates, however, suggests a fruitful econometric research agenda. Clearly, the potential for growth externalities appears to be considerable, and one might reasonably wonder about the importance of proximity and regional growth engines after seeing these results. How much of Asian growth is attributable to leadership, first by the United States, then Japan, and then the NIEs, each in turn conferring the seeds of endogenous growth upon their neighbors? The answers to this provocative question have important implications for other regions, such as Africa and Latin America, which are further removed from what were traditionally seem as growth poles, but they can ultimately be ascertained with more detailed empirical analysis.

To a certain extent, our counterfactual results are dependent upon the way in which we have characterized the causes of Japan's recession. For example, by assuming the main culprit was productivity, our "recovery" was neoclassical rather than Keynesian in nature, essentially supply-side rather than demand-side. This neoclassical focus influences the nature of domestic, trade, and induced-international adjustments. Certainly, Japan's trading partners might prefer a demand-side recovery, which boosts Japanese absorption without animating its export potential. Unfortunately, such policies are unsustainable because they ignore issues of closure in the balance of trade, public expenditure-receipts, and savings-investment that we as applied general equilibrium modelers cannot ignore. Beyond this, it could be observed that the government has already tried the demand-side approach without appreciable success. Furthermore, it can be argued that a Keynesian approach didn't work because it ignored the historical productivity collapse and failed to prescribe the structural adjustments needed to overcome it. The liquidity trap critiques of Japanese monetary stimulus (e.g. Krugman, 1998a,b,c) really imply the same conclusion: macro policies that ignore microeconomic structural problems are ultimately fruitless.

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