

# **Inequality and economic growth: Should we be concerned by the digital divide?**

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## **Abstract**

Inequality is a basic social concern. Its impact on economic growth is also a concern. Inequality is not the homogenous concept economists study. Some inequality is purely stochastic while others reflect differences in taste, entrepreneurship, incentives or institutions. Some inequality remains unexplained, only observed ex post while other inequality is the result of intermediate markets. However, most inequality is chronic. It remains largely insensitive to economic and institutional conditions even in the long run. Chronic inequality is path dependent, changing little from generation to generation and it is largely impervious to competition. Conditions such as gender discrimination, ethnic, religious, and other forms of discrimination, as well as social stratification-based prejudices are some of the factors that contribute to sustain it. It follows that much of existing inequality is socially inefficient and more harmful than poverty. Trends toward lower short run inequality may be welcome but they do not compensate for the stable if not increasing inequality.

Information and communication technologies (ICT) are having a profound effect on our societies. How ICT is likely to impact growth through inequality is uncertain. ICT has the ability to provide a high level of anonymity that would blur the harm of discrimination and racism. It has also the potential of lowering the discrepancy in the relative cost of living of the poor and the rich as illustrated by the microcredit revolution. At the same time, it can also contribute to increases in digital inequality known as the digital divide.

The objective of this paper is to develop an analytical framework that can then be used to define the digital divide and to formulate appropriate economic growth policies. The framework views the digital

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divide as the outcome of the confluence of, on one hand, social inequality and, on the other hand, information and communication technology (ICT). Increases in inequality have been a global phenomenon over the past half century. In this environment, ICT's success and growing diffusion has made it a resonance chamber that amplifies inequality to generate the digital divide to the detriment of economic growth. Inequality, the disparity in the control over resources, excluding one's innate aptitudes, lessens growth. It results from market imperfections that demand to be addressed. Growth-based inequality is also caused by market failures. Examples include resources that are used below their potential, slow response to market signals, and a marginal product that is so low that it cannot provide the minimum goods workers need to be productive. Those failures undercut the market's ability to respond efficiently. Remedying such market failures would make markets more efficient, help the poor, and expand growth.

One would reasonably expect ICT to further growth by diminishing management costs both at the level of firms and at the level of markets. ICT's contribution can be direct within firms through a better use of technologies. It can be indirect as when, say ICT help manage regulation more efficiently. Today's empirical literature generally concludes that ICT's overall contribution has been positive and that ICT has been lowering digital poverty. Dollar and Kraay's conclusion (Dollar and Kraay 2002) for aggregate growth: "Growth is good for the poor" can be extrapolated to ICT. Evidently, in both cases the conclusion holds only where inequality does not change. The digital divide amplifies the heterogeneity of behavior and makes it context-specific and a function of socioeconomic characteristics. Together with inequality, it distorts markets in pernicious ways fostering class-specific behaviors that are rational at the level of individuals and yet that are socially inefficient.

## 1. Introduction

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The objective of this paper is to provide a new perspective to the analysis and study of inequality and the inefficient allocation of resources that affect growth in a society. Such perspective is circumscribed to the access, acquisition and use of Information and Communication Technologies (ICT), a phenomenon that is leading to the digital divide and digital inequality.

The stake of the economic debate on inequality is economic growth. Inequality and economic growth have both been increasing around the world for a number of decades now. To better understand what one deals with when discussing inequality and growth, it is useful to consider a basic economic framework. We choose here to derive it from simple conventional economic assumptions for no other reason than it is the most familiar for most readers. We argue that inequality and growth are inversely related while we recognize that there are circumstances when they are positively correlated. However, we argue also that a positive relationship between inequality and growth is a short run phenomenon and that one cannot conclude from it that inequality should not be an economic inefficiency concern. Conclusions such as arguing that inequality is growth enhancing would require complex and counter-intuitive hypotheses (Burtless 2007) (Alesina and Rodrik 1994).

We begin by establishing the heterogeneity of a concept such as inequality. We consider how inequality is managed through time and we show that it can be the result of some stochastic process and/or it can be sustained. Stochastic inequality, a situation where individuals have no control over their initial endowment and over the resources they can select from to develop her abilities, may generate inefficiencies (Aghion and Durlauf 2005). One talks of managed or non-stochastic inequality when individuals are able to gain control over resources independently of their talents, as when they inherit them from earlier generations.<sup>1</sup> Such inequality results in an inefficient allocation of society's resources that represents a difference between private and social welfare. Non-stochastic inequality undermines society's ability to develop its resources efficiently.

We now turn our attention to ICT. ICT is particularly important because most would agree that it effectively acts as a resonance chamber that end up amplifying inequality. This process has come to be known under the name of digital divide. We show that the digital divide emerges to the detriment of economic growth (Barja and Gigler 2004).

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<sup>1</sup> The concept of efficiency becomes somewhat more complex to specify when one considers that an individual's utility function depends upon her ability to transfer resources to a later generation. In that case, one would face a tradeoff between the change in ability across generations and the role played by the motivation to transfer resources to future generations.

One would reasonably expect ICT to further growth by lowering management costs both at the level of firms and at the level of individual markets. Such contribution can be direct within firms through a better use of technologies. It can be indirect, say a more efficient management of regulation. Today's empirical literature generally concludes that ICT's overall contribution has been positive and that ICT has been lowering digital poverty.

What matters for us here is that the digital divide amplifies the difference in behavior between those who are at the top of the inequality scale and those who are at the bottom. It makes it context-specific and a function of socioeconomic characteristics. Where there are poor who do not have the same ability to use ICT as the rest of society, in other words, where the ability to use fruitfully ICT is correlated with social classes, then the confluence of ICT and inequality distorts markets in pernicious ways. For instance, significant inequality as found among developed countries in a country such as the U.S. and, among developing countries, in Latin America tends to foster class-specific behaviors that are rational at the level of individuals and yet that are socially inefficient (Mueller and Schement 2001).

There is no general agreement about the impact of the digital divide. Even if the divide is generally recognized, some argue that it is not different from other social divide that emerge when new products, say, color television are introduced. Those reject all justifications to focus on the digital divide as a problem that should be addressed separately through divide-specific government policies (Mueller and Schement 2001). However, most see the digital divide as a concern that deserves attention (Bauer, Kim and Wildman 2003). We show that this issue depends upon the interdependence between inequality and digital inequality. Where digital inequality amplifies inequality, the digital divide needs to be evaluated on its own.

One can justifiably be concerned by the effectiveness of policies that would use ICT to reduce inequality when ICT was already seen as the cause of an increase in inequality. There are many stories of serious attempts by governments to bridge the digital divide but many of those have led to a dead-end. This means that effective government intervention is a challenge. At the same time we do not see any credible alternative to following that path nor do we see that path as hopeless.

We approach the analysis of the way ICT and inequality may affect economic growth through a three-pole model with a feedback mechanism. The first pole is economic growth that reflects, using Adam Smith's terminology, an expansion in the extent of the market. The second pole is inequality which undermines "the extent of the market," hence growth, through market rigidities. The third pole is the adoption of ICT with its potential to increase the rate of growth. Significant inequality means that there

is a discrepancy between the actual and potential abilities of the population with a significant fraction of the population with inadequate human capital given the society's wealth, i.e. a population that is unable to achieve its potential.<sup>2</sup>

This paper consists of four additional sections. In the next section we review briefly the growth literature from the perspective of the three dominant frameworks, exogenous and endogenous growth models as well as GPT growth models. We study what the key determinants might be and how these frameworks might trace the way various determinants. The third section is devoted to the analysis of inequality and its impact on growth. The idea is to better understand the role inequality plays in an economy. In the fourth section we focus on the digital divide due to the combined impact of inequality and ICT on growth. In the fifth and concluding section we define the digital divide and suggest some basic policy considerations.

## 2. Review of the literature on economic growth

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The economic growth literature can be divided in three parts, the exogenous approach, the endogenous one, and the GPT model. We review them in turn, spending far more time on the framework that has received by far the most attention, exogenous growth.

The theory of economic growth is derived from the theory of production. One assumes that inputs such as labor and capital, at the level of sectors, are efficiently combined to produce the actual output level. The population increases through time and investments increase the stock of capital. The technology is assumed to determine how well one does with those inputs. Given the technology in an exogenous environment, the process is stable and population growth translates in a proportional output increases leaving people just as well off.

In 1956 Solow (Solow 1957) introduced the neoclassical, exogenous framework that is still today the most common benchmark by which to evaluate economic growth. Solow's model is built around an aggregate production function where the economy's total output is expressed as a function of its labor and capital inputs. The economy is assumed to be neoclassical, i.e., it is static and competitive and competition requires constant returns to scale in order to exhaust the output whenever factors are paid in

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<sup>2</sup> DiMaggio et al. review the literature that studies this factor. They conclude that the problem is real and that it is more serious for ICT that is largely interactive than for one way broadcasting.

function of their marginal product. Predictably, the economy's growth rate is constant, a function of the sum of the rate of capital depreciation and of the rate of population growth. Solow identifies increase in the output with technological change. Empirically, technological change is estimated as total factor productivity, the residual that cannot be explained by the production function. Solow assumed that technological change was a function of time. In practice, total factor productivity is the "unexplained" residual, i.e., a shift in the production surface that is due to factors that are not controlled by decision-makers. That unexplained represented 80% of the year to year changes.

In the exogenous model, the increased output level for given resources do not reflect economies of scale. Rather they reflect either a move within the production function space toward the envelope boundary and/or an outward shift of the envelope due to technological change. Technological change takes the form of a stable and continuous flow through time. Today's literature does not consider a move of the production space; the production process is assumed to be efficient.

From a firm's perspective, pure competition means that it does not pay to invest in R&D. Solow concluded that the majority of the outward shift of the production function, 80%, reflected technological change, this unexplained element that is often called "manna from heaven." Jorgenson alone and with others (Jorgenson 2000; Jorgenson and Griliches 1967; Jorgenson and Stiroh 1999) has worked on explaining the change in output by studying those relationships between outputs and inputs that are of constant quality: a 2007 computer and a 1977 computer are translated into new measures such that they can be compared with one another. That correction can be shown not to resolve the "manna from heaven" problem but just to shift it some of Solow's balanced exogenous shift in the production envelope to a factor (input and/or output-specific) unexplained, exogenous outward move of the same envelope. This means that, effectively, once one explains shifts such as the drastic changes in ICT prices we will find that it is an ICT-specific technological change that explains the massive substitution in favor of ICT.

The static structure that links inputs and outputs with time makes the framework's growth characteristic intuitive. One works on the basis of a macroeconomic equilibrium where growth is constrained by population growth in the long run. This is above all a reflection of the diminishing marginal return on capital that limits how much capital it is efficient to invest, hence what the long run, neoclassical growth rate might be. The model is built around an aggregate production function that links the economy's resources with its output. Past a certain level of capital, the return on investment is too low to justify increasing further that level.

Jorgenson's model excludes infra-marginal situations. For instance, it is assumed that ICT has always been an option even when it was an unknown output, say, in 1900. Jorgenson assumes that firms must have consumed a very small quantity of ICT in 1900, say,  $\alpha$ , of ICT in order to avoid corner solutions.

ICT's contribution to economic growth has been the subject of many discussions since Solow's 1987 quip (Solow 1987) that computers can be seen everywhere except in productivity. Stiroh and Jorgenson were the first, in 1999, to use the exogenous growth productivity framework to identify ICT's impact on the economy. They concluded that the regular drop in ICT prices became even more drastic starting in 1995 and that those changes led firms to substitute in significant quantities ICT for other inputs. Their conclusion meant that ICT did not have a significant impact on economic growth. By then those who had used the general purpose technologies (GPT) framework had come to the conclusion that ICT's impact on economic activities would take time before it would have a substantial impact on economic growth.

Romer introduced endogenous growth analysis where 'endogenous growth theory' means that: "the growth rate is determined from within the model and is not given as an exogenous variable" reviving interest in economic growth (Romer 1986; 1990). Some studies, subsequent to Romer's work, say, Jones and Langlois, suggest that the influence of knowledge, the cornerstone of Romer's work, on growth has to be revised downward.

Endogeneity as it is used in the literature has become increasingly ambiguous. This can be illustrated through Segerstrom's and Parente's contributions who respectively consider themselves working with endogenous and exogenous growth models. However, "*three parameters (the innovation size parameter  $\lambda$ , the population growth rate  $\eta$ , and the R&D difficulty parameter  $\mu$ ) completely determine the long-run economic growth rate*" in Segerstrom's model (Segerstrom 1998). Parente calls his models, "the perfect competition exogenous growth model" even if firms decide whether to upgrade the technology in those models. In addition, the world knowledge and the local institutions impact directly the cost of upgrading and shifting to a higher technology level (Parente 2006).

This does not diminish in any way Romer's contribution just as Romer's contribution does not diminish Solow's. Just as few if any depart from Solow's AK model, today's endogenous and exogenous growth theories have indelibly been marked by the kinds of questions Romer was asking. Whatever one may mean by endogeneity and whether one considers one's work exogenous or endogenous, one's contribution to the study of economic growth today owes to both Solow's AK model and to Romer's endogenization of the unexplained residual, technological change. Thus, Parente who positions his

approach as exogenous, considers that: “[m]ost economists agree that technological change is the source of sustained increases in per capita output. Most economists further agree that the creation of this knowledge is the result of research and development efforts undertaken by individuals and firms” (Parente 2006).

The third key approach to the study of growth is the GPT framework that has innovation as its core. It sheds all links with neoclassical analysis. In a GPT world, things do not flow evenly from period to period. GPT innovations are bulky and they take time to evolve. Nevertheless, they have their own life cycle, becoming increasingly efficient until they reach maturity. In that environment, firms allocate resources for future payoff. The cost of that future payoff, i.e., how much resource they allocate to innovate, is a function of GPT as it is at that particular stage. In its early phase, as the technology needs to be better mastered and as its implementation is time consuming and costly firms that adopt the technology begin by being less productive as they invest in the new technology and learn how to use it to become highly efficient.

The nature of GPTs such as the time it takes before an innovation can be identified as a GPT means that stakeholders do not appropriately evaluate the potential of their innovation, i.e., that it is not possible to talk of optimal investment in R&D. The presence of significant externalities and the impossibility to internalize all innovation suggests that there is, as in the previous models, “manna from heaven.”

### **3. Inequality as a determinant of economic growth**

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We review in this section inequality, defined by Hoffman and Centeno as, “*the distribution of power and resources... [and] the allocation of goods, services, and basic opportunities [that are] equally unbalanced*” (Hoffman and Centeno 2003). We show that inequality is the source of significant economic distortions that can only result in shortcomings in the efficient allocation of resources.

Economists focus on the ways factors such as technology and investment might foster growth through the transformation of the production process. Through production theory, the study of economic growth relies on mainstream assumptions such as the hypothesis that activities take place within a neoclassical-like static market environment with efficient factor allocation. This means in particular, that the economy is assumed to be operating efficiently, i.e., on the production possibility frontier itself. A society’s resources are organized through market forces in such a way that one would not be able to

reorganize them to achieve greater social welfare. There is a number of assumptions that are implicit to this model that we want to consider in this section of the paper, assumptions that relate to inequality.

This particular model results with some inequality in as much as marginal products will differ among workers. However, it does not explain how those differences survive in the long run. If we believe Becker, market forces would create an incentive for workers to migrate to jobs that have a higher marginal product and, in the long run, the mobility of labor across trades would ensure that all are doing equally well (Becker 1957; 2002). In other words, we would have a society without inequality.

If inequality demonstrates a high level of economic distortions, then the global trend toward greater inequality is a concern for economic growth that deserves attention. This is even more important in some regions such as the U.S. and Latin America. For instance, reviewing the U.S. data, Wolff and Zacharias conclude that: *“the income gap between the capitalist households and the rest can only be described as massive... [and] that the non-skilled workers are substantially behind the other groups of earner households”* (Wolff and Zacharias 2007). Studies point to the exceptional income and wealth disparity in the LAC region (Ramos 1996; Székely and Hilgert 1999).

Inequality is the reflection of the distribution of resources across society (Ramos 1996). It reflects an inability of markets to adjust with sufficient efficiency and maybe even a sign of market failure. Identifying the source of such market weaknesses is important since it highlights the central role that must be played by policies that increase the efficiency of markets or, if required, correct for market failures.

Abstract models such as Becker’s specify markets in a world where governments and social institutions are costless and essentially irrelevant. As has been the case with theoretical economic growth models such as Solow’s exogenous growth model and Romer’s endogenous growth models, removing such hypotheses result in models that are unable to explain conditions one observes internationally. For instance, Becker’s approach cannot explain outside of a quasi-tautological specification why segregation survived for so long in the south of the United States and why inequality has remained such a cornerstone of South America (Ramos 1996). We would like to argue that fostering competition is useful in removing inequality but that it is only one among many factors and that it is unlikely to be the main one.

Becker’s analysis is not robust to small changes in the hypotheses. His analysis does not explain why inequality has generally increased for the past half century. Markets are powerful tools but they have

also their weaknesses as shown by McMillan (McMillan 2002). They were less efficient than the English commons for centuries and they remain unworkable in large irrigation systems in various parts of the world (Sengupta 2001).

### 3.1. Stochastic inequality and status-based inequality

Those who have studied inequality as an empirical problem have belabored on how to arrive to a workable specification of what inequality might mean (Bourguignon and Morrison 2002). Theorists have also searched for different ways to apprehend the concept (Aghion and Howitt 1998). We would like to expand the analysis here by considering two broad classes of inequality, stochastic inequality and status-based inequality. The distinction is important because stochastic inequality is generally efficient while status-based inequality is inefficient.

To better tackle the inequality problem, it is useful to specify a few concepts:

**Aptitude:** Those inborn, initial conditions with potential to develop into skills an individual is born with.

**Ability:** An n-dimensional vector that specifies how well an individual would perform specific tasks. An individual's ability corresponds to that individual's aptitude as transformed by education, other socio-economic factors such as health, and learning-by-doing on the job. The n dimensions are the dimensions that are relevant in performing any trade. Some dimensions may be generic, e.g., knowing how to read, while others may be trade specific, e.g., knowing how to work high voltage electric systems.

**Managed inequality:** where some groups within the population are able to control either their abilities or their work status independently of their abilities; e.g., where some socially preferred status is inherited.<sup>3</sup>

**Stochastic inequality:** where the abilities of the members of a population are randomly distributed (possibly through a stationary process).

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<sup>3</sup> This is also called "invested inequality" where the verb "invest" is defined as follows: "allocate one's resources, time, energy, and/or effort to protect one's status (in forms such as higher income, greater control of knowledge,...) in the expectation of a benefit in the short run and/or in the long run for, say, descendants." Specifically, this means that one uses some resources to protect one's status in order to achieve a position that is superior to the one resulting from the random distribution of "aptitudes."

Aghion and Howitt consider a population with randomly distributed abilities. While no one has a control over the kind of abilities one has and while inequality emerges from a stochastic process, they show that inequality may nevertheless be inefficient.

The most significant dimension of the stochastic inequality is its instability. Individual whose random draw give them superior aptitudes have an incentive to invest in activities that can protect their status, influence those institutions that constrain their activities, and expand abilities through allocating resources to have more education and more of other activities good for them and people they are related to, especially their descendants.

Stochastic inequality is consistent with, say, neoclassical analysis. However, it is hard to find that it has any policy relevance. In practice, there is no evidence of stochastic inequality and the kind of inequality one observes every day is closely linked to group dominance. Group dominance is the rational outcome of the allocation of resources by those groups that are able to claim a larger share of society's resources - being rich is both preferable to being poor and inexpensive relative to poverty (Alesina, Di Tella and MacCulloch 2004; Hout 2002). In those situations, inequality is sustained by lobbying-based governances rich are successful in having implemented by society.

In practice, non-stochastic inequality is directly linked to discrimination and the exclusion discrimination creates. In turn, discrimination results in individuals developing different frames of reference depending upon their social status (Becker 1957). Those different frameworks become the foundation upon which rational decision making is established, i.e., they establish distortions. Discrimination becomes one of the factors that define the decision processes across the economy resulting in inequality-specific response to economic signals. For instance, inequality creates an incentive for those who have proportionately a larger share of society's resources to take steps to protect and even reinforce their status.<sup>4</sup>

With more resources, those people have a greater control over information and have the ability to manage it to their advantage the way they are able to manage the greater resources they have access to. Those resources can be used to influence and reshape society's institutions, e.g., decreasing resources allocated to public education in favor of private education. Those individuals have an incentive to enhance their ability to protect subsequent generations. They have the incentive to coordinate as a "club"

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<sup>4</sup> Alesina and La Ferrara approach the problem of discrimination from an ex post perspective, considering that various groups that are discriminated against have a culture that does not fully overlap with that of the dominant culture (Alesina, A. and E. La Ferrara (2005). "Ethnic Diversity and Economic Performance." *Journal of Economic Literature* 43: 721-761.) Their model applies to countries such as Canada and the United States as well as much of Europe and Australia and New Zealand. It does not apply where discrimination and prejudice has been long standing.

some of their efforts creating, possibly de facto, an upper class. The outcome is the emergence of a sustained inequality largely independent of the aptitude random draw.

It is the question of economic growth that makes the distinction between stochastic and managed inequality so important. As we noted, stochastic inequality reflects the initial endowment of individuals. As such it is not associated to systematic distortions that result in inputs being either less or more efficient than they should be.

Society has limited resources to transform the initial aptitude endowment into abilities that are available to society to produce wealth. Under a generalized Beckerian world one could derive an optimal allocation of the resources society allocates to transform aptitudes into abilities. This could also be done through Yang's new classical framework. Society is better off where those who have the best set of aptitudes to achieve desired abilities under the broad resource constraints are the one who are selected to be prepared to that task. Managed inequality means that some who are less suited to achieve such abilities are in fact selected. The inefficiency comes from the need to allocate more resources to prepare those individuals taking away resources that would be allocated to training the most gifted for a particular task.

### **3.2. The question of efficiency**

Setting aside the kinds of questions we have raised above about the efficient allocation of resources to transform society's endowment in aptitudes into a corresponding endowment in abilities, we consider here other dimensions of the link between growth and inequality.

An exogenous change, say a change in taste or a change in demand associated with technological change, can trigger as in Solow's model an expansion in economic activities. Such an expansion is likely to impact the relative demand for various sets of abilities, hence the marginal product of various types of labor. One can expect that there will be in the short run winners and losers. This means that exogenous changes produce inequalities in the short run. This is interpreted by many as a sign that economic growth creates inequality and that this is a good sign. Yet, this does not follow since improving the adjustment process, say through retraining of the displaced labor, would shorten the adjustment period and improve the chance of achieving greater growth.

The coexistence of a negative and positive relationship between inequality and growth, where an increase in the rate of growth may increase inequality, is not the paradox it seems to be. An increase in

the rate of economic growth that may result from factors such as the reduction of inequality may bring about distortions while markets adjust to the new environment. Those conditions mean that growth has made some factors scarcer and others more plentiful. Those market adjustments take time and, in the mean time, some factors benefit, while others are worse off. The GPT framework suggests this kind of process with skilled resources playing a central role in the early stage of the deployment of a new technology, and then becoming increasingly important as the technology matures. This model has been used to explain the recent increases in inequality. This is because market forces should put downward pressure on inequality (Cimoli, Primi and Pugno 2006).

When discussing inequality and its impact on the economy and economic growth one needs a benchmark. The criteria we choose here is how inequality affects economic growth, independently of all ethical considerations. Inequality is inefficient if it results in a lower output and/or higher costs than necessary (Alesina and La Ferrara 2005).

Given the economic questions we are studying, individuals make decisions both as consumers and as factors of production within society, i.e., the “labor” input of production functions (Yang 2001). We accept that most if not all societies develop organizations and culture that support some level of “inefficiency.” This has been acknowledged as a more general proposition by individuals such as Parente and Prescott that is at the heart of their model (Parente and Prescott 1993; 1994). In those situations where inequality is relevant some individuals are inadequately productive because of their social status. Yet, efficiency requires the absence of social distortions that impacts individuals as economic decision makers. It is only in that setting that individuals must be free to develop and use their abilities recognizing the constraint society’s scarce resources imposed without bias on the capacity of individuals to build upon their aptitudes to develop their abilities. This is not inconsistent with assuming that variations in the endowment of individuals exist. The key factors are that choices must be free and yet constrained by the need to achieve economic efficiency. Individuals can be more or less effective depending upon the resources they are initially endowed with and the resources and environment available within society.

Economic efficiency means that individuals have an inherent potential, their aptitudes. That potential can only be partially actualized through the individuals’ private choices as well as their social environment. The factors at play include the original potential, i.e., their aptitudes, the individuals’ choices, and the constraints both society’s resources and its social environment. Those factors are completely intertwined with one another and it is hard to establish how much of the realized potential of an individual can be attributed to that her own basic aptitudes, to her free choices, and to the constraints

imposed by her environment. It is nevertheless essential, if one is concerned by efficiency, to understand how much of a shortfall there is, i.e., how much of the inefficiency is due to social inequality as opposed, say to the lack of competition. In spite of the challenge we know that the shortfall is large when we observe what happens in places where factors such as gender or racial discrimination change (Clotfelter, Ladd and Vigdor 1981; Neal 2005).

Some go beyond Dollar and Kraay to argue that inequality may not be bad after all since it is the outcome of growth, greater growth resulting in greater inequality. However, this conclusion is based upon the assumption that the frictions and institutions that impact the market adjustment process are fixed, given. As a result, the idea that inequality might be good since it reflects economic growth is inappropriate from a policy perspective. Policies should target institutional and other forms of rigidities so as to increase the economy's efficiency. That process would lower inequality. In other words, the inequality that follows growth points to rigidities that slow down the market adjustments and it is those that need to be targeted.

### **3.3. Models of inequality**

Aghion and Howitt develop a simple model of inequality to show how greater inequality means slower growth (Aghion and Howitt 1998). In this paper, we are concerned with the Aghion and Howitt inequality to introduce the concept of efficient inequality. Going further, we do not believe that their model points to inequality-based inefficiency. In Aghion and Howitt, there is no discrimination and there is nothing to distort the individuals' aptitudes and to stunt those of some. Individuals have different aptitudes but those aptitudes are determined randomly with everyone, regardless of history, having an equal probability of being at the top of the pyramid. Inequality is not inherited nor is there a transfer of wealth to sustain its present distribution within the population nor is there a taste to discriminate or for the rich to allocate resources to protect their status. The inequality reflects the interaction between on one hand market forces that determine what talents are in demand and on the other hand how those talents are distributed within the population. There are no constraints on the ability of individuals to use efficiently those talents. Where markets are competitive and where there are no adjustment costs, inequality will generally not be economically inefficient.

Adam Smith's analysis can be used to formulate a model that is in many ways even simpler, where individuals are assumed to be all born with the same initial aptitudes. The model becomes more complex once one looks at it from a dynamic perspective. Then those aptitudes are converted into diverse sets of capabilities as individuals select trades in the course of the division of labor (Yang 2001), presuming

path dependence, i.e., assuming that people by choosing trades in response to the division of labor find it increasingly difficult to change specialization.

In this model, inequality arises, presumably, from the division of labor. The division of labor means that different people will specialize in different ways, individuals building experience along different trade paths. Once one assumes that retraining is costly, i.e., that the change of specialization is hard to implement then Adam Smith's model thus expanded may result in stochastic inequality, comparable ex post. Individuals cannot know ex ante those professions that will become the most in demand since this is determined by the technological path, an exogenous path. Those who happen to select those "successful" positions benefit creating inequality.

In those models inequality and efficiency are largely independent of one another. This could be true even if differences in aptitudes were at least partially inherited once again as long as the process is random (Davis 2007). Inefficiency is independent of that inequality as long as individuals are not able to influence the abilities of their descendants and/or the institutions, e.g., the political process. The inequality these models generate is unlikely to be particularly significant, i.e., that inequality is unlikely to explain the high level inequality that is observed in, say the U.S.A. and Latin America. For instance, there is no indication that such inequality harms the efficiency in regions with low inequality such as in Scandinavia.

### **3.4. Conclusion**

In the above analysis we do not consider the potential burden of transfers across individuals can have on the economy and on efficiency (Alesina and Rodrik 1994). If those transfers are due in part to the desire to correct innate differences in abilities, then those transfers may explain some economic inefficiency in spite of the gain in social welfare. Since they would be stable they would not explain a positive correlation between inequality and growth. Inequality is most likely to arise where individuals are able to affect the transformation of aptitudes into abilities an individual uses to contribute efficiently to the economic process.

In the more common situation people with control over a larger share of society's resources allocate rationally some of those resources to influence society's decision process and have governance that are favorable to them. Their resources give them, for instance, a better control on information and utility maximization leads them to use such asymmetry to their benefit. Such conditions enables that/those group(s), based upon rational, utility maximizing incentives as well as ability to maintain the

discriminatory status quo, to foreclose discrimination-reducing policies (Becker and Murphy 1992; Neal 2005)<sup>5</sup>.

The preceding analysis points to a situation where decisions are distorted. This is not to say that poor, for instance, do not respond. We see in a number of places where inequality increases in crime, increases that are rational even if one has to introduce the question of inequality-based inefficiency in Becker's analysis (Becker 1968). As long as those changes are not so disruptive and so costly for those with resources (including for resources to protect themselves and their property), hence power, those inefficiencies are utility-enhancing (Moser, Winton and Moser 2005). Those distortions mean that most if not all resources are used suboptimally. The poor do not have access to resources, say education, that would enable to reach their potential, i.e., to contribute the most to society. The rich have to forego some resources that could be used to further society's output to buttress and possibly expand their power. Those misallocations reflect a wide range of market failures.

Rephrasing inequality in terms of market failures has significant policy implications. In other words, it is important to understand that the ability to reduce market failures and/or market needs to be the economic benchmark for society's inequality-reducing policies. This leads us to argue that policies should focus on making economic adjustments as smooth. Ideally, it should be designed to remove market failures. For instance, where growth creates shortages in some types of labor, shortages that lead to increased inequality, policies should insure that conditions are set that increases the ability to identify and educate poor who, in term of a discrimination-free basis, to be qualified for those kinds of labor. Devising such policies is a challenge but it should not be as hard as suggested by the literature. Loury's analysis of affirmative action, for instance, is very sensitive to the specification he chooses and very small changes, e.g., more than the choice between skilled and unskilled work options, with a single wage for each leads to a different result (Loury 1992).

#### **4. ICT and inequality on growth**

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In this paper we focus on the ways the market may fail to provide the kind of ICT infrastructure that corrects some of the inefficiencies that can be traced to inequality. The approach we consider faces many challenges as illustrated by numerous examples of failures in attempts that were made to introduce ICT solutions to meet the needs of the poor (Digital Opportunity Initiative 2001; Keniston and Kumar 2003; Warschauer 2003). The Digital Opportunity Initiative concludes that: "*There is no suggestion that*

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<sup>5</sup> The Economist suggests in a recent issue that this may very well be the case in the U.S. in the context of education (The Economist 2007b).

*ICT can eliminate the need for these or offer a panacea for all development problems. But detailed analysis of experience around the world reveals ample evidence that, used in the right way and for the right purposes, ICT can have a dramatic impact on achieving specific social and economic development goals as well as play a key role in broader national development strategies. The real benefits lie not in the provision of technology per se, but rather in its application to create powerful social and economic networks by dramatically improving communication and the exchange of information. ICT is already being used highly effectively to directly address development goals,”* conclusion that is corroborated by others.

We have shown that inequality tends to be bad for the economy even if poverty tends to decrease. At the same time, many see ICT's contribution as positive. If the two were independent of one another, one would expect to have to evaluate the net effect of those two countervailing forces. The problem is that they are not comparable. One can assess digital poverty the way one studies overall poverty and even the most superficial observations leave little doubt that digital poverty is decreasing almost everywhere – this is not surprising since the starting point is complete digital poverty.

This does not exclude the possibility that ICT might increase the chasm between poor and rich with the rich having access to ever more sophisticated ICT while expanding ICT contributes in relative terms less and less to the poor. This situation is happening today in many places. Broadband and Internet access are not expanding anywhere among the poor the way they are among the rich. They need to be differentiated from mobile since the latter's chasm has been growing far more slowly. Then Internet raises two questions to be considered here, namely whether or not ICT has been worsening inequality and, then, if it is increasing inequality, whether it is inequality that undermines ICT's potential or whether the causality goes from ICT to inequality, i.e., whether ICT amplifies the social cost of inequality.

The negative potential of a combination of ICT and inequality has led researchers to introduce the concept of the digital divide. We consider below how an economist would look at the digital divide, hence how she would want to define it. The digital divide makes the study of economic growth that much more complex since ICT contributes, absent inequality, to economic growth throughout the most developed segment of the economy. We understand the digital divide as a force that limits society's ability to achieve higher productivity.

ICT's contribution to economic growth has been the subject to a lot of discussions since Solow's 1989 quip that computers can be seen everywhere except in productivity. Stiroh and then Stiroh and

Jorgenson were the first to use the exogenous growth productivity framework to identify ICT's impact on the economy (Jorgenson and Stiroh 1999; Stiroh 1998). They concluded that the U.S. economy went through a dramatic drop in ICT prices: "*the large decline in the rental price of computers*" i.e., exogenous changes in the price for ICT "*that generated substantial returns for the economic agents who undertake IT investments.*" Those changes led to a 'massive' substitution of ICT for other inputs: "*massive substitution towards high-tech capital goods is raising the relative productivity of firms and industries that are able to invest and restructure their activities*" (Stiroh 2000). In addition, that drop became particularly pronounced starting in 1995. Firms responded to those changes by the kind of substitution we just described conditional upon the "fundamental technological progress" experienced by "the computing-producing sector," i.e., these "unexplained," exogenous changes in price where "*the benefits of investment are internal in the form of enhanced productivity or higher wages... with little evidence that productivity gains spill over to others.*"

Jorgenson and Stiroh described sarcastically the difference in approach with GPT: "*The Solow paradox... has generated a kind of Computer Cargo Cult among economists and economic historians, patiently awaiting the deluge of spillovers,*" yet the question relates in a large part to those externalities Stiroh mentioned. The exogenous growth model is a neoclassical model and, as such, it is biased against externalities. Those are considered a residual, i.e., whatever might be left once one has done one's best to explain the observed data. Jorgenson's overall position can be traced back at least to Knight and the debate with his mentor, Young. While Knight is probably the most eloquent proponent of neoclassical analysis, it is Young who offered its most devastating critic (Young 1928).

Inequality considerations, especially when they are combined with inequalities at the ICT level mean that we need to consider issues of aggregation. Stiroh had already argued, in a different context, that "*[a]ggregate analysis is inappropriate since it obscures basic distinctions*" between a move along the production surface and a shift of that surface when studying how ICT affected growth. While the context is different, the transposition to the inequality cum ICT question is straightforward, hence our conclusion that aggregation is a particularly serious issue. Inequality and inequality combined with ICT means that there is a shortfall in the society's inputs to the production process. This means in turn that the economy is performing far away from the production frontier. Neoclassical analysis focuses on allocation questions. Once one is away from the boundary, those become much less relevant.<sup>6</sup> It is the study of what can help a society move toward its production frontier and what can help move the frontier outward that matters.

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<sup>6</sup> We have here the difference between classical and neoclassical analysis. While allocation is central to neoclassical analysis, classical analysis' primary concern was growth.

This brings us to an overlay to the earlier discussion, how the digital divide affects efficiency and how the emergence of the digital divide affects growth. Only by addressing those questions can we hope to progress with respect to the economic growth problem.

The fundamental issues with inequality, where one is solely concerned with economic efficiency, are issues such as how inequality distorts the development and allocation of human capital. Our concern here is whether ICT is one of those dimensions that contribute to inefficiency. This means that we need to work harder to understand the limitations of markets even in the most neoclassical environments. In such an environment, efficiency is assumed to require that factors of production be paid their marginal product. In any society, even in the most normal circumstances, there are individuals whose marginal product is positive and yet too low to ensure their survival – after all, the lower bound of the marginal product is zero (and we are not talking of a Malthusian scenario). Unless society take a Malthusian view of survival, those individuals are capable of contributing to the economy but this requires some form of transfer. Acknowledging the possibility of some market failures does not justify singling out ICT. Some argue that poverty is associated with even more basic problems, say basic nutrition needs. On such ground, they dismiss the digital divide as a problem that has been created artificially by stakeholders that stands to benefit from it, say incumbent telecommunications operators that would use the divide to claim that they must receive subsidies comparable to the traditional universal service obligation (Mueller 1997).

There is a recent real life experience that shows that this is not the case, it is the experience of Casenave and Lane-Petit that led them to create a new NGO, “Telecom Sans Frontier” (TSF; [www.tsfi.org](http://www.tsfi.org)).<sup>7</sup> Casenave and Lane-Petit were working as volunteers to address the disaster that affected the Kurde region of Irak in the early nineties when they discovered accidentally that, *“[i]n a camp, the refugee becomes just a number. If he succeeds to contact relatives, he knows that he will be able to set in motion a powerful help network: the family.”*<sup>8</sup> Recently, Saffer formulated a theoretical model that provides something that may become the underpinning to Casenave and Lane-Petit’s contribution. Saffer’s model treats social interaction as an economic good (Saffer 2005).

TSF’s experience establishes that ICT is not an ordinary commodity, i.e., that it cannot be considered from a pure poverty/inequality perspective without reference to economic efficiency. TSF’s experience put in the center of the discussions the social nature of human being, i.e., that externalities are not

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<sup>7</sup> Telecom Without Borders

<sup>8</sup> The pay-off from telecommunications was much greater The Economist (2007a). Disasters and Telecoms: Telecommandos. The Economist. What TSF had to put in place to help people provided also the kind of ICT infrastructure that has become vital to the coordination of efforts across NGOs ([www.ciosansfrontieres.org](http://www.ciosansfrontieres.org)).

marginal but that they are at the core of ICT. TSF and “CIO Sans Frontières”<sup>9</sup> experience supports focusing on the digital divide, i.e., the interaction of inequality and ICT as a GPT. For instance, it helps understand why one observes individuals who forego some of the most essential needs to be able to access mobile communications.

The successful use of ICT in an environment where the poor live so as to provide some remedy to inequality forces those who formulate policies and those who implement them to be innovative, looking for new models. Nevertheless, there are many justifications for selecting ICT as a tool that has the potential to turn around the burden of a “digital divide” into faster growth. Thus Liu and San note that: “[n]ew ICTs can be adopted both selectively and innovatively to directly enhance the welfare of the poor” (Liu and San 2006). Even if it is clearly a complex approach to implement ICT successfully to remedy inequality, even if it requires considerable learning, and even if there is the danger of capture by stakeholders, the benefits are such as to justify facing the challenge. Besides, the approach requires for its success the parallel implementation of a mainstream ICT strategy for the formal economy.<sup>10</sup>

ICT features that have high potential include the provision of a class/ethnicity-neutral interface where individuals from the privileged classes do not have many of the inherent advantages they have in direct, contacts (Valaitis 2005). Then ICT’s neutral interfaces can benefit the poor since such interfaces can be designed to reveal little about the individual’s social class. The same type of Internet-based interfaces can also make it possible for the poor to access with confidence

As one gain experience, one would expect that society will become increasingly expert at designing “pro-poor/pro-equality” ICT. Those infrastructures should eventually become cheaper, i.e., have lower transaction costs (Langlois 2000). This would make them more successful than today’s options.

## 5. The digital divide and policy implications

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As we have seen that inequality tends to be more relevant than poverty, in the same way we would like to suggest that relative digital poverty is the relevant criteria. This is because relative digital poverty is

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<sup>9</sup> CIO Without Borders

<sup>10</sup> Joseph, K. J. (2002). Growth of Ict and Ict for Development: Realities of the Myths of the Indian Experience. WIDER Discussion Paper. United Nations University, World Institute for Development Economics Research. talks of two dimensions to the deployment of ICT, growth and diffusion. His paper is a critique of the Indian approach to ICT development that has focused uniquely on ICT growth. In Latin America, ICT growth means primarily the deepening in the use of ICT in the mainstream, national economies. Our approach does not challenge the merits of this kind of fostering ICT growth. On the other hand, it stresses, as Joseph does, how essential the diffusion dimension is. Our focus is on the impact of ICT on the poor (long-tail), informal economies.

highly correlated with inequality. The presence of digital inequality where there is already pure inequality has come to be called the **digital divide**.

### 5.1. But, what is the digital divide?

To start in an effort to better understand what the digital divide might mean, we can start with the National Telecommunications and Information Agency (NTIA) approach: “*The chief concern with respect to household computer and Internet access is the growing digital divide. Groups that were already connected... are now far more connected, while those with lower rates have increased less quickly. As a result, the gap between the information ‘haves’ and ‘have nots’ is growing over time*” (NTIA, 1999). Compain rephrased it in a more compact manner as, “the perceived gap between those who have access to the latest information technologies and those who do not”

While NTIA gives a technology-centric definition, Greco and Floridi start from the consumer to argue that: “The digital divide (DD) is caused by the various difficulties encountered by people in their (lack of) interactions with ICTs and hence in accessing information contents, services and resources” (Greco and Floridi 2004).

Selwyn sets the digital divide debate in terms of social inclusion (Selwyn 2002). From such a broader perspective, Fink and Kenny consider the possibility that there may not exist a simple problem with digital inequality. This leads them to go the next step defining the digital divide in terms of what might be the dominant difficulty that may be isolating individuals and communities from the rest of the world. They identify, “four possible interpretations... [that] appear in the literature”:

1. A gap in *access* to use of ICTs—crudely measured by the number and spread of telephones or web-enabled computers, for instance.
2. A gap in the *ability* to use ICTs—measured by the skills base and the presence of numerous complimentary assets.
3. A gap in *actual* use—the minutes of telecommunications for various purposes, the number and time online of users, the number of Internet hosts, and the level of electronic commerce.
4. A gap in the *impact* of use—measured by financial and economic returns. (Fink and Kenny 2003).

Keniston considers the scope of the digital divide from still another perspective identifying four divides:

1. “*The first divide is that which exists within every nation, industrialized or developing, between those*

*who are rich, educated, and powerful, and those who are not.*

2. *A second digital divide, less often noted, is linguistic and cultural. In many nations this divide separates those who speak English or another West European language from those who do not.*
3. *The third digital divide follows inevitably from the first two -- it is the growing digital gap between the rich and the poor nations.*
4. *To these three digital divides we can add, in countries like India and America, yet a fourth: the emergence of a new elite group,... the beneficiaries of the enormous successful information technology industry and the other knowledge-based sectors of the economy such as biotechnology and pharmacology....”*

DiMaggio et al. provides a definition that complements Kenniston's as well as Fink and Kenny's definitions. They define the digital divide as “inequalities in access to the Internet, extent of use, knowledge of search strategies, quality of technical connections and social support, ability to evaluate the quality of information, and diversity of uses” (DiMaggio et al. 2001). It is a particularly rich definition, one that may not be very accessible by itself and yet one that synthesizes the basic concepts developed above. On the other hand, DiMaggio et al. have chosen to replace the earlier definition by a very restrictive one: “Who has access to the Internet, who does not have access, and how has this changed?” (DiMaggio, Hargittai, Celeste and Shafer 2004). This enables them to study the more general subject of digital inequality.

While definitions that are exclusively technology-centric are misleading because they focus on a problem that is real but that is only one among a number of problems, one needs to consider dimensions that are found in each of the other definitions. Creco and Floridi's definition goes in the right direction but it says little that is useful when considering policies that address whether the digital divide is something that one should be concerned of. To wit, one would have a hard time using it to argue that there is a market failure, i.e., the need for policy intervention. DiMaggio et al., Fink and Kenny, and Keniston each present complementary dimensions of the digital divide that can be used individually and as a whole to evaluate the likelihood of a market failure.

## **5.2. Is there a digital divide?**

The digital divide has become the source of lively debates among academics, politicians, and other stakeholders. The existence of discrepancies in ICT capabilities across regions and across social classes is not questioned. The debates relate to issues such as whether these differences are significant, e.g., whether they will progressively disappear, whether it may in fact be good as ICT is relatively new good,

and whether it might lead to a further exacerbation of inequality (Bauer et al. 2003; Campbell 2001; Tuomi 2000; DiMaggio and Hargittai 2001; DiMaggio et al. 2004 ). We begin by reviewing some of the challenges as to the digital divide's relevance. We address the works of those authors who see merits in the concept of the digital divide and study their definitions.

Among those who take the position that the digital divide is a non-issue, there are those who consider that market forces can deal with the problem (Compaine 2001; Longhorn and Blackmore 2003; Mueller 2001). Proponents argue that divides are a reality of nature and that they emerge as soon as there is a new good or new service. The view is that ICT is no different from those other innovations and that market forces eventually work things out. In fact, proponents believe that the divide is essential because, when the early adopters de facto help the producer to refine the production process and to build scale economies, the process is progressively able to take advantage of economies of scale. Those economies mean that the good or service becomes progressively cheaper to produce, i.e., that more and more people are able to afford it. The early adopters contribute to eliminate the digital divide.

### **5.3. The issue of efficiency**

DiMaggio and Hargittai may be the most interesting among those in as much as they have used, in different papers, two totally different definitions delineating the spectrum of definitions. In one paper, (DiMaggio and Hargittai 2001) they reduce the digital divide to its crudest form, access to ICT technology. In the other (DiMaggio et al. 2004), they provide a particularly enlightening and certainly complex definition. In the later, the technology component needs not even be part of the digital divide. Their choice of definitions reflects the unease many have with respect to definitions they see as potentially too comprehensive. The problem is that many appear to see the need to use a more comprehensive definition and yet they are concerned by with the boundary of the issues that should be tackled within the digital divide. Some see the digital divide as essentially an equity issue (Frischmann 2001). As we have a criterion, economic efficiency, we do not face that problem. The definition we propose stresses the digital divide's time dimension, an issue that has not been formally tackled in the literature. Formulating policies that are effective is challenging but doable is one of our conclusions and policy recommendations.

It is the proper of the economic process to be largely embedded within a political process with which it is closely intertwined. Since social and political considerations have a direct bearing on the various stakeholders' economic outcome, it is rational for them to invest in influencing those environments to reshape them in ways that would be beneficial to them. Then the proper scientific question has to do

with establishing a proper hypothesis, say the economically inefficient introduction of the digital divide issue, and a methodology to establish whether there is inefficiency or not (Stigler 1971).

The market is efficient at eliminating the digital divide. More important, the proponents of that model argue that the market mechanism eliminates the danger of betting on the wrong technologies. Wallsten, one of the proponents, cites ISDN as one example (Wallsten 2003). ISDN is a centralized, data network technology that incumbent telephone operators pushed in the late eighties and in the nineties with some regulatory support. With the exception of Germany, ISDN has rarely been implemented on a large scale in spite of the large investments that had been made. ISDN received its coup de grace from TCP-IP that quickly emerged as an efficient, decentralized protocol. Competition played a key role in helping TCP-IP to gain the upper hand.

It is widely accepted that markets are a powerful tool that is able to deal with complex problems. One loses all the richness and strength of markets when one looks at them as algorithms and takes their efficiency as an article of faith. At the same time, McMillan is one among many who has placed markets in their proper perspective, providing a view that points to the diversity of markets and the diversity of ways they solve intricate problems. McMillan's analysis highlights also how common it is for government to intervene and how at times it enhances efficiency and at other time it makes the situation worse. Sociologists have also looked at markets from a different perspective, stressing that they were institutions that are embedded within social structures rather than mathematical algorithms. Their conclusions appear to hold even in those markets that are the most automated, e.g., financial markets (Swedberg 2003).

Establishing whether a market solution is superior to a centralized solution is complex as anyone who has studied the question in the context of the theory of the firm knows too well. Being able to specify it as a scientific problem is even more complex. For this reason, markets are an essential part of the search for an efficiency approach but certainly not the only one. Solutions must inevitably point to multiple equilibrium. In addition, the market model of the digital divide they make allusion to assumes that goods are homogenous with respect to allocation through the market mechanism and embedded at best to an a-historical time where the future and past are interchangeable.<sup>11</sup>

Fink and Kenny have looked at the digital divide from a different perspective. They view the digital divide as a tool some stakeholders, including politicians, use to “capture” the government to their

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<sup>11</sup> For instance, their approach excludes such possibilities as learning-by-doing and path-dependence.

personal benefit independently of whether or not there is merit in it (Fink and Kenny 2003).<sup>12</sup> They use a sarcastic tone to dismiss alternative solutions. They posit that: “*the core of the digital divide creed is that the spread to ubiquity of information and communication technologies (ICTs) in developed countries is leaving the developing world behind, with potentially cataclysmic consequences in terms of development prospects.*” As far as they are concerned, the digital divide is one possibility among many. Besides, they contend seeing many signs that the present situation is not as bad as what they call “the digital divide creed” would suggest.

They are not as categorically opposed to the concept as other proponents and their actual position is not all that far from Rappoport et al.’s rather guarded conclusion (Rappoport, Kridel and Taylor 2002). Once again, that line of reasoning consists for most in an assertion rather than a provable hypothesis. Proving scientifically their contention is a challenge since it requires a far more careful specification of the problem than they have done.

#### **5.4. Policy implications**

The economic analysis of inequality and of digital divide begs the question about the criteria, if any, that should be used to identify a market failure and justify an intervention. Fallis sees the digital divide as the issue of access to knowledge (Fallis 2004). Nevertheless, he takes also the position that the approach should not be solely epistemic and that it should also have ethical consideration. In the context of ICT and inequality, markets have limits in their ability to ensure efficient outcomes, i.e., situations will emerge where one has to complement or even substitute alternative approaches. While the question is whether the digital divide has merits, few studies specify clearly the criteria decision makers should adopt when looking at responding to the digital divide through policies. For us, as far as the digital divide is concerned just as with inequality, we adopt economic efficiency which we find the simplest and least controversial benchmark.

Inequality is nowadays largely associated with ICT’s digital divide and the policy issues with the digital divide can be compared to those with inequality. The inequality applies within countries and across countries, and many have been concerned by the emergence of a digital divide between those two groups of countries. The digital divide is seen as demonstrating a growing discrepancy between the growth achieved in developed countries and that achieved in developing countries (DiMaggio, Hargittai, Neuman and Robinson 2001; Fink and Kenny 2003; Keniston and Kumar 2003; Quah 2007). Because of

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<sup>12</sup> They further argue that the divide has increased within countries in absolute terms while it has decreased proportionally across countries, developing countries catching up developed countries. This means that the national divide has worsened. It also means that **it is not possible** to establish whether the poor in developing countries are getting better off or worse off compared to the overall population in developed countries.

the broad similarity between the digital divide within countries and that across countries, the geographical concentration ICT fosters among the most innovative sectors is a concern for LAC as it is within LAC for the poor and less educated (Audretsch and Feldman 1996). While we concentrate our attention on inequality in the digital world for reasons such as those that can be derived from Audretsch, we acknowledge the problem of digital poverty, a concept that has been introduced by Barrantes, and its direct relevance to the study of inequality. It is interesting to look at it as a mirror image of the poverty-inequality issue in the ICT world (Barrantes 2004). Here also, the issue is not that conditions are necessarily worsening, that digital poverty is growing. There is ample evidence that it is rapidly diminishing. Rather, the digital divide is related to the relative position of the lower classes relative to the rich and it matters because, even if the poor have an increasing access to ICT, they are nevertheless increasingly falling behind.

Quah quantifies in a cost-benefit analysis some of the ways ICT may contribute to growth including, *“human capital accumulation, lower poverty, deliver information to schools and hospitals, improve public-services provision, and make patterns of production more efficient.”* Those are the factors that he considers in his effort to quantify the costs and benefits of the digital divide. He concludes that, on the whole, lowering the digital divide would be highly beneficial. Furthermore, he acknowledges additional factors through which ICT can reinforce its contribution to growth. For instance Quah considers that it can *“mobilize political action, build institutions, and foster accountability and governance”* (Quah 2007). Since our concern in this paper is the significance of the process through which ICT impacts inequality, hence, given our earlier results, growth, it is important to note that the impact of those factors on economic growth is not fully determined without an understanding of the way inequality works as a conduit. Thus, if a country is uniformly poor, then existing governances are likely to contribute to inadequate growth. On the other hand, if a country has segments of their economy that are well integrated in a modern economic system, that country has an experience with governance and the challenge is to develop ways to apply that general type of governance across all segments of society.

There are complementary dimensions to the digital divide, first the digital divide’s time dimension, its social dimension, and then the comparison with universal service and the rapid penetration of cellular telephone among the poor.

Most of the debates around the digital divide imply that ICT is an established and unchanging technology that appeared, fully matured one day. In this world, the upper class has had an early access to the technology and they have learned to take advantage of it to increase their ability to fructify their initial endowment to their benefit. Once one is able to give the poor access to ICT, e.g., a computer and,

say, broadband Internet access, then the poor will be able to do the same thing. This is scarcely the reality. The digital divide is a dynamic reflection of society inequality when ICT evolves in response to highly innovative, ever evolving technologies. The digital divide cannot be solved with a static solution, e.g., train the poor to use to their benefit web 1.0 to foster their own utility. Addressing the digital divide requires a mechanism that addresses that evolution, at least until ICT reaches a sufficient level of stability.

The experience over two third of a century in some places with the universal service obligation would seem to justify focusing on the technological issue of access. The experience with the rapid adoption of mobile telephony, at times in complex situations may suggest to some that the digital divide is a marginal problem with no significant implications for efficiency and economic growth (The Economist 2007c). The problem with that view is that ICT is not a homogenous good. Almost any individual, regardless of education and experience, appear to have no problem using primarily telephony and broadcasting or cable distribution. Those types of ICT do not require much to learn how one might benefit from it and how to use it and, as it has been pointed out, those services are common among the poor even if not in the same proportion as among the rich (Kenny 2001; Mueller and Schement 2001). The digital divide is a problem because of a subset of ICT services: the Internet-based services. Even at that level, some look at the digital divide as an extrapolation of universal service and, from a network design rather than conventional access, see the possibility of reducing the digital divide (Camp and Tsang 2001). However, they look at infrastructure services that facilitate communications, not the upper layers where the services and content individuals create and use are located. Those are services the utility of which is not intuitive without any considerable experience and learning, i.e., in which society needs to invest to bridge the digital divide.

The digital divide reflects distinct issues that have to be approached in different ways. Let's assume that we are part of the traditional telephone industry. The digital divide suggests a problem that the regulator may be able to remedy jointly with the industry: since a segment of the population is unable to access ICTs because they cannot afford to pay for access, then one can work out a fund that industry participants would contribute to and that would be used to finance those individuals' access. In this approach, one presumes that there is a problem with the access to the telephone network. It is generally assumed that there is a market failure with access to the digital divide. This is a well-known problem in regular telephony and the conventional solution, in practice, has been to provide access under some form of universal service obligation. This policy is meaningful if the fund increases social welfare. Economists have studied the provision of universal service and some have made the parallel between universal service and digital divide (Owen 2002). Owen points to the problem of government failure

with the government treating the digital divide fund as an entitlement. Selwyn sees it as the work of “an ‘unusual alliance’ of academics, IT industry executives, politicians and social welfare organizations” (Selwyn 2002).

On the other hand, the digital divide from an economic efficiency perspective needs not be restricted to the physical access as considered above. It can be seen as an inadequate ability to access and use new ICT-based services that are due directly or indirectly due to inequality including possibly poverty that reduces individuals and households’ contribution to economic activities in spite of their inherent capacity to do so. This broader perspective reflects also DiMaggio and Hargittai’s suggestion that the most pressing issue is less and less the technological issue of physical access to the Internet and more and more a question of digital inequality reflecting the need to focus more on social inclusion (DiMaggio and Hargittai 2001; Selwyn 2002). It also means that there may exist a “digital divide” in spite of adequate access to physical telecommunications facilities, e.g., access to DSL, cable facilities, and/or WiFi is available and affordable by low-income households, a possibility that seems to be confirmed by a number of studies (McLaren and Zappalá).

Rappoport, Kridel, and Taylor have sought to evaluate the extent to which one can identify empirically a digital divide (Rappoport et al. 2002). They conclude that, “*although socioeconomic and demographic factors are clearly important determinants of broadband Internet demand... Internet end-use factors are also important... [A digital divide] is far more likely to be a geographic phenomenon (rural versus urban) rather than one formed by socioeconomic and demographic factors.*” They do conclude that there exists a digital divide. Carveth and Kretchmer arrive to generally similar conclusions for Europe (Carveth and Kretchmer 2002).

Economic efficiency raises other issues. For instance, were the poor well informed of the benefits they could derive from ICT, then it would be more efficient to provide them a voucher that enables them to allocate their resources optimally (Frank 2006).<sup>13</sup> In addition, access and management of information is sensitive to the kinds of information involved and the kinds of platform used. Mobile’s success demonstrates that there exist kinds of information that can be transferred and managed successfully even with limited technical knowledge. The discrepancy between mobile’s oral communication and Internet-based knowledge management suggests that the digital divide between classes may be significantly greater where the information cannot readily be dealt with orally. Where it is complex to inform the poor of how they could benefit from ICT services, the situation with the digital divide associated most ICT

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<sup>13</sup> One finds that result in any microeconomic textbook. In practice, the result requires than taxation and transfer through taxation or within the industry be apolitical. If this is not the case, and it seems not to be the case as far as the universal service and the digital divide are concerned, then the conventional textbook solution is irrelevant and an industry-based transfer may be socially optimal.

services, then the process is far more complex. McLaren and Zappalá's results may be interpreted by some as demonstrating a low demand for ICT services.

While the above explanation is a possible interpretation, it is probably a misleading one demonstrating an overly simplistic treatment of the problem. For instance, past experience and limited social mobility mean that rational poor would have a very low expectation about the probability of getting even a marginally better job, independent of the knowledge they may gain through ICT to expend their ability to contribute to economic activities (Ramos 1996). This is further supported by Hout's suggestion that "... *others' income affect how some Americans perceive their own incomes and that change of view causes them to act or respond differently*" (Hout 2003). It is also likely that such individuals have to work long hours to make ends meet, making it harder for them to invest in the accumulation of wealth-producing knowledge. For these and other reasons, analyses such as the one produced by McLaren and Zappalá means that the observed outcome might be socially inefficient even if it is efficient at the level of individuals.

## **5.5. Conclusion**

We have identified the digital divide as the conduit through which inequality conspire to restrict people's ability to take advantage of ICT to reach their potential, hence to contribute to economic efficiency.

Rising inequality in many parts of the world means a growing digital divide that means that those societies have not been able to take advantage of the ICT resources they could muster, hence have fallen short of their growth potential. It is important to understand the forces that are contributing to inadequate growth but it would be even be better to understand whether policies can be designed that could remedy the problem.

The links between, on one hand, ICT and inequality and, on the other hand, between ICT and growth lead one to query as to whether the digital divide is unavoidable. A priori it is hard to imagine how a technological change that would appear to improve growth should be harmful. If it is unavoidable, then the object of policies is to minimize its harmful effect. Nevertheless, if it is not inescapable, then one needs to better understand what kinds of policies could take advantage of the benefits that can be drawn from ICT to improve the situation.

The issue with the digital divide is not digital poverty but the pace they gain access to ICT relative to the

rich, i.e., the pace at which they get relatively more and more behind. On the whole an increase in digital poverty, at least at an individual level, is not the case; ICT has been helping the poor. This is well illustrated by mobile communications and its significant contribution to growth in places such as Africa (Waverman, Meschi and Fuss 2005).

The existence and growth of the digital divide means that, left to themselves, market forces are unable to ensure that the poor can contribute efficiently to the economy. The kinds of steps that are particularly interesting are the steps that are centered upon ICT to remedy inequality. There are specific experiences that have been successful in addressing the digital divide problem (Gigler 2001; Gillett, Lehr and Osorio 2003; Oddo 2002). Warschauer's observations suggest that individual experiences have to be evaluated critically and that success is hard to achieve (Warschauer 2003). This is not surprising in light of Tongia's conclusion that the bottleneck to the construction of the infrastructure is not technological but regulatory (Tongia 2006).

## 6. Bibliography

- Acemoglu, D. (2001). Deunionization, Technical Change and Inequality. Carnegie-Rochester Conference Series of Public Policy.
- Aghion, P. and S. Durlauf, Eds. (2005). Handbook of Economic Growth. New York, Elsevier.
- Aghion, P. and P. Howitt (1998). Endogenous Growth Theory. Cambridge, MA., MIT Press.
- Alesina, A., R. Di Tella and R. MacCulloch (2004). "Inequality and Happiness: Are Europeans and Americans Different?" Journal of Public Economics **88**: 2009-2042.
- Alesina, A. and E. La Ferrara (2005). "Ethnic Diversity and Economic Performance." Journal of Economic Literature **43**: 721-761.
- Alesina, A. and D. Rodrik (1994). "Distributive Politics and Economic Growth." Quarterly Journal of Economics **109**(2): 465-490.
- Audretsch, D. B. and M. Feldman (1996). "R&D Spillovers and the Geography of Innovation and Production." American Economic Review **86**: 630-640.
- Barja, G. and B.-S. Giger (2004). The Concept of Information Poverty and How to Measure It in the Latin America Context. Digital Poverty: Latin American and Caribbean Perspectives. H. Galperin and J. Mariscal. Lima, International Development Research Center, Canada: 11-28.
- Barrantes, R. (2004). Analysis of Ict Demand: What Is Digital Poverty and How to Measure It? Digital Poverty: Latin America and Caribbean Perspectives. H. Galperin and J. Mariscal. Lima, International Development Research Center, Canada: 29-54.
- Bauer, J. M., J. Kim and S. S. Wildman (2003). Broadband Deployment: Toward a More Fully Integrated Policy Perspective. East Lansing, Quello Telecommunication Management & Law, Michigan State University.
- Becker, G. S. (1957). The Economics of Discrimination. Chicago, Chicago University Press.
- Becker, G. S. (1968). "Crime and Punishment: An Economic Approach." Journal of Political Economy **76**(2): 169-217.
- Becker, G. S. (2002) "Human Capital." The Concise Encyclopedia of Economics: Library of Economics and Liberty, DOI:
- Becker, G. S. and K. M. Murphy (1992). "The Division of Labor, Coordination Costs, and Knowledge." Quarterly Journal of Econometrics **107**(4): 1137-1160.
- Beggs, G. J. (1995). "Novel Expert Evidence in Federal Civil Rights Litigation." American University Law Review.
- Bourguignon, F. and C. Morrison (2002). "Inequality among World Citizens: 1820-1992." American Economic Review **92**(4): 727-744.
- Burtless, G. (2007). "Inequality Trends: The Facts and Why They Matter." Cato Unbound.

- Camp, J. and R. Tsang (2001). Universal Service in a Ubiquitous Digital Network. Faculty Research Working Papers Series. Cambridge, MA, John F. Kennedy School of Government, Harvard University.
- Campbell, D. (2001). "Can the Digital Divide Be Contained?" International Labour Review **140**(2): 119-144.
- Carveth, R. and S. B. Kretchmer (2002). "Policy Options to Combat the Digital Divide in Western Europe." Informing Science **5**(3): 115-123.
- Cimoli, M., A. Primi and M. Pugno (2006). "A Low-Growth Model: Informality as a Constraint." CEPAL Review **88**: 85-102.
- Clotfelter, C. T., H. F. Ladd and J. L. Vigdor (1981). "Segregation and Resegregation in North Carolina's Public School Classrooms." North Carolina Law Review **81**: 1463-1512.
- Compaine, B. M. (2001). Declare the War Won. Digital Divide: Facing a Crisis or Creating a Myth? B. M. Compaine. Cambridge, MA, MIT Press.
- Davis, L. S. (2007). "Explaining the Evidence on Inequality and Growth: Informality and Redistribution." The B.E. Journal of Macroeconomics **7**(1 (Contributions), Article 7).
- Digital Opportunity Initiative (2001). Creating a Development Dynamic; Final Report of the Digital Opportunity Initiative, United Nations Development Program (UNDP), Accenture, Markle Foundation.
- DiMaggio, P., C. Celeste, E. Hargittai and S. Shafer (2004). Digital Inequality: From Unequal Access to Differentiated Use. Social Inequality. K. Neckerman. New York, Russell Sage Foundation: 355-400.
- DiMaggio, P. and E. Hargittai (2001). From the 'Digital Divide' to Digital Inequality: Studying Internet Use as Penetration Increases. Working Paper Series. Princeton, Center for Arts and Cultural Policy Studies, Woodrow Wilson School, Princeton University.
- DiMaggio, P., E. Hargittai, C. Celeste and S. Shafer From Unequal Access to Undifferentiated Use: A Literature and Agenda for Research on Digital Inequality.
- DiMaggio, P., E. Hargittai, W. R. Neuman and J. P. Robinson (2001). "Social Implications of the Internet." Annual Review of Sociology **27**: 307-336.
- Dollar, D. and A. Kraay (2002). "Growth Is Good for the Poor." Journal of Economic Growth **7**(3): 30.
- Drori, G. S. and Y. S. Jang (2003). "The Global Digital Divide: A Sociological Assessment of Trends and Causes." Social Science Computer Review **21**(2): 144-161.
- Fairlie, R. W. (2002). Race and the Digital Divide. Santa Cruz, CA, Department of Economics, University of California Santa Cruz.
- Fallis, D. (2004). Some Epistemology and the Digital Divide. Computing and Philosophy Conference. Canberra.

- Fink, C. and C. J. Kenny (2003). *W(H)ither the Digital Divide?* Washington, D.C., World Bank.
- Frank, R. H. (1984). "Are Workers Paid Their Marginal Products?" *American Economic Review* **74**(4): 549-571.
- Frank, R. H. (2006). *Microeconomics and Behavior*. New York, McGraw-Hill Irwin.
- Frischmann, B. M. (2001). "Privatization and Commercialization of the Internet Infrastructure: Rethinking Market Intervention into Government and Government Intervention into the Market." *The Columbia Science and Technology Law Review* **2**(1).
- Gigler, B.-S. (2001). "Empowerment through the Internet: Opportunities and Challenges for Indigenous People." *TechKnowLogia*: 33-37.
- Gillett, S. E., W. H. Lehr and C. Osorio (2003). *Local Government Broadband Initiatives*. P. o. I. a. T. C. (ITC). Cambridge, MA, MIT.
- Greco, G. M. and L. Floridi (2004). "The Tragedy of the Digital Commons." *Ethics and Information Technology* **6**: 73-81.
- Gregersen, B. and B. Johnson (2001). *Learning Economy, Innovation Systems and Development*. *ESST Converge Project*. Aalborg, Aalborg University.
- Hoffman, K. and M. A. Centeno (2003). "The Lopsided Continent: Inequality in Latin America." *Annual Review of Sociology* **29**: 363-390.
- Hout, M. (2002). *Money and Morale: What Growing Inequality Is Doing to Americans' Views of Themselves and Others*. *Working Paper*. Berkeley, CA, Survey Research Center, University of California at Berkeley.
- Hout, M. (2003). *Money and Morale: What Growing Inequality Is Doing to Americans' Views of Themselves and Others*. *Working Paper*. Berkeley, CA, Survey Research Center.
- Jorgenson, D. W. (2000). "Information Technology and the U.S. Economy." *American Economic Review* **91**(1).
- Jorgenson, D. W. and Z. Griliches (1967). "The Explanation of Productivity Change." *The Review of Economic Studies* **34**(3): 249-283.
- Jorgenson, D. W. and K. J. Stiroh (1999). "Information Technology and Growth." *American Economic Review* **89**(2): 109-115.
- Jorgenson, D. W. and K. Vu (2005). "Information Technology and the World Economy." *Scandinavian Journal of Economics* **107**(4): 631-650.
- Joseph, K. J. (2002). *Growth of Ict and Ict for Development: Realities of the Myths of the Indian Experience*. *WIDER Discussion Paper*, United Nations University, World Institute for Development Economics Research.
- Keniston, K. and D. Kumar, Eds. (2003). *The Four Digital Divides*. Delhi, Sage.

- Kenny, C. J. (2001). "Information and Communication Technologies and Poverty." TechKnowLogia: 7-11.
- Langlois, R. N. (2000). Knowledge, Consumption, and Endogenous Growth. Department of Economics Working Paper. Storrs, CT, University of Connecticut.
- Liu, M.c. and G. San (2006). "Social Learning and Digital Divides: A Case Study of Internet Technology Diffusion." Kyklos **59**(2): 307-321.
- Longhorn, R. and M. Blackmore (2003). Re-Visiting the Valuing and Pricing of Digital Geographic Information.
- Loury, G. C. (1992). "Incentive Effects of Affirmative Action." Annals of the American Academy of Political and Social Science **523**: 19-29.
- McLaren, J. and G. Zappalá "The 'Digital Divide' among Financially Disadvantaged Families in Australia." First Monday.
- McMillan, J. (2002). Reinventing the Bazaar; a Natural History of Markets. New York, Norton.
- Moser, C., A. Winton and A. Moser (2005). Violence, Fear, and Insecurity among the Urban Poor in Latin America. The Urban Poor in Latin America. M. Fay. Washington, The World Bank: 125-178.
- Mueller, M. and J. R. Schement (2001). Universal Service from the Bottom Up: A Study of Telephone Penetration in Camden, New Jersey. The Digital Divide: Facing a Crisis or Creating a Myth? B. M. Compaine. Cambridge, MA, MIT Press: 119-146.
- Mueller, M. L. (1997). Universal Service: Competition, Interconnection and Monopoly in the Making of the American Telephone System. Washington, D.C., AEI Press.
- Mueller, M. L. (2001). Universal Service Policies as Wealth Redistribution. The Digital Divide: Facing a Crisis or Creating a Myth? B. M. Compaine. Cambridge, MA, MIT Press.
- Neal, D. (2005). Why Has Black-White Skill Convergence Stopped?
- NTIA (National Telecommunications and Information Agency) (1999). Falling through the Net: Defining the Digital Divide - a Report on the Telecommunications and Information Technology Gap in America. N. N. T. a. I. Agency), U.S. Department of Commerce.
- Oddo, A. R. (2002). "Bridging the Digital Divide: Financial and Ethical Challenges." Teaching Business Ethics **6**: 15-25.
- Owen, B. M. (2002). Broadband Mysteries. Broadband: Should We Regulate High-Speed Internet Access? R. W. Crandall and J. H. Alleman. Washington, D.C., AEI-Brookings Joint Center for Regulatory Studies: 9-38.
- Parente, S. L. (2006). "The Failure of Endogenous Growth." Knowledge Technology & Policy **13** (4).
- Parente, S. L. and E. C. Prescott (1993). "Changes in the Wealth of Nations." Federal Reserve Bank of Minneapolis Quarterly Review **17**(2): 3-16.

- Parente, S. L. and E. C. Prescott (1994). "Barriers to Technology Adoption and Development." Journal of Political Economy **102**(2): 298-321.
- Phelps, E. S. (1972). "The Statistical Theory of Racism and Sexism." American Economic Review **62**(4): 659-661.
- Quah, D. T. (2007). *The Digital Divide*. London, London School of Economics.
- Quillian, L. (2006). "New Approaches to Understanding Racial Prejudice and Discrimination." Annual Review of Sociology **32**: 299-328.
- Ramos, J. R. (1996). "Poverty and Inequality in Latin America: A Neostructural Perspective." Journal of Interamerican Studies in World Affairs **38**: 141-157.
- Rappoport, P. N., D. J. Kridel and L. D. Taylor (2002). *The Demand for Broadband: Access, Content, and the Value of Time*. Broadband: Should We Regulate High-Speed Internet Access? R. W. Crandall and J. H. Alleman. Washington, D.C., AEI-Brookings Joint Center for Regulatory Studies: 57-82.
- Rodrik, D., A. Subramanian and F. Trebbi (2002). *Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development*. NBER Working Paper. Cambridge, MA, National Bureau of Economic Research.
- Romer, P. M. (1986). "Increasing Returns and Long-Run Growth." Journal of Political Economy **94**(5): 1002-1037.
- Romer, P. M. (1990). "Endogenous Technological Change." Jour of Political Economy **98**(5): S71-S102.
- Saffer, H. (2005). *The Demand for Social Interaction*. NBER Working Paper Series. Cambridge, MA, National Bureau of Economic Research.
- Segerstrom, P. S. (1998). "Endogenous Growth without Scale Effects." American Economic Review **88**(5): 1290-1310.
- Selwyn, N. (2002). *Defining the 'Digital Divide': Developing a Theoretical Understanding of Inequalities in the Information Age*. Occasional Paper. Cardiff, School of Social Sciences, Cardiff University: 36.
- Sengupta, N. (2001). A New Institutional Theory of Production: An Application. New Dehli, Sage.
- Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*. London, Methuen.
- Solow, R. M. (1957). "Technical Change and the Aggregate Production Function." *The Review of Economic Studies* **39**(3): 312-320.
- Solow, R. M. (1987a). *We'd Better Watch Out*. New York Times Book Review. 36.
- Steinmueller, W. E. (2001). "Icts and the Possibilities for Leapfrogging by Developing Countries." International Labour Review **140**(2): 193-210.
- Stigler, G. J. (1971). "The Theory of Economic Regulation." Bell Journal of Economics and Management Science **2**(1): 3-

- Stiroh, K. J. (1998). "Computers, Productivity, and Input Substitution." Economic Inquiry **36**(2): 175-191.
- Stiroh, K. J. (2000). Investment and Productivity Growth: A Survey from the Neoclassical and New Growth Perspectives. Occasional Paper. Ottawa, Industry Canada Research Publication Program.
- Swedberg, R. (2003). Principles of Economic Sociology. Princeton, Princeton University Press.
- Székely, M. and M. Hilgert (1999). What's Behind the Inequality We Measure: An Investigation Using Latin American Data. Research Department Working Paper. Washington, D.C., Inter-American Development Bank.
- The Economist (2007a). Disasters and Telecoms: Telecommandos. The Economist.
- The Economist (2007b). Schools and Race: Still Separate after All These Years. The Economist. **383**: 31-32.
- The Economist (2007c). To Do with the Price of Fish: How Do Mobile Phones Promote Economic Growth? A New Paper Provides a Vivid Example. The Economist.
- Tongia, R. (2006). Connectivity and the Digital Divide - Technology, Policy, and Design Tradeoffs for Developing Regions. TPRC. Arlington, VA, USA.
- Tuomi, I. (2000). Beyond the Digital Divide. University of California at Berkeley Human-Centric Computing Workshop, Berkeley, CA.
- Valaitis, R. K. (2005). "Computers and the Internet: Tools for Youth Empowerment." Journal of Medical Internet Research **7**(5).
- Wallsten, S. (2003). Regulation and Internet Use in Developing Countries, AEI-Brookings Joint Center for Regulatory Studies.
- Warschauer, M. (2003). Technology and Social Inclusion: Rethinking the Digital Divide. Cambridge, MA, MIT Press.
- Waverman, L., M. Meschi and M. Fuss (2005). The Impact of Telecoms on Economic Growth in Developing Countries. Africa: the impact of mobile telephones. Vodafone. London, U.K.: 10-23.
- Wolff, E. N. and A. Zacharias (2007). Class Structure and Economic Inequality. Working Paper. Annandale-on-Hudson, NY, The Levy Economics Institute of Bard College.
- Yang, X. (2001). New Classical Versus Neoclassical Frameworks. Malden, MA, Blackwell.
- Young, A. (1928). "Increasing Returns and Economic Progress." The Economic Journal **38**: 527-542.

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