Infrastructure, Productivity and Urban Dynamics in Côte d'Ivoire

An Empirical Analysis and Policy Implications

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Abstract

Recent contributions in economic geography reflect renewed interest in issues of location and spatial concentration of economic activities, yet there are still few empirical studies of developing countries, particularly in Africa.

This paper aims to contribute to this body of knowledge by (i) documenting wide regional disparities in economic activity and infrastructure (especially between the north and the south), which were partly determined by regional development policy, and (ii) examining empirically to what extent spatial factors such as agglomeration economies contribute to labor productivity—and therefore to urban dynamics—using recent panel data from Côte d'Ivoire for the period from 1980 to 1996.

The analysis indicates significant urbanization economies, notably those related to infrastructure, but the size of these economies varies across sectors and activities. In addition to providing linkages between markets, roads are critical in fostering dynamic growth of the urban areas in the hinterland, resulting in the concentration of economic activities. Localization economies also stimulate industrial productivity. And yet, as the poor growth record of Côte d'Ivoire in this period shows, the country failed to take advantage of these economies, and its declining capital stock, including infrastructure, may have contributed to the economic decline. The paper shows, for example, that inadequate road infrastructure clearly constrained the productivity of primary (agriculture and resource extraction) and tertiary (services) industries that take up the bulk of the total economic activity.

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Infrastructure, Productivity and Urban Dynamics in Côte d'Ivoire

An empirical analysis and policy implications

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Zeljko Bogetic, Lead economist (AFTP1) and Issa Sanogo, Economist (AFTP4), respectively. This paper builds in large part on the dissertation by Issa Sanogo (2001) on regional development policies and location of economic activities in Côte d'Ivoire. Helpful comments from Bob Blake and Santiago Herrera are gratefully acknowledged. The authors are solely responsible for any remaining errors.

SUMMARY

Recent contributions in economic geography reflect renewed interest in issues of location and spatial concentration of economic activities, yet there are still few empirical studies of developing countries, particularly in Africa.

This paper aims to contribute to this body of knowledge by (i) documenting wide regional disparities in economic activity and infrastructure (especially between the north and the south), which were partly determined by regional development policy, and (ii) examining empirically to what extent spatial factors such as agglomeration economies contribute to labor productivity—and therefore to urban dynamics—using recent panel data from Côte d'Ivoire for the period from 1980 to 1996.

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Table of Contents

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1. BACKGROUND

1.1 Some Long Term Economic Trends

Looking at long term trends as a background to our analysis, after a period of economic "boom" (1960 to about 1979), Côte d'Ivoire entered a long term period of decline, from which it never recovered. (Figures 1-2). This pattern is apparent whether one looks at broad trends in the overall per capita real output or its components, as well as population, and labor force (Table 1). GDP, consumption, and investment peaked in 1979, and then fell in the early 1980s. Exports per capita did grow, albeit slowly, in real per capita terms from 1979 to 2002. Gross capital formation—including that on infrastructure— which was clearly an important driver of growth in the first two decades of independence, became a factor of the observed decline. In short, most of the progress achieved by Côte d'Ivoire between 1960 and 1979 was lost in the 1980s and 1990s.

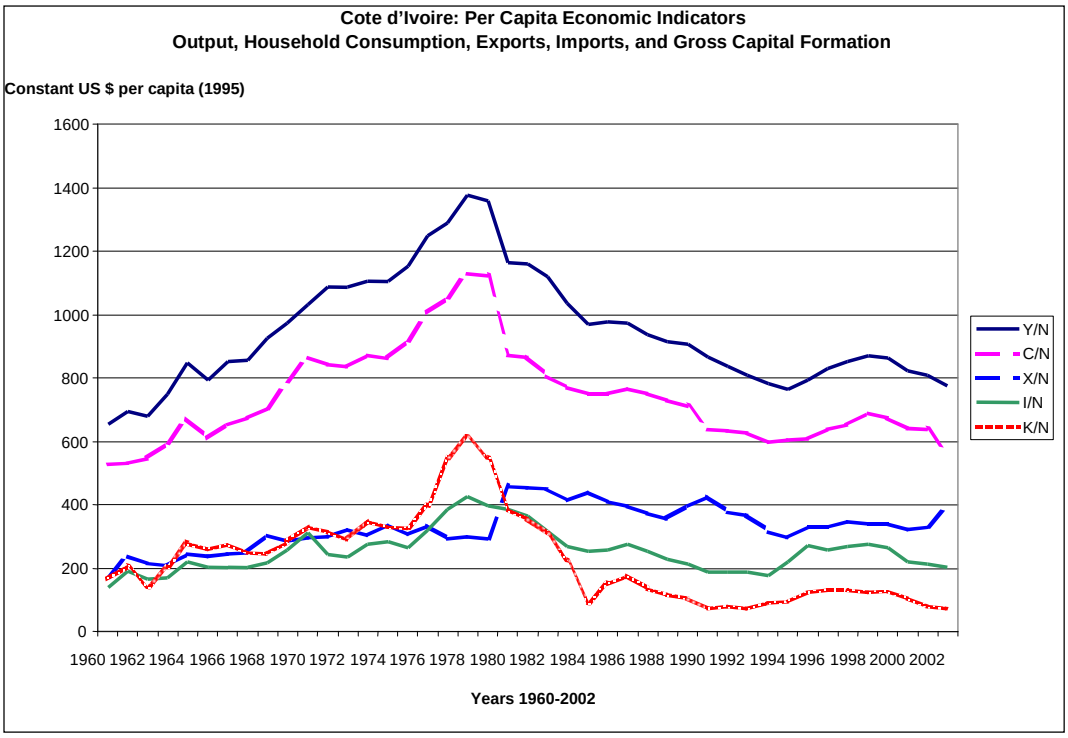
Table 1: Summary of Growth, 1960-1979 vs. 1979-2002 (in percent)

Compound Average Annual Growth	1960-1979	1980-2002
Real per Capita:		
GDP, Consumption, Trade & Investment		
Output (GDP) per capita	3.92	-2.40
Household Consumption per capita	4.07	-3.03
Exports per capita	2.85	1.26
Imports per capita	5.61	-2.90
Gross Capital Formation per capita	5.61	-2.90
Population Growth	3.95	3.26
Labor Force Growth	3.46	3.28

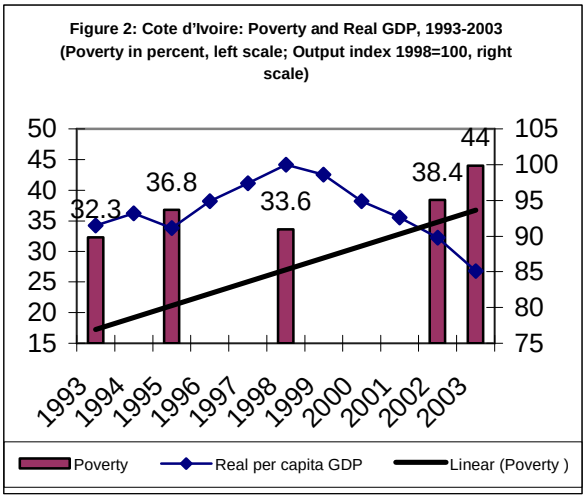
Source: Bogetic, Noer and Espina (2004) based on the World Bank LDB data.

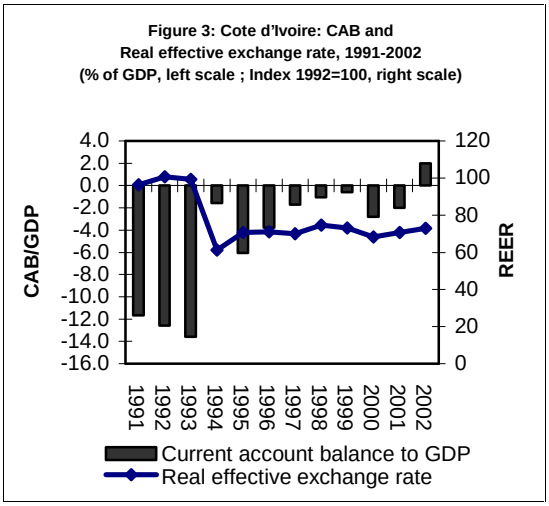
Gross capital formation (physical investment) peaked in 1978, and never recovered. Having achieved a real GDP level of $1,379 per capita in 1978 (in 1995 US dollars), real output has fallen to under $776 per capita in 2002, which is lower than the $849 achieved in 1964! Consumption per capita dropped by half from 1979 to 2002. While these trends were partly driven by the rapid population growth, the decline in capital formation was one of the important factors of overall economic decline.

Figure 1: Cote d'Ivoire—Per Capita Output, Consumption, Exports, Imports, Investment 1960-2002



The brief 2002-03 civil conflict[1] came on top of the two decades of declining per capita real GDP and rising poverty. As such, the conflict alone does not explain the secular economic decline since the late 1970s; it aggravated the already unfavourable long-term economic trends (Figures 2-3).





Source: World Bank staff live database, and IMF and Bank staff estimates.

[1] For details, see World Bank (2003).

Against this background, Côte d'Ivoire kept pursuing an active policy of regional development that influenced regional allocation of infrastructure spending. In fact, since the end of the 1960s, regional development policy in Côte d'Ivoire was guided by the principles of the traditional growth pole theory. Industrialization was viewed as a key tool of reducing regional disparities in income and growth. The objective of this policy was the creation of vibrant areas of urban economic activities around "growth poles" and/or industrial districts (Perrin, 1967).

1.2 Growth Pole Theory in Action

A growth pole is defined by two main characteristics. The first is an industrial pole, consisting of industries favored by the dynamic forces of a growth pole (Perroux, 1960). Such an industrial pole was established in Côte d'Ivoire, after it gained its independence in 1960, based on exports of select agro-industrial goods (e.g., palm tree oil, pineapples, bananas, etc.) in the south of the country, and some import substitution development programs (e.g., sugar cane, cotton). The second characteristic is urban agglomeration, a spatial cluster of economic activity accompanied by social and economic infrastructure. This second characteristic is considered key to creating productive interactions (technical or market) up and down the chain of economic integration (Perrin, 1967, 1975).

Regional development policy in Côte d'Ivoire was initially implemented during the period of strong, although spatially inequitable, economic growth. Real GNP grew at an average annual rate of 7.5% during the 1970-1980 decade, largely due to the growth in cash crops (e.g., coffee, cocoa, and wood). This growth was financed largely through an intermediary institution—*Caisse de Stabilization et de Soutien des Prix des Produits Agricoles, CSSPPA*—designed to stabilize prices of agricultural products and cushion the impact of fluctuations in external conditions on the domestic market.

A typical "dual economy" pattern of development emerged. On the one hand, agglomeration economies favored a highly concentrated pattern of local development—especially around the capital city of Abidjan. Economies of scale, and the concentration of social and educational opportunities in Abidjan, not only for people from Côte d'Ivoire but also for the sub-region as a whole, served as a powerful migration pull. It was in this period that this bustling city became known as the regional business hub of West Africa. On the other hand, many regions were left behind in terms of the development of adequate infrastructure, services, and economic opportunities.

Since 1980, however, with the downturn in prices of key commodities and the rising overvaluation of the CFA franc, Côte d'Ivoire's economic fortunes took a turn for the worse. For the following 13 years (1981-1993), the country registered an average annual *decline* in real GNP by about 1 percent. Then, after a short period of strong growth (1995-98), stimulated by the 1994 devaluation of the CFA franc, the country entered unprecedented political instability that culminated with the civil war in the period from September 2002 to April 2003. Regional development issues subsided from the political agenda dominated by conflict related concerns.

Throughout the last four decades, however, the country kept struggling with deep-seated structural problems. The key structural problems were linked to (i) the narrow industrial and agricultural base; (ii) the wide economic, social, and regional disparities; (iii) the isolation of vast areas of the country from the main centers of urban and industrial growth; and (iv) the economy's high vulnerability to external shocks (e.g., drought, the decline in international commodity prices). Also, the structural adjustment programs of the 1980s, and the policies of internal and external liberalization in the 1980s and 1990s failed to meet early expectations (e.g., Azzam and Morrisson, 1994, CERDI, 1996, Cogneau & Mesple , 1999).[2]

The objective of this paper is to investigate empirically questions of how, and to what extent, the spatial organization of economic activity of Côte d'Ivoire was influenced by infrastructure investments. Specifically, we investigate if large infrastructure investments favored the integration of secondary cities into the mainstream of the Côte d'Ivoire economy—an economy that is highly polarized between Abidjan and the peripheral areas3—and if it is possible to harness the forces of urban externalities and neighborhood effects for improved spatial public policy. In contrast to early spatial models, we explore the link between economic activity and urban growth as a dynamic process of location decisions. Viewed in the broader development context outlined above, the analysis may also contribute to a better understanding of the secular economic decline that Côte d'Ivoire experienced since the late 1970s.

Infrastructure investments have been recognized in development literature as an influential factor in urban-rural disparities, urban development, and economic growth. Many infrastructure investments have characteristics of public goods—non-exhaustive and non-exclusive in consumption—and therefore may be undersupplied by the private sector in certain circumstances. Yet, infrastructure investments facilitate private investments by lowering production costs and opening new markets, thereby creating new profit opportunities. Roads reduce transportation costs. Ports reduce transaction costs and facilitate trade, exposing local firms to the innovative forces of international competition. Ashauer (1989, 1990) for example, finds that road building helped increase economic growth in the United States. Also, the World Bank's World Development Report 1994 highlighted multiple links between infrastructure and development and emphasized how policy can improve not only the quantity, but also the quality of infrastructure services in developing countries. Stressing the reverse links from urbanization and development to infrastructure expenditures, Randolph, Bogetic, and Heffley (1996), using pooled data from 27 low- and middle-income countries, found strong influence of level of development, urbanization rate, and labor force participation on per capita infrastructure expenditures.

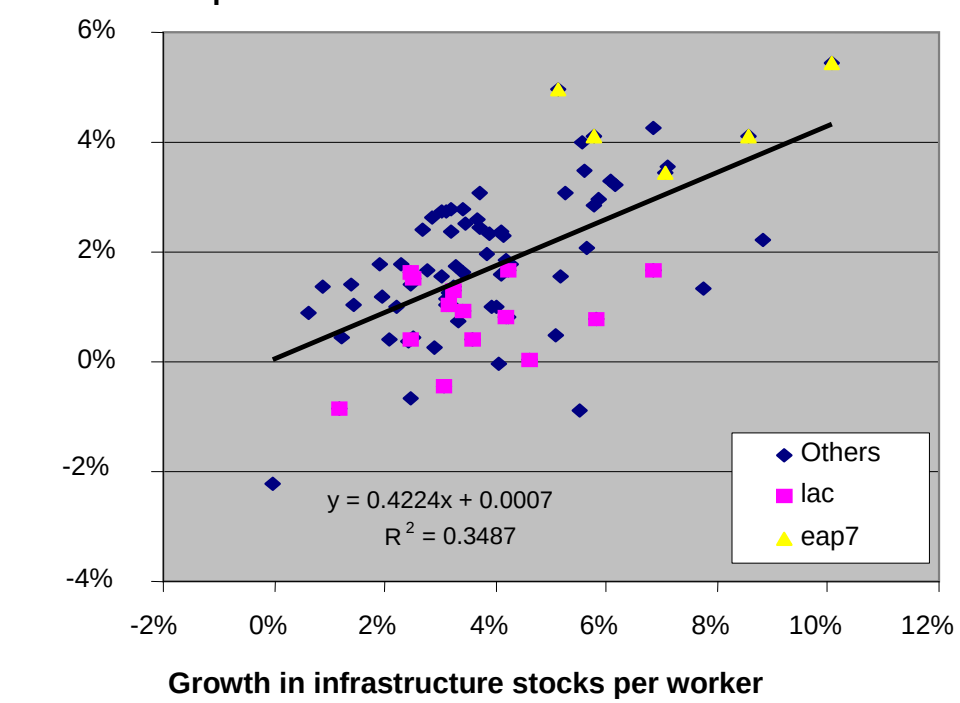
More recent comparative experiences show serious consequences of underinvestment in infrastructure for economic growth. The positive correlation between infrastructure accumulation and growth is now well established (Figure 4; also see Leipziger, 2001). Moreover, in a recent study by Easterly and Serven (2004), for example, it is shown

[2] During 1981-1986, adjustment policies resulted in contradictory effects, mainly in agriculture. The temptation to control the cocoa and coffee supply, combined with the slow removal of price controls, subsidies, and exemptions, worsened the overall economic performance, and led to the failure of the adjustment policies from 1987 to 1993. The main instrument of adjustment, the exchange rate, was not used until 1994.

[3] Over the period of analysis, 1980-96, Abidjan accounted, on average, for about 90 percent of value added, and 80 percent of industrial employment in the country.

unambiguously that about one-fifth of Latin American growth underperformance relative to East Asia was directly related to underinvestment in infrastructure.

Figure 4: Infrastructure Accumulation and Growth
(1960-97 country averages, percent)



Source: Easterly, Calderón and Serven (2003).

The organization of the paper: Section 2 reviews regional disparities in terms of economic structure and infrastructure, and examines regional specificities using the estimated coefficients of localization and specialization. It shows wide regional disparities in the location of economic activities, especially between the traditionally poor north and the wealthier south. In Section 3, we take the analysis further by asking whether and how such variations in regional factors, beyond the standard factors of production, affect urban dynamics as an empirical function of labor productivity. Section 4 contains concluding remarks and some policy implications.

Box 1: Modeling the Location of Economic Activities

Early models of the location of economic activities aimed to explain and predict the spatial structure of the location of economic agents. Much of this work was concerned with location decisions of producers, as well as spatial structures of farming activities, distribution of cities, and location of households. In analyzing optimum location of agricultural producers around a circular city, i.e., the points in space where profits are maximized, H. Von Thünen (1826) was the first to highlight the importance of transportation costs in economic location. But it was Alfred Weber (1909) who first analyzed the optimum location of industrial activities as a function of the distance between sources of supply and the market. In a simplified version of the Weber model, the location of industry is close to a source of supply if a good produced is "weight losing" i.e., if the output is lighter or less perishable than the materials used in its production. In the opposite case, when output is heavier and more perishable than constituent materials, it pays for an industry to locate near the market. In this model, an industry would never locate between the two points—supply and market—because this interior solution results in additional costs of loading and unloading, reduces the number of work days, and limits the gains from "long haul economies" (i.e., the tendency of transportation costs to increase less than proportionately with distance.). The average cost per unit of distance declines with distance because all modes of transport involve certain fixed costs independent of the distance—"terminal costs." So doubling the length of the trip does not result in doubling the total cost. In a more complex version of the model, Weber introduces multiple markets and raw materials, spatial variation in costs (notably labor costs), as well as agglomeration economies.

A key target of criticism of the Weber model is its hypothesis of perfect competition. The model, therefore, neglects possible influences of location on demand, which is related to the good's production. But, in fact, it is quite possible that location may give a degree of monopoly power to a business, implying that a modeling approach to location decisions based on the theory of the imperfect competition may be more appropriate. As a result, in contrast to Weber, W. Christaller (1933) develops an analysis of economic forces determining the spatial structure of cities, resulting in a well-known "theory of central places." His analysis concerns the supply of services and the pattern of location of markets and cities, rather than that of industries. Then A. Lösch (1944) went on to combine the theory of the central places with that of industrial location. His analysis emphasizes the influence of demand on industrial location. Lösch extends Weber's theory by developing a complex theory of the pattern of location of economic activities as a process of adjustment (similar to trial-and-error) towards equilibrium. It emphasizes the importance of transaction costs (i.e., transfer costs) and economies of scale in explaining the location of industries. As such, this could be considered as an application of Chamberlin's theory of monopolistic competition. Moreover, the Lösch theory is a first attempt to analyze location theory in a general equilibrium framework.

While most of the Weber-Lösch type models analyze location patterns as an equilibrium outcome of standard hypotheses of profit/utility maximization, more recent approaches emphasize the possibility of a less balanced dynamics of regional concentration. A number of authors recently show that the dynamics of location may lead away from equilibrium with ever-stronger concentration of activities in certain geographical areas (e.g., Krugman, 1992, Catin, 1991, 1997, Henderson, Shalizi & Venables, 2000, Henderson, Kuncoro & Tuner, 1995, Martin & Rogers, 1995, Lall, Shalizi & Deichmann, 2001, Glaeser, Kallal, Scheinkman & Shleifer, 1992). Our framework of analysis relies on this latter approach, which seems to emerge as a "new theory of economic geography" (Krugman 1991).

2. REGIONAL DISPARITIES IN ECONOMIC ACTIVITY AND INFRASTRUCTURE

2.1 Description of Data and Their Weaknesses

Two categories of data were used in the analysis of urban and regional disparities (production and infrastructure data) for the period 1980-1996. Production data on sector value added used in descriptive and econometric analyses are from the financial data base (*Banque de Données Financiere—BDF*) of the National Institute of Statistics (*Institut National Statistique—INS*) for the period 1980-1996. Infrastructure data were obtained from the urban and regional database of the *BNETD (Bureau National d'Etudes Techniques et de Développement)* and then complemented with data from road maps and maps of health and education facilities from the INS.

While these data represent the best available information in Côte d'Ivoire on sector value added and infrastructure, both sets have certain weaknesses. Regarding production data, there are three potential weaknesses. First, a regional production data set was made possible after the 1997 administrative reform, which assigned enterprise headquarters to specific geographic areas, thereby dividing the country into 16 regions and on the basis of a nomenclature of 33 economic sectors according to the National Accounting System (*Systeme de Comptabilité National—SCN*). In the absence of primary data, this method relied on regional surveys and regional statistical institutions. Nevertheless, the method may be biased insofar as the declared location of the headquarters of an enterprise does not always correspond to the actual location of its main economic activity. Proximity to public (e.g., government, ports, etc.) or private (e.g., banks, airports, etc.) institutions and services may be important organizational reasons for establishing company headquarters in a location different from that of its mainstream activity. In such cases, the telephone directory of the Chamber of Commerce and Industry of Côte d'Ivoire (*Chambre de Commerce et d'Industrie—CCI-CI*, 1996) was used to locate certain activities more precisely to their actual location. While eliminating much of the bias in the data base, this exercise was limited by the fact that not all the businesses were indexed in this directory. Another weakness in the data—that could not be corrected—may have resulted from information asymmetries about the exact location of businesses caused by the inadequate monitoring and tracking system. Indeed, it is important to keep in mind that production data reflect the policy of regional allocation of investments and fiscal incentives used to affect the location decisions of businesses. Finally, regarding infrastructure, data on the stock of physical infrastructure in the regions of Côte d'Ivoire were available only for the year 1995. This suggests caution in interpreting the results.

2.2 Regional Specificities in Production

Notwithstanding the limitations of data, available information allows development of useful indicators to analyze regional specificities in production. We calculated two types of indicators (Jayet, 1993) (see Annex 2):

(i) **Location coefficients of economic activities,** which measure the ratio of average regional value added weighted by the activities in the regions, and its counterpart

at the national level. Essentially, it is a measure of *regional concentration*: A low coefficient indicates a strong spatial dispersion of economic activity and the inverse implies a concentration of activity in a small number of regions; and

(ii) **Regional specialization coefficients,** which allow identification of regional specificities in production. Essentially, it is a measure of *regional specialization:* It identifies a cluster of activities with a large share of regional value added.

2.3 The Concentration of Sector Activities

An inspection of estimated location and specialization coefficients leads to three principal conclusions:

- **First, estimated location coefficients show that agro-industrial activities are most concentrated in the regional space (Table 2).** In order of declining importance, other spatially concentrated industries are textiles (sector 11) in the central and northern parts of the country, tobacco (sector 10) in the center, rubber (sector 16) in the southwest, and the timber industry (sector 13) in the west and south-west.[4] This territorial configuration of the agro-industrial complex is mostly a result of the regional development policy pursued during the 1970s. The policy emphasized locating these industries close to their supply of raw materials. In this context early in the 1960s and 1970s, a focus of economic development policy was developing the wood processing industry in thickly forested areas (sector 3), another was based on import-substitution food processing (sector 1)[5] This policy and the resulting spatial distribution of these activities persisted, with some modifications, both through the long crisis period (1980-1993) and the growth period in the aftermath of the devaluation of the CFA franc. Moreover, since 1994, demand in global markets tended to reinforce the existing location of economic activities, because gains in productivity due to restructuring and privatization of state enterprises tended to favor the existing enterprises and their locations. Despite their precision when used to rank specific activities, location coefficients do not reflect clearly the degree of specialization of the regions compared with the core activities.

[4] The legend of sector numbering is provided in annex 1.

[5] This intensive forestry operation led to a decline of forestry resources from about 15 millions ha in the 1960s to less than 3 million ha late in the 1990s—this decline in resources encouraged the country to diversify its processing industries. Wood-processing activities (sector 13) intensified after the franc CFA devaluation of 1994, due to the import of timber from neighboring countries. So the increase in the coefficient of sector 3 is due to the imports of timber.

Table 2: Location Coefficients of Economic Activities (1980-1996)

Sector k	1980-96	1994-96
01	0.277	0.228
02	0.220	0.145
03	0.278	0.459
04	0.123	0.168
05	0.124	0.444
06	0.127	0.287
07	0.125	0.175
08	0.105	0.170
09	0.049	0.127
10	0.421	0.500
11	0.665	0.624

Sector k (continued)	1980-96	1994-96
12	0.123	0.167
13	0.160	0.187
14	0.123	0.169
15	0.110	0.153
16	0.360	0.446
17	0.107	0.139
18	0.123	-
19	0.100	0.133
20	0.121	0.161
21	0.121	0.163
22	0.138	0.202

Sector k (continued)	1980-96	1994-96
23	0.101	0.083
24	0.123	0.179
25	0.121	0.165
26	0.112	0.155
27	0.089	0.162
28	0.123	0.167
29	-	-
30	0.125	0.167
31	0.123	-
32	0.058	0.095
33	-	-

Source: Sanogo (2001) and the authors' estimates.
Note: The correlation between these rankings in two sub-periods is 85 percent. See the calculation methodology in annex 1.

- **Second, estimated specialization coefficients show that the most economically specialized regions are Agnéby, Valley of the Bandama, and Denguélé** (Table 3). These regions are also known by a high concentration of economic activities. By contrast, the least specialized regions are Sassandra, Lagoons, High Sassandra, and Lakes; in other words, these latter regions feature a wide variety of economic activities.
- **Third, compared with the whole period of analysis (1980-1996), despite considerable persistence and even an increase in specialization across regions, there seems to be evidence of some diversification in a few regions in the final years of this period.** Specifically, during 1994-1996, regions of Agnéby and Valley of the Bandama appear to have somewhat diversified their activities, due to recent privatization of textile firms (Pages and Sanogo, 2000).

Table 3: Specialization Coefficients of Regions

Regions' name	Period 1980-96
Agnéby	0.853
Vallée du Bandama	0.836
Denguélé	0.826
Worodougou	0.800
Montagnes	0.788
Savanes	0.762
Sud Bandama	0.759
N'Zi Comoé	0.755
Sud Comoé	0.713
Marahoué	0.702
Moyen Comoé	0.702
Zanzan	0.694
Bas Sassandra	0.664
Lagunes	0.651
Haut Sassandra	0.610
Lacs	0.516

Regions' name	Sub-period 1994-96
Worodougou	0.939
Montagnes	0.938
N'Zi Comoé	0.928
Denguélé	0.883
Vallée du Bandama	0.866
Agnéby	0.826
Savanes	0.803
Bas Sassandra	0.780
Marahoué	0.765
Zanzan	0.765
Moyen Comoé	0.751
Sud Bandama	0.750
Sud Comoé	0.745
Lacs	0.683
Lagunes	0.682
Haut Sassandra	0.662

Source: Sanogo (2001) and the authors' estimates.
Note: The correlation between rankings of two sub-periods is 77 percent. See the calculation methodology in annex 1.

- **Fourth, regional specialization seems to persist strongly over time, but to a lesser extent than in particular regions.** The correlation coefficient of location coefficients between two sub-periods is 0.85 compared with the correlation coefficient of specialization coefficients between two sub-periods. As one would expect, regions find it easier to change over time the degree of specialization than to move major economic activities, as the cost of the latter (i.e., sunk costs of locating an industry) may outweigh the former.

- **In sum, an analysis of regional specificities in production reveals a high degree of localization and specialization and their persistence in the regions of Côte d'Ivoire.** Overall, the results of analyzing both sets of coefficients show that regional structures did not change significantly, despite considerable changes in the overall economic environment. In fact, evidence from the end of the study period suggests a *reinforcement* of the existing regional economic structure. The next obvious question taken up in the following section is assessing differences in regional performance using productivity indicators of economic activity.

2.3 Labor Productivity Growth and Inter-Regional Disparities

Analyzing links between productivity growth and the advantages of location and spatial concentration of economic activities is important for understanding how regional development policy affects spatial economic outcomes. Such analyses, commonly prepared since the 1970s for developed countries (e.g., references), pose some practical problems in the developing country context, especially that of Côte d'Ivoire. Measuring productivity gains in developing countries generally, and in Côte d'Ivoire in particular, is more difficult because of at least three reasons: (i) growth is driven largely by basic factor accumulation; (ii) lengthy economic recession in Côte d'Ivoire (1980-1993) is not the ideal data ground for analysis of productivity growth; and (iii) there are significant data problems partly because of the failure of official statistics to capture much of the informal sector.

Regional differentials of gains in regional productivity can, however, be discerned from the national data, allowing a tentative indication of gains in labor productivity in the formal sector of the economy. These gains and losses are measured by the difference between the growth rate of the value added in constant prices (Base year Index 100 = 1985) and the growth rate of labor employment. This difference next is weighted by the total variance of differences with a view to relate the variability of productivity to the frequency of enterprise entry/exit from the data base, reflecting changes in economic conditions. The results show that between 1980 and 1996, the formal sector of the Ivorian economy recorded a weak average annual growth of measured labor productivity of about 0.5% per year[6], with an annual average gain increasing to 3.9% in the short period of return to growth (1994-1996), following the devaluation of the CFA franc in 1994. However, variations in measured labor productivity across regions varied widely (see table 4).

[6] This is not unexpected in view of the large share of agricultural activities, which are imperfectly captured in the official statistics both in terms of value added and employment. Growth in Côte d'Ivoire depends more on agricultural exports (mostly cocoa/coffee), which during 1980-1986 contributed to a decline in GDP of, on average, about 1% a year.

Table 4: Gains and Losses in Regional Productivity

	Average Annual Productivity gains (+)/losses(-) (%)		Average share of the region in the whole economy, 1980-1996 (%)	
	1980-1996	1994-1996	Value added	Employment
Côte d'Ivoire as a whole :	0.48	3.90	100.0	100.0
Of which: Lagunes (incl. Abidjan)	0.72	3.46	89.8	84.4
Other regions	0.43	4.25	10.2	15.6

Source: BDF data, Sanogo (2001) and the authors' estimates.

Estimates show considerable productivity gains in the region of the Lagoons (that includes Abidjan, the political and commercial capital) where the bulk of economic activity is located. The region represents close to 90 percent of value added and more than 80 percent of total employment in the formal sector of Côte d'Ivoire. In the period of observation (1980-1996), the region registered an average annual growth in labor productivity to be about 67% higher than in the rest of the country. Interestingly, the period of return to growth (1994-1996) indicates a reversal of the productivity growth gap to a 23% gap in favor of the other regions (Table 4 above).

The main losers were the regions in the north (Denguélé, Savannahs, Worodougou, Zanzan) and the Lakes (Yamoussoukro, the administrative capital), which show a loss in productivity in the whole period 1980-96. For the short growth period (1994-96), these regions, however, show positive, albeit weak, growth of measured labor productivity, with the exception of the regions of the northwest (Denguélé and Worodougou). However, the weak performance in measured productivity does not reflect the whole picture because of the dominance of informal activities in the northwestern regions. The absence of hard national and annual data on informal activities results in an underestimate (or an overestimate) of gains (or losses) in regional productivity. Estimated disparities in regional productivity, therefore, reflect differences in relative importance of formal sector activities. One indicator of comparison showing these disparities is relative average annual growth of labor productivity in a sector compared with that of the region (Table 5). Calculation of this indicator across primary, secondary and tertiary industries in all the regions suggests the following three conclusions:

Table 5: Contributions of Main Sectors to Regional Productivity

Region	Sector Productivity Relative to Regional Averages 1980-1996		
	Primary	Secondary	Tertiary
Agnéby	- forestry (1.46)	- textile (1.85) - timber (1.85)	- trade (2.52)
Bas Sassandra		- seeds (4.78) - timber (2.40) - chemical (2.09)	- trade (4.39)
Denguélé		- seeds (1.40)	
Haut Sassandra		- timber (1.22) - rubber (2.11)	- transport (4.14) – trade (2.34)
Lacs		- seeds (2.36) - mechanical engineering (-1.60)	- trade (-1.67)
Lagunes	- mining (8.19)	- oil (4.91) engineering works (1.85) energy (2.40)	- trade (2.03)
Marahoué		- seeds (0.58)	- transport (1.42) - trade (1.16)
Montagnes	- forestry (0.45)	- seeds (0.41)	- trade (1.02)
Moyen Comoé	- food products (0.92)	- canned foods (1.72)	- transport (1.70) - trade (1.37)
N'Zi Comoé		- seeds (0.52)	- trade (1.40)
Savanes		- seeds (1.33)	- transport (1.41) - trade (1.54)
Sud Bandama		- seeds (0.58)	- trade (1.30)
Sud Comoé	- export products (0.53)		- transport (2.58) - trade (3.88)
Vallée Bandama		- fat foods (1.19) – tobacco (3.22) chemical (1.77)	- construction (1.27) - transport (0.88)
Zanzan		- seeds (0.58)	- transport (1.21) - trade (1.39)
Worodougou			- construction (1.20) - trade (1.43)

Source : BDF data, Sanogo (2001) and the authors' estimates.

- **Primary activities** with high contribution to regional productivity growth were those related to raw materials for export or industrial use (e.g., beverages, mining, cash crops). Unfortunately, agricultural activities are not well represented in the formal sector captured by the data.
- **Secondary (non-mining industry) activities** with particularly high productivity compared with regional average are concentrated in agro-industry, which is represented in almost all the regions, especially in wheat processing areas. The differences in regional productivity of these activities reflect a policy of establishing agro-industrial activities under a program of promoting regional development in the mid-1970s (Berthelemy & Bourguignon, 1996). In contrast to these areas dominated by agro-industrial activities, the region of the Lagoons is characterized by heavy industries, especially oil, construction materials, and electric energy industries
- **Tertiary (service) activities** with the highest productivity growth compared with regional averages are commerce, transportation, and construction. Construction, however, is poorly covered by the official statistics (and largely present in the Valley of Bandama), perhaps due to the poorly captured construction of one of the large markets in Bouaké.

2.4 Infrastructure Typology

The importance of infrastructure for development has been long recognized (e.g., World Bank 1994, Kessides 2004). Infrastructure productivity stems from its capacity to produce services and the factors of production used. There are two essential infrastructure categories:

- **Social infrastructure,** which is designed to maintain and to develop human capital (education, social services, and health);
- **Economic infrastructure,** which is designed to provide economic services such as energy, telecommunications, water, gas, road maintenance, dams, transportation, etc.

In this paper, we use disaggregated indicators of *economic and social infrastructure*, calculated on the basis of stocks of physical infrastructure in the regions of Côte d'Ivoire in 1995, which have been updated using the urban and regional data base of the BNETD (Table 6).[7]

2.5 Infrastructure Disparities and Typology of Regions

Regional disparities in *economic infrastructure* were estimated using three key variables:

- density of road network (ROAD), defined as number of kilometers (or square kilometers) per 1,000 **population**;
- development of the postal network (POST), defined as the number of inhabitants per postal mailbox;
- access to safe drinking water (WATER) estimated by the number of inhabitants per subscriber of the state water company (Société de Développement des Eaux de Côte d'Ivoire).

Disparities in *social infrastructure* are captured by selected education and health indicators. Indicators of social infrastructure are proxied for education by the rates of primary (ELEM) and secondary (SECON) or by access indicators measured by the number of classes per square kilometer (CLASSelem and CLASSsecon). As for the health services, indicators used are demographic pressure (DEMO) measured by the number of inhabitants per health center, and spatial access (ACCESS) estimated by the distance (in Km) traveled to the nearest health center. The latter indicator is only a theoretical, synthetic measure, given difficulties measuring actual distances.[8]

[7] Indicators used are inspired by the study by Mitra, Varoudakis and Veganzones (1998, pp. 844-55.).
[8] $(S/3.14)^{0.5/}n$, where S= region's area in square kilometers, n= number of health center in the region.

Table 6: Levels of Economic and Social Infrastructure Endowments By Region, 1995

	ROAD	POST	WATER	CLASS elem	CLASS secon	ELEM	SECON	DEMO	ACCESS
Agnéby (Agboville)	0.41	182	61	-	0.04	-	0.57	12,430	1.25
Bas-Sassandra (San Pedro)	0.15	246	167	0.07	0.01	0.69	0.46	21,058	1.39
Lacs (Yamoussoukro)	0.27	83	32	0.40	0.09	0.81	0.62	8,591	1.03
Lagunes (Abidjan)	0.30	55	20	1.09	0.32	0.72	0.51	24,859	0.43
Montagnes (Man)	0.20	153	146	0.13	0.02	0.94	0.49	10,960	0.90
Denguélé (Odienné)	0.15	93	73	0.07	0.01	0.57	0.34	5,540	2.29
Marahoué (Bouaflé)	0.17	202	140	-	0.02	-	0.46	14,348	1.20
Moyen-Comoé (Abengourou)	0.30	171	59	0.15	0.04	0.72	0.60	11,554	1.29
N'Zi-Comoé (Dimbokro)	0.26	83	47	-	0.02	-	0.53	5,962	1.08
Savanes (Korhogo)	0.21	162	75	0.05	0.01	0.63	0.45	7,661	0.92
Sud-Bandama (Divo)	0.18	223	180	-	0.02	-	0.56	14,225	1.12
Vallée du Bandama (Bouaké)	0.20	105	38	0.13	0.38	0.72	0.67	10,556	0.96
Worodougou (Séguéla)	0.17	206	128	-	0.00	-	0.38	7,183	1.57
Zanzan (Bondoukou)	0.21	237	111	0.04	0.01	0.53	0.31	6,768	1.22
Sud-Comoé (Aboisso)	0.28	168	35	-	0.02	-	0.56	7,488	1.11
Haut-Sassandra (Daloa)	0.24	200	127	0.26	0.05	0.78	0.66	14,379	0.77
National average	0.23	161	90	0.15	0.07	0.71	0.51	11, 473	1.16
Standard deviation	0.07	58	51	0.27	0.11	0.11	0.10	5.257	0.39

Source : Urbandata (BDUR) of BNETD. Sanogo (2001) and authors' estimates.
Note : Names of regional capitals are in brackets.

Regional differences and similarities among infrastructure indicators are analyzed using the principal component analysis (PCA). This technique "provides an objective basis to synthesize a large number of characteristics and separate those that are related from the unrelated ones" (Isard 1972, volume 2, pp.141). PCA is performed to simplify the description of a set of interrelated variables in a data matrix. PCA transforms the original variables into new uncorrelated variables, called principal components. Each principal component is a linear combination of the original variables. The information conveyed by a principal component is its variance. The principal components are derived in decreasing order of variance. Thus, the most informative principal component is the first, and the least informative is the last. In this application, the PCA analysis refers to the manner in which regions characterized by a body of infrastructure variables separate themselves from the average represented by the average variables (Bry 1993). This makes it possible to eliminate redundant explanatory variables in econometric modeling. If some regions possess the same factor (a cluster of variables) and strong correlations among their characteristics, they are said to constitute one type of region.

The PCA analysis shows interesting preliminary results (Table 7). Every factor (F) shows positive and negative coordinates of different regions and infrastructure indicators. For all indicators, factors 1 to 5 contribute cumulatively to 91% of the variance of variables. In Figure 1, axes 1 and 2 represent 62% of this contribution. To simplify interpretation and to facilitate the representation of data in the factor space, we limit ourselves to these two factors.

Table 7: Principal Component Analysis (PCA) of the Regions' Infrastructure Endowment

Factors (F)	Weight (%)	Positive coordinates		Negative Coordinates	
		Regions*	Indicators*	Regions*	Indicators*
F1	42,1	WOR, ZAN, DEN, MAR, SBA, BAS	ACCESS, POST, WATER	LAG, VAL, LAC	CLASSelem, CLASSecon, SECON, ACESS, DEMO, ELEM
F2	61,5	BAS, HSA, SBA, LAG, MON	DEMO,WATER, POST	NCO, SCO, DEN, AGN , LAC	ACCESS
F3	76,3	AGN, SBA, SCO, HAS	ACCESS, SECON,, POST	DEN, LAG	ELEM, ACCESS
F4	84,6	LAG , AGN		VAL, HSA, MON	ELEM, SECON
F5	91,0	VAL, SBA, MAR	CLASSecon	MCO, ZAN	ELEM

Source: Sanogo (2001) and the authors' estimates.

*The regions and variables are ranked in descending order of the absolute value of the coordinates. Only the coordinates equal to or higher than one for the regions and than 0.4 for the indicators are selected. These are all statistically significant at 5% level (correlation matrix and test values are in the annexes).

The positive coordinates of factor 1 (ACCESS, POST, WATER) correspond to a weak availability of economic and social infrastructure. In fact, the longer length of theoretical distance to a health center (ACCESS) or the greater the number of inhabitants per postal mailbox (POST) or per subscriber to drinkable water (WATER), the weaker the level of this infrastructure type. Not surprisingly, the regions characterized by these indicators are in the poor north of the country: Worodougou (WOR), Zanzan (ZAN) and Denguélé (DEN). But it also includes some regions in the comparatively more developed south: Marahoué (MAR), South Bandama (SBA), and Lower Sassandra (BAS).

These regions are in sharp contrast to the regions of the Lagoons (LAG). Valley of the Bandama (VAL) and Lakes (LAC) are the regions best endowed with infrastructure according to factor 1. This better spatial allocation of infrastructure is due to education infrastructure (CLASSelem, CLASSecon), human capital (ELEM, SECON), and the road network (ROAD). But the high demographic pressure (DEMO) on health services constitutes a handicap for the region of the Lagoons.

Regions with high demographic pressure on infrastructure[9] are Lower Sassandra (BAS), High Sassandra (SBA), the Lagoons (LAG), and the Mountains (MON); regions with low demographic pressure are N'Zi Comoé (NCO), South Comoé (SCO), Denguélé (DEN), l'Agneby (AGN), and the Lakes (LAC). However, regional characteristics captured by factor 2

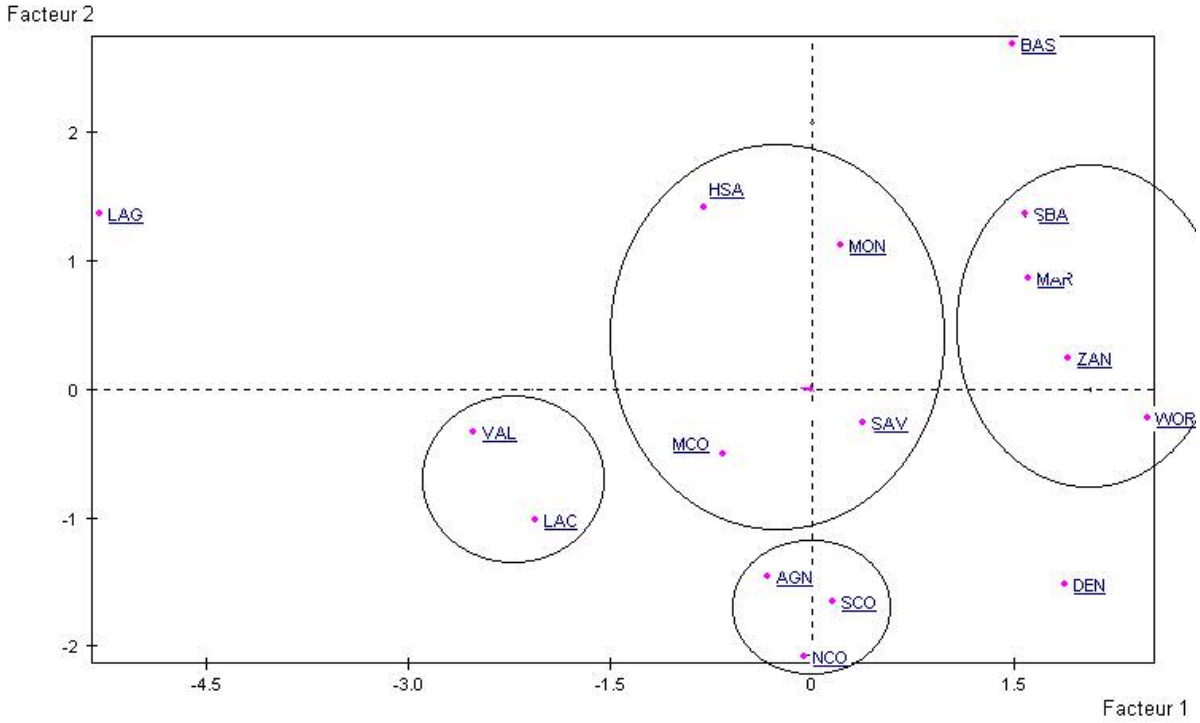
[9] In terms of variables DEMO, WATER, POST, ELEM, SECON.

do not reinforce those captured by factor 1, and therefore do not lend themselves to straightforward conclusions. For this purpose, a factor space is presented with two axes (F1 and F2) to better assess the dominant characteristics of the regions. Figure 1 reveals some interesting "new regions" emerging from this clustering: the Lagoons, Low Sassandra, and Denguélé. The region of the Lagoons, for example, is better endowed by economic and social infrastructure, but it too constitutes, together with Low Sassandra, one of the regions with very high demographic pressure compared to the rest of the country. This in turn represents a problem for the provision of adequate quantity and quality of health services. This result reflects the fact that these two regions are more diversified in terms of economic activities, making them attractive to the population from other regions, strengthening the continuous north-south migrations. In the case of Low Sassandra, the strong concentration of population resulted initially from the state policy of project location in the region of southwest (ARSO) and the Valley of the Bandama (AVB). This policy began in 1970 and was at the root of the subsequent population movements from the center and north towards these regions.

In contrast to these regions, Denguélé (located in the northwest part of the country) is one region which is poorly endowed by infrastructure, especially social (Figure 5). This could be explained by the fact that this region has the lowest demographic pressure in the country. In addition to having very low road density, it has one of the least favorable indicators of theoretical distance to health centers of about 2.3 km, compared with the national average of 1.2 km.

9

Figure 5: Principal Component Mapping of Regions by Type



In addition to the "new regions" cluster identified by the analysis, we also identify three large groups of regions in figure 5. The first group encompasses the regions of South Bandama, Marahoué, Zanzan, and Worodougou, which represent the “regions less endowed” with economic infrastructure. This group may be broadened to include the region of Denguéle characterized by a weak density of road network and low access of the population to drinkable water and postal services.

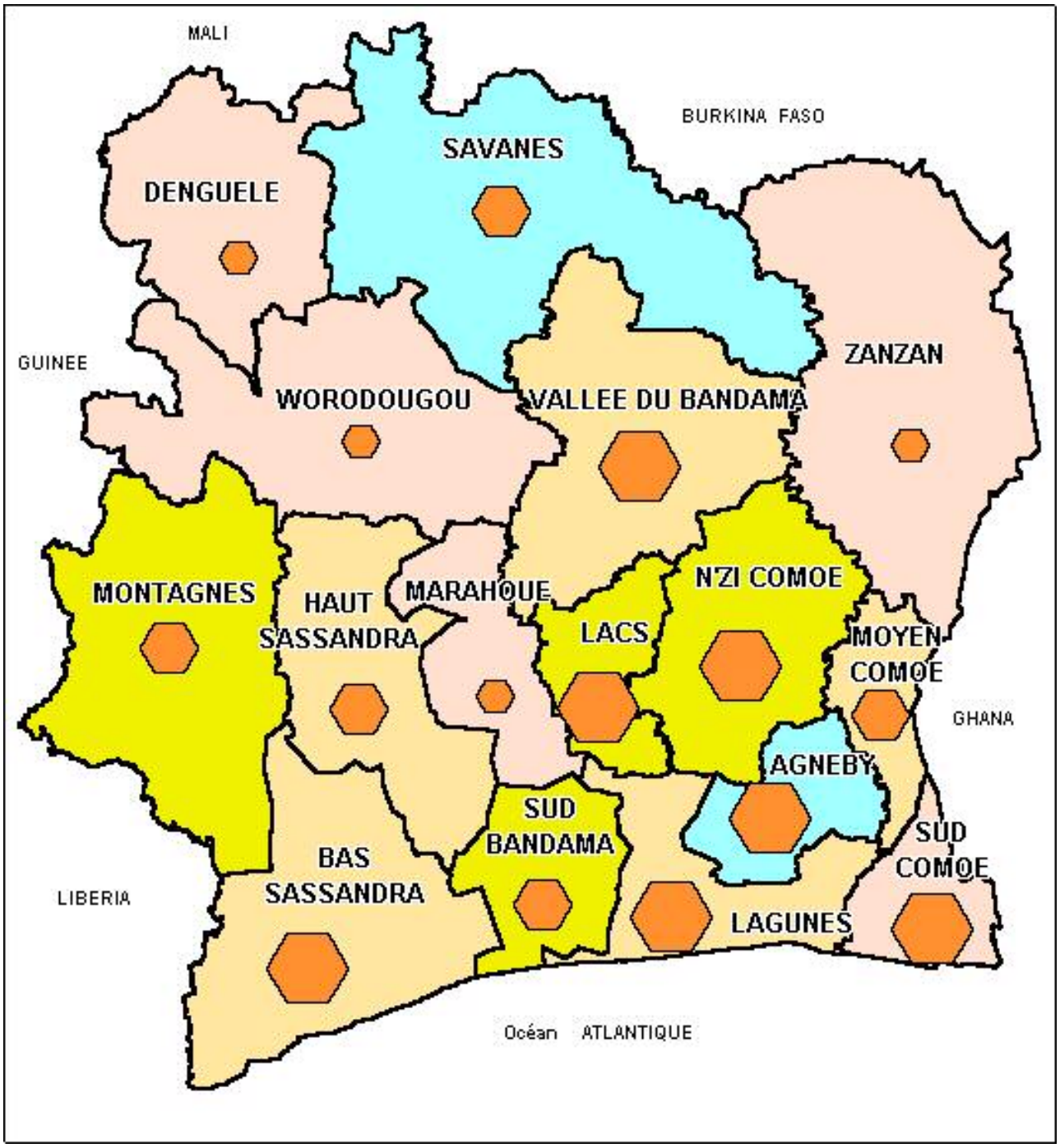
A second cluster of regions with infrastructure indicators near national average (center of the figure) may be called “regions with average endowments”. Nevertheless, each region has peculiarities noticeable on the figure. For example, the region of High Sassandra has access to a good regional coverage of health infrastructure, but with high demographic pressure. The Mountains region has a high level of primary infrastructure. The Savannahs region, by contrast, has good coverage with health infrastructure and low demographic pressure. Finally, the region of Middle Comoé is characteristically showing infrastructure endowments about equal to the national average.

Finally, the third and fourth comparatively heterogeneous clusters represent the regions of the Lakes, Valley of Bandama, Agnéby, South Comoé, and N'Zi Comoé. These regions are characterized by a high density of road network, good access of the populations to drinkable water, and comparatively solid coverage of postal services. Together with the region of the Lagoons, these regions constitute "regions better endowed " with economic infrastructure. The regions of Agnéby, South Comoé, and N'Zi Comoé stand out as regions with the highest density of road network.

2.6 Infrastructure Location Bias Compared with Economic Activity

The map below combines typology of regions with their economic specialization. It shows that industrial regions (beige) or those in the process of conversion towards tertiary industries (yellow) enjoy overall infrastructure endowments at least equal to the national average. Similarly, regions with dominant agricultural activities (blue) are equally at least as well endowed with infrastructure as the national average). Only the regions that are neither agricultural nor industrial (pink), are poorly endowed with infrastructure compared with the national average, with the exception of South Comoé which benefits from the proximity of the more developed region of the Lagoons.

Map 1: Location of Economic Activities and Infrastructures in Côte d'Ivoire, 1995



Legend:

- Small size hexagon = low economic and social infrastructure (ESI) endowment
- Medium size hexagon = Medium ESI endowment
- Large hexagon = High level ESI endowment
- Rose = Regions characterized by a long experience of tertiary economic activities
- Yellow = Regions shifting to tertiary activities
- Beige = Regions with industries
- Blue = Regions specialized in agriculture

Regional characteristics of infrastructure make it possible to establish a typology of three groups of regions with statistically significant and relatively differentiated infrastructure endowments. This typology shows a pattern of spatially unequal investment efforts of the government since the 1960s, which resulted in higher levels of investments in the central, southwest and western regions compared to the regions of the north and the northeast (Map 1).

The large share of external financing in the overall infrastructure financing has strengthened the bias favoring regions with strong density of economic activities. It also reinforced the sense of limited social and economic development of the poor, rural regions. For example, in the period from 1968 to 1982, it appears that World Bank share of Bank-financed total project costs, estimated at about 45 percent, was also invested with the view towards a particular spatial allocation of economic activities (Paulais, 1995). The southern region alone benefited from more than half of the Bank credits while the poor regions of the north and the east received very modest shares (7.5 and 1.1 percent, respectively). The financing of investments in urban areas also favored the coastal and forest zones, concentrating more than 80 percent of these investments in Abidjan.

These regional disparities lead to a natural empirical question to which we turn next: what is the impact of the spatial dispersion of economic and social infrastructure on urban dynamics in Côte d'Ivoire? We approach this question within the framework of an augmented empirical analysis of productivity of local economic activities as a function of factors of production and relevant spatial variables.

Table 8: Regional distribution of the Bank's contribution to financing infrastructure in Côte d'Ivoire, 1968-1982

(including co-financing in millions of USD, constant prices of 1980)

Region	Total share in the total cost of projects		Urban share	
	Million USD	Percent	Million USD	Percent
North	145.65	7.51	17.31	2.35
Middle West	192.42	9.92	4.04	0.55
West	184.54	9.52	23.28	3.16
Southwest	241.07	12.43	34.84	4.74
Center	157.67	8.13	34.75	4.73
South	996.53	51.39	618.45	84.14
East	21.42	1.10	2.39	0.33
All the regions	1939.29	100.00	735.06	100.0

Source: Paulais T. (1995): Urban Development in Côte d'Ivoire, the World Bank's projects, p.93
Note: Excluding Energy projects and locally unidentified components.

3. LABOR PRODUCTIVITY AND URBAN DYNAMICS

Wide regional disparities in economic activity and infrastructure allocations documented in the previous section beg the question whether and to what extent the regional factors influenced regional productivities as the most important economic measure of long-term regional growth. This is the question to which we turn in this section. Specifically, looking beyond the traditional factors of production, we are interested in exploring the spatial factors determining the pattern of urban and regional productivity. Our empirical implementation is based on a theoretical equation of labor productivity arising from the combined theoretical work of Henderson (1988) and empirical work of Catin (1991, 1997).

Generally, urban areas specialize in certain products partly in line with their internal and external economies of scale. Internal economies result from the scale of production at the center of the region (a sector or an enterprise). External economies, sometimes called agglomeration economies, correspond to advantages in terms of productivity of a sector of activity in a region compared with other regions, because of this sector's size and structure. The measure of their impacts on the levels of productivity and, therefore, on urban growth, allows an analysis of factors that shape spatial asymmetries.

3.1 Definitions of the Model and Variables

Estimates of productivity discussed in this section are dynamic. This dynamics is in the sense that internal and external economies of scale defined in the econometric model result from an interactive relation capturing long-term accumulation of localized knowledge which affects regional productivity. When the accumulation of knowledge is spread exclusively among enterprise in the *same* activity or sector, this is an example of *localization economies* or externalities of the Marshall-Arrow-Romer (MAR) type. These externalities take account of the quality as well as the quantity of labor. If, however, the accumulation of knowledge is spread among *all* the activities or sectors of a regional space, these external economies of scale are said to be *urbanization economies* or Jacobs-type externalities. These notions of external scale economies may contribute to identification of factors explaining inter-sectoral and inter-regional disparities in productivity. The identification of these different causal relations is based on a combination of a theoretical model of Henderson (1988) and the empirical work of Catin (1991, 1997). Hence, we posit the following econometric equation of labor productivity as a function of the use of capital and labor, and other variables capturing dimensions of scale economies and urbanization economies. Expected signs of estimated coefficients in parentheses[10]

$$\underset{}{LVAEFF} = f\ (\underset{(+)}{LICEFF},\ \underset{(+/-)}{LEFF},\ \underset{(+)}{LEFFES},\ \underset{(+)}{LVAPOP},\ \underset{(-)}{TURB},\ \underset{(+/-)}{TURB2},\ \underset{(+/-)}{RAKM2},\ \underset{(+/-)}{RAKM22},$$

$$\underset{\mathbf{(+/-)}}{RAPOP},\ \underset{\mathbf{(+/-)}}{RAPOP2},\ \underset{\mathbf{(+/-)}}{TURAP}) \qquad (1)$$

[10] See annex 3 for the theoretical formulation of the model.

Where

LVAEFF, the dependent variable, represents:

the logarithm of measured labor productivity (the ratio between added value in constant prices based in 1985, and total employment of the sector);

Standard production variables represent:

(i) the logarithm of the intensity productivity measured by the ratio between cumulative gross investment and total employment (LICEFF); and

(ii) the logarithm of total employment of the sector (LEFF). These variables may show ambiguous effects because of the problem of efficiency of use (e.g., underutilization of capacity, internal organization of production etc.).

Variables of scale economies are defined by:

(i) internal scale economies or externalities measured by the logarithm of the average size of an enterprise LEFFES (the ratio between the total employment of the sector and the number of enterprises in this sector). The effect of this variable may be interpreted as an effect of internal scale economies ("large enterprise" effect of a sector of activity with monopolistic leanings) or an external economy effect à la Porter, which is linked to a strong competition between a multitude of small and medium size enterprises in the center of the sector (" industrial district" effect);

(ii) localization economies measured by the logarithm of the regional value added per capita LVAPOP. This variable measures an impact of the size of the region on sector productivity;

Variables of urbanization economies represent:

(i) urbanization rate TURB (the share of urban in the total population of a region). This variable may exercise positive or negative influence on sector productivity with minimum or maximum threshold effects (TURB2) for more or less significant urban population;

(ii) the "enclave" variable of the region measured by the ratio between the number of kilometers of paved roads (covered by bitumen) and the total square kilometers of the region (RAKM2). A positive (or negative) sign may be interpreted as a relative ease (or difficulty) of road traffic in the region;

(iii) the availability of road infrastructure (RAPOP) measured by the number of kilometers of paved roads per capita. This variable captures the degree of congestion due to an excessive use of road infrastructure (negative sign); this variable may have a threshold effect (RAPOP2) similar to the urbanization rate variable; and

(iv) the interplay (positive or negative) between the urbanization rate and road infrastructure in the regions, which is captured by variables TURB and RAPOP that are allowed to interact through a multiplicative variable TURAP.

3.2 Results of Econometric Estimates

The explanatory power of the estimated models varies between the low 17 percent and high 83 percent for all sectors of activity in a given panel (Table 9). Also, the coefficients of the model are found to be jointly non-zero according to F-test and Chi-2 Wald tests.

Table 9: Estimates of the Productivity Function (dependant variable LVAEFF)[11]

	Primary Sector			Secondary Sector				Tertiary Sector		
	S01	S02	S03	S06	S11	S13	S16	S24	S26	S27
LICEFF	-0.28***	-	-	0.49***	-	-0.28*	-1.22***	0.11	0.21*	0.30***
	(-2.60)			(11.18)		(-1.68)	(-3.90)	(1.33)	(1.74)	(5.95)
LEFF	0.46*	0.08*	0.21***	-	-0.50***	-0.29***	-1.23***	-0.23***	-0.45***	-
	(1.89)	(1.71)	(2.95)		(-3.51)	(-4.32)	(-4.02)	(-3.46)	(-2.86)	
LEFFES	-0.44*	-	-0.46***	0.14***	-	0.21***	-	-	-	-
	(-1.93)		(-4.93)	(3.21)		(4.50)				
LVAPOP	0.51***	0.19***	-	0.05**	0.53***	-	0.30*	0.47*	-	0.10***
	(3.78)	(2.66)		(2.25)	(5.52)		(1.82)	(1.88)		(2.93)
TURB	-0.74***	-	0.69***	-0.02*	-0.62***	-	0.69***	-	-	0.10*
	(-3.70)		(3.72)	(-1.85)	(-5.40)		(5.09)			(1.66)
TURB2	0.07***	0.05***	-0.04***	-	0.06***	0.01**	-0.05***	-	-	-0.01**
	(3.58)	(5.86)	(-3.60)		(5.85)	(2.27)	(-6.04)			(-2.15)
RAKM2	-0.35***	-0.75***	-	-0.14***	-	0.45***	0.26***	0.13*	-	-0.21***
	(-3.25)	(-5.09)		(-3.93)		(3.82)	(2.95)	(1.95)		(-2.70)
RAKM22	-	-	-	0.03***	-0.03***	-0.05***	-	-	-0.03***	0.05***
				(4.16)	(-3.97)	(-2.69)			(-1.84)	(3.41)
RAPOP	-0.67***	-	-	-	-	0.25***	-0.88***	-0.14***	-0.30**	0.27***
	(-7.37)					(5.90)	(-2.98)	(-3.92)	(-2.41)	(5.86)
RAPOP2	-	0.11***	0.04**	-	-	-	0.12***	-	-	-0.03***
		(4.64)	(2.16)				(3.64)			(-6.14)
TURAP	-	-0.05***	-0.11***	-	0.02***	-0.05***	-0.06*	-	-	-
		(-4.42)	(-4.30)		(3.16)	(-4.82)	(-3.05)			
Constant	9.76	5.25	5.86	3.25	7.26	7.89	17.19	4.85	7.47	4.02
No. observations	51	85	85	136	51	68	51	85	85	238
R2	0.81	0.53	0.61	0.83	0.78	0.67	0.74	0.37	0.17	0.44
Wald Chi 2 or F	177.30	89.60	122.76	626.26	156.85	121.05	12.21	5.82	9.55	98.49
Prob (Chi 2 or F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000

Source: BDF data, Sanogo (2001) and the authors' estimates.
Note: t- Student statistic in brackets; * denotes 10% significance; ** denotes 5% significance; and *** denotes 1% significance.

3.3 The Important Role of Urbanization Economies in the Primary Sector

The impact of factors of production: employment and capital intensity

In the primary sector, the level of employment (LEFF) exercises a positive and significant influence on productivity in food producing agriculture, agricultural goods for exports or industrial use, and forest exploitation. By contrast, capital intensity (LICEFF) is not an important factor influencing sector productivity because of the low level of mechanization, which is the source of technological growth and gains in productivity. In the

[11] See annex 4 for detailed results

special case of food producing agriculture, these weaknesses are reflected in the negative impact on measured labor productivity.

The impact of scale economies variables

Medium-size sectors of activity measured by the number of employed workers per enterprise (LEFFES) exercises a significant negative influence on the level of productivity in food producing agriculture and farming destined for export or industrial use. Because formal primary sector activities are not representative of the total activity in the regions, this negative influence reflects less internal than external diseconomies of scale. In fact, the predominance of the informal enterprises, and small and medium size formal enterprises in the primary sector reflects within-sector competition. This type of competition which pits formal against informal activities in the same sector may generate negative externalities ("neighborhood effects") on the productivity of the primary modern sector. The regions with high value added capita (LVAPOP) are positively and significantly associated with measured labor productivity in food producing agriculture, and agricultural goods export or industrial use. The textile industry, in particular, seems most sensitive to this variable, perhaps reflecting the fact that demand (i.e., high income) drives productivity in this sector. To the extent this industry is most concentrated in urban areas (see section I above), the growth of regional economies is accompanied by a spatial concentration via growing within-sector interactions (supply effect) and demand (income effect).

The impact of urbanization economies variables

The regional "enclave" variable (RAKM2) negatively affects productivity in the primary sector. The weak regional network of paved roads constitutes a constraint on gains in productivity because it limits the transport of goods from rural towards urban areas. This constraint is sharpened by road congestion problems, captured by a negative and significant sign of the variable RAPOP. The intensive enterprise use of infrastructure results in a decline of return to infrastructure, especially at the level of measured labor productivity in the primary sector.

The rate of urbanization of the regions (TURB) also exercises wide influence on productivity. The urbanization rate exerts negative impact on productivity in food producing agriculture with a significant, minimum urbanization threshold effect (TURB2). This effect also is present in agriculture for export and industrial use, suggesting that the urbanization rate must rise beyond a minimum threshold to exert a positive influence on the productivity of these two primary sector activities. In the forest exploitation, this positive impact characterizes the regions of Agnéby, Lagoons, High Sassandra, and Low Sassandra, which have comparatively higher rates of urbanization than the rest of the country. The positive influence of the urbanization rate, however, is reduced by the probable presence of agglomeration diseconomies after a maximum threshold urban concentration.

3.4 The Dominant Effects of Scale Economies and Location in the Agro-Industry

The impact of factors of production variables

With the exception of activities related to the processing of grain and flour, factors of production (employment and capital intensity) exert a negative and significant influence on agro-

industrial productivity. This result can be explained by an underutilization of these factors during the long economic recession (1980-1993) during which most agro-industrial enterprises remained in the hands of the state while undergoing extensive restructuring. The belated privatization measures adopted in 1991 and, especially, the devaluation of the CFA franc in 1994 triggered "catch-up" effects between 1994 and 1996 but the contribution of the reallocation of labor on productivity seemed to have been marginal (Berthélémy and Söderling, 1999). As for the available and used capital stock, the inefficiency of its use in the production processes during the economic crisis limited the scope for technically imbedded progress, and engendered direct negative influence on agro-industrial productivity.

The impacts of scale economies

The scale economy variables have an overall positive effect on agro-industrial productivity. In particular, the positive influence for medium-size enterprises reflects a "neighborhood effect" of small and medium-size enterprises linked by external scale economies arising from the competition in the sector of grain and flour. On the other hand, in other agro-industrial activities which are characterized by an oligopolistic market structure and larger enterprises (i.e., enterprises with more than 500 employees), the positive effect corresponds to internal scale economies.

Localization economies measured by the size of the regional economy are found to raise industrial productivity in the more specialized regions. Except for the grain and flour industry, this specialization is characteristic of the regional industrial development policy pursued since 1970. Under competitive pressure, these aging activities have increasingly reoriented themselves towards sub-regional and international markets, which explains their high productivity.

The impacts of urbanization economies

The overall effect of urbanization economies is ambiguous, and it varies by sector. In contrast to the processing of grain and flour, and textiles, the urbanization rate exerts a positive influence on productivity in the rubber industry. Compared with upstream agricultural products for exports or industrial use, the rubber industry is subject to agglomeration effects arising from other agro-industrial and agricultural activities clustered in the same geographical area. Therefore, the observed positive influence of the urbanization rate on productivity in raw materials cannot be separated from the one exerted on productivity, which is due to industrial processing of these materials.

The urbanization rate seems to have a negative impact on agro-industrial activities. (e.g., the grain and flour industries, textiles, and the wood industry). These activities are subject to agglomeration diseconomies related to transport costs and distance. For example, most important textile enterprises are located in the center or the south of the country, while most farms and farm-gate cotton processing factories (semi-processed cotton) are in the north. The grain and flour processing industries, are situated in densely concentrated urban areas (notably the region of the Lagoons), which are far from the areas of rural production. In theory, these location choices could perhaps have been justified by the perceived need to concentrate aggregate demand in the south of the country, and to direct economic growth (notably textiles)

towards large-scale exports in the European markets. But any positive neighborhood effects have probably been insufficient, and outweighed by agglomeration diseconomies in the grain and flour processing industries, textiles, and timber industries.

3.5 The Impact of Urbanization Economies on the Tertiary Sector and the Role of Infrastructure

The impact of factors of production variables

Increases in capital stock (equipment, storage, etc.) are found to bolster productivity in the tertiary sector (i.e., transport and communication, trade, etc.). But the *intensity* of labor use is negatively associated with productivity.

The impacts of scale economies and urbanization economies

Internal scale economies (neighborhood effects) à la Porter are not statistically significant in any estimates of productivity levels in the tertiary sector. The size of the regional economy (for localization economies) and the urbanization rate (for urbanization economies), however, exert significant and positive impact on t**he** productivity of transport and communication, and trade activities.

As expected, another variable of urbanization diseconomies—the congestion of roads variable (RAPOP)—shows a negative influence on productivity in transport, communication, tourism, and the hotel industry. The importance of good roads (square kilometers under paved roads—RAKM2) in the regions of the Lagoons, Valley of the Bandama, Low Sassandra, High Sassandra, and Zanzan) is clearly an asset that favorably influences the productivity levels of transport and communication activities. But congestion effects due to the overuse of roads are a clear drag on productivity.

4. POLICY IMPLICATIONS AND CONCLUDING REMARKS

In this paper, we document wide regional disparities in economic activity and infrastructure. These disparities, especially between the north and the south, were partly determined by the regional development policy. The paper also examines empirically the contribution of agglomeration economies to labor productivity—and therefore to urban dynamics—using a recent panel data from Côte d'Ivoire for the period from 1980 to 1996.

The analysis indicates significant urbanization economies, notably those related to infrastructure, but the size of these economies varies across sectors and activities. In addition to providing linkages between markets, roads are critical in fostering dynamic growth of the urban areas in the hinterland, resulting in the concentration of economic activities. Localization economies also stimulate industrial productivity. And yet, as the poor growth record of Côte d'Ivoire in this period shows, the country failed to take advantage of these economies. Its declining capital stock, including infrastructure, may have contributed to the overall economic decline.

The paper shows, for example, that inadequate road infrastructure was an important constraint to economic activity. This especially so in the poorer regions of the north. Inadequate roads clearly constrained the productivity of primary (agriculture and resource extraction) and tertiary (services) industries that take up the bulk of the total economic activity.

Effects of congestion of roads on productivity in primary and tertiary sectors suggest that greater investment in road infrastructure is needed. This especially so in the poor regions oriented towards agriculture and the tertiary sector, which happen to be located in the north.[12] Such infrastructure investments could have positive effects on productivity and urban and regional growth: (i) effects stemming from improving the collection and transport of agricultural products from the hinterland to centers of regional and sub-regional markets; (ii) effects arising from reduced delays and costs of access to markets, higher producers' farm-gate prices because of lower transaction costs, and (iii) demand effects stemming from the intensification of trade flows with neighboring countries in the north. Also, in the rural environment, higher producer prices and a policy of ensuring access to health and education infrastructure constitute an important instrument for promoting faster human capital accumulation with direct effects on productivity, incomes, and poverty reduction.

[12] Henderson (2000), for example, estimates that increased road density (measured by an increase of one standard deviation of road density) has the potential to raise the annual average growth rate in low income countries by about ¼ of 1 percentage point.

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Annex 1: Two digit economic activity classification in Côte d'Ivoire

Sector	Number	Economic activity definition
Primary sector	01	Feeding agriculture, livestock and hunting products
	02	Agricultural products for industry and exports
	03	Timber products
	04	Fishery products
Secondary sector	05	Mining products
	06	Seeds (grain and flour products)
	07	Canned food processed
	08	Beverages and ice foods
	09	Fat foods
	10	Other foods, tobbacco
	11	Textile products
	12	Leather products and shoes
	13	Wood processed products
	14	Produits pétroliers
	15	Chemical products
	16	Rubber processed products
	17	Engineering works and glassware
	18	Raw Metals
	19	Transport materials
	20	Other mechanical and electric products
	21	Other industrial products
	22	Electricity, gas and water
Tertiary sector	23	Construction
	24	Transport and telecommunication
	25	House renking and managing
	26	Other services
	27	Trade
	28	Banking services
	29	Banking service related products
	30	Insurance services
	31	Public administration services
	32	Private administration services
	33	Housekeeping services

Annex 2

ECONOMIC ACTIVITY LOCATION COEFFICIENTS (1980-1996)

Sector 01	g= {agn, lac, mco, sav}		
	g	Other regions	Total
01	990873392.9	2422236713	3413110106
Other sectors	19096738138	1.40126E+12	1.42036E+12
Total	20087611531	1.40368E+12	1.42377E+12
E01			942718756.7
E01*			3404928094
S01			0.276868918

Sector 02	g= {agn, sav, sco, hsa}		
	g	Other regions	Total
02	3536213498	11507155455	15043368954
Other sectors	21741303980	1.38699E+12	1.40873E+12
Total	25277517478	1.39849E+12	1.42377E+12
E02			3269134934
E02*			14884422910
S02			0.219634644

Sector 03	g= {agn, bas, lac, mon, nzi, sba, hsa}		
	g	Other regions	Total
03	2183168670	4782753571	6965922241
Other sectors	50086576992	1.36672E+12	1.41681E+12
Total	52269745662	1.3715E+12	1.42377E+12
E03			1927434644
E03*			6931840894
S03			0.278055234

Sector 04	g= {lag}		
	g	Other regions	Total
04	6061015835	0	6061015835
Other sectors	1.24323E+12	1.74477E+11	1.41771E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E04			742750701.4
E04*			6035214014
S04			0.123069488

Sector 05	g= {lag, mon}		
	g	Other regions	Total
05	55799860856	26201013.23	55826061869
Other sectors	1.19734E+12	1.70609E+11	1.36795E+12
Total	1.25314E+12	1.70635E+11	1.42377E+12
E05			6664402301
E05*			53637123712
S05			0.124249808

Sector 06	g= {bas,lac,den,mar,mco,nzi,sav,sba,zan,hsa}		
	g	Other regions	Total
06	3943315069	21802900920	25746215989
Other sectors	36984090019	1.36104E+12	1.39803E+12
Total	40927405088	1.38284E+12	1.42377E+12
E06			3203220657
E06*			25280644557
S06			0.126706447

Sector 11	g= {agn, val}		
	g	Other regions	Total
11	71641553321	29559579446	1.01201E+11
Other sectors	56962011792	1.26561E+12	1.32257E+12
Total	1.28604E+11	1.29517E+12	1.42377E+12
E11			62500465347
E11*			94007798299
S11			0.664843412

Sector 12	g= {lag}		
	g	Other regions	Total
12	4230145459	0	4230145459
Other sectors	1.24507E+12	1.74477E+11	1.41954E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E12			518385629.1
E12*			4217577345
S12			0.122910758

Sector 13	g= {agn, bas, mco, nzi, sba, hsa}		
	g	Other regions	Total
13	7343107816	31328706778	38671814594
Other sectors	41579237852	1.34352E+12	1.3851E+12
Total	48922345668	1.37485E+12	1.42377E+12
E13			6014302583
E13*			37621429358
S13			0.159863745

Sector 14	g= {lag}		
	g	Other regions	Total
14	8842457222	0	8842457222
Other sectors	1.24045E+12	1.74477E+11	1.41493E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E14			1083604050
E14*			8787540395
S14			0.123311416

Sector 15	g= {lag}		
	g	Other regions	Total
15	44470724653	744445472.3	45215170126
Other sectors	1.20482E+12	1.73733E+11	1.37856E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E15			4796473780
E15*			43779258058
S15			0.109560417

Sector 16	g= {bas, mco, hsa}		
	g	Other regions	Total
16	9432178245	15567601015	24999779260
Other sectors	24462244224	1.37431E+12	1.39877E+12
Total	33894422469	1.38988E+12	1.42377E+12
E16			8837031697
E16*			24560812278
S16			0.359802094

Sector 21	g= {lag}		
	g	Other regions	Total
21	20972202657	63927984.64	21036130642
Other sectors	1.22832E+12	1.74413E+11	1.40274E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E21			2513956848
E21*			20725323331
S21			0.1212988

Sector 22	g= {lag}		
	g	Other regions	Total
22	1.55846E+11	0	1.55846E+11
Other sectors	1.09345E+12	1.74477E+11	1.26793E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E22			19098186381
E22*			1.38787E+11
S22			0.137608114

Sector 23	g= {lac, lag, wor, hsa}		
	g	Other regions	Total
23	77561075715	1594397522	79155473237
Other sectors	1.18182E+12	1.62796E+11	1.34462E+12
Total	1.25938E+12	1.64391E+11	1.42377E+12
E23			7545007723
E23*			74754776855
S23			0.100930108

Sector 24	g= {lag, mar, zan}		
	g	Other regions	Total
24	1.94396E+11	3212596922	1.97609E+11
Other sectors	1.05571E+12	1.70458E+11	1.22616E+12
Total	1.2501E+12	1.7367E+11	1.42377E+12
E24			20891547088
E24*			1.70182E+11
S24			0.122759789

Sector 25	g= {lag}		
	g	Other regions	Total
25	2181445620	3687843.66	2185133464
Other sectors	1.24711E+12	1.74473E+11	1.42159E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E25			264090604.2
E25*			2181779832
S25			0.121043655

Sector 26	g= {lac, lag, sco}		
	g	Other regions	Total
26	98265545114	1689347455	99954892569
Other sectors	1.15367E+12	1.70152E+11	1.32382E+12
Total	1.25193E+12	1.71842E+11	1.42377E+12
E26			10374664761
E26*			92937631727
S26			0.111630397

Sector 07	g= {lag, mco}		
	g	Other regions	Total
07	50298450578	23948682.76	50322399260
Other sectors	1.2012E+12	1.72245E+11	1.37345E+12
Total	1.2515E+12	1.72269E+11	1.42377E+12
E07			6064797475
E07*			48543783300
S07			0.124934586

Sector 08	g= {lag}		
	g	Other regions	Total
08	33589595197	673794616.9	34263389814
Other sectors	1.21571E+12	1.73803E+11	1.38951E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E08			3525032364
E08*			33438833805
S08			0.105417324

Sector 09	g= {val}		
	g	Other regions	Total
09	8763618972	59875635167	68639254139
Other sectors	1.06436E+11	1.2487E+12	1.35513E+12
Total	1.152E+11	1.30857E+12	1.42377E+12
E09			3209900087
E09*			65330194320
S09			0.049133484

Sector 10	g= {nzi, val}		
	g	Other regions	Total
10	35920223538	38940654909	74860878447
Other sectors	79743718905	1.26917E+12	1.34891E+12
Total	1.15664E+11	1.30811E+12	1.42377E+12
E10			29838699648
E10*			70924749252
S10			0.420709272

Sector 32	g= {lag, mon, den, wor, hsa}		
	g	Other regions	Total
32	4885579619	288253117.2	5173832736
Other sectors	1.25666E+12	1.61939E+11	1.4186E+12
Total	1.26154E+12	1.62227E+11	1.42377E+12
E32			301263474.5
E32*			5155031592
S32			0.058440665

Sector 17	g= {bas, lag}		
	g	Other regions	Total
17	12912100476	0	12912100476
Other sectors	1.25988E+12	1.50981E+11	1.41086E+12
Total	1.27279E+12	1.50981E+11	1.42377E+12
E17			1369232774
E17*			12795001445
S17			0.1070131

Sector 18	g= {lag}		
	g	Other regions	Total
18	393239.6645	0	393239.6645
Other sectors	1.24929E+12	1.74477E+11	1.42377E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E18			48189.78281
E18*			393239.5559
S18			0.122545614

Sector 19	g= {lag}		
	g	Other regions	Total
19	14873739000	394234115.9	15267973116
Other sectors	1.23442E+12	1.74083E+11	1.4085E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E19			1476788506
E19*			15104245371
S19			0.097773074

Sector 20	g= {lac, lag}		
	g	Other regions	Total
20	42853765156	153890728.3	43007655884
Other sectors	1.20816E+12	1.72609E+11	1.38076E+12
Total	1.25101E+12	1.72763E+11	1.42377E+12
E20			5064741799
E20*			41708530553
S20			0.121431797

Sector 27	g= {bas, lac, lag, mon, den, mar, mco, n'zi, sav, sba, wor, zan, sco, hsa}		
	g	Other regions	Total
27	1.9794E+11	2697718357	2.00638E+11
Other sectors	1.09723E+12	1.25906E+11	1.22313E+12
Total	1.29517E+12	1.28604E+11	1.42377E+12
E27			15425060388
E27*			1.72364E+11
S27			0.089491307

Sector 28	g= {lag}		
	g	Other regions	Total
28	1369907875	74614.2533	1369982489
Other sectors	1.24793E+12	1.74477E+11	1.4224E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E28			167810684.6
E28*			1368664264
S28			0.122609093

Sector 30	g= {lag}		
	g	Other regions	Total
30	24972182345	0	24972182345
Other sectors	1.22432E+12	1.74477E+11	1.3988E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E30			3060230572
E30*			24534183967
S30			0.124733334

Sector 31	g= {lag}		
	g	Other regions	Total
31	342141318.1	0	342141318.1
Other sectors	1.24895E+12	1.74477E+11	1.42343E+12
Total	1.2493E+12	1.74477E+11	1.42377E+12
E31			41927906.3
E31*			342059099.4
S31			0.122575036

REGIONS SPECIALIZATION COEFFICIENTS (1980-1996)

Agnéby	g= {01, 02, 03, 11, 13}		
	g	**Other sectors**	**total**
Agnéby	12883343194	520393913.1	13403737108
Other regions	1.52412E+11	1.25796E+12	1.41037E+12
total	1.65295E+11	1.25848E+12	1.42377E+12
Eagn			**11327212601**
Eagn*			**13277551068**
Sagn			**0.853110076**

Bas sassandra	g= {03, 06, 13, 16, 17, 27}		
	g	**Other sectors**	**total**
Bas	20266444582	3230031355	23496475937
Other regions	2.77387E+11	1.12289E+12	1.40028E+12
total	2.97654E+11	1.12612E+12	1.42377E+12
Ebas			**15354270794**
Ebas*			**23108714186**
Sbas			**0.664436397**

Lacs	g= {01, 03, 06, 20, 23, 26, 27}		
	g	**Other sectors**	**total**
Lac	1435289664	278415368.9	1713705033
Other regions	4.57446E+11	9.64613E+11	1.42206E+12
total	4.58881E+11	9.64891E+11	1.42377E+12
Elac			**882963635.5**
Elac*			**1711642354**
Slac			**0.515857553**

Lagunes	g= {04, 05, 07, 08, 12, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32}		
	g	**Other sectors**	**total**
Lag	1.02215E+12	2.27145E+11	1.2493E+12
Other regions	29168091630	1.45309E+11	1.74477E+11
total	1.05132E+12	3.72454E+11	1.42377E+12
Elag			**99666352612**
Elag*			**1.53096E+11**
Slag			**0.651007293**

Montagnes	g= {03, 05, 27, 32}		
	g	**Other sectors**	**total**
Mon	3744158629	97563897.99	3841722527
Other regions	2.64859E+11	1.15507E+12	1.41993E+12
total	2.68603E+11	1.15517E+12	1.42377E+12
Emon			**3019393990**
Emon*			**3831356520**
Smon			**0.7880744**

Denguélé	g= {06, 27, 32}		
	g	**Other sectors**	**total**
Den	124857492	1389947.866	126247439.9
Other regions	2.31433E+11	1.19221E+12	1.42365E+12
total	2.31558E+11	1.19221E+12	1.42377E+12
Eden			**104325023.1**
Eden*			**126236245.4**
Sden			**0.826426854**

Marahoué	g= {06, 24, 27}		
	g	**Other sectors**	**total**
Mar	466324839.4	0	466324839.4
Other regions	4.23526E+11	9.99779E+11	1.42331E+12
total	4.23993E+11	9.99779E+11	1.42377E+12
Emar			**327455452**
Emar*			**466172105.1**
Smar			**0.702434677**

Moyen comoé	g= {01, 06, 07, 13, 16, 27}		
	g	**Other sectors**	**total**
MCO	2081355837	126671729.1	2208027566
Other regions	3.4171E+11	1.07985E+12	1.42156E+12
total	3.43791E+11	1.07998E+12	1.42377E+12
Emco			**1548194842**
Emco*			**2204603292**
Smco			**0.702255525**

N'Zi Comoé	g= {03, 06, 10, 13, 27}		
	g	**Other sectors**	**total**
Nzi	463551617.7	562818.9359	464114436.6
Other regions	3.46419E+11	1.07689E+12	1.42331E+12
total	3.46882E+11	1.07689E+12	1.42377E+12
Enzi			**350476549.2**
Enzi*			**463963146.8**
Snzi			**0.755397388**

Savanes	g= {01, 02, 06, 27}		
	g	**Other sectors**	**total**
Sav	2574361284	187780540.7	2762141825
Other regions	2.42266E+11	1.17874E+12	1.42101E+12
total	2.4484E+11	1.17893E+12	1.42377E+12
Esav			**2099367055**
Esav*			**2756783224**
Ssav			**0.761527797**

Sud bandama	g= {03, 06, 13, 27}		
	g	**Other sectors**	**total**
Sba	1101941906	58129749.07	1160071655
Other regions	2.7092E+11	1.15169E+12	1.42261E+12
total	2.72022E+11	1.15175E+12	1.42377E+12
Esba			**880302181.9**
Esba*			**1159126443**
Ssba			**0.75945311**

Vallée banda.	g= {09, 10, 11}		
	g	**Other sectors**	**total**
Val	1.08308E+11	6892135324	1.152E+11
Other regions	1.36394E+11	1.17218E+12	1.30857E+12
total	2.44701E+11	1.17907E+12	1.42377E+12
Eval			**88508496789**
Eval*			**1.05879E+11**
Sval			**0.835941522**

Worodougou	g= {23, 27, 32}		
	g	**Other sectors**	**total**
Wor	182571581	0	182571581
Other regions	2.84784E+11	1.13881E+12	1.42359E+12
total	2.84967E+11	1.13881E+12	1.42377E+12
Ewor			**146030021.8**
Ewor*			**182548169.7**
Swor			**0.799953361**

Zanzan	g= {06, 24, 27}		
	g	**Other sectors**	**total**
Zan	337684013.2	2693377.013	340377390.2
Other regions	4.23655E+11	9.99777E+11	1.42343E+12
total	4.23993E+11	9.99779E+11	1.42377E+12
Ezan			**236321195.5**
Ezan*			**340296017.1**
Szan			**0.694457718**

Sud comoé	g= {02, 26, 27}		
	g	**Other sectors**	**total**
Sco	861220883.2	60498696.36	921719579.6
Other regions	3.14775E+11	1.10808E+12	1.42285E+12
total	3.15636E+11	1.10814E+12	1.42377E+12
Esco			**656885005.3**
Esco*			**921122878.1**
Ssco			**0.713135045**

Haut sassan.	g= {02, 03, 06, 13, 16, 23, 27, 32}		
	g	**Other sectors**	**total**
Hsa	7248408195	941510771	8189918966
Other regions	3.89146E+11	1.02644E+12	1.41558E+12
total	3.96394E+11	1.02738E+12	1.42377E+12
Ehsa			**4968243770**
Ehsa*			**8142808357**
Shsa			**0.610138855**

Annex 3: Theoretical labor productivity function

We started with a Cobb-Douglas version of a Trans-Log production function à la Henderson (1988), as following :

$$X = g(S)X^{*}(K), \text{ with :} \qquad \textbf{(1)}$$

- $X^{*}(K)$: a combination of production factors with constant return to scale in each sector ;
- K : a vector of inputs ;
- $g(S)$: technical progress is assumed Hicks neutral. It measures specific characteristics of economic activities such as size and technology endowment in an urban area ; $g(S)$ represents external scale economies.

The assumption of technical progress was admitted regarding the regional development policy undertaken by the Ivorian government, based mainly on building capital intensive agro-industries. According to Bohoun and Kouassy (1997), a relatively high capital-labor ratio could have led to a regional capital accumulation. However, the long-term technology diffusion effects were likely limited by the combination of extensive capital accumulation and disinvestments due to a long period (1980-1993) of economic recession. Beyond observed low productivity gains in all the regions, the main issue is to analyse the determinants of regional disparities. Therefore, we assume that regional disparities depend on region-specific characteristics, such as the spatial organization of economic activities.

Dividing equation 1 by the number of employees, we get equation 2 as following :

$$X / N_0 = g(S)X^{*}(k), \text{ where} \qquad \textbf{(2)}$$

- N_0 measures the number of employees in the sector at the level of the region ;
- k represents a vector of ratio of inputs to the number of employees.

Putting equation 2 in the logarithmic form, with ***log[X*(k)]=f(logk)*** and using a Taylor limited development of first order around each input set as an unity ($k_i=1$), we get a Cobb-Douglas equation as following :

$$\log(X / N_0) = C_0 + \log[g(S)] + \sum \alpha_i [\log(k_i)] \qquad \textbf{(3)}$$

With equation 3, one can define the components of g(S) as a function of agglomeration effects and the vector of k_i variables:

$$g(S) = e^{\varepsilon_0} N^{\varepsilon_N} \text{ where:} \qquad \textbf{(4)}$$

- $\varepsilon_0 = d(\log X)/d(\log N_0) = \phi/N_0$ [13] ;

[13] $X=e^{-\phi/N0}N^{\varepsilon N}X^{*}(K)$; the logarithmic form is : $\log X=-\phi/N_0+\varepsilon_N \log N+\log(X^{*}(K))$ from we derive : $d(\log X)/d(\log N_0)=\varepsilon_0=[d(\log X)/dN_0]$ $N_0= N_0 d(-\phi/N_0)/ dN_0= N_0\phi/N_0^2=\phi/N_0$.

- N = whole population of the region.

ε_0 and ε_N correspond to the elasticity of the production of each sector in the region relative, respectively to N_0 and N, other variables remaining constant.

The logarithmic form of $g(S)$ is as in equation 5 :

$$\log(g(S)) = -\phi / N_0 + \varepsilon_N \log N \qquad \textbf{(5)}$$

ε_0 is a decreasing function of N_0. The localization economies are defined by $1/N_0$, due to potential colinearity between N_0 and N, which takes partly into account urbanization economies. According to Henderson (1988), this definition reduces the colinearity problem. In addition, it shows that sectoral productivity gains at regional level depend positively on the improvement of localization economies. The second component of the right side of equation 4 measures the impacts (positive or negative) of the urbanization economies on productivity gains. However, both of these variables are not relevant enough to identify all the causation links between agglomeration economies and urban/regional productivity gains. Indeed, the colinearity problem mentioned above is not a big issue for Henderson's model, due to the fact that it leads to estimation errors, but with very limited bias on the convergence of estimators. The limits of these variables are rather in their economic relevance. N identify demand effects as well as urbanization economies. $1/N_0$ could also correspond to a standard production input. As such, it overestimates the impacts of localization economies, ignoring the human capital component of labor and the overall economic size of the region. Solving these limits suggests clarifying the components of the vector of ratios of inputs k_i as in Catin's (1991, 1997) empirical models.

The capital-labor is an important source of the productivity differences between regions (Catin, 1997). In general, reducing regional development disparities and improving the level of labor productivity, require an increase in capital-labor and capital-output ratios (capital coefficient). However, measuring the stock of private investment is extremely difficult in developing countries, due to weakness of the data systems. We used a proxy, the gross cumulative private investment, which does not distinguish amortization of equipment and its residual value. We assume that with long series (1980-1996), most of the old/initial equipment is retrenched from the stock or renewed. We also assume that the technology used in each region is evolving, depending on the level of education, the working experience of employees and regional specificities. Therefore, the quality of labor becomes a variable of localization economies, but there was no relevant variable available for our model. We consider that this lack of variable has a minor impact on the quality of the econometric estimation. According to Hugon (2000), the causal link between education and labor productivity is ambiguous in Côte d'Ivoire, due to a misalignment between the academic content of education and market demand. There are many reasons explaining this observation: the weak rate of conversion of graduates into rural workers, the weak link between education and productivity in the public sector, the high unemployment rate of new graduates, the weak link between the quality of education and knowledge acquired, and the poor use of graduates in the whole economic system.

Annex 4: Econometric tests of the model

We used econometrics of panel data to estimate the model in order to take into account differences between regions and sectors[14]. In this context, the spatial dimension changes, depending on the number of regions where the sector is available. The econometrics of panel data is expected to improve the quality of estimates by including regional specificities, and allowing different methodology regarding the characteristics of the residuals. In addition, including the spatial dimension reduces risks of stochastic trends (Varoudakis and Véganzonès, 1998). We assume that the residuals of the reduced form of our model are randomly distributed, serially independent, and with minimum and constant variances. In addition, independent variables are assumed to be exogenous.

However, these assumptions imply some tests in order to identify the right econometric method to use. The first range of tests correspond to the specification tests to check for existence (or lack) of individual and/or temporal specificities. These tests are known as heteroskedasticity and serial independence tests. We ran a Breusch-Pagan (BPml) test. A high value (low value) of Breusch-Pagan statistic, associated with a low probability (high probability) will suggest that we include (exclude) regions specificities in (from) the model. The table below shows that the Breusch-Pagan test rejects the assumption of lack of regional specificities in widely spread sectors in the country. Two sectors are concerned: S06 (grain and flavour processing industries) and S27 (trade). The reason for this result is that, from one region to another, economic activities can show different characteristics, despite belonging to the same economic sector.

Breusch-Pagan Test applied to the reduced form of the labor productivity equation

Sector number as in annex 1	Regions concerned	Results	
		BP_{ml}	Probability
Primary sector			
S01	Agnéby, Lagoons, Savannah	1,58	0,2093
S02	Agnéby, Lower-Sassandra, Lagoons, South-Comoé	1,45	0,2282
S03	Agnéby, Lower-Sassandra, Upper-Sassandra, Lagoons, Mountains	1,04	0,3085
Secondary sector			
S06	Lower-Sassandra, Upper-Sassandra, Lakes, Lagoons, Middle Comoé, South Bandama, Valley of Bandama, Zanzan	3,30	0,0693
S11	Agnéby, Lagoons, Valley of Bandama	1,52	0,2173
S13	Agnéby, Lower-Sassandra, Upper-Sassandra, Lagoons	1,87	0,1715
S16	Lower-Sassandra, Upper-Sassandra, Lagoons	1,51	0,2188
Tertiary sector			
S24	Lower-Sassandra, Upper-Sassandra, Lagoons, Valley of Bandama, Zanzan	0,08	0,7767
S26	Lower-Sassandra, Upper-Sassandra, Lakes, Lagoons, Valley of Bandama	1,84	0,1755
S27	Agnéby, Lower-Sassandra, Upper-Sassandra, Lakes, Lagoons, Marahoué, Mountains, N'Zi Comoé, Savannah, South Bandama, South Comoé, Valley of Bandama, Zanzan	38,38	0,0000

[14] Panel data are compiled using annual data of economic sectors covering the period 1980-1996 (17 years). For each sector, the spatial dimension (the number of the region) is repeated each year.

In addition to the Breusch-Pagan test, we ran a Hausman specification test to check the exogeneity of independent variables. The goal of this test is to know if regional specificities are random or constant. If this test failed in rejecting endogeneity of independent variables, while regional specificities are admitted by the Breusch-Pagan test, then one cannot use the General Least Squares (GLS) method, due to bias and non-convergence of estimators. These distortions can be corrected by generating new independent variables as the difference between each original variable and its average annual value. This approach is known as the WITHIN method. It helps to distinguish sectors which should use the GLS method (meaning that regional specificities are random) from the others (where regional specificities are constant). A high value (H) of Hausman test statistic (low probability) rejects exogeneity of independent variables, relative to the random component of residuals. In such a case, one should use the WITHIN method. If not, we use GLS method. The table below suggests that we use the WITHIN method in three sectors (S16, S24 and S26).

Hausman specification Test applied to the reduced form of the labor productivity equation

Sector number as in annex 1	**Results**		
	H	**Probability**	***Choice of Method***
Primary sector			
Agriculture vivrière, élevage et chasse (S01)	3,02	0,9334	*MCG*
Agriculture destinée à l'industrie et à l'exportation (S02)	6,54	0,3652	*MCG*
Exploitation forestière (S03)	10,26	0,1140	*MCG*
Secondary sector			
Travail des grains et farines (S06)	5,15	0,5251	*MCG*
Industries textiles (S11)	5,48	0,4839	*MCG*
Industries du bois (S13)	1,01	0,9982	*MCG*
Industries du caoutchouc (S16)	31,57	0,0005	*WITHIN*
Tertiary sector			
Transports et télécommunications (S24)	23,10	0,0016	*WITHIN*
Autres services (hôtellerie, tourisme, etc.) (S26)	30,10	0,0000	*WITHIN*
Activités de commerce (S27)	8,68	0,3701	*MCG*