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RESEÑAS

Electronic Commerce and Developing Countries: a Computable General Equilibrium Analysis

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RESUMEN

Es ampliamente reconocido que el comercio electrónico reduce costos de transacción, incrementa la eficiencia y produce importantes cambios en la administración y los procesos productivos de los negocios. Asimismo, en el ámbito macroeconómico, un creciente número de economistas reconocen que el comercio electrónico *Business-to-Business* puede tener un impacto positivo en la productividad y el crecimiento de los países desarrollados. Este artículo hace un análisis cuantitativo del impacto del comercio electrónico sobre la economía global cuando las economías en desarrollo se atrasan tecnológicamente y cuando alcanzan a los países desarrollados. El análisis se centra en la reducción de costos y asume que el comercio electrónico puede reducir costos de servicios, particularmente, en el comercio al por mayor y por menor, transporte, así como en el sector financiero. Los experimentos se basan en un modelo computable de equilibrio general, el GTAP, de trece sectores y seis regiones. Las reducciones de costos en el sector servicios son simuladas por un crecimiento de la productividad. A excepción de los servicios de transporte acuático, los resultados en general revelan que cuando los países en desarrollo se atrasan tecnológicamente, la brecha entre el ingreso de los países en desarrollo y los países desarrollados se incrementará. Los países en desarrollo perderán bienestar y verán deteriorados sus términos de intercambio y reducidos sus salarios. Los resultados también indican que una convergencia en la productividad del sector servicios ofrece la posibilidad a los países en desarrollo de incrementar su competitividad e incrementar la producción, los salarios y el bienestar.

ABSTRACT

It is widely recognized that electronic commerce reduces transaction costs, increases efficiency and produces important changes in management and production process of businesses. At the macroeconomic level, there is also a growing trend among econo-

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mists to agree that Business-to-Business electronic commerce can have a positive impact on productivity and growth of developed countries. This paper focuses on the quantitative analysis of the impact of electronic commerce on the global economy, when developing economies fall behind technologically and when they catch-up with developed countries. The analysis is centered on cost savings and assumes that electronic commerce can reduce costs of services, particularly, in retail and wholesale trade, transport, financial and business services. Experiments are based on a thirteen-sector and six-region aggregation framework, using a computable general equilibrium model, the GTAP model. Cost savings in services are simulated through a productivity growth scenario. Except for waterway transport services, the results, in general, reveal that when developing countries fall behind technologically, the income gap between developing and developed countries will increase. Developing countries will lose welfare, deteriorate in terms of trade and reduce wages. The results also point out that convergence in productivity in services offers the possibility for developing countries to increase their external competitiveness and increase output, wages and welfare.

INTRODUCTION

The United States, the leading country in electronic commerce, has shown impressive GDP and productivity growth in the 1990s, particular an acceleration of productivity growth in the 1995-2000 period. This acceleration could in part be explained by the intensive utilization of information technology, in particular electronic commerce, which is defined simply as commerce through the Internet. Electronic commerce reduces transaction costs, increases efficiency and produces important changes in management and production process of businesses.

It is expected that European countries would catch-up quickly with the leading country and developing countries, with a certain degree of preparedness, could also converge in productivity with the leading countries.

This paper analyzes the overall impact of electronic commerce on the global economy, when developing countries fall behind technologically and when they catch-up with the leading countries. It assumes that electronic commerce has a direct impact on cost savings of services, particularly, in wholesale and retail trade, financial and business services, and transport services. Experiments are based on a thirteen-sector and six-region aggregation framework, using a computable general

equilibrium model, the GTAP model. Cost savings in services are simulated through a productivity growth scenario.

The paper is organized in eight sections. The first section provides a brief description of cost savings that may result through Business-to-Consumer and Business-to-Business electronic commerce. The second section gives a brief description of the relationships between information goods, traditional goods and market structure. The third section presents briefly some recent studies of the overall impact of electronic commerce on developed countries. The fourth section describes the methodology used. The fifth and sixth sections show the results of two experiments on the outcome when: (a) developing countries fall behind technologically and, (b) developing countries converge in productivity in services sectors. Finally, the last section presents the conclusions.

Electronic commerce and cost savings

It is recognized that electronic commerce will reduce transaction costs, increase efficiency, and produce important changes in management and production processes of businesses.

By linking industries and consumers through the Internet, Business-to-Consumer (B2C) electronic commerce will significantly reduce transaction costs. B2C electronic commerce increases access to information for consumers. It reduces therefore searching costs and allows consumers to find the lowest price for a product or service. B2C electronic commerce also allows producers to reduce entry barriers to a market because the cost of having a website is much lower than the installation of a «brick-and-mortar» firm. Larger number of sellers will increase competition and reduce monopolist profits of firms.

By linking industries and suppliers electronically along the supply chain, Business-to-Business (B2B) electronic commerce will contribute most to reducing costs. It reduces procurement costs because it enables the finding of the lowest supplier prices. It increases efficiency because greater competition among suppliers will reduce monopolistic profits and encourage disintermediation. It also reduces the cost of providing financial services or other services that can be made availa-

ble electronically through the Internet. Moreover, better flow of information reduces inventory stocks.

Garicano and Kaplan (2000) consider that transaction costs can be classified into coordination and motivation costs, and that B2B electronic commerce has the potential to affect both types of transaction costs.

Coordination costs are related to the determination of prices and details of a transaction, to the mutual knowledge of potential buyers and suppliers and to bring them together to conduct a transaction. B2B electronic commerce reduces this type of costs by improving the efficiency of business processes, for example, when a transaction that is normally conducted by phone or fax is made by Internet, or when business processes are redesigned. Coordination costs are also reduced when B2B electronic commerce improves access to direct information, for example, by reducing searching costs of finding suppliers and allowing them to reach more potential buyers at lower cost. B2B electronic commerce also contributes to reduce coordination costs in providing better information concerning the availability, characteristics and prices of products, and obtaining more knowledge on buyers and suppliers.

Motivation costs are related to the costs of informational incompleteness and imperfect commitment. Costs of informational incompleteness are generated when buyers and suppliers do not have all the relevant information to find out whether the terms of an agreement are fulfilled, for example, whether the product provided by the supplier satisfies all the technical requirements of a productive process. B2B electronic commerce reduces these costs through the standardization of products. Costs of imperfect commitments are also generated when buyers and suppliers do not have the ability to bind themselves. Electronic commerce contributes to reduce all these costs in standardizing processes and allowing for an electronic tracing of products.

It is expected that most cost reductions produced by B2B electronic commerce will be in procurement costs. According to Goldman Sachs analysts (1999), it is estimated that in the United States, the percentage saving in cost of inputs that take place in migrating from traditional

procurement systems[1] to B2B electronic commerce varies from 2% for coal to 39% for electronic components. These cost savings are the result of the combined effect of reduction in transaction costs and greater competition among suppliers. Table 1 shows the savings in cost of inputs by industry.

Electronic Commerce and Market Structure

In analyzing the economic impact of electronic commerce, it is worth examining the relationship between the nature of goods or services and the market structure of firms. There are two types of goods or services: traditional and information goods.

For information goods,[2] electronic commerce encourages the formation of oligopolistic markets. As information goods are characterized by high fixed costs and very low variable costs, firms producing information goods will have increasing returns to scale[3] that encourage the formation of monopolies. From the demand side, network effects[4] generated by the Internet will create economies of scale, which in turn create entry barriers and reinforce monopolistic power. Network effects also generate first mover advantage, which may explain why Dot Com firms offering information goods are encouraged to achieve rapid market penetration and become the market standard.

For traditional final goods, B2C electronic commerce can move economic activity closer to the theoretical case of perfect competition, for example, it allows immediate access to information for consumers, reduces transaction costs and barriers to entry. Electronic commerce increases therefore competitiveness and improves the allocation of resources.

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1 They are based on paper, telephone, fax, electronic data interchange (EDI) or value added networks (proprietary networks).

2 Information goods refer to goods that can be distributed in numeric form, for example, software, films, etc.

3 Increasing returns to scale imply that unit costs decrease in the measure that output increases. It has to be noted that the traditional theory assumes decreasing returns to scale.

4 The larger the number of users of an information good, the larger the probability that other people will start using it.

Table 1

Estimated B2B Cost Savings by Industry

Industry	Cost Savings %
Aerospace Machinings	11
Chemicals	10
Coal	2
Communications/Bandwidth	5-15
Computing	11-20
Electronic Components	29-39
Food Ingredients	3-5
Forest Products	15-25
Freight Transport	15-20
Healthcare	5
Life Science	12-19
Machinings (Metals)	22
Media & Advertising	10-15
Maintenance Repair and Operating Supplies	10
Oil & Gas	5-15
Paper	6
Steel	17

Source: Goldman Sachs Investment Research, «B2B: 2B or Not 2B? Version 1.1», November 1999, p. 8.

For traditional intermediate goods, B2B electronic commerce reduces economies of scale. The optimum size of businesses and incentives to vertical integration will decrease. Vertical integration was necessary to ensure better flow of information and low transaction costs. These functions are now ensured by electronic commerce. However, some business models of B2B electronic commerce can encourage the formation of monopolies or monopsonies. On 25 February 2000, General Motors Corporation, Ford Motor Company and Daimler Chrysler jointly announced the creation of a virtual marketplace that would operate as an independent business.

It has to be mentioned that traditional monopolies behave differently than those of information goods. While traditional monopolies reduce production and increase prices to have larger monopolistic profits (markup), monopolies of information goods increase production and adopt price policies to sell to a larger number of clients to cover fixed costs and reap monopolistic profits. Monopolies of information goods accomplish this through the production of various versions of information goods, for example. Shapiro and Varian (1998) identify eleven types of versioning.[5] These versions are variations of the same information good that are destined to different segmented markets, such that they are sold at a high price to those markets that show high preferences for the product and at a low price to those markets that value it less. Shapiro and Varian consider that for information goods, growth is a necessary strategy because only a large volume of production can make the product valuable to the consumer. They suggest that because very few firms can acquire an initial growth advantage on their own to become the standard of the market, firms should form alliances, cultivate partners and ensure compatibility.

[5] They are: delay (real-time vs. delayed information), user interface (elaborated vs. simple interface), convenience (user-friendly vs. hard utilization), image resolution (high-resolution vs. low-resolution quality), speed of operation (high-speed vs. low-speed version), flexibility of use (flexible vs. restricted utilization), capability (more vs. less capability), features and functions (more vs. less features and functions), comprehensiveness (more vs. less comprehensiveness), annoyance (low-price versions use start-up delay and reminders to persuade the consumer to buy the full version) and technical support (with vs. without technical support).

Electronic Commerce and Productivity Growth

Despite the growing evidence of the importance of electronic commerce at the microeconomic level, there have been some doubts about its impact on economic growth. These last years, there was a debate as to whether information technology explains the acceleration in productivity growth. The root of this debate was the fact that the United States, the leading country in information technology and electronic commerce, has experienced impressive GDP growth since 1995. This output expansion has been characterized by an acceleration in productivity growth, very low unemployment rates, low inflation rates, and a reduction of fiscal deficits. This debate was linked to the «Productivity Paradox»,[6] which stated that productivity statistics do not seem to provide any evidence of the impact of computer and information technologies. It is possible to identify three main positions among economists to explain the productivity paradox: (i) there is a mis-measurement problem, (ii) there is nothing paradoxical,[7] and (iii) the observation of positive macroeconomic effects requires decades rather than years as the economy is in a transition process.

Robert Gordon considers that 1.00% of the productivity growth originated from the computer-manufacturing industry and that technological progress acceleration in all other industries is null. He wrote: «For the economy as a whole, extra capital plus growth in computing technical progress constitute the whole of the increase in labor productivity: the contribution from technological progress outside computing is zero».[8]

Nordhaus (2001) evaluated the above Gordon hypothesis and rejected it. Using a new approach to measuring industrial productivity he showed that during the 1996-1998 period, productivity growth in both the new economy[9] and non-new economy sectors grew faster than in the 1977-1995 period. He concludes that productivity growth is wides-

6 In 1987, Robert Solow, professor at the Massachusetts Institute of Technology (MIT) and Nobel prize-winner economist, said that we see the computer age everywhere except in productivity statistics.

7 Economists adopting this position are called «computer revolution skeptics».

8 *The Economist*, June 8, 2000.

9 Nordhaus defines new economy as machinery, electric equipment, telephone and telegraph, and software. These sectors represented 9 per cent of GDP in 1998.

pread and is not concentrated specifically in a few sectors of the new economy.

The Annual Report of the Council of Economic Advisers (2001) shows evidence of productivity growth in both computer and non-computer sectors. The Report considers that changes in productivity have cyclical and structural components. A structural acceleration in productivity may originate from four sources: (i) capital deepening, (ii) improvements in labor quality, (iii) technological progress in computer-producing industries, and (iv) technological progress in other industries.

Table 2 shows statistical estimates of labor productivity and its components; labor productivity being calculated as the average of income-and-product side measures of output per hour worked. These figures indicate that in private non-farm business sector there has been a structural acceleration in productivity for the 1995-2000 period, compared to the 1973-1995 period, due to the productivity growth in both computer and non-computer sectors.

The contribution coming from the productivity growth of the non-computer sector is calculated as a residual and it accounts for 1 per cent of the acceleration in productivity. This last figure represents, therefore, the impact on productivity growth of technological progress and management, and production system improvements outside the computer sector, for example, electronic commerce, computer and web based learning, etc.

These results are consistent with the idea that the use of information technology contributes most to the expansion of productivity, but not the production of information technology products.

> [...] the animating force for productivity and wage growth in the New Economy will be the pervasive use of digital electronic technologies to increase efficiency and productivity. (Atkinson and Court 1998)

Table 3 shows the productivity growth in various services industries, as measured by the value added per full-time equivalent employee. These figures show that there is an acceleration in productivity growth after 1995, in sectors, such as wholesale and retail trade, financial and business services. Although there are some data problems in certain sectors, these figures seem to give some support to the hypothe-

Table 2

Accounting for the Productivity Acceleration in the 1990s
(Private nonfarm business sector; average annual rates)

Item	1973 to 1995	1995 to 2000	Change (percentage points)
Labor productivity growth rate (percent)	1.39	3.01	1.63
Percentage point contributions			
Business cycle effect	0.00	0.04	0.04
Structural labor productivity	1.39	2.97	1.58
Capital services	0.70	1.09	0.38
Labor quality	0.27	0.27	0.00
Computer sector TFP	0.18	0.36	0.18
TFP excluding computer sector	0.22	1.22	1.00

Note: TFP denotes total factor productivity
Source: The Annual Report of the Council of Economic Advisers (2001), p. 28.

sis that use of information technology and improvements in business practices have, in fact, increased productivity growth.

Some studies have tried to evaluate the impact of electronic commerce on developed countries using macro-econometric or computable general equilibrium models. Their results indicate that electronic commerce have a significant positive impact on GDP growth and other macro-economic variables.

A study of the Goldman Sachs Bank (Brookes and Wahhaj 2000) used the Multimod[10] model to estimate the macroeconomic impact of B-to-B electronic commerce on some developed countries (USA, Japan, Germany, United Kingdom and France). It first calculates savings from procurement in selected industrial sectors, and uses input-output accounts to calculate price reductions of inputs for other industries. It then uses the Multimod model to estimate the total effect on the economy. The results indicate that in the five economies, B-to-B electronic commerce will raise GDP by about 5%, with over half of this increase expected within the next 10 years.

A study of the Australian government[11] used a mixed methodology to estimate the impact of electronic commerce on the Australian economy. It combines qualitative information provided by business leaders from selected industry sectors with quantitative analysis provided by the MONASH model.[12] The study estimated that electronic commerce will increase GDP by about 2.7% (direct and indirect effects) by the year 2007. It will also increase imports and exports, improve terms of trade, and increase real wages. The increase in trade will result in trade deficit.

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10 MULTIMOD (MULTI-region econometric MODel) is a dynamic multi-country macro model of the world economy, which has been designed to analyze the impact of shocks across countries as well as the effect of fiscal and monetary policies of developed countries on the global economy. It has been developed since 1988 by the International Monetary Fund.

11 *E-commerce beyond 2000*, Commonwealth Department of Communications, Information Technology and the Arts.

12 The Monash model is a dynamic computable general equilibrium model of the Australian economy, which has been designed for policy analysis and forecasting. It has been developed since 1993 by the Centre of Policy Studies of the Monash University, Australia.

Table 3

Labor Productivity Growth by Private Industry - Services
(Average annual percent change)

Item	1989 to 1995	1995 to 1999	Change (percentage points)
Transportation	2.48	1.72	-0.76
Trucking and warehousing	2.09	-0.73	-2.82
Transportation by air	4.52	4.52	0.00
Other transportation	1.51	2.14	0.63
Communications	5.07	2.66	-2.41
Electric, gas, and sanitary services	2.51	2.42	-0.09
Wholesale trade	2.84	7.84	4.99
Retail trade	0.68	4.93	4.25
Finance	3.18	6.76	3.58
Insurance	-0.28	0.44	0.72
Real estate	1.38	2.87	1.49
Personal services	-1.47	1.09	2.55
Business services	-.16	1.69	1.85
Health services	-2.31	-1.06	1.26
Other services	-0.72	-0.71	0.01

Source: The Annual Report of the Council of Economic Advisers (2001), p. 32.

In short, there is now a growing trend among economists to agree that B2C and B2B electronic commerce can have a positive impact on productivity and growth of developed countries.

The impact of electronic commerce on the global economy: a computable general equilibrium analysis

This section and the next two will focus on the quantitative aspect of the impact of electronic commerce on the global economy when developing regions fall behind technologically, and when they catch-up with developed regions.

The analysis is centered on cost savings, and assumes that electronic commerce can reduce costs of services. As services are important inputs to other production sectors, their cost reductions will spread across the economy. In a partial equilibrium framework, a cost reduction will push the supply curve out to the right, thereby achieving a new equilibrium where output will increase and prices will decline. Special attention is given to the analysis of the effects of cost reductions in transport services, wholesale and retail trade, as well as business and financial services. Except in transport services, these are the sectors where the use of information technology and improvements in business practices through electronic commerce have contributed the most to productivity increase of the United States. Although, at present, there is no evidence of productivity growth in transport services (see table 3), this sector is, however, included because it is expected that the transformation of the traditional transport chain and other features of electronic commerce will produce significant gains in productivity (UNCTAD 2000: 51-54).

For the purposes of the analysis, countries were aggregated into six regions: Developed countries, Eastern Europe, Asia, Latin America, Africa and Rest of the World. Commodities were aggregated into thirteen sectors: primary/food, manufacturing, trade, air transport, waterway transport, other transport, communications, financial services, insurance, business services, recreational services, government and other services. Factors of production were divided into five factors: capital, land, unskilled labor, skilled labor and natural resources.

To analyze the impact of cost savings in services on the global economy, due to electronic commerce, a general equilibrium framework is

used. Experiments are based on a thirteen-sector with a six-region aggregation using a computable general equilibrium model.[13] Specifically the GTAP[14] model is used to run the simulations. The multi-sector specification makes it possible to consider the transmission of technological change effects across sectors of a region, while the multi-region specification enables us to analyze the transmission across regions. Although electronic commerce of information goods could have an important impact on the overall economy, characteristics of these goods (increasing returns) and data restrictions (aggregation) do not allow taking into account the behavior of information goods firms by using the current framework.

It must be pointed out that the simulations below should be considered as an exploratory exercise that is used to understand the nature and direction of impacts of e-commerce, but not for forecasting purposes.[15]

Falling behind technologically

The first experiment simulates a cost reduction in services in developed countries only due to electronic commerce. The aim of this experiment is to examine the impact of electronic commerce on developing regions when they do not keep up with developed regions technologically. This cost reduction is simulated through an increase in productivity of 1% in services sectors.[16] It should be mentioned

[13] A computable general equilibrium model or CGE model is general because it specifies the behavior of several economic agents, it is in equilibrium because prices of goods and factors adjust according to the market, and finally, it is computable because it produces numerical results.

[14] The standard GTAP model is a multi-region, computable general equilibrium model, with perfect competition and constant returns to scale. The full GTAP version 5 database covers 65 regions, with five production factors and 57 commodities, and is constructed with data for 1997. It has been developed by the Center for Global Trade Analysis, Purdue University, West Lafayette, USA.

[15] In fact, the analysis is a comparative static one, in which the changes between equilibria given a change in productivity in services sectors are analyzed.

[16] A better approach could be to simulate a reduction in margins (the difference between producer and consumer prices), however, the GTAP model has not the option to work with these margins. It gives only a special treatment to international trade and transport margins (the difference between fob and cif prices).

that an increase in productivity[17] of 1% is equivalent to a downward shift of the unit cost function by 1%, ceteris paribus. The experiment consists of eight separate simulations: a 1% increase in productivity in (1) trade sector, (2) air transport, (3) waterway transport, (4) other transport, (5) financial services, (6) business services, and (7) all precedent services.

The 1% technological shock does not correspond to the rate of technological progress of the services sector of developed countries. It is only a working hypothesis. It can be considered as the rate at which services sector productivity grows relative to other regions.

Given the hypotheses of the GTAP model, a productivity growth in services of developed countries will expand output of services and increase price of production factors[18] (income effect) in a first step, then it will reduce the price of services[19] in a second step (price effect). In an open economy and in a partial equilibrium framework, terms of trade will deteriorate or not depending on whether the services are exportable or not.[20] In a general equilibrium framework the impact on other markets is considered. If the income effect is larger than the price effect, it is possible that the price of other sectors increases in relative terms bringing about an amelioration of the terms of trade of developed countries.[21] In this case, depending on the composition of exports and imports of developing countries, it is possible that developing countries lose welfare[22] through a deterioration of terms of

17 In terms of the CGE notation, a shock of 1% in total factor productivity is programmed by augmenting the technological augmentation parameter, ao, in 1%. This corresponds to a Hicks-neutral technological change, which means that 1% of more output will be produced by using the same quantity of factors and intermediate inputs.

18 Wages and remuneration of other production factors are assumed to be a function of the productivity.

19 The GTAP model does not have a monetary sector, that is, all results are expressed in real terms. In this case, the reduction of prices refers to relative prices.

20 For example, when the productivity growth is in the import-competing sector, terms of trade will improve.

21 That is, when «other sectors» are mainly export sectors such that the price of exports of developed countries rises relative to the price of their imports.

22 Changes in economic welfare represent a rise in income that can be allocated to aggregate private consumption, aggregate government consumption and savings.

trade. This explains a part of the results of the experiment, which are presented below.

Output of trade services mainly includes retail and wholesale trade.[23] Output of retail and wholesale trade is measured by the total value of commercial margins. As these margins are important elements of transaction costs, a reduction in the cost of trade services could capture a portion of the effect of B2C and B2B electronic commerce. Column 1 of table 4 shows the results of the productivity growth in trade services. For developed countries, it can be observed that the effect of this shock in terms of GDP, wages and welfare is significant. A 1% increase of productivity in this sector results in a GDP increase of 0.22%, a wage increase of 0.03% and 0.05% for unskilled and skilled labor respectively, welfare gains of 47.9 billions of 1997$ and an amelioration of the terms of trade of 0.01%. When developing countries fall behind technologically, the gap between developed and developing countries increases, with falling terms of trade, wages and welfare.

Output of transport services of goods is measured by the total value of transport margins. Electronic commerce generates improvements in the supply chains that produce productivity gains and cost reductions in the transport sector. Table 4 columns 2-4 shows the results of the simulation where productivity increases in transport services of developed countries only. For example, an increase of productivity of 1% in waterway transport services in developed countries will result in GDP rise of 0.02%, welfare gains of 2.9 billions of US$ and deterioration of 0.01% of the terms of trade. For developing countries, cost reductions of waterway transport services in developed countries will ameliorate terms of trade improving the competitiveness of exports from developing regions. Complementary tables[24] indicate that developing countries will increase imports of waterway transport services from developed countries and reduce their output and that the freed resources will be allocated to more productive activities. In short, improvements in terms of trade and a better allocation of resources in developing countries will increase their welfare.

[23] It also includes commission trade, hotels and restaurants, repairs of motor vehicles and personal and household goods.

[24] Complementary tables are available upon request.

The financial services sector includes financial services and auxiliary activities. Output of this sector is measured by the sum of implicit and explicit charges. Electronic commerce can have an important impact on productivity of this sector, by reducing costs on «brick and mortar» establishments. Table 4, column 5 shows the results of the productivity growth in financial services in developed countries only. For developed countries, a 1% increase of productivity entails a GDP rise by 0.06% and welfare gains of 11.9 billions of 1997$. When developing countries do not keep up with developed regions technologically, the gap between developed and developing countries will increase, with wages and welfare deteriorating.

The business services sector includes business activities, real estate, and renting. As business activities include professional «knowledge» services, electronic commerce can reduce margins through, for example, electronic service delivery. Table 4, column 6 shows the results of the increase in its productivity. For developed countries, a 1% increase of productivity results in GDP rise of 0.16% and welfare gains of 34.8 billions of 1997$. When developing countries fall behind technologically, the results indicate a fall in wages and welfare for Eastern Europe, Latin America and Rest of the World. Asia and Africa will reduce wages but welfare will not change much.[25]

It is to be recalled that the numerical results of this analysis have to be considered with caution and interpreted not in quantitative and absolute terms but in qualitative and relative terms. This analysis does not intend to make forecasting but to identify some tendencies of the overall impact on developing countries of electronic commerce, which initial impact is simulated through a productivity growth of some services sectors.

In brief, except for the case of the waterway transport services, the analysis suggests that when developing regions fall behind technologically, in general, the gap between developed and developing countries could be larger. Electronic commerce could constitute, therefore, an additional factor increasing this gap.

[25] Results show that all developing countries will reduce output of business services but Asia and Africa will reduce the most (-1.01% and -0.75% respectively).

Table 4
Experiment 1: a 1% increase in productivity in developed countries only

Item	Trade Services (1)	Air Transport (2)	Waterway Transport (3)	Other Transport (4)	Financial Services (5)	Business Services (6)	Services (1) to (6) (7)
Welfare (Millions of US$ of 1997)							
Developed	47942	3365	2896	17238	12071	35081	117869
Eastern Europe	-55	-13	21	11	-8	-53	-93
Asia	-121	130	528	261	-8	1	802
Latin America	-197	-5	83	-19	-52	-123	-301
Africa	45	4	69	-40	-12	5	-23
Rest of the World	-196	-38	96	-8	-56	-124	-309
GDP – Quantity Index (percentage change)							
Developed	0.22	0.02	0.02	0.08	0.06	0.16	0.54
Wages – Unskilled Labor (percentage change)							
Developed	0.03	0.01	0.00	0.01	0.02	0.08	0.15
Eastern Europe	-0.12	-0.03	-0.01	-0.08	-0.05	-0.14	-0.42
Asia	-0.13	-0.02	0.01	-0.07	-0.04	-0.13	-0.36
Latin America	-0.13	-0.03	-0.02	-0.08	-0.05	-0.14	-0.44
Africa	-0.11	-0.02	0.00	-0.09	-0.04	-0.13	-0.39
Rest of the World	-0.14	-0.04	-0.02	-0.10	-0.06	-0.16	-0.50
Wages – Skilled Labor (percentage change)							
Developed	0.05	0.01	0.00	0.03	0.00	0.06	0.14
Eastern Europe	-0.12	-0.03	-0.01	-0.07	-0.06	-0.18	-0.45
Asia	-0.12	-0.02	0.01	-0.06	-0.04	-0.15	-0.37
Latin America	-0.13	-0.03	-0.02	-0.08	-0.05	-0.15	-0.46
Africa	-0.11	-0.03	0.00	-0.10	-0.05	-0.16	-0.44
Rest of the World	-0.13	-0.04	-0.01	-0.09	-0.06	-0.19	-0.52
Terms of trade							
Developed	0.01	0.00	-0.01	0.00	0.00	0.00	-0.01
Eastern Europe	-0.02	0.00	0.01	0.00	0.00	-0.02	-0.03
Asia	-0.01	0.01	0.03	0.01	0.00	0.00	0.04
Latin America	-0.03	0.00	0.02	0.00	-0.01	-0.01	-0.02
Africa	-0.02	0.01	0.04	-0.01	0.00	0.01	0.03
Rest of the World	-0.03	0.00	0.02	0.00	0.00	-0.01	-0.03

It should be noted that this analysis refers only to the increase of productivity in services sectors, and does not take into account the impact of reduction of inventory stocks and the increase of competitiveness in intermediate services.[26]

Catching-up

It is expected that in the next few years the productivity gap, generated by electronic commerce, between the European countries and the United States, the leading country, will rapidly close down as European productivity growth increases faster than that experienced in the United States. This process is known as convergence in productivity. Convergence in productivity will take place when the countries lagging behind the technological frontier grow more rapidly in productivity than the leading countries.

The same could be true for developing countries with a reasonable degree of readiness. The impact of electronic commerce on developing countries could be even more intense than that of developed countries because the scope to reduce inefficiencies and increase productivity is much larger than in developed countries.

The second experiment simulates a cost reduction in services, due to electronic commerce, in a single developing region only. The aim of this experiment is to examine the impact of this cost reduction on a single developing region when it converges in productivity for the services sectors, that is, when the rate of productivity of these sectors grows faster relative to other regions. The experiment consists of twenty-eight separate simulations. For each developing region,[27] a 1% increase in productivity is simulated in (1) trade sector, (2) air transport, (3) waterway transport, (4) other transport, (5) financial services, (6) business services, and (7) total of (1) to (6). The results should then be interpreted as the overall effect, on developing countries, of one additional percentage point of productivity growth in services sec-

[26] The impact of reduction of inventories could be incorporated by simulating a technological change in the production sectors. The impact of the increase in competitiveness could be incorporated by simulating a reduction of the monopolist profits of the enterprises (markup).

[27] Asia, Latin America and Caribbean, Eastern Europe, and Africa.

tors relative to other regions. The rate at which these services grow in productivity determines the time for closing the gap between the leading countries and developing countries.

The results of technological progress in services in a single developing region are presented in annexes 1-4. They indicate that an increase of productivity of 1% in services will reduce prices, increase economic activity, wages and welfare. For example, in the case of the Asia region (Annex 1), productivity growth in trade services (column 1) is expected to increase GDP by 0.13%, wages by about 10% and welfare by 3.6 billions of 1997. The results also indicate that output and exports of trade services would rise, while the value added and imports would decrease. The simulations for the other services sectors (columns 2 to 6) indicate that productivity growth in trade (which includes retail and wholesale trade), followed by other transport and business services, result in the highest welfare gain for Asian countries.

In reducing costs, increasing efficiency, reducing time and importance of distances, electronic commerce could become an important tool for development. A reasonable degree of electronic commerce preparedness[28] of developing countries could give rise to the potential catch-up with leading countries. Thus, the discussion on the convergence of sectoral productivity could be treated as forming part of the discussion on economic convergence of economic development literature, that is, the tendency for poorer countries to grow faster than rich countries, and, consequently, to converge in living standards. Although there are many explanations for the absence of economic convergence, the results of the study of Sachs and Warner (1995) support the idea that appropriate economic and legal frameworks give developing countries the potential to catch up with leading countries. During the 1970-89 period, they examine economic convergence for a set of countries and found out that a sufficient condition for it is that countries adopt appropriate market-based economic policies.

[28] Electronic commerce preparedness implies the existence of e-commerce related-infrastructure, human capital, and economic and legal frameworks.

Conclusions

The results of these experiments indicate that the overall effect of productivity growth in services sectors (which is assumed to simulate the direct effect of electronic commerce) will result in welfare gains for regions adopting it.

They point out that when developing regions fall behind technologically, the gap between developing and developed countries could increase. Except in waterway transport services, the results show that productivity growth in trade, financial and business services, air and other transport services of developed countries could deteriorate terms of trade and reduce welfare and wages of developing countries.

Convergence in productivity of services contributes to raise the external competitiveness of developing-countries exports and reduce international trade and transport margins. The results suggest that by increasing the productivity of services, electronic commerce offers the possibility for increasing welfare in developing countries.

It has to be noted, once more, that the findings of this paper should be carefully interpreted. The paper has tried to identify the nature and direction of impacts of electronic commerce on developing countries, and, consequently, the results may depend on the approach used to simulate the direct impact of electronic commerce (cost savings in services) and on the hypotheses of the GTAP model framework.

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Annex 1 - Asia: The Effect of one Additional Point of Productivity Growth in Services Sectors

	Trade Services (1)	Air Transport (2)	Waterway Transport (3)	Other Transport (4)	Financial Services (5)	Business Services (6)	Services (1) to (6)
Welfare, Millions of US$							
. Asia	3601	1914	1530	2389	863	1706	12012
. World	3766	1970	1626	2536	866	1781	12555
GDP, percentage change							
. Volume	0.13	0.07	0.06	0.09	0.03	0.06	0.43
. Prices	-0.05	0.00	0.00	-0.02	0.00	0.02	-0.05
Terms of trade	-0.02	-0.01	-0.01	-0.01	0.00	-0.01	-0.06
Wages, percentage change							
. Unskilled labor	0.09	0.08	0.06	0.07	0.03	0.09	0.42
. Skilled labor	0.10	0.09	0.06	0.07	0.02	0.11	0.46
Output, percentage change							
. Primary	0.01	0.00	0.01	0.01	0.01	-0.02	0.02
. Manufacturing	0.01	0.01	0.02	0.00	0.03	-0.08	-0.02
. Trade Services	0.69	0.04	0.02	0.03	0.02	0.02	0.83
. Air Transport	-0.01	0.59	0.02	0.07	0.00	-0.02	0.64
. Waterway Transport	0.03	0.00	0.43	0.04	0.03	-0.01	0.51
. Other Transport	0.03	-0.03	-0.01	0.71	0.01	-0.02	0.69
. Financial Services	0.00	0.01	-0.01	0.01	0.14	-0.01	0.15
. Business Services	-0.08	-0.05	-0.05	-0.05	-0.02	1.27	1.02
Value Added, percentage change							
. Primary	0.01	0.00	0.01	0.01	0.01	-0.02	0.02
. Manufacturing	0.01	0.01	0.02	0.00	0.03	-0.08	-0.02
. Trade Services	-0.31	0.04	0.02	0.03	0.02	0.02	-0.17
. Air Transport	-0.01	-0.41	0.02	0.07	0.00	-0.02	-0.35
. Waterway Transport	0.03	0.00	-0.57	0.04	0.03	-0.01	-0.48
. Other Transport	0.03	-0.03	-0.01	-0.29	0.01	-0.02	-0.30
. Financial Services	0.00	0.01	-0.01	0.01	-0.85	-0.01	-0.84
. Business Services	-0.08	-0.05	-0.05	-0.05	-0.02	0.27	0.02
Exports, percentage change							
. Primary	-0.17	-0.18	-0.09	-0.12	-0.05	-0.21	-0.82
. Manufacturing	-0.05	-0.02	0.01	-0.04	0.02	-0.18	-0.26
. Trade Services	2.68	-0.02	-0.09	-0.06	-0.01	-0.08	2.40
. Air Transport	-0.12	2.57	-0.01	0.16	-0.02	-0.14	2.44
. Waterway Transport	-0.08	-0.05	1.85	0.10	0.02	-0.09	1.74
. Other Transport	-0.09	-0.17	-0.06	2.70	-0.03	-0.19	2.14
. Financial Services	-0.25	-0.11	-0.17	-0.17	3.69	-0.10	2.87
. Business Services	-0.20	-0.16	-0.17	-0.16	-0.04	3.44	2.70
Imports, percentage change							
. Primary	0.10	0.10	0.08	0.09	0.05	0.07	0.49
. Manufacturing	0.07	0.04	0.04	0.05	0.02	0.05	0.28
. Trade Services	-0.78	0.07	0.08	0.08	0.02	0.08	-0.45
. Air Transport	0.14	-0.95	0.06	0.02	0.04	0.12	-0.56
. Waterway Transport	0.15	0.08	-1.07	0.00	0.01	0.10	-0.75
. Other Transport	0.09	-0.02	-0.10	-1.20	0.04	0.1	-1.11
. Financial Services	0.15	0.07	0.08	0.11	-1.77	0.06	-1.30
. Business Services	0.08	0.01	-0.15	0.08	0.03	-0.61	-0.57

Annex 2 - Latin America: The Effect of one Additional Point of Productivity Growth in Services Sectors

	Trade Services (1)	Air Transport (2)	Waterway Transport (3)	Other Transport (4)	Financial Services (5)	Business Services (6)	Services (1) to (6)
Welfare, Millions of US$							
. Latin America	1920	1199	860	1439	949	1236	7614
. World	1885	1174	879	1454	910	1195	7507
GDP, percentage change							
. Volume	0.10	0.06	0.05	0.07	0.05	0.06	0.38
. Prices	-0.04	0.00	0.00	-0.02	0.00	0.01	-0.05
Terms of trade	0.01	0.00	-0.01	-0.01	0.01	0.00	0.00
Wages, percentage change							
. Unskilled labor	0.06	0.07	0.05	0.06	0.06	0.10	0.39
. Skilled labor	0.07	0.08	0.05	0.07	0.04	0.10	0.42
Output, percentage change							
. Primary	0.00	-0.02	-0.01	-0.01	0.01	-0.01	-0.03
. Manufacturing	0.02	-0.01	0.00	-0.01	0.04	0.00	0.04
. Trade Services	0.59	0.05	-0.02	0.04	0.05	0.08	0.84
. Air Transport	0.00	0.76	0.02	0.06	0.02	0.03	0.89
. Waterway Transport	0.03	0.01	0.68	0.05	0.06	0.03	0.86
. Other Transport	0.03	0.00	0.01	0.75	0.03	0.03	0.86
. Financial Services	0.01	0.01	-0.01	0.01	0.19	0.03	0.25
. Business Services	-0.03	-0.01	-0.01	-0.01	0.00	0.49	0.44
Value Added, percentage change							
. Primary	0.00	-0.02	-0.01	-0.01	0.01	-0.01	-0.03
. Manufacturing	0.02	-0.01	0.00	-0.01	0.04	0.00	0.04
. Trade Services	-0.40	0.05	0.02	0.04	0.05	0.08	-0.16
. Air Transport	0.00	-0.24	0.02	0.06	0.02	0.03	-0.10
. Waterway Transport	0.03	0.01	-0.32	0.05	0.06	0.03	-0.14
. Other Transport	0.03	0.00	0.01	-0.25	0.03	0.03	-0.14
. Financial Services	0.01	0.01	-0.01	0.01	-0.80	0.03	-0.74
. Business Services	-0.03	-0.01	-0.01	-0.01	0.00	-0.51	-0.56
Exports, percentage change							
. Primary	-0.08	-0.14	-0.07	-0.11	-0.07	-0.13	-0.61
. Manufacturing	-0.08	-0.11	-0.07	-0.11	0.00	-0.13	-0.50
. Trade Services	3.59	-0.06	-0.13	-0.15	-0.05	0.02	3.20
. Air Transport	-0.12	3.42	-0.05	0.10	-0.06	-0.07	3.21
. Waterway Transport	-0.10	-0.10	2.71	0.05	0.07	-0.06	2.56
. Other Transport	-0.12	-0.17	-0.08	3.21	-0.08	-0.13	2.60
. Financial Services	-0.19	-0.16	-0.17	-0.20	3.78	-0.13	2.90
. Business Services	-0.17	-0.18	-0.16	-0.20	-0.14	3.73	2.86
Imports, percentage change							
. Primary	-0.03	0.05	0.04	0.05	0.05	0.06	0.30
. Manufacturing	-0.10	0.06	0.05	0.08	0.06	0.09	0.43
. Trade Services	1.03	0.06	0.08	0.10	0.07	0.05	-0.96
. Air Transport	-0.12	-1.15	0.06	0.02	0.08	0.10	-0.84
. Waterway Transport	-0.08	0.05	-1.19	0.01	0.02	0.07	-0.97
. Other Transport	-0.09	0.03	-0.03	-1.16	0.08	0.10	-0.89
. Financial Services	-0.23	0.09.09	0.12	-1.71	0.10	-1.19	
. Business Services	-0.16	0.09	0.03	0.12	0.10	-1.27	-0.83

Annex 3 - Eastern Europe: The Effect of one Additional Point of Productivity Growth in Services Sectors

	Trade Services (1)	Air Transport (2)	Waterway Transport (3)	Other Transport (4)	Financial Services (5)	Business Services (6)	Services (1) to (6)
Welfare, Millions of US$							
. Eastern Europe	664	89	56	345	122	492	1770
. World	642	79	80	350	101	416	1671
GDP, percentage change							
. Volume	0.22	0.03	0.03	0.12	0.04	0.15	0.58
. Prices	-0.08	0.02	0.00	0.02	0.02	0.06	0.04
Terms of trade	0.01	0.00	-0.02	-0.01	0.01	0.03	0.02
Wages, percentage change							
. Unskilled labor	0.14	0.05	0.03	0.14	0.06	0.21	0.63
. Skilled labor	0.19	0.05	0.03	0.16	0.06	0.24	0.72
Output, percentage change							
. Primary	0.04	-0.01	0.00	-0.01	0.00	-0.03	-0.02
. Manufacturing	0.01	-0.04	-0.02	-0.11	-0.01	-0.14	-0.30
. Trade Services	0.62	0.02	0.01	0.07	0.03	0.11	0.85
. Air Transport	-0.04	1.49	0.00	0.06	-0.02	-0.08	1.41
. Waterway Transport	0.01	-0.01	1.13	0.14	0.01	-0.04	1.22
. Other Transport	0.03	-0.01	0.00	1.03	-0.01	-0.03	1.01
. Financial Services	0.00	-0.02	-0.01	-0.05	0.62	-0.05	0.48
. Business Services	0.02	-0.01	-0.01	-0.03	-0.01	0.88	0.85
Value Added, percentage change							
. Primary	0.04	-0.01	0.00	-0.01	0.00	-0.03	-0.02
. Manufacturing	0.01	-0.04	-0.02	-0.11	-0.01	-0.14	-0.30
. Trade Services	-0.38	0.02	0.01	0.07	0.03	0.11	-0.15
. Air Transport	-0.04	0.49	0.00	0.06	-0.02	-0.08	0.41
. Waterway Transport	0.01	-0.01	0.12	0.14	0.01	-0.04	0.22
. Other Transport	0.03	-0.01	0.00	0.03	-0.01	-0.03	0.01
. Financial Services	0.00	-0.02	-0.01	-0.05	-0.38	-0.05	-0.51
. Business Services	0.02	-0.01	-0.01	-0.03	-0.01	-0.12	-0.15
Exports, percentage change							
. Primary	-0.19	-0.11	-0.05	-0.26	-0.10	-0.43	-1.13
. Manufacturing	-0.12	-0.09	-0.05	-0.26	-0.06	-0.38	-0.96
. Trade Services	3.76	-0.08	-0.08	-0.28	-0.12	-0.34	2.84
. Air Transport	-0.15	3.49	-0.02	0.07	-0.08	-0.28	3.02
. Waterway Transport	-0.07	-0.03	1.75	0.18	-0.01	-0.11	1.71
. Other Transport	-0.10	-0.09	-0.04	2.68	-0.09	-0.30	2.04
. Financial Services	-0.26	-0.11	-0.09	-0.39	4.08	-0.43	2.77
. Business Services	-0.20	-0.13	-0.09	-0.40	-0.15	3.75	2.75
Imports, percentage change							
. Primary	0.12	0.03	0.02	0.08	0.04	0.14	0.43
. Manufacturing	0.14	0.04	0.02	0.11	0.05	0.18	0.54
. Trade Services	-1.65	0.05	0.04	0.17	0.07	0.24	-1.08
. Air Transport	0.21	-1.00	0.03	0.08	0.06	0.23	-0.40
. Waterway Transport	0.13	0.04	-0.96	-0.02	0.03	0.13	-0.65
. Other Transport	0.12	0.10	0.04	-1.36	0.06	0.18	-0.85
. Financial Services	0.12	0.03	0.03	0.12	-1.57	0.14	-1.13
. Business Services	0.11	0.07	0.05	0.16	0.06	-1.11	-0.66

Annex 4 - Africa: The Effect of one Additional Point of Productivity Growth in Services Sectors

	Trade Services (1)	Air Transport (2)	Waterway Transport (3)	Other Transport (4)	Financial Services (5)	Business Services (6)	Services (1) to (6)
Welfare, Millions of US$							
. Africa	1214	144	139	1214	233	383	2663
. World	1139	141	160	1139	218	351	2568
GDP, percentage change							
. Volume	0.21	0.03	0.03	0.21	0.04	0.07	0.48
. Prices	-0.02	0.01	0.00	-0.02	0.00	0.04	0.05
Terms of trade	0.04	0.00	-0.01	0.04	0.01	0.01	0.03
Wages, percentage change							
. Unskilled labor	0.19	0.04	0.03	0.19	0.05	0.11	0.53
. Skilled labor	0.24	0.06	0.04	0.24	0.04	0.14	0.65
Output, percentage change							
. Primary	0.02	-0.02	0.00	0.02	0.00	-0.06	-0.09
. Manufacturing	0.02	-0.03	-0.01	0.02	0.01	-0.06	-0.12
. Trade Services	0.55	0.01	0.01	0.55	0.03	0.02	0.66
. Air Transport	-0.08	1.35	-0.01	-0.08	-0.01	-0.05	1.25
. Waterway Transport	0.05	-0.01	0.76	0.05	0.02	-0.02	0.83
. Other Transport	0.05	0.00	0.00	0.05	0.02	-0.01	0.82
. Financial Services	0.02	0.00	0.00	0.02	0.21	0.02	0.26
. Business Services	-0.02	-0.01	-0.01	-0.02	0.03	1.13	1.09
Value Added, percentage change							
. Primary	0.02	-0.02	0.00	0.02	0.00	-0.06	-0.09
. Manufacturing	0.02	-0.03	-0.01	0.02	0.01	-0.06	-0.12
. Trade Services	-0.45	0.01	0.01	-0.45	0.03	0.02	-0.34
. Air Transport	-0.08	0.34	-0.01	-0.08	-0.01	-0.05	0.25
. Waterway Transport	0.05	-0.01	-0.23	0.05	0.02	-0.02	-0.17
. Other Transport	0.05	0.00	0.00	0.05	0.02	-0.01	-0.18
. Financial Services	0.02	0.00	0.00	0.02	-0.79	0.02	-0.73
. Business Services	-0.02	-0.01	-0.01	-0.02	0.03	0.13	0.09
Exports, percentage change							
. Primary	-0.22	-0.10	-0.04	-0.22	-0.06	-0.24	-0.85
. Manufacturing	-0.26	-0.11	-0.06	-0.26	-0.04	-0.26	-0.96
. Trade Services	3.33	-0.10	-0.08	3.33	-0.03	-0.26	2.60
. Air Transport	-0.33	3.46	-0.04	-0.33	-0.04	-0.18	2.90
. Waterway Transport	-0.19	-0.06	2.18	-0.19	-0.02	-0.15	1.70
. Other Transport	-0.31	-0.10	-0.06	-0.31	-0.05	-0.21	2.52
. Financial Services	-0.47	-0.10	-0.09	-0.47	4.06	-0.23	2.83
. Business Services	-0.35	-0.08	-0.07	-0.35	0.05	3.70	3.00
Imports, percentage change							
. Primary	0.19	0.05	0.03	0.19	0.05	0.12	0.56
. Manufacturing	0.27	0.05	0.04	0.27	0.06	0.15	0.71
. Trade Services	-1.18	0.05	0.04	-1.18	0.00	0.13	-0.85
. Air Transport	0.23	-1.16	0.03	0.23	0.05	0.12	-0.69
. Waterway Transport	0.19	0.05	-1.37	0.19	0.04	0.12	-0.91
. Other Transport	0.20	0.09	0.00	0.20	0.05	0.11	-0.95
. Financial Services	0.29	0.05	0.05	0.29	-2.00	0.13	-1.32
. Business Services	0.32	0.06	0.04	0.32	0.02	-0.97	-0.37