The New Economy: Global Effects

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A critical question facing the global economy is whether the new technology underlying the information revolution will be persistent and translate into higher economic growth in the United States and other countries around the world. A key component of this happening will be government and legislative action to provide incentives that facilitate innovation, investments in human capital, and the opening up and further development of capital markets to mobilize the financing necessary to support new technology innovations and implementation.

In what follows, we will make a case that the new economy is unique and holds out promise of accelerating growth around the world. We will also argue that the benefits of the new economy in individual countries will depend on the degree to which national policies will act to facilitate the new economy innovations in information, communications, and biotechnology.

What is the New Economy?

Much attention has been given to the revolution taking place in the new economy. However, less discussion has focused on what exactly is the new economy. The new economy is not restricted to a single nation, and entails the confluence of a number of interdependent processes. A key feature appears to be a decline in the cost of producing knowledge, accessing the world's stock of knowledge, and applying knowledge relative to the cost of producing physical goods. Of particular importance is the confluence of the improvements in electronic technology (computers), the expansion of communications technology including telecommunications (fiber optics), wireless communications, and broad band digital communications. While transport and shipment costs continue to fall, their rate of decline has clearly leveled-off relative to the on-going decline in the cost of communications (Baldwin and Martin, 1999). These technological evolutions have resulted in and been exploited by the development of the Internet. The Internet allows for the contraction of time and space with enormous potential for efficiency gains in commerce. The opportunity for near instantaneous communications anywhere around the globe allows for the separation in space of design, marketing, and production. It allows for markets to no longer be defined in location, but in electronic form. It thus takes away the traditional location limitations of markets, and creates the potential for truly global markets, a point made clearly by Cairncross, 1997, in her book, *the death of distance*.

The new economy involves a transformation in product value from the physical resources employed in production, to the knowledge that is embedded in the product. Thus, computer chips, software, and pharmaceuticals bring us value for what is embedded in them rather than only the physical resources committed to them. This

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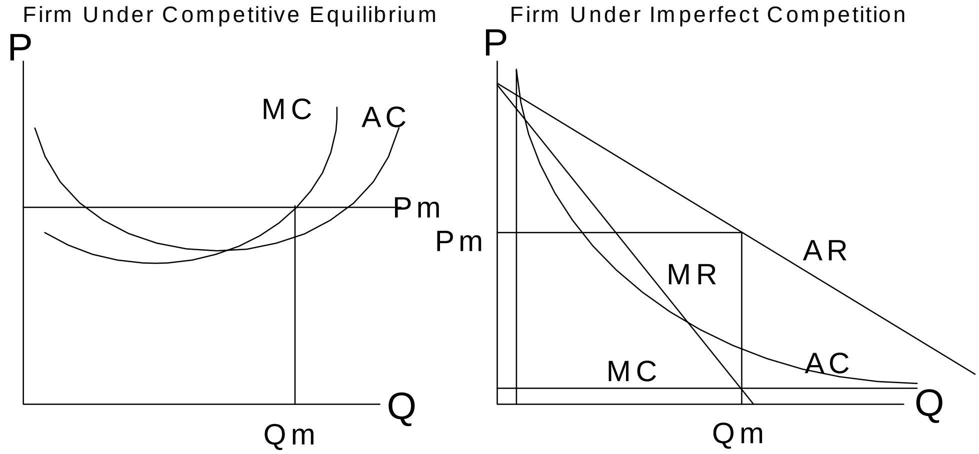
value, as we suggested later, amounts to a positive externality for reasons noted by Romer (1990), namely, that the embedded knowledge is non-rival and only partially excludable. The emergence of the new economy also transforms the concept of work from what we can lift to what problems we can overcome, how we can think and solve problems. An information, or digital processing-based world, is one in which the goods produced involve large fixed costs in comparison to marginal costs. Thus the marginal costs of producing Windows software may be less than one dollar while the investment costs of producing the software is in the hundreds of millions and possible billions of dollars. An environment in which the marginal costs of production are relatively insignificant in comparison to fixed costs is a form of market failure. Under competitive market conditions, no firm with such a cost structure could long survive. Markets with firms defined by such cost structures generate enormous pressure for real prices to decline. Thus the price of a given fixed capacity computer may decline by as much as 50 percent in one year and the innovation cycle for a doubling of capacity may be as low as 18 months. In this situation, firms are motivated to search for market niches, or product variety, where they can exert some monopoly power, if only for a short time, in order to obtain cost recovery.

As shown in figure 1, as monopoly power declines, the firm is less likely to recover costs, and/or be motivated to expand the scale of the market, for example, by exporting to other countries. The same forces exist in production. In a multistage firm, such as a computer manufacturer, scale may be obtained in final assembly by outsourcing the production of intermediate product components to a host country, which may produce similar intermediate components for manufacturers elsewhere in the world. Not only are economies of scale obtainable, but also the host country can draw upon the services of its primary resources, broadly defined, that it has in relative abundance, thus further lowering the cost of the intermediate product.

The characteristics of knowledge explains why it holds substantial potential for increasing economic growth. Knowledge is a public good with property rights that are rarely enforceable, and it is non-rival. The use by one does not exclude the use by others. Thus knowledge implicitly yields a positive externality which generates increasing returns, as in Romer (1990). A one-time investment potentially raises the production function of a large number of firms and activities. Furthermore, it is difficult to observe and quantify directly. Measures of knowledge are indirect. We look at inputs (years of schooling, manuals, investments in R&D), or the consequence of its accumulation (number of patents, or the unexplained residual in growth accounting). The partial excludability of knowledge also suggests more than the obvious, i.e., that incentives for its production and dissemination tend to be far less than is socially optimal. This characteristic suggests that this source of growth is only likely to be persistent in an environment where property rights can be better defined and enforced.

Of course, these characteristics of knowledge existed long before emergence of the new economy. Clearly, other factors must be at play that has induced the so-called second wave of globalization discussed by Baldwin and Martin (1999). These factors are almost surely linked to the opportunities created by the relative reduction in cost of producing and accessing new product and processes technologies. They entail institutional innovations such as the emergence of utility patents, pressures for further expanding agreements among nations on trade in intellectual property rights, and the willingness of nations to open both their goods and capital markets to the broader world economy. These innovations increase the positive externalities of embedded

Figure 1:



knowledge capital, lower the direct cost of accessing knowledge stock in other countries, and capture the economies of scale and relative resource costs unique to a particular country. We return to these points later.

What Impact has the New Economy had on the United States?

The U.S. economy grew twice as fast in the second part of the 1990's as in the first, averaging approximately 4 as compared with 2 percent. Particularly noticeable was the acceleration in productivity growth at the end of the growth period. This is distinct from the usual pattern where productivity growth increases at the beginning of a growth period and slows at the end. On average, labor productivity growth increased by 1 percent per year to 2.5 percent in the late 1990's compared with 1.5 percent in the early part of the decade. Total factor productivity increased from 0.32 percent a year in the first half of the 1990's compared with 0.99 percent a year between 1995-1998 (Jorgenson and Stiroh, 2000). What is even more important is where that technical change took place (table 1). The largest contributions to TFP growth between 1958-96 were, by their order of importance: trade, electronic and electric equipment, agriculture, industrial machinery and equipment, transport and warehousing, communications, and food products. Industries with a negative contribution to TFP growth in their order of importance were: services, construction, finance, insurance, and real estate, government enterprise, printing and publishing, and petroleum and gas.

While the positive contributors seems related to information technology, the negative ones are harder to understand. How can technological change be un-done, i.e., a negative TFP growth rate? While all of the negative contributors are understandably low productivity growth areas, the negative values are likely to be the result of our inability to capture changes in input and/or product variety, quality over time, for from other structural changes in the sector, such as the presence of fixed costs (Barro, 1998). Services, such as medical care which comprise about 14 percent of U.S. GDP, are notoriously difficult to quantify. However, in spite of the problem with qualitative differences, the negative contributing industries are not likely to be actually experiencing high rates of technical change.

Table 1: Sources of U.S. Economic Growth by Industry, 1958-96

	Output	Contribution of Inputs				TFP	ALP	Domar	Weighted	Weighted
	Growth	Capital	Labor	Energy	Materials	Growth	Growth	Weights	TFP	ALP
Services	4.34	0.84	1.70	0.07	1.92	-0.19	0.92	0.29	-0.06	0.27
Construction	1.43	0.07	0.87	0.02	0.91	-0.44	-0.38	0.08	-0.03	-0.03
Finance, Insurance and Real Estate	3.42	1.14	0.94	0.00	1.52	-0.18	0.66	0.16	-0.03	0.11
Government Enterprises	2.86	1.24	1.08	0.23	0.83	-0.52	0.49	0.03	-0.01	0.01
Printing and Publishing	2.51	0.55	1.20	0.02	1.19	-0.44	0.14	0.02	-0.01	0.00
Petroleum and Gas	0.43	0.61	-0.10	0.06	0.20	-0.44	0.88	0.01	0.00	0.01
Gas Utilities	0.56	0.66	-0.04	0.14	0.05	-0.24	0.94	0.01	0.00	0.01
Tobacco Products	0.43	0.59	0.05	0.00	-0.01	-0.20	0.88	0.00	0.00	0.00
Lumber and Wood	2.24	0.21	0.33	0.02	1.70	-0.02	1.55	0.01	0.00	0.02
Private Households	3.50	3.55	-0.06	0.00	0.00	0.00	5.98	0.14	0.00	0.86
General Government	1.35	0.60	0.75	0.00	0.00	0.00	0.46	0.12	0.00	0.05
Leather Products	-2.06	-0.11	-1.13	-0.02	-1.08	0.28	2.08	0.00	0.00	0.00
Metal Mining	0.78	0.73	-0.07	-0.07	-0.26	0.44	0.99	0.00	0.00	0.00
Nonmetallic Mining	1.62	0.59	0.18	0.06	0.34	0.46	1.52	0.00	0.00	0.00
Coal Mining	2.35	0.82	0.00	0.06	0.63	0.84	2.32	0.00	0.00	0.01
Other Transportation Equipment	1.31	0.23	0.37	0.00	0.52	0.18	1.00	0.02	0.00	0.02
Furniture and Fixtures	2.91	0.31	0.58	0.02	1.44	0.56	1.78	0.01	0.00	0.01
Stone, Clay, and Glass	1.86	0.26	0.37	0.00	0.82	0.41	1.30	0.01	0.00	0.01
Primary Metals	1.14	0.13	0.05	-0.03	0.77	0.22	1.51	0.02	0.00	0.03
Miscellaneous Manufacturing	2.53	0.34	0.41	0.00	0.95	0.82	2.08	0.01	0.00	0.01
Petroleum Refining	2.21	0.44	0.24	0.49	0.71	0.33	0.80	0.02	0.01	0.02
Paper Products	2.89	0.50	0.40	0.05	1.51	0.42	1.96	0.02	0.01	0.04
Textile Mill Products	2.23	0.12	0.02	0.01	0.86	1.23	2.54	0.01	0.01	0.02
Apparel and Textiles	2.03	0.24	0.17	0.00	0.82	0.80	2.00	0.01	0.01	0.02
Motor Vehicles	3.61	0.28	0.29	0.02	2.78	0.24	2.28	0.04	0.01	0.09
Electic Utilities	3.22	1.01	0.20	0.67	0.83	0.51	2.52	0.02	0.01	0.05
Fabricated Metals	2.28	0.26	0.28	0.00	1.09	0.65	1.88	0.02	0.02	0.05
Rubber and Plastic	5.17	0.47	1.16	0.08	2.43	1.04	1.94	0.02	0.02	0.03
Instruments	5.23	0.65	1.44	0.03	1.99	1.12	2.57	0.02	0.02	0.04
Chemical Products	3.47	0.74	0.47	0.09	1.58	0.58	2.02	0.04	0.02	0.09
Food Products	2.20	0.21	0.18	0.00	1.27	0.54	1.59	0.05	0.03	0.08
Communications	5.00	1.62	0.53	0.02	1.95	0.88	3.93	0.04	0.03	0.14
Transport and Warehouse	3.25	0.20	0.72	0.12	1.34	0.86	1.74	0.06	0.05	0.10
Industrial Machinery and Equipment	4.79	0.52	0.75	0.02	2.04	1.46	3.15	0.04	0.06	0.13
Agriculture	1.70	0.19	-0.13	-0.04	0.51	1.96	3.21	0.03	0.07	0.11
Electronic and Electric Equipment	5.46	0.76	0.65	0.03	2.04	1.98	4.08	0.04	0.07	0.15
Trade	3.66	0.62	0.83	0.04	1.19	0.98	2.49	0.18	0.18	0.46

Source: Jorgenson, Dale W., and Kevin J. Stiroh. "Raising the Speed Limit: U.S. Economic Growth in the Information Age." Unpublished from Website, May 1, 2000, pp. 62 with modifications.

On the other hand, the industries with high contributions to TFP growth are examples of where technical change is related to the information revolution. Electronic and electrical equipment, industrial machinery and equipment include both computer manufacturing and chip manufacturing. The large contributions to TFP growth of the trade sector, agriculture, transport and warehousing, and food industries are all examples of industries that have exploited information technology.

Using data from the United States Bureau of Labor Statistics (BLS) also provides some insight into the source of increasing productivity growth in the United States (table 2).

Table 2: Productivity and Costs: Selected Manufacturing Industries, 1987-96*

SIC Code	Industry	Employment	Output per hour	Output	Unit Labor Costs
357	Computer and Office Equipment	376	37.5	43.1	-25.3
254	Partitions and Fixtures	88	24.6	31.2	-1.6
367	Electrical Components and Assessories	650	18.6	27.4	-14.5
274	Miscellaneous Publishing	88	22.3	25.9	0.8
366	Communication Equipment	277	16.1	18.7	-2.8
252	Office Furniture	65	10.8	18.5	-6.7
374	Railroad Equipment	34	23.5	17.8	-8.6
226	Textile Finishing except wool	68	18.8	17.2	-9.5
391	Jewelry, Silverware, and Plated Ware	49	14.3	15.6	-2.5
272	Periodicals	136	12.3	15.3	11.6
394	Toys and Sporting Goods	111	16.4	14.5	-7.4
372	Aircraft and Parts	501	0.9	12.4	-1.0
371	Motor Vehicles and Equipment	986	8.7	11.0	-4.3
321	Flat Glass	17	6.0	10.8	-7.7
289	Miscellaneous Chemical Products	94	9.2	10.6	-0.9
352	Farm and Garden Machinery	105	2.8	10.5	-0.5
353	Construction and Related Machinery	243	6.9	10.5	-0.1
286	Industrial Organic Chemicals	138	14.0	10.2	-12.3
	Total/Average	4,069	13.8	18.4	-6.7

*'Source: Table 1, Productivity and Costs: Manufacturing Industries, 1987-96, BLS, May 26, 2000.

Computer and office equipment had an annual growth rate in output of 43.1 percent and in terms of output per hour of 37.5 percent for the decade of 1987-96. Electrical components and assessories had an annual growth rate of 27.4 and a growth rate in output per hour of 18.6 percent. The former industry produced computers while the latter produced computer chips. Unit labor costs also declined dramatically by 25.3 percent and 14.5 percent per year. The decline in unit labor costs also resulted in rapid declines in the price of computers and computer chips. Computer prices fell 28 percent a year between 1995-98 compared with 15 percent per year between 1990-95 (Jorgenson, p. 3). Effectively, high rates of technological change in the design and production of semi-conductors spill-over in terms of level effects in other sectors, such as computers, by lowering unit component cost. The result is to employ more labor and other resources to produce computers of higher capacity at lower cost. All else constant, no change has occurred in the rate of TFP growth in computer construction, per se.

The impact of dramatic price declines in the computer industry has resulted in the rapid growth of the industry. That rapid growth, rather than declining over time, continues to be a driving force in the overall growth of the U.S. economy. The rapid decline in computer prices has lead to the expected substitution of computers for other capital inputs. The rapid growth also has the cumulative effect of increasing the importance of the computer and related industries as a share of the U.S. economy. Thus while computer inputs contributed less than one-tenth of one percent to U.S. growth between 1959 and 1973, the growth contribution of computers increased to 0.46 percent per year in the late 1990's. Furthermore, software and communications equipment contributed an additional 0.3 percent to growth in the late 1990's (Jorgenson, p. 2). Thus the combined direct impact of the information industries added almost 0.8 percent to the growth of the U.S. In the years to come, as these industries continue to increase their share of the U.S. economy, their contribution to growth will increase further.

Note that the identities of the growth accounting exercise do not link the rate effects of growth in factor productivity to the level effects. The contribution to growth from changes in the level of labor, capital and other inputs are directly related to growth in factor productivity. If an economy can be adequately stylized by a either a neo-classical or Romer (1990) type growth model with transition dynamics as Robertson (1998) and Lin and Roe (1999) have shown, then the transition contribution of the level effects of changes in inputs can be "extracted" from the growth accounting exercise. Robertson (1998) finds that capital's contribution to growth in the US GDP in 1992 was about 92 percent because the economy was in long-run equilibrium and only the remaining 8 percent was due to the transition. However, it appears that since about 1995 that the US economy is "farther from" its long-run equilibrium than it was in the early 1990s. If so, the above growth accounting exercises tend to underestimate the contribution of growth in factor productivity and overestimate the contribution of growth in input levels to growth in GDP. Moreover, the growth accounting exercises do not account for changes in level effects that are due to the cost reductions obtained from the out-sourcing of intermediate factors mentioned above.

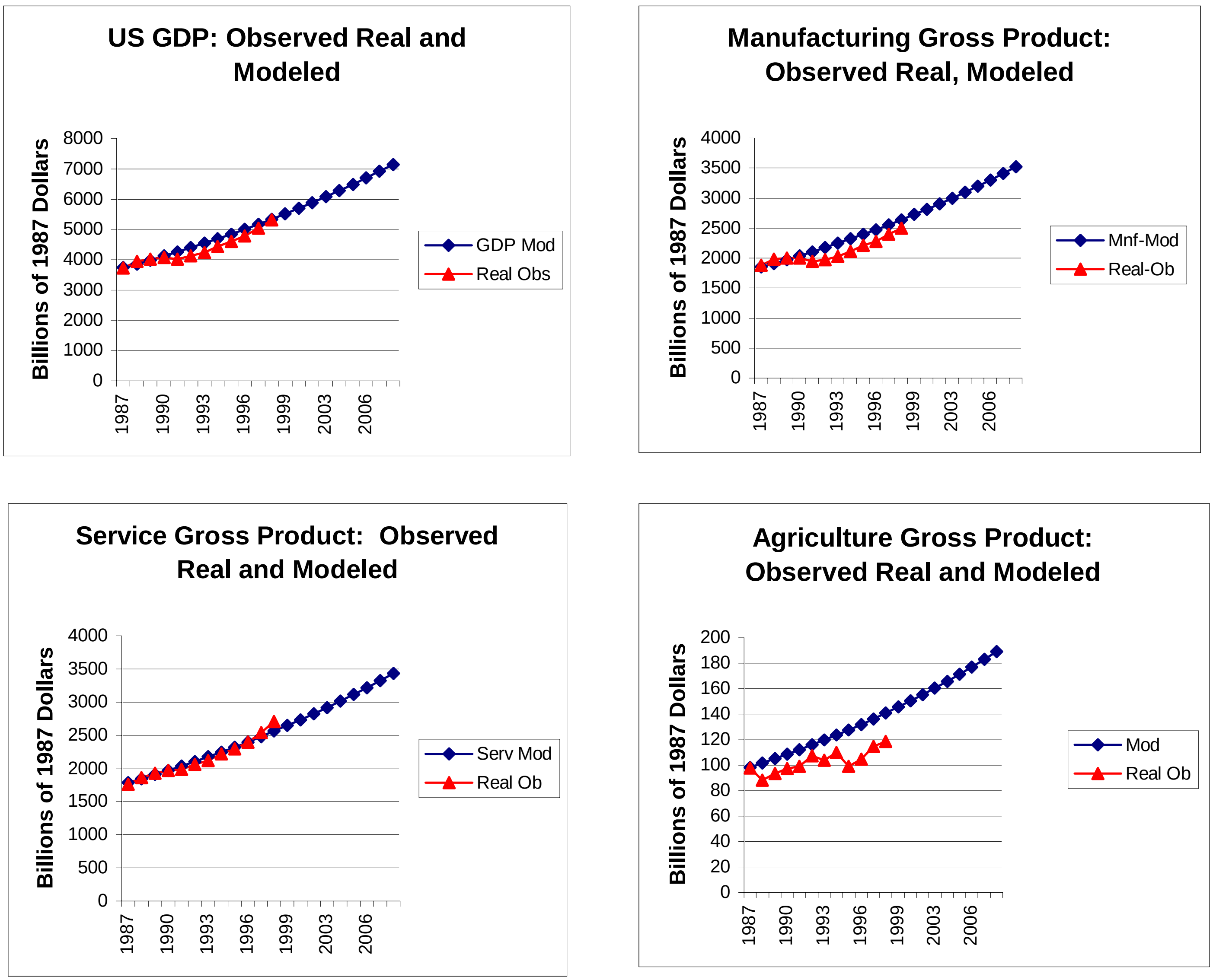
While it is beyond the scope of this paper to model these complicated effects, some insights can be provided by showing whether and to what extent the US economy deviates from a path that a model would predict in the absence of technological spillovers and scale economies. To this end a three sector neo-classical growth model was calibrated to the path of the U.S. economy for the year 1987. The model is discussed in Roe (2000). The model is of the Ramsey-Cass-Koopman's variety with infinitely lived households, three factors of production (labor, capital, land) and three goods, a home good, an agricultural good, and the rest of the economy. Labor and capital are mobile, while land is sector specific. Capital and land are the two assets in the model. Each sector of the economy is permitted to have a different rate of growth in TFP with TFP in agriculture exceeding that of the rest of the economy, as shown in the data. The rest of the economy, and agriculture are open, but foreign (domestic) households are not permitted to have claims on other country assets. Rates of growth in factor productivity, and factor shares are taken from Jorgenson (2000) except that data on sectoral total factor productivity (TFP) growth rates were computed for the years 1987-1992. The rate of time discount and other parameters are taken from various other sources (see Roe, 2000). The results of this exercise are shown in Figures 2 and 3.

Notice that the model predicts beyond the 1987 year reasonably well for a dynamic "calibration model." However, note importantly for purposes here that the rate of growth of observed real US GDP (i.e., the slope of observed real GDP) out performs the model following the 1990-93 down turn in the economy. This higher rate of growth is caused by the service sector, and by the manufacturing sector. Agriculture, being less than 2 percent of the economy appears to suffer price or weather shocks. Otherwise its rate of growth in gross output is roughly equal to that forecast by the model.

Focus next on the service and manufacturing sector shares (fig. 3). Data show a marked upturn (down turn) in the service (manufacturing) sector share starting in about

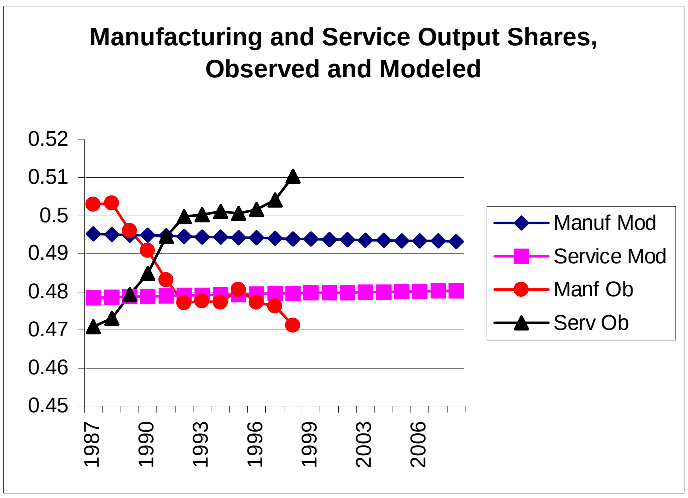
1995-6 which the model does not capture well. In the second panel of Figure 3, the model's parameters are altered to increase its rate of convergence to the steady state, although this causes a deterioration in its ability to predict levels (not shown). The results obtained still cannot match the share data, although the direction of changes in shares is improved

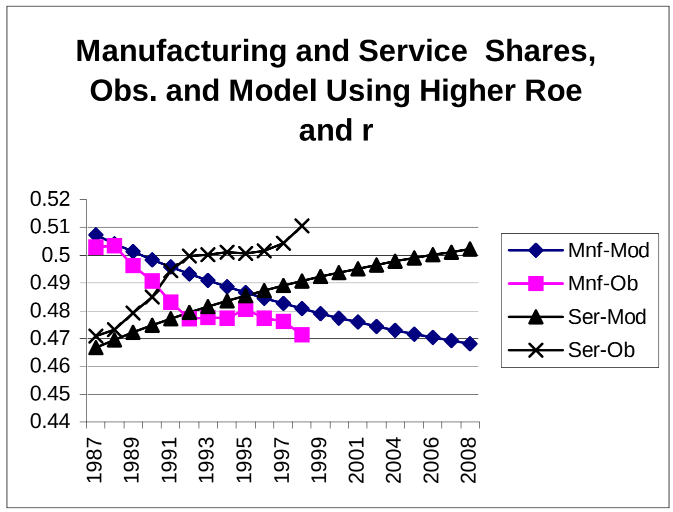
Figure 2: Basic Results



Clearly, these results suggest that the US economy is experiencing positive TFP shocksthat are driving the economy farther from its long-run equilibrium. As a consequence, the proportional contributions of changes in input levels to growth in GDP are almost surely being overestimated by Jorgenson et al and by others. The

Figure 3: Shares of Output





implication is that the contribution of growth in TFP is even larger than suggested in these studies.

What Impact Will the New Economy have on the Global Economy?

The evidence examined in the last section led to the conclusion that the United Stated economy is, indeed, benefiting from the productivity gains encompassed in the “New Economy”. Based on preliminary estimates for a relatively short time period, the base non-inflationary growth rate for the U.S. economy is now anywhere from 0.5 to 1 percent higher than it was during the period 1980-1995. The issue we want to turn to now is whether the developments in the information economy that have had such profound impacts on the United States are likely to have similar impacts on other countries around the world. In this next section, attention is placed on why some countries are likely to benefit while other may be left behind.

The answer to the question of global impacts of the information economy critically depends on the degree of technological transfer and spillover from the United States to other countries, or more generally, from nations in which the dominant share of the world's stock of knowledge resides to other nations. Is there evidence that the transformations taking place in the United States is impacting other countries?

First, what is happening in the United States with regard to spillovers is relevant. The evidence from Jorgenson is both convincing and troubling. While the growth of the computer industry has demonstratively generated technological change as measured in overall TFP in the United States, the issue of the benefits to industries which use information technology is less clear. As he states:

> "…rewards from new technology accrue to the direct participants; first, to the innovating industries producing high-tech assets, and second, to the industries that restructure to implement the latest information technologies. There is no evidence of spillovers from production of information technology to the industries that use this technology. Indeed, many of the industries that use information technology most intensively, like finance, insurance, and real estate, and services, show high rates of substitution of information technology for other inputs and relatively low […or negative…] rates of productivity growth." (Jorgenson, p. 4)

If Jorgenson's generalization is extended on a global basis, then the expectation is that the benefits of information technology will flow mostly to countries with direct involvement and less to others that only use information technology. Thus, the first preliminary hypothesis is that the information revolution is likely to have less impact on follower countries than on primary development countries. Current evidence suggest that in addition to the United States, Canada, the UK, Australia, and India have heavy involvement with the evolution of information technology. They are thus likely to show lagged increases in TFP which mirror those in the United States.

There are three primary ways that information technology can be transferred across boarders. It can be captured as embedded capital in the purchase of imported capital and inputs. It can be transferred as know-how through foreign direct investment. And it can be learned or decoded from the imports. There is evidence that each of these mechanisms leads to increases in productivity growth in the receiving country.

Before turning to the evidence on the transfer and spillover effects through these mechanisms, let's first consider the theoretical underpinnings for generating technical transfers and spillovers.

Theoretical Arguments

The basic theories underlying the empirical studies which will be sited are rooted in models of endogenous growth in open economies. There are two main mechanisms for knowledge accumulation. Trade may change a country's pattern of specialization toward goods with higher learning potential (Krugman, 1997, Lucas, 1993). Trade may also lead to importing new inputs with higher levels of embodied technology. The former suggest that knowledge is increased domestically while the latter suggests that trade is a vehicle for encouraging knowledge to be transferred internationally.

The domestic model is a variant of the “learning by doing” formulation. Managers and workers learn by participating in the manufacturing process. In the international model, the access to higher technology inputs and processes leads to technical change. Trade, especially the import of a large variety of technical inputs, foreign investment, and travel by executives can all lead to technical transfer and productivity increases. With regard to the issues of the transfer of knowledge industries, participating in the production of computers, computer chips, software development and the Internet can all lead to technical transfer of major proportions.

The potential mechanisms for the transfer of knowledge can be quite different. In the first instance, through the direct transfer of purchase of knowledge based inputs, the transfer is carried through the market, including, licensing, contracting, joint ventures and so forth. The country importing goods and intermediate factors that embody a relatively high research and development (R&D) content can decode, extract and extend that knowledge content depending, largely, on the level of own human capital. Since the goods and intermediate factors containing the highest shares of embodied R&D are likely to emanate from countries endowed with a relatively high stock of technical knowledge, i.e, Western and European countries, it is likely that technological spillovers from the imports from these countries is higher. Knowledge transferred through direct foreign investment is likely to embody process technologies as well.

Given free or low cost access to information, travel by executives and/or high tech personnel, knowledge can be distributed at very low cost, as a pure spillover. With access to the Internet, and to public research in developed countries, the productivity impact is likely to be larger than in just the trade of knowledge intensive inputs.

Grossman and Helpman (1991) conjecture that industrial economies rich in human capital will undertake more research and thus grow faster. By opening their economies and stimulating international trade, developing economies can obtain a variety of technologically sophisticated inputs, and also participate in knowledge based industries which will result in higher growth rates. One might even propose that during the transition phase, those developing countries that maximize this strategy would experience extremely high rates of economic growth. Diao et al (1999) find empirical evidence supporting this view. For example, that Japan pursued such a strategy during the 1970s and 1980s by biasing (relative to free trade) its trading pattern to encourage imports of intermediate factors from countries with relatively high levels of technical knowledge embodied in their exports.

Thus it is through these mechanisms that the endogenous growth literature with opened economies holds out the promise that the information revolution embedded in the “New Economy” can and will be result in significant growth benefits for countries outside of the United States. It will be argued in the next section that countries that maximize this strategy are more likely to experience higher rates of economic growth, while countries that continue to resist openness in the face of the new economy developments will continue to lag behind. The result is likely to be an increase in income inequality across countries. The latter countries, in this situation, are also likely to face deterioration in their terms of trade, thus suffering from other negative level effects on growth.

Importing Technology

Coe and Helpman (1995) establish an empirical connection between international R&D spillovers and economic growth by estimating how much variation in TFP for a sample of OECD countries is explained by variations in domestic and foreign R&D stocks. Foreign R&D stocks are defined as the import share-weighted average of trading partners' domestic R&D capital stocks. The impact of foreign R&D is expected to be positively related to the trade composition of the country's trade with higher outcomes expected if a country imports from high R&D countries. Thus if the overall R&D stock of a country increases, the R&D intensity of its imports also increases. Through trade, a country can gain access to another country's R&D stock, enabling the importing country to introduce new production designs at lower cost. Coe and Helpman (1995) find that both the foreign and domestic R&D increases TFP. For large countries, the domestic component is more important, while for small open countries the foreign component is more important. These results for OECD countries were confirmed for developing countries in a later study by Coe, Helpman, and Hoffmaister (1997). They found that East Asian countries have benefited most from foreign R&D. The implication is that foreign R&D is critical for developing countries economic growth and that openness to and trade with industrial countries is a critical dimension of development success.

Clearly, the kind of imported products should impact on the degree of productivity transfer. Imports of consumer goods should have less impact than imports of investment goods. Wolfgang Keller (2000) focuses on this issue and consistent with Coe and Helpman shows that both domestic and foreign R&D stocks positively impact on TFP. Eaton and Kortum (1996) estimate that 90 percent of growth in small OECD countries derives from foreign innovations.

Foreign Direct Investment

The evidence on the impact of foreign direct investment (FDI) on domestic TFP growth is mixed. More than 80 percent of royalty payments for international technology transfers were made from subsidiaries to their parent firm (UNCTAD, 1997). Multinational firms are most often found in industries with high R&D expenditures relative to sales, a large research organization, rapid product innovation, technical complexity, and a high level of product differentiation. Knowledge is more mobile than tangible assets and is non-excludable implying that the use in one application does not preclude the use in other applications or locations.

Multinational technical transfer does not necessarily imply a benefit to the local economy. For such a benefit to occur there must be spillovers. These could occur in many ways: employees moving from foreign subsidiaries to domestic firms, linkages between foreign subsidiaries and domestic firms, and imitation effects. Caves (1974), Globerman (1979), and Blomstrom and Persson (1983) find evidence of spillovers at an industry level. Recent studies show more mixed results. Firms with foreign ownership have higher TFP, but there is no evidence that there is spillover to local firms in the short-run. In some instances where there is a limited local market, the local firms actually lose TFP because of a loss of market share. Spillovers will occur when local firms can adapt the technology of the foreign subsidiary and face up to the foreign firm competition.

Exporting

Exporting to foreign markets can be a mechanism for transferring technology. Exporting to a foreign market requires knowledge of that market. Often this involves supplying firms who market and will help no only define the product design, but also help with process technology to manufacture to the requirements of the market. Pack (1993) shows that firms that export are more efficient than firms selling only in the domestic market. Competition in the international market requires firms to be more efficient. Thus it is not clear whether more efficient producers enter the export market or whether firms become more efficient by selling into the international market. Evidence to date is mixed on this. However, in the information sector, there are many firms that produce components on contract with foreign firms. These firms typically both import and export products to a foreign manufacturer. For these firms, it is clear that the technical transfer of process technology is an important component of the contract relationship.

What does the general evidence about technical transfer and productivity growth suggest about prospects for the information technology and growth of the new economy outside of the United States?

There is already a lot of evidence that U.S. computer and software companies use foreign contracting and subsidiaries to produce components of their computers and software. Hong Kong, Malaysia, Taiwan, and China, have large industries based on manufacturing components for U.S. computer makers. India has a major growth industry of providing software development on contract with major U.S. software developers. The expansion of the Internet allows for very rapid communication of new product design and software development. Thus the combination of the information capacity of computers with the communication links of the Internet have reduced the cost of space and time. This is particularly true for information related industries where the product value is independent of its weight and dimensions.

The key issue is what are the preconditions for participating in the information revolution and the global new economy. In other words, who will gain and who will be left behind? We move to that issue in the next section.

Who will be Left Behind?

One of the most pervasive patterns observable in the modern global economy has been the widening of income differential both within countries and between countries (Shane et al, 2000). As with all international phenomenon, the issue of openness to international trade and investments is a key to understanding who benefits and who loses from the internationalization of the information revolution.

Many (e.g., Baldwin and Martin, 1999, Sachs and Warner, 1995) have suggested that the world is entering its second wave of globalization. The first began with the industrial revolution and reached its high around 1914. The second wave started roughly in the early 1960s. The wave is associated with historically unprecedented rates of economic growth in many countries around the world. The result has been the lifting of a larger proportion of the world's poor from poverty than at any previous time in history. Whereas the first globalization tended to lead to a deindustrialization of the South, the second wave seems to be leading to a reindustrialization of at least part of the South. The superficial similarities between the two waves involved the share of GDP in trade and capital flows, and substantial reductions in technical and policy barriers to international transactions. The fundamental differences involve the initial conditions and the underlying economic forces driving the second wave. It is the nature of these forces and their apparent strengthening that leads to the conjecture that the gains from trade liberalization in developing countries will yield far greater benefits to long-run economic growth in per capita income than had the same reforms been initiated as recently as the Uruguay Round.

One fundamental difference between the two waves lies in the impact that the reduction in the cost of international exchange of ideas, product, and process technology has on economic growth. Accompanying this reduction in costs, is the fundamental change in cost structures which information technology companies face. The marginal cost of knowledge production and exchange appears to be falling relative to fixed cost. Together, these changes have given rise to growth in many middle and lower income countries' real income per capita in two ways. First, these changes have induced growth in country's total factor productivity that is directly linked to technological spillovers from foreign trade (Coe et al, 1997). These spillovers flow from developed countries, which posses the major stock of the world's technical knowledge, to developing countries. Second, higher returns to a country's resources accrue because these changes induce out-sourcing from developed countries to better accommodate the factor services that developing countries have in relative abundance. Countries that recognize these potential gains, and whose institutional environment can be changed at a relatively low cost to accommodate these changes, are likely to experience the largest gains. Others are likely to only experience gains if the terms of trade turn in favor of their primary commodity exports. The above conjecture is more likely to be the case to the extent that the fundamental forces driving the second wave of globalization are stronger and more prevalent today than they were at the time to the Uruguay Round.

This leads us back to the role of policy as a critical factor is determining the winners and losers from the information revolution. It has been shown that the trade orientation of a country is a critical determinant of the success of that country in achieving high levels of economic growth (World Bank, 1996). Why is it that Korea and Indonesia had the same per capita incomes in 1960, but today Korea has a per capital income which is 7 times that of Indonesia. Korea with the encouragement and support of the United States radically transformed its domestic policy from a highly inward to a highly outward orientation. That redirection of policy in Korea led to a process of technical transfer through the mechanisms discussed in the previous section that resulted in rapid sustained economic growth of unprecedented rates. Indonesia, on the other hand, followed highly inward oriented policies until quite recently. It was that difference in policy orientation rather than resource base, capacity of the work force, or any other factor which in its long term consequences explain the difference.

We are in the early stages of an information -digital processing- revolution, which will dramatically transform every aspect of how we live and work. The pace of change is accelerating. Leaders of the countries around the world have a strategic decision to make. Are they going to be part of this revolution or are they going to stay behind? The cost of participating in this revolution is increased openness and loss of control over domestic rent seeking. The benefits of joining are rates of economic growth, which seemed impossible just a few short years ago. As surprising as it may seem, a substantial number of countries will choose to opt out of this revolution. The pace of change is too frightening. The lose of control more than they can put up with. The consequence of these decisions will determine the winners and losers in the international arena. It will determine who moves forward and participates in unimagined growth and wealth creation and who gets left behind.

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