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## **TECHNOLOGICAL DEVELOPMENTS AND THEIR EFFECTS ON WORLD TRADE: ANY IMPLICATONS FOR GOVERNMENTS?**

by

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### **Abstract**

This paper summarizes new developments in world trade, technological changes worldwide, and their reflections on recent theoretical studies in economics. After defining the economic globalization and schematizing of its relations with international trade, economic growth and technological change, dramatic increases in world trade in goods, services and financial assets in last decades are statistically documented in Chapter 2. Theoretical studies of economists on international trade and economic growth are surely affected by the fact that the actual technological developments have strong implications for world trade and output growth. In Chapter 3, this new perspectives in economics are discussed. Last chapter presents some concluding remarks with special reference to the role of governments in the process of technological development within a more and more globalizing world economy.

**Key Words:** Technological development, international trade, new trade and growth theories, technology policy, education policy, health policy

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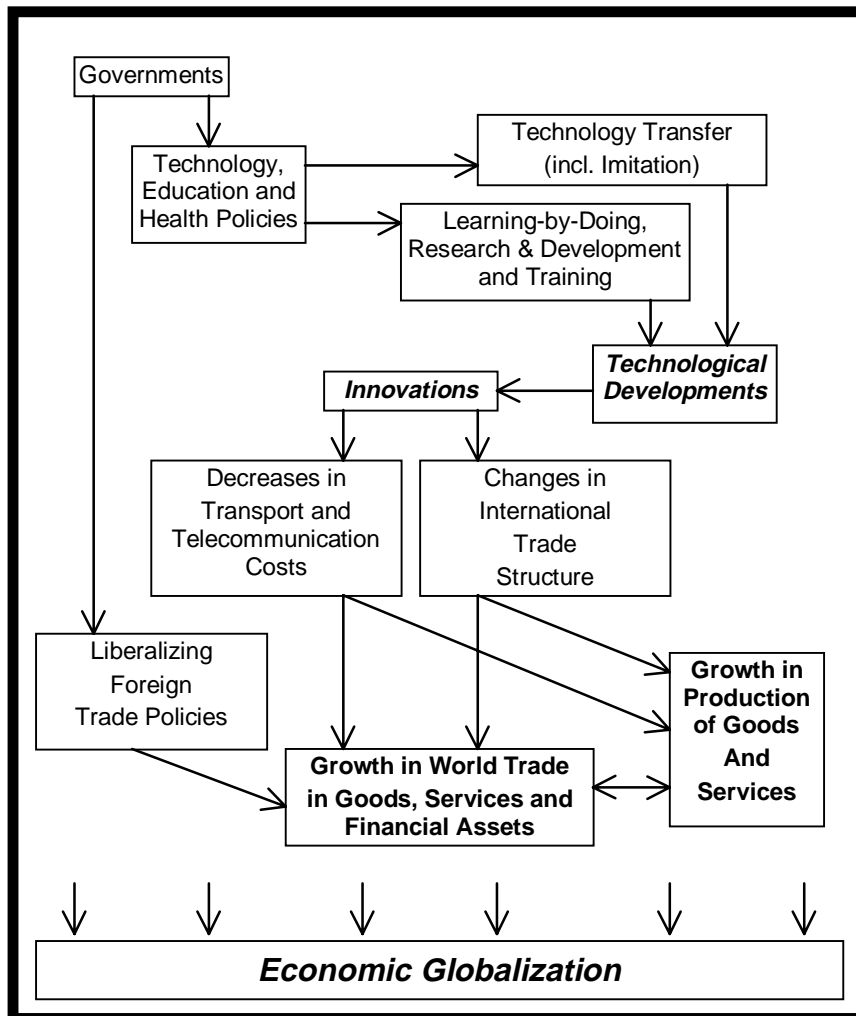
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**1. Introduction**

*Economic globalization*, as defined by the Staff of the International Monetary Fund (IMF) in *World Economic Outlook* - May 1997, p. 45, refers to the growing economic interdependence of countries worldwide through the increasing volume and variety of cross-border transactions in goods and services and of international capital flows, and also through the more rapid and widespread diffusion of technology. Both *the new technological advances* which have sharply reduced transportation and telecommunication costs and dramatically changed the structure of international trade in the same time, and worldwide *efforts to liberalize foreign trade* in goods, services and financial assets foster the growth in global trade in last decades as schematized in Figure 1. That is, new or improved technologies lower the *natural* barriers of space and time that separate national markets while liberalization policies the *artificial* barriers to the international movement of goods, services and capital.

Furthermore, the spillover effects resulting from technological innovations that increase international trade in the world are one of the fundamental sources of output growth. The former effect is discussed in the framework of the so-called *new international trade theories* while the latter in that of the *endogenous growth theories*. Additionally, the growth stimulating effects of trade are a common topic both for new trade and growth theorists.

**Figure 1: Fundamental Sources of Economic Globalization**  
 (Relations between Technological Development, World Trade and Output Growth)



As shown in Figure 1, technological developments may be accepted as the engine of the economic globalization in the world. Therefore, it is actually crucial how we define the concepts of *technological development* and *innovation* in order both to understand and comment the recent developments in the world economy.

*The level of technology*, broadly speaking, can be defined as a stock or a combination of our knowledge and experiences on production process, product quality, organization of production and management, marketing and services (Kibritçioğlu, 1997). Technological change or development refers then to the improvements or increases in the "level" of technology.

*Innovations*, on the other hand, are that sort of technological changes which are really putted into practice by firms. In this sense, every innovation is a technological development, but not vice versa. One can differentiate at least two sorts of innovations: *process innovations* and *product innovations*. Process innovations or unit cost reductions caused by technological change induce increases in output quantity keeping the product quality and the quantities and qualities of inputs the same. The latter includes then only the quality improvements by outputs.

The sources of technological progress - no matter what sort of innovations are considered - can be separated in two groups, internal and external sources. Under externality of sources, I understand that they are external to the relevant firm. This is *technology transfer* or *imitation*. Internal sources mainly cover *learning by doing* (experience or time economies), *research and development*, and *training activities* within the firm.

This paper summarizes new developments in world trade, technological changes worldwide, and their influences on recent theoretical studies of economists. Next chapter departs from the definition of economic globalization and the schematic presentation of its relations with international trade, economic growth and technological change (Figure 1) in this introductory chapter. Dramatic increases in world trade in goods, services and financial assets in last decades are statistically considered also in Chapter 2. Recent theoretical studies of economists on international trade and economic growth are surely affected by the fact that actual technological developments have strong implications for world trade and output growth. In Chapter 3, this new perspectives in economics are

discussed. Last chapter presents some concluding remarks with special reference to the role of governments in the process of technological development within a more and more globalizing world economy.

## **2. World Trade and Economic Globalization: Some Stylized Facts**

Along the 1980s and 1990s, the extent of globalization in the world economy has increased remarkably. The figures in Table 1 state that both the production of goods and services in real terms has risen about 25 % between 1985 and 1995. However, global trade in goods in terms of values has increased 157 % which was a combination both of a price effect (44 %) and a quantity effect (79 %). It should be noted that the last growth rate is nearly three times higher than the growth rate of production. In the same time, the rise in the value of world exports of commercial services was more than 200 %.

Table 2 shows the sectoral breakdown of world exports of goods in 1994. Most of the goods exported worldwide originate from the manufacturing sector. This is also the case in Turkey. By focusing on the direction of world merchandise trade as seen in Table 3, we conclude that (1) the largest share of world exports of goods belongs to industrial countries, (2) the largest share of global imports of goods is also realized by industrial countries, and (3) industrial countries' exports is at a broad extent directed to other industrial countries while developing countries' exports is also mostly oriented to industrial countries.

**Table 1: Development of World Trade in Goods and Services**

	Index Values (1985=100)		
	1985	1990	1995
Real World GDP	100.0	117.6	124.7
World Production of Goods (total)	100.0	116.3	124.4
Agriculture	100.0	109.9	117.6
Mining	100.0	116.3	129.1
Manufacturing	100.0	119.0	126.2
Value of Exports of Goods (total)	100.0	178.6	257.1
Agriculture	100.0	158.7	222.2
Mining	100.0	113.6	120.5
Manufacturing	100.0	204.1	310.2
Volume or Quantity of Exports of Goods (total)	100.0	133.3	178.7
Agriculture	100.0	111.1	138.9
Mining	100.0	126.6	157.0
Manufacturing	100.0	138.9	190.3
Unit Value of Exports of Goods (total)	100.0	133.3	144.0
Agriculture	100.0	142.9	160.0
Mining	100.0	90.1	77.5
Manufacturing	100.0	147.1	163.2
Value of Exports of Commercial Services* (total)	100.0	208.2	306.6

\* Commercial exports = sum of services like tourism and transportation (excl. State services).

Source: WTO, *Annual Report 1996*, Geneva.

**Table 2: World Exports of Goods and Services (1994)**

	Exports Values and World Shares in 1994		
	Total Exports (billiards \$)	Share as a Percentage of Total Exports (%)	Share as a Percentage of Sectoral World Exports (%)
Value of World Exports of Goods (total)	4 107.0	100.00	100.00
Agriculture	492.6	11.99	100.00
Mining	439.1	10.69	100.00
Manufacturing	3 052.2	74.32	100.00
Value of Turkish Exports of Goods (total)	18.1	0.44	0.44
Agriculture	2.5	0.06	0.50
Mining	0.3	0.01	0.06
Manufacturing	15.4	0.37	0.50
Value of World Exports of Comm. Services*	1 036.8	100.00	
Value of Turkish Exports of Comm. Services*	10.7	1.03	

\* Commercial exports = sum of services like tourism and transportation (excl. State services).

Sources: WTO, *Annual Report 1996*, Geneva; Central Bank of Turkey, *Electronic Data Distribution System*, Ankara.

The picture presented in Table 3 for a specific year, namely 1994, is surely a result of changes since many years. Table 4 shows annual average growth rates for merchandise trade of different country groups in the period of 1983-1994. It implies that developing countries' exports are slightly shifted from industrial countries to other developing countries.

The world trade matrix for goods in Table 5 underlines most important export sector and market combinations for each exporting country group in 1994. In all countries, the primary export sector is manufacturing industry, except the Middle Eastern and African countries which are relative resource abundant and hence, export mainly mining sector products or oil.

The sectoral breakdown of the world manufactured exports according to four technological categories<sup>1</sup> and its change from 1980 to 1996 are presented in Table 6 and 7. They show that the pattern of world manufactured exports is changing in favor of high tech products since the second half of the 1980s, but the trend is slowing down. Additionally, it is observed that the share of developing countries on high tech manufactured exports has risen from 8.1 % in 1980 to 29.8 % in 1996. If we look at the figures in Table 8, we can mainly note that the technological pattern of manufactured exports in Turkey is still dominated by low tech products.

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<sup>1</sup> The classification of manufactured products by technologies from Lall (1998) is as follows: (1) *Resource based*: mainly processed foods and tobacco, simple wood products, refined petroleum products, dyes, leather (not leather products), precious stones and organic chemicals. (2) *Low technology*: such as textiles, garments, footwear, other leather products, toys, simple, metal and plastic products, furniture and glassware. (3) *Medium technology*: mainly automotive products, most industrial chemicals, standard industrial machinery, and simple electrical and electronic products. (4) *High technology*: fine chemicals and pharmaceuticals, complex electrical and electronic machinery, aircraft and precision instruments.

**Table 3: Direction of World Merchandise Trade, 1994 (percentage of world trade)**

Source of Exports	Importing Countries												World Total
	Industrial Importers					Developing Importers							
	USA	EU 15	Japan	Other Ind.	Total	Africa	Asia	Devel. Europe	Middle East	West. Hemi- sphere	Total		
<b>Industrial Countries</b>	9.2	29.7	2.6	6.3	<b>47.8</b>	1.3	9.4	2.6	2.1	3.8	<b>19.3</b>	<b>67.7</b>	
USA	...	2.6	1.3	3.2	7.0	0.2	2.2	0.2	0.4	2.2	5.2	12.2	
European Union (15)	2.9	23.6	0.8	2.4	29.7	1.0	2.6	2.3	1.3	1.0	8.1	38.3	
Japan	2.8	1.5	...	0.5	4.8	0.1	3.8	0.1	0.3	0.4	4.7	9.4	
Other Industrial	3.5	2.1	0.6	0.3	6.4	0.1	0.9	0.1	0.1	0.2	1.3	7.8	
<b>Developing Countries</b>	6.6	7.1	3.2	1.2	<b>18.1</b>	0.6	8.5	1.8	1.0	1.5	<b>13.3</b>	<b>32.3</b>	
Africa	0.3	0.9	0.1	0.1	1.3	0.2	0.1	0.0	0.0	0.0	0.4	2.0	
Asia	3.9	2.7	2.3	0.7	9.5	0.2	7.1	0.3	0.5	0.4	8.5	18.2	
Developing Europe	0.2	1.9	0.1	0.1	2.3	0.0	0.3	1.4	0.1	0.0	1.9	4.2	
Middle East	0.4	0.8	0.6	0.1	1.9	0.1	0.8	0.1	0.2	0.1	1.3	3.5	
Western Hemisphere	1.9	0.8	0.2	0.2	3.1	0.0	0.3	0.0	0.1	0.9	1.3	4.4	
<b>World Total</b>	<b>15.9</b>	<b>36.8</b>	<b>5.8</b>	<b>7.5</b>	<b>65.9</b>	<b>1.9</b>	<b>17.9</b>	<b>4.5</b>	<b>3.1</b>	<b>5.3</b>	<b>32.6</b>	<b>100.0</b>	

Source: WB (1996), *Global Economic Prospects and the Developing Countries*, Washington, DC.

**Table 4: Growth of Merchandise Trade in Nominal Dollars, 1983-1994 (as annual percentage growth)**

Source of Exports	Importing Countries												World Total
	Industrial Importers					Developing Importers							
	USA	EU 15	Japan	Other Ind.	Total	Africa	Asia	Devel. Europe	Middle East	West. Hemi- sphere	Total		
<b>Industrial Countries</b>	8.8	8.6	9.5	8.7	<b>8.7</b>	2.2	12.9	8.5	-0.2	11.1	<b>8.4</b>	<b>8.6</b>	
USA	...	7.1	8.5	10.0	8.5	1.1	11.3	6.7	1.1	12.4	9.5	8.9	
European Union (15)	8.5	8.9	14.4	7.8	8.9	2.3	14.4	10.1	0.2	10.0	7.3	8.5	
Japan	9.6	10.1	...	5.9	9.3	3.3	13.3	-2.4	-4.0	10.6	9.7	9.4	
Other Industrial	8.5	7.2	7.1	9.7	8.0	1.4	11.5	0.6	0.8	5.5	7.1	7.5	
<b>Developing Countries</b>	9.3	6.1	6.2	8.4	<b>7.3</b>	5.3	14.9	3.5	1.4	8.2	<b>10.4</b>	<b>8.1</b>	
Africa	1.5	1.7	0.8	3.2	1.7	8.4	10.7	-1.3	6.0	1.9	6.8	2.5	
Asia	12.7	15.2	10.5	12.2	12.7	8.9	18.2	8.4	3.8	16.4	15.6	14.0	
Developing Europe	14.5	7.0	4.8	9.6	7.5	-3.8	9.2	4.4	-3.0	6.1	7.4	5.4	
Middle East	3.9	-1.3	-1.1	1.6	-0.3	2.5	3.9	-3.0	1.4	-6.2	1.5	0.9	
Western Hemisphere	7.0	3.9	4.8	4.6	5.8	-0.6	11.1	-6.5	-3.0	9.6	6.8	5.9	
<b>World Total</b>	<b>9.0</b>	<b>8.1</b>	<b>7.5</b>	<b>8.6</b>	<b>8.3</b>	<b>3.0</b>	<b>13.7</b>	<b>5.9</b>	<b>0.2</b>	<b>10.2</b>	<b>9.1</b>	<b>8.4</b>	

Source: WB (1996), *Global Economic Prospects and the Developing Countries*, Washington, DC.



**Table 5: World Trade Matrix for Goods (1994, milliards of US\$) \***

		<i>Importers</i>								
		<i>World</i>	<i>North America</i>	<i>Latin America</i>	<i>Western Europe **</i>	<i>CEEC, BR and CIS</i>	<i>Africa</i>	<i>Middle East</i>	<i>Asia</i>	
<b>E x p o r t e r s</b>	<i>World</i>	Agriculture	492.6	56.8	24.8	230.4	18.7	16.8	16.5	122.5
		Mining	439.1	81.4	18.5	171.7	11.8	7.6	6.8	132.0
		Manufacturing	3 052.2	648.9	163.4	1 270.7	84.2	65.7	88.5	701.2
	<i>North America</i>	Agriculture	95.0	24.3	10.8	15.3	1.5	3.2	2.8	36.4
		Mining	45.6	25.3	4.2	6.3	0.2	0.3	0.4	8.9
		Manufacturing	501.6	188.0	76.4	96.7	3.6	5.8	11.9	119.2
	<i>Latin America</i>	Agriculture	48.3	12.1	8.3	17.3	0.9	1.2	1.3	7.1
		Mining	41.9	19.3	9.0	6.4	0.2	0.3	0.2	5.8
		Manufacturing	92.0	56.8	21.0	7.8	0.1	0.8	0.5	4.8
	<i>Western Europe **</i>	Agriculture	213.0	9.2	3.9	162.2	10.6	7.2	6.3	12.3
		Mining	112.8	10.7	0.9	88.0	2.5	1.8	1.7	4.8
		Manufacturing	1 425.6	126.0	39.0	951.3	59.8	41.4	44.0	150.0
	<i>CEEC, BR and CIS</i>	Agriculture	17.5	0.4	0.2	9.7	3.5	0.3	0.5	2.9
		Mining	37.6	1.9	0.2	25.1	7.5	0.2	0.2	2.5
		Manufacturing	64.4	3.9	1.6	35.0	11.1	1.1	2.2	9.2
	<i>Africa</i>	Agriculture	17.5	0.9	0.2	9.9	0.4	2.4	0.5	3.2
		Mining	41.0	10.7	1.1	22.3	0.4	2.3	0.3	4.0
		Manufacturing	24.3	1.9	0.6	14.1	0.2	3.9	0.7	2.9
	<i>Middle East</i>	Agriculture	5.3	0.1	0.1	1.9	0.2	0.3	1.9	0.6
		Mining	90.4	9.8	2.3	19.1	0.5	2.5	3.6	49.3
		Manufacturing	27.4	5.6	0.4	7.7	0.7	0.6	4.6	6.6
	<i>Asia</i>	Agriculture	96.0	9.8	1.2	14.0	1.7	2.3	3.3	60.1
		Mining	69.3	3.8	0.8	4.2	0.4	0.4	0.4	56.8
		Manufacturing	917.0	256.6	24.8	158.1	8.7	12.2	24.6	408.6

Source: WTO, *Annual Report 1996*, Geneva.

\* Shaded cells in this table combines both the most important exports sector and market for the relevant exporting country group.

\*\* EU countries and Turkey are included in this group. CEEC: Central and Eastern European Countries; BR: Baltic Republics.

**Table 6: Technological Breakdown of World Manufactured Exports  
(for selected years and periods)**

		<i>Technological Categories</i>				
		Resource Based	Low Tech	Medium Tech	High Tech	Total
Shares (%)	1980	19.5	25.3	38.6	16.5	100.0
	1985	19.3	23.4	37.3	20.1	100.0
	1990	15.5	23.7	38.5	22.2	100.0
	1995	14.0	22.0	36.9	27.1	100.0
	1996	13.7	21.3	37.2	27.7	100.0
Annual Rates of Growth (%)	1980-1985	2.0	0.7	1.6	6.3	2.3
	1985-1990	10.1	15.3	15.7	17.4	15.0
	1990-1995	6.4	6.9	7.7	13.0	8.6
	1995-1996	-0.2	-0.9	3.0	4.5	2.1
	1980-1996	5.7	6.9	7.8	11.6	8.1

Source: Calculated by Lall (1998) from UN Comtrade data.

**Table 7: Technological and Geographical Breakdown of  
World Manufactured Exports (1980-1996, in %)**

		<i>Technological Categories</i>				
		Resource Based	Low Tech	Medium Tech	High Tech	Total
Annual Rates of Growth (%)	World	5.7	6.9	7.8	11.6	8.1
	Industrial Countries	5.2	5.9	7.2	9.8	6.6
	Developing Countries	7.4	12.6	17.4	21.1	14.0
	Developing less Industrial	2.2	6.7	10.2	11.3	7.4
Developing Country Shares (%)	1980	17.9	15.0	3.0	8.1	9.8
	1996	23.1	34.4	11.5	29.8	23.0
	Change in Share	5.2	19.4	8.6	21.7	13.3

Source: Calculated by Lall (1998) from UN Comtrade data.

**Table 8: Technological Breakdown and Development of Manufactured Exports of Turkey (for selected years and periods)**

		<i>Technological Categories</i>				
		Resource Based	Low Tech	Medium Tech	High Tech	Total
Shares (%)	1985	22.0	62.3	13.4	2.3	100.0
	1996	17.5	63.9	12.8	5.7	100.0
Annual Rates of Growth (%)	1985-1990	6.4	13.5	3.2	27.5	11.3
	1990-1996	11.5	10.2	17.9	16.4	
	1985-1996	9.1	11.7	11.0	21.3	11.4

Source: Calculated by Lall (1998) from UN Comtrade data.

### 3. Technological Development and New Trade and Growth Theories

Main characteristics of modern economic globalization summarized in the previous chapter of this study have strong reflections on the theories of international trade and economic growth developed in the last three decades.

The works of Posner (1961), Hufbauer (1966), Vernon (1966) and others in the 1960s have led to the rediscovery of the importance of technology in foreign trade and international investment. "New" theories of international trade (NTTs) developed by economists such as Grubel, Lloyd, Greenaway, Aquino, Tharakan, Brander, Spencer, Krugman, Helpman, Grossman, Eaton and Dixit since the middle of the 1970s can be seen as a fruitful synthesis of the following two ideas: (1) Economies of scale (or increasing returns to scale) is one of the most important sources of international trade and specialization, (2) Issues of industrial organization can be modeled as the outcome of non-cooperative games among firms and possibly other players (Krugman, 1989: 347-349). The latter is the essence of the new industrial organization approach of the 1970s.

The NTTs has two interrelated generations. *The intra-industry trade literature* constitutes the first generation of the new industrial organization and trade theories. Intra-industry trade defined as simultaneous export and import within the same category of a manufacture product in a specific country is a phenomena which may be caused by factors such as product differentiation, economies of scale, border trade (transport costs), structure of consumer preferences, re-exports or intra-firm trade.<sup>2</sup>

NTTs are generally not theory but *policy oriented* since they rely on market failure arguments for protection. Market failure can be a result of the existence of technological externalities or of economies of scale and imperfect competition. Spillover effects or externalities in the process of production of technologies stimulate the discussions on the necessity of protection of domestic high tech industries and restructuring of economies by technological and educational policies. These policies are aimed at production of technological externalities through inducing research and development activities and investing in human capital. By using the assumption of increasing returns to scale and imperfect competition in a game-theoretical framework, the issue of the necessity for protecting domestic oligopolists or monopolists is also discussed. This second generation of new theoretical discussions on international trade is called as *strategic-trade-policy* or *industrial-targeting literature*.

Following the seminal work of Paul Romer (1983, 1986) and thus using the framework of *the new or endogenous growth theory* (NGT) that has too many versions, it is attempted to handle the long-term economic growth problem as an *endogenous or self-sustaining* economic process by either (1) accepting the *endogenity* of technological improvements under the assumptions of *increasing* returns to scale and increasing marginal productivity of accumulated factor(s) of production, or (2) adding the assumption of non-decreasing

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<sup>2</sup> The emergence of intra-industry trade worldwide since the 1960s has played an important role in the process of economic globalization by affecting the commodity and country structure of foreign trade and promoting the increases in the quantity of the international traded goods.

marginal productivity of the "accumulatable" factor(s) of production to the assumptions of *constant* returns to scale and *exogeneity* of technological change.

Main stream endogenous-growth models rely on the existence of technological spillover effects in *research and development* (Romer, 1990; Aghion & Howitt, 1992, 1994; Grossman & Helpman, 1989, 1990, 1991), in *human capital* (Lucas, 1988; Stokey, 1988, 1991; Becker, Murphy & Tamura, 1990; Young, 1991) or in *public technological infrastructure investments* (Barro, 1991), while others such as Jones & Manuelli (1990) and Rebelo (1991) prefer keeping the constant returns to scale assumption and assume that the marginal productivity of accumulated factor is *not decreasing*.

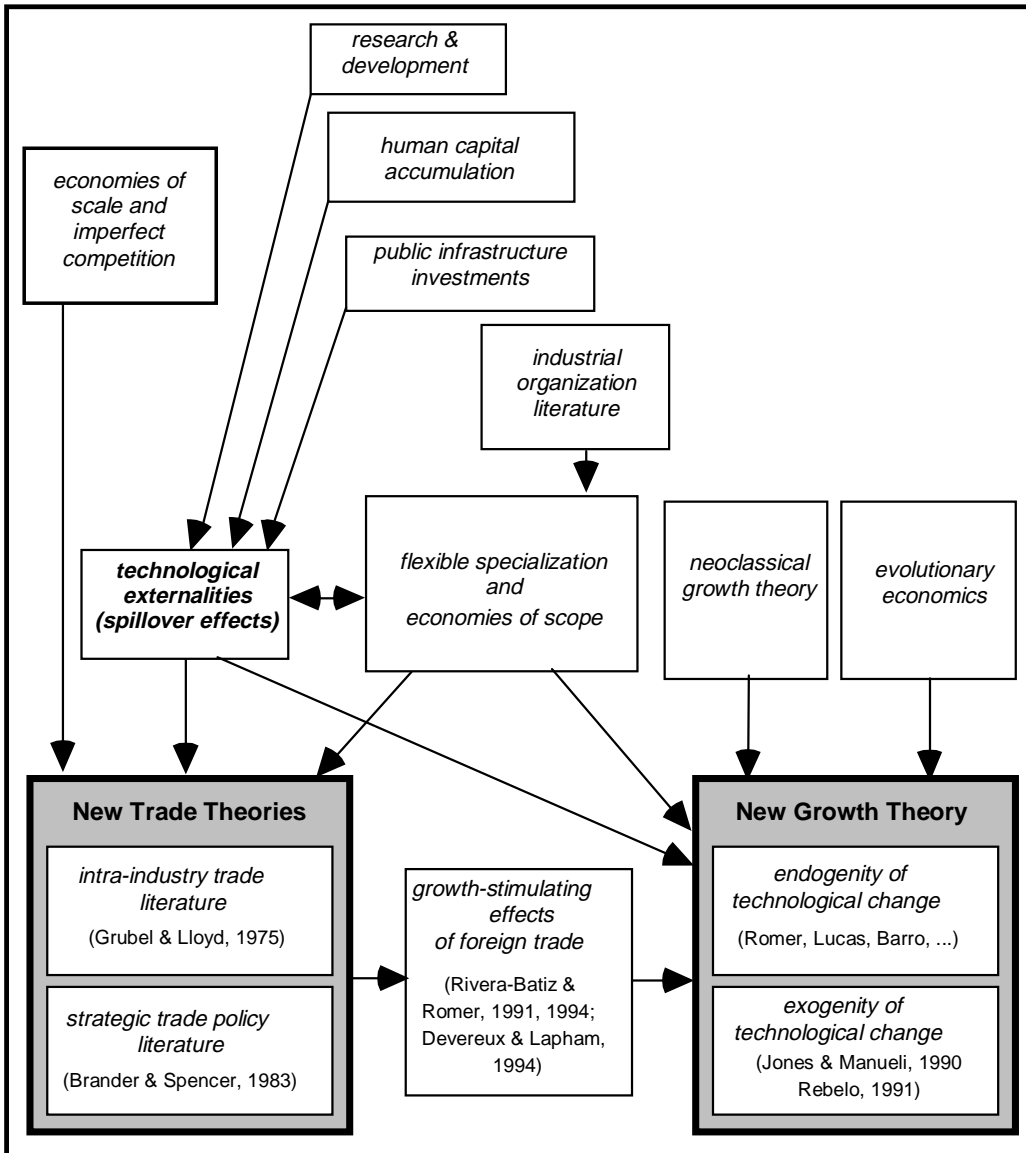
Both new trade and growth theories seem to have a common starting point (see Figure 2). That is the technological development which plays a crucial role in the recent economic globalization in the world. According to the new growth theorists, on the one hand, governments must support accumulation of human capital, extending and improving the technological infrastructure in the country and research and development activities of domestic firms through their coordinated policies of technology, education and health. The strategic importance of this argument bases on the fact that this sort of investments have not negligible spillover effects which ensure the self-sustainability of long-run economic growth.

According to the new trade theorists, on the other hand, technological externalities may be the dominant determinant both in the formation of trade structure and the process of international specialization.<sup>3</sup> Technological gap between industrialized and developing countries as a source of foreign trade, on the other hand, may be closed either due to a greater research & development effort in the less advanced countries or due to the continual dissemination of information from the advanced ones or both.

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<sup>3</sup> For a survey of the literature on relations between international trade and technology please see Cheng (1984).

**Figure 2: Relations between New Trade and Growth Theories**



#### 4. Concluding Remarks

Economic globalization presents economies and policymakers worldwide with both new opportunities and new challenges. It rises (1) productivity of production factors like labor and capital, (2) the degree of competition among firms, (3) average living standards in terms of consumption of goods and services, and (4) international financial flows. Global trade and rising competition, and hence economic globalization, induce worldwide economic growth. But, at the same time, it is also one of the fundamental sources of structural changes such as the sectoral reallocation of resources and relative factor price changes.

Monetary, fiscal and foreign trade policies of governments must accommodate to the *policies of technology, education and health* that are only fruitful in the "very long-run". This argument of an economists may be not new but it is an often overlooked truth because both of the myopia of politicians and unconsciousness of voters particularly in developing countries. International diffusion of advanced technologies due to the imitation of imported goods, the licensing agreements or the foreign direct investments imposes to the governments the necessity to design their trade and technology policies as a whole. Because, both trade and growth are mainly influenced by the level of technology, and then, foreign trade stimulate economic growth worldwide.

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