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Efficiency of Financial Micro Intermediation in the WAEMU Countries: A Stochastic Frontier Production Analysis.

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Abstract

This paper investigates the efficacy and technical efficiency of financial micro intermediation in the productive process of the WAEMU economies over the period 2002-2007 using a stochastic frontier production model with technical inefficiency effects. Four specific variables of the financial dualism deepening and the financial micro intermediation are considered: the ratio of microcredit to GDP, the microcredit growth rate, the share of microcredit in the economy financing due to the private sector and the agents preference for decentralized deposits. Our findings show that the four variables have positive effect on technical efficiency with 0.6 of semi-elasticity estimated on average whereas bank loans have on average only 0.3 on average. We conclude that the financial micro intermediation development which results from the financial dualism deepening makes it possible to almost double increase the productive efficiency in WAEMU area.

Key words: Financial micro intermediation, financial dualism, stochastic frontier, technical efficiency, WAEMU.

Efficacité de la micro intermédiation financière dans les pays de l'UEMOA : une approche par la frontière stochastique de production.

Résumé

L'objectif de ce papier est de mettre en évidence l'efficacité et l'efficience technique de la micro intermédiation sur la période 2002-2007 dans le processus productif des économies de l'espace UEMOA à travers un modèle de frontière stochastique de production avec effets d'inefficience technique. Les variables spécifiques de mesure de l'approfondissement du dualisme financier et de la micro intermédiation financière sont, le ratio du volume de microcrédit sur le PIB, le taux de variation de microcrédit, la part du microcrédit dans le financement de l'économie dû au secteur privé et la préférence des agents pour les dépôts décentralisés. Ces quatre variables affectent positivement l'efficience technique avec une semi-élasticité estimée de 0,6 alors que le crédit bancaire ne l'affecte que pour 0,3. Le développement de la micro intermédiation financière qui résulte de l'approfondissement du dualisme financier permet d'accroître presque doublement l'efficience productive des économies de l'espace UEMOA.

Mots clés : Micro intermédiation financière, dualisme financier, frontière stochastique de production, efficience technique, UEMOA.

Classification JEL: D24, G21, J24, L25, O12

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1- Introduction

Previous studies have conducted the analysis of the duality of financial system in the developing countries using theories of financial repression approach (Mackinnon & Shaw, 1973) and imperfect or asymmetrical information theories approach (Stiglitz & Weiss, 1981). By privileging the orthodox mechanisms of market operating, the scheme of financial liberalization that she proposes since the years 1990, occults the internal dynamics of the local financial system in WAEMU² area; beyond financial repression and the market imperfections, the segmentation of the circuits of the saving mobilization and loan supply, which integrates more the underground or informal system in permanent development, must be considered to take into account the heterogeneity of the economic financing system.

Referring to the etymological sense of the terms “credit” and “fiduciary currency”, viz, the confidence, the development of the Decentralized Systems of Financing (DSF) finds its justification in the reputation, the social guarantee, the space, temporal or ethnic proximity, the interpersonal relationships in the center of credit and currency. This dimension of the intermediate finance mechanisms in the developing countries characterized by a weak “bancarisation” very strongly concentrated in addition, inaugurates a new approach of the financial deepening in a context of duality. Lanha (2006) described this as microeconomic financial deepening.

Theoretically, the consecutive financial deepening after liberalization means development temporal and space, in particular banking systems of financing. We rather show dynamic recent DSF like participating of the financial dualism deepening in the WAEMU countries, taking into account the segmentation which characterizes the financial system this area: on the one hand, an exclusive traditional banking system, with strong urban concentration and on the other hand, an increasingly inclusive intermediate system. Like principal corollary rising from this complementarity structural and functional (Sodokin, 2006) of the financial model thus described, it is the effectiveness of the financial intermediation: we formulate consequently, the assumption that the financial dualism deepening in the economies underdeveloped allows to increase significantly the efficacy and the efficiency of the financial intermediation, to improve thus, the impact of the monetary policies.

The objective of this paper is to show then, that with the segmentation of the financial system in the WAEMU area, is posed more and more with acuity, the question of the relevance and the effectiveness of the financial intermediation, essential vector of a priori elaborate monetary policies for the only formal sector which remains marginal and excluding. It consists of the study of the relation between the development of the micro intermediation analyzed in terms of financial dualism deepening and economy productivity, using a stochastic frontier production function, often applied on a microeconomic level in the study of banking industry in particular. Our methodology takes as the preliminary point Battese & Coelli (1995) then Méon & Weill (2006) upon the approach by the technical inefficiencies effects starting from the monetary and real variables on the one hand then measurements of the financial dualism deepening on the other hand, using a panel data in the WAEMU countries over the period 2002 and 2007. It consists in measuring the relative distance to an estimated and optimal stochastic frontier

² West African Economic and Monetary Union created in 1994 to reinforce the West African Monetary Union born in 1960, including eight countries i.e., Benin, Burkina Faso, Cote d’Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo.

production function given the inputs, the absolute advantage being the definition of two error terms, one related to the technical inefficiency and the other random one. The rest of the paper is organized into five sections. Section 2 is devoted to the theoretical and empirical review and section three discusses the methodological framework of the study. Empirical results are presented and discussed in section four while section five concludes.

2- Review of literature

Taking support on a secular tradition of informal finance in WAEMU region, and in answer to the banking crisis of the years 1980, the BCEAO³ undertook to promote and structure the new financial intermediaries, the microfinance institutions (MFI), able to offer financial or nonfinancial services in favor of the important fringe of the population excluded of the classical banking system. Officially registered in WAEMU area by the monetary authorities, in fact the BCEAO, they do not have the status of the traditional banks, but are located at their border with the traditional tontine or protective savings (Lelart, 2002). By Decentralized Financial System (DFS) or Microfinance Institution (MFI), it is necessary to generally understand, the offer of financial service (microcredit, micro saving, micro insurance, transfer of funds) to the profit of agents with low-incomes. The microfinance can be defined as: “... *a small credit, with an amount relatively low, appreciably lower than the credit than a company or a household can solicit in a bank. This credit is required by people who have a relatively low income. It is often asked to develop an income-generating activity, which it is about an old activity that one would like to extend or from a new that one would like to create*” [translation], Lelart (2005, p.50).

The heterogeneous characteristic of the financial systems usually called “financial dualism” constitutes one of the distinctive features of the underdeveloped economy. It is traditional to oppose the formal financial sector to the informal financial sector, but whose respective borders are not as well encircled. In the spirit of the theories based on financial repression, Eboué (1990) noted that the financial systems of the developing countries are marked by an insufficient financial intermediation, a disarticulation characterized by an extreme segmentation of liquid saving collection processes. Traditional banks and structures of microfinance co-exist in a more and more segmented environment. Particularly, the MFI seem effective and essential vectors to not only fight poverty but to also carry out financial inclusion. They are alternate mechanisms of financial and monetary transformation providing durable financial services to the target economic agents to support their economic activities and their process of accumulation towards an empowerment in the long term.

This organization of the micro intermediation in particular makes it possible to reduce the multiple problems of informational asymmetry (moral hazard and adverse selection) involved in the financial contracts and also the transaction and monitoring costs. They present in fact, some true potential suitable for increase the financial deepening in the developing countries (Tanimoune, 2007). In evaluating the role of each of the two segments of the market in the development of countries, Dimitri et al. (1991), show that beyond the institutional impact, financial and monetary dualism also affects the effectiveness of financial and monetary policies. Starting from a model applied to a closed less developed economy characterized by a dualistic financial system, Tanimoune (2007) empirically studied this point of view as regards financial policy in the WAMU. By considering the official financing sector formed by the central bank

³ Banque Centrale des Etats de l’Afrique de l’Ouest, the central bank common to the eight countries in WAEMU area and emitting the single currency, the CFA franc.

and a representative bank of the financing institutions on the one hand and the decentralized financing sector represented by a co-operative saving and credit institutions, the author shows that in segmented financial environment, any financial policy can generate under optimal equilibriums. More specifically, the impact of financial and monetary dualism - according Dimitri et al. (1991) who adopt this terminology - on the effectiveness of the monetary policies appears explicitly in the complementarity of McKinnon (1973) and Shaw (1973) theories.

It is necessary to point out that the informal sector uses fiduciary quasi-currency exclusively, which constitute a component of the monetary base. Consequently, there is no monetary creation, the financial contracts of deposit or loan being concluded in liquid assets. The differential of interest rate is born from the difference in offer of saving and loan behaviors in the two segments of the market. In general, the interest rate of the deposits or the loans is positively correlated with the level of the risk, which is really, higher on the non-official segment taking into account informational asymmetries in particular. Eboué (1990) provides a theoretical explanation of the formation of the differential rate observed in a repressed economy. Households and micro firms are rationed in the official market because of the intermediation costs and the absence of securities which make their loan request ineligible. *“The debtor rate being controlled downwards by the authorities, which pursue a goal of financing at weak cost of industrial projects in public sector, the banks cannot practice an crowding out of the high-risk customers by raising the supply price of credit”* [translation], p 32. The effectiveness of the monetary policy under the constraints of financial and monetary dualism depends then on the degree of overlap of the two spheres, formal and informal with monetary and nonmonetary intermediation, according to the segment concerned. Because, basically, the demand for banknotes of the non financial agents is all the more high as the informal interest rate is important; this positive effect being due to the existence of the informal credit market, where the transactions are done primarily in fiduciary currency.

Levine (1996) evokes among the theoretical reasons which found the existence and the development of the financial system, in addition to the mobilization of the domestic saving and the optimal allowance of the resources, the facility of the goods and services exchange in the economy: *“the existence of a financial sector can reduce the importance of these market imperfections, reduce the risk of liquidity and thus support the development of the real sphere”*. The market imperfections concern in particular, information asymmetries and transaction costs, which are more permanent in the less developed economies. Justifying the existence of the financial system and more particularly of the banks, Diamond and Dybvig (1984) base their argument on the illiquidity risk. In the absence of any financial system, it is possible that the agents committed only for very short term projects but less profitable in order to covering against the illiquidity risk. In return, the existence of a bank being used as intermediary and having for role to transform the liquid deposits of the agents into illiquid assets in the long term makes it possible to reduce their illiquidity risk. Same manner, the activity of the decentralized structures of financing contributes to this covering of illiquidity risk of nonfinancial agents in margin of the classical banking system. This is why, within the framework of the economies with dualistic financial system, the financial deepening must be understood like the development of three complementary subsystems: the financial market which remains still embryonic, the banking sector as a monetary intermediary and the microfinance institutions recognized like non-monetary intermediaries.

During the last fifteen years, since 1993, with the adoption of the microfinance specific regulation in WAEMU region, the microfinance sector has recorded a strong expansion as the principal indicators of access to the financial services offered attest to this. The volume of the recorded transactions (outstanding credit and deposit), the number of institutions approved and the size of the clientele are in continuous progression with incontestable implications on the financial intermediation, the “bancarisation” rate (extension of bank facilities) and the monetary regulation in the area. In the plan of the financial intermediation, the DFS recorded a regular increase in the deposits of customers. The collected resources are estimated at FCFA⁴ 459.2 billion in December 2008, against FCFA 19.3 billion at the end of December 1994 (BCEAO, 2008). The credit outstanding, assessed at FCFA 19.4 billion in 1994 increased by more than 20% to be valued at FCFA 441.8 billion in 2008 (BCEAO, 2008). The increase in the volume of the transactions went on all fours with the clientele diversification and a vast network in all the union countries. *The access widening of the services offered to all the social layers results in a sharp competition between the MFI and the traditional banking system, in particular on the segment of the loan market to the Small Micro Enterprises and the middle-classes. It results from it, in addition to the objective of financial inclusion, and with the detriment of a useful complementarity of the two financial spheres, a deepening growing of financial dualism in the economies of WAEMU countries.*

The theoretical literature and the empirical studies on these problems are limited. It is necessary to point out that it is about a reconsideration of the financial system components in a less-developed economy like WAEMU countries. Three sub-systems can be spotted theoretically: the financial market, the traditional banking system and the decentralized structures of financing. If the deepening means development and expansion of the financial sphere, generally constituted of the two first sub-systems, the deepening of financial dualism includes this first dimension but also, that of the specific development of the third sub-system to knowing, the microfinance institutions.

Contrary to the developed economies marked by an increasingly financial or capital market, agent financial or nonfinancial economic behaviors in developing countries are not yet favourable to the development of this important component of financial system in general. In WAEMU area, only one exchange stock operates, the Regional Stock Exchange (BRVM), based in Abidjan in Ivory Coast, with much reduced transactions, the number and size of listed companies, the capitalizations and the animation. While waiting for the installation of a regional dynamic financial market whose operating capacity will certainly be limited at the beginning, there would not existed a significant bias to consider only the two compartments of the financial system to knowing, the banks and the MFI. Economic activities financing in the union is then mainly assured by these two financial structures, each one running in a precise segment of the financial market.

Generally, the official financial system is comprised of the central bank, the commercial banks, the investment and development banks, the savings banks, the insurance companies and the social security offices. Some have monetary functions while others having non-monetary functions. In addition to the BCEAO, the money issuing institute, the official monetary and

⁴ The CFA franc (FCFA) is the currency used in the Communauté Financière Africaine (CFA) area, which is composed of the West African Economic and Monetary Union (WAEMU) and the Central African Economic and Monetary Council (CEMAC).

financial sphere is dominated by the commercial banks, which are often subsidiary companies of foreign banks. Taking into account organizational specialty related to informational asymmetries and transaction costs, the loan activities of these official banking institutions are largely intended for the public enterprises and some private large companies. The volume of the credit incurred and the money supply relative to GDP as well make it possible to approach the financial deepening in the economy. Their evolution in spite of the intrinsic limits of the traditional banking system testifies to the financial development which remains still marginal from the point of view of the bancarisation of the union economies. Nissanke (2001) shows that the share of the credit operations in the traditional banking sector remains relatively weak compared with the similar transactions carried out by the micro financial structures in favour of the households and the entrepreneurial micro-structures.

This observation explains the double dimension of the financial deepening in WAEMU space, i.e. the permanent reinforcement of financial dualism with the development of microfinance institutions. If financial dualism is characteristic of a segmented financial system, where a formal compartment and an informal compartment coexist, the financial dualism deepening means basically thickening and expansion of the micro financial intermediation due to the microfinance structures. Using the concept adopted by Sodokin (2006), the microbanks are popular financial micro structures, in general small and self-organized units of financing, more or less institutionalized, specialized in the credit operations to the households with low-incomes and the small companies by the recycling of the saving mobilized in particular. Thus, rather than to be a reducing factor of the duality of the financial system of the economies concerned, the financial deepening is characterized by the development of a micro intermediation due to these microbanks which take part more of the financial system segmentation: consequently, it's advisable to call here this mechanism, the financial dualism deepening.

Just like the financial deepening implies economic effects on the growth, the impact of the financial dualism deepening on the financial and monetary sphere is convincing, given the induced effects of the duality in the financial system on the control and the effectiveness of the monetary policies. In the absence of a dynamic and efficient financial market, financial and non-financial agents behavior functions on the loanable funds (deposits and credit) markets according to the two segments of the financial system are determinative in the monetary policy appreciation. From this point of view, and in conformity with the results of Eboué (1990), interest rate like equilibrium variable or its differential between both the informal sector and the official sector are relevant indicators in the analysis. Then, beyond the financial deepening, there would subsist a financial dualism deepening, which allows to primarily characterize the financial model in WAEMU area, which model determines the range and the density of the financial intermediation whose productive efficiency and monetary effect can dope the growth and reinforce the monetary policy channel.

The study of channels by which, financial intermediation influences the productivity and macroeconomic efficiency at the real level locates in the theoretical currents of the financial deepening. Levine (2005) identifies four principal channels. The production of information ex-ante makes it possible to drain the saving of the households and a better allowance of the resources by the transformation of the expiries to the profit of the investors selected on profitability criteria of the projects. By the nature of the relations between financial investors and intermediaries, monitoring allows in particular a more increased incentive for productivity, for performance and profitability of the companies so forced by the respect of the financial

contracts. The reduction of transaction costs related to the saving mobilization, primarily different from an agent to another through the technological innovation, constitutes a third function of intermediation. Lastly, the financial intermediation development supports the extension of the exchanges on the goods and services market, and thus increases the specialization and the productivity of the economic systems.

Two major contributions permit to explain the differences in economic growth in developed countries (Kuhry and Weill, 2008). The first shows the positive link between the financial development and the growth with more particularly the positive impact of the financial intermediation development (Levine, 2000). The second contribution comes from the recent theories of the economic growth, which deny any causality with accumulation but rather with the productivity growth (Easterly and Levine, 2001). The differences in income between countries would result then from the differences in productivity explained by the financial intermediation. Arestis et al (2006) study the relation between the financial intermediation and the productivity over the period 1963-1992 including the 26 OECD countries with the Data Envelopment Analysis (DEA) approach based on the techniques from linear programming, the proxy of financial intermediation being, the ratio domestic credit of the private sector to GDP. They conclude with the existence of a positive relation between financial intermediation development and productive efficiency.

Méon and Weill (2006) identify three limits with this approach. The absence of developing countries in the panel would not enable to obtain conclusive results; the regression of the efficiency scores on the variables of financial intermediation does not include control variables such as human capital however important in the study of the productivity; finally, the method used would not permit to reduce the endogeneity bias between the development of the intermediation and the productivity. Extending the analysis to a panel of 47 countries and including as well developed countries as undeveloped, and starting from the method initiated by Battese and Coelli (1995), Méon and Weill (2006) show that financial intermediation development is correlated with a certain degree of productive efficiency; only, this obviousness depends well on the level of economic development of the countries, because the less the economy is developed, the less is the impact of the development of the financial intermediation on efficiency with sometimes, a negative influence in the poor countries.

This last approach of the productive efficiency measurement related to the financial intermediation offers an ideal analysis framework of respective dynamic of both banking financial and micro financial sectors in the WAEMU union. If this approach integrates the first two limits identified earlier, it does not make it possible to withdraw the endogeneity skew, which is studied by Kuhry and Weill (2008) adopting the Generalized Moments Method (GMM) applied to the dynamic panel, initiated by Arellano and Bond (1991) then Arellano and Borer (1995). Approximating the financial intermediation development by three ratios namely, the private sector credit to GDP, the banks liquid liability to GDP and the share of the bank credit in the economy financing, the authors confirm the obviousness of a direct relationship between financial intermediation and productive efficiency in 41 countries over the period 1991-1995; only, the intensity of this relation depends absolutely on the intermediation variable proxy. The analysis on the panel data provides additional details upon the relation between the financial intermediation development and efficiency resulting from the more accurate estimates; it permits moreover to mitigate double causality between the two variables because the MMG in dynamic

panel takes into account endogeneity skew and makes it possible to deduce some new roles of financial intermediation explaining the differences in productive efficiency between countries.

With a sample of one hundred developing countries between 1960 and 1985, De Gregorio and Guidotti (1995) find a positive relationship between financial development and growth. They concluded that this relationship becomes negative when the study is restricted to the Latin-American countries due probably to the perverse effects of liberalization in 1970s and 1980s in these countries. In addition, by distinguishing between the short run and long run, using a panel of 75 countries between 1960 and 2000, Ranciere and Loayza (2005) found that the impact of the financial development depends intrinsically on the prospect retained: on the long run, the impact is positive whereas it is negative on the short term. A more detailed analysis enable the authors to conclude that the inverse relation is especially due to the most fragile economies upon the financial system which are included in the sample.

3- Methodology

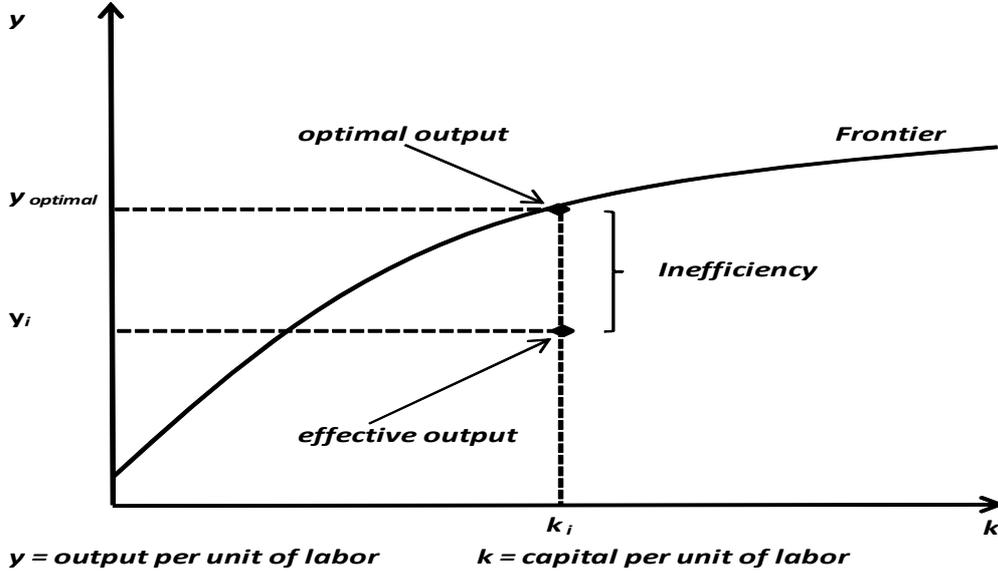
In this section, we present the methodological framework used to assess the productive efficiency due to the financial micro intermediation. We present the efficiency measurement approach, the econometric model, the data and the tools used.

The measure of efficiency is due for the first time to Koopmans (1951) in his work on the productive processes analysis. But it is Farrel (1957) who proposes in a practical way, an approach by the estimate the firm efficacy frontier, starting from the observation of the real situations of production. Two types of efficiency are distinguished: one of technical origin and the other related to a bad choice of factorial combinations in connection with the product. More particularly, technical efficiency measures the way in which the firm chooses the optimal quantities of inputs entering the production process. Following work of Farrel, two methods were mainly developed to evaluate the frontier production function. One on a parametric stochastic approach, and the other on a non parametric approach based in particular on the method of Data Envelopment Analysis (DEA) initiated by Charnes et al (1978) then Banker et al (1984). More specifically, the DEA method seeks to determine an optimal combination of input, given a level of output; thus it records efficiency and capacity score for each firm, each bank or decentralized structures of financing according the research.

Only, any program of this type is solved as much time than of firms included in the analysis; hence it is too difficult to solve. Other methodological and empirical difficulties can appear consequently, given the number of studied units and the extent of the study: eight countries in these case. This is why we privilege the approach of Battese and Coelli (1995) which introduce the stochastic frontier production approach on panel data to study the productive efficiency of the firms through a search relating to Indian farmers.

Schematically, the frontier production function is represented by graph 1.

Graph 1 : Productive efficiency frontier



Technical efficiency measures the distance which separates the production function of a firm or a country, compared to the optimal production function given the quantities of input. While comparing the measurements of technical efficiency by both methods of DEA and stochastic frontier production analysis, Weill (2006) conclude with a greater robustness from the scores with the last approach. Two equations are adopted within this framework: a stochastic frontier production function and a technical inefficiency model. The first written in terms of the original production values is:

$$Y_{i,t} = \text{Exp}(X_{i,t} \beta + V_{i,t} - U_{i,t}) \quad (1)$$

Where, Y_{it} denotes the production for the i -th firm ($i=1, 2, \dots, N$) at the t -th observation ($t=1, 2, \dots, T$). X_{it} denotes a $(1 \times k)$ vector of values of known functions of input production extended to other explanatory variables associated with the i -th firm at the t -th observation. β is a $(k \times 1)$ vector of unknown parameters to be estimated. V_{it} is assumed to be a vector of random errors, independently and identically distributed according to $N(0, \sigma_v^2)$.

The terms U_{it} are non-negative random variables, associated with technical inefficiency of production, which are assumed to be independently distributed, such that U_{it} is obtained by truncation (at zero) of the normal distribution with mean $z_{it}\delta$, and variance σ_u^2 , then, according to $N(z_{it}\delta, \sigma_u^2)$. z_{it} is a $(1 \times m)$ vector of explanatory variables associated with technical inefficiency of production of firm over time. δ is a $(m \times 1)$ vector of unknown coefficients.

It is under these various assumptions that the average of the technical inefficiency effects, measured by U_{it} , in the stochastic frontier model (1) could be specified as follows,

$$U_{i,t} = Z_{i,t}\delta + W_{i,t} \quad (2)$$

where the $W_{i,t}$ is assumed to be a random variable, defined by the truncation of the normal distribution with zero mean and variance σ^2 , given the distribution of U_{it}

Battese and Coelli (1995) note that the assumption that the $U_{i,t}$ and $V_{i,t}$ are independently distributed for all $t=1, \dots, T$ and $i=1, \dots, N$, is simplifying but restrictive condition. To account for a possible relation between the technical inefficiency effects and the random errors in the frontier, alternative models are required.

The technical efficiency of production for i -th firm at the t -th observation is given by the equation,

$$TE_{i,t} = \text{Exp}(-U_{i,t}) = \text{Exp}(-Z_{i,t} \delta - W_{i,t}) = \frac{Y_{i,t}}{\text{Exp}(X_{i,t} \beta + V_{i,t})} \quad (3)$$

where $\text{Exp}(X_{i,t} \beta + V_{i,t})$ constitutes the stochastic frontier production and $Y_{i,t}$ represents the level of the production observed.

From this representation, Méon and Weill (2006) studied the production efficiency of the financial intermediation applied to 47 countries considering a stochastic frontier including the two equations (1) and (2). We adopt this specific methodology extending the model to the financial variables allowing to capture the role of the financial intermediation in the two sectors: banks and MFI. Thus, Cobb-Douglas function is retained to represent the equation of production, including physical and human capitals.

$$\ln(Y/L) = \beta_0 + \beta_1 \ln(H/L)_{i,t} + \beta_2 \ln(K/L)_{i,t} + \beta_3 \ln(Open)_{i,t} + \beta_4 \ln(Rsav)_{i,t} + V_{i,t} - U_{i,t}$$

with, i denotes the country and t , the year of observations. Y/L , H/L and K/L respectively measure the product, the human capital and the physical capital per unit of labor. $Open$ measures the trade openness whose proxy is the degree of openness whereas $Rsav$ constitutes the saving rate. In addition, $V_{i,t} - U_{i,t}$ conserve their characteristics defined previously.

$$\text{The second equation is then, } U_{i,t} = Z_{i,t} \delta + W_{i,t} \quad (5)$$

$Z_{i,t}$ represents a vector of specific explanatory variables associated with the countries - banks and MFIs - which are supposed to influence their technical efficiency, in particular, financial dualism deepening or micro intermediation measurements, which will be clarified; δ constitutes a vector of parameters to be estimated, whereas $W_{i,t}$ is an error term distributed according to a truncated normal distribution with mean zero and variance $\sigma^2 = \sigma_v^2 + \sigma_u^2$

The specification of the equation which states the vector $Z_{i,t}$ results although the financial micro intermediation mechanism through some variables that could account for and to identify the effects on the productivity of the economies studied. In reference to the current literature on the financial intermediation, we retain the ratio of the credit to the private sector relative to GDP while specifically distinguishing the microcredit and the bank credit⁵. This approach is justified by the increasingly thorough segmentation of the loanable funds market in the zone with consequent financial dualism deepening. The second variable proxy of the micro intermediation constitutes the ratio of the microcredit relative to the total volume of loans to the private sector, which permit to give an account of the dynamics of evolution on MFI market share in the financing of the economies studied. Microfinance institutions constitute nonmonetary intermediaries which in the short or medium term recycle mainly the deposits mobilized in

⁵ The credit to the private sector is regarded as the sum of the Microfinance loan on the one hand and the banking loan on the other hand.

credit. The deposits are thus the principal component of the available resources. Contrary to Tanimoune (2007), we do not make the assumption that the credits are always equal to the deposits but retain nevertheless the principle of the agent preference for the decentralized deposits. Hence, the ratio that reports the MFI deposits to the bank deposits is retained like a micro intermediation proxy to explain the productive efficiency. Lastly, among the other explanatory variables of productive efficiency, we include, the inflation rate, the ratio of deficit spending and current external deficit reported to the nominal GDP.

$$U_i = \delta_0 + \delta_1 Bank_i + \delta_2 Mfi_i + \delta_3 Inf_i + \delta_4 Sbud_i + \delta_5 Defc_i + W_i \quad (6)$$

where, U_i measures the technical inefficiency in the i -th country and W_i an error term. *Bank* and *Mfi* are financial intermediation measurements, whereas *Inf*, *Sbud* and *Defc* measure respectively, inflation rate, budget and external deficit ratio, reported to the nominal GDP. In practice, the four indicative variables of financial micro intermediation are integrated in the regression one after the other.

The macroeconomic data used to estimate the stochastic frontier production function are extracted from three data bases mainly: the PENN World Table 6.3 concerning the variables L , Y , GCF ⁶, but also, the bank credit, the saving rate, the inflation rate and the coverage rate used as a proxy of the trade openness; moreover, the budget and the external deficit expressed as a percentage of the nominal GDP are provided by the WAEMU reports upon the multilateral monitoring and the statistics of schooling rate used to approximate the human capital are from Quenum (2008). Finally, the micro intermediation variables come from BCEAO statistical data base. We adopt the World Bank approach of constructing the product per worker (Large Domestic Product per Worker) within the PWT6.3 framework, resulting from the relationship between the GDP per capita multiplied by the population and the number of workers⁷. In reference to the theoretical and empirical developments of the capital accumulation, (Easterly and Levine, 2001), we consider the capital stock as a cumulative process resultant, the current physical capital being thus equal to the stock at the previous period augmented by the current net stream of investment taking into account the depreciation. In practice, starting from an average stock calculated over the decade preceding the period study (1992-2001) and taking into account 10% of depreciation rate, the physical capital stock tendency was generated, given the gross capital formation (GCF). The relative data with GCF and L result from the base PWT6.3 downloaded on the World Bank web site.

The evaluation of human capital is not easy, whereas its contribution to the productivity remains no marginal; just like the investment in physical capital, the investment in education results in increase productive factors. Considering the analysis of Becker (1964) for which the growth is primarily determined by the human capital accumulation, Lucas (1988) conclude that there exists two main sources of human capital accumulation, i.e., education and training by the practice. The same observations are concluded by Mankiw, Romer and Weil (1992) then Barro (1991), identical with Nelson and Phelps (1966) assertion that the human capital stock constitutes the key motor of growth and not the difference in the rates; the differences in growth between the

⁶ Gross Capital Formation

⁷ The definition retained here is that of the International Labor Organization (ILO), the total labor force then including elderly the 15 year old and more which satisfies the definitions of the economically active population: all the people who provide work for goods and services production for one given period. It includes at the same time the employees and the unemployed.

countries being determined by the differences between their human capital stocks at the origin of their respective capacities to generate technical progress. In order to introduce the human capital like factor of production, we need to have data in terms of stocks. One generally agrees to use the number of years in study in the active population to approach the human capital quantitatively; but an alternative to the unavailability data in stream, consists in considering the schooling rate or the public expenditure in education sector. We use the approach of the average schooling rate, like a variable proxy of the human capital starting from the rates relative to the three orders of teaching, the primary education (weight=1), the secondary (weight=2) and the superior (weight=3) given the quality of their contributions to the formation of the human capital⁸.

FRONTIER 4.1 applications elaborated by Coelli (1996) makes it possible to estimate simultaneously the various coefficients associated with stochastic frontier production and technical inefficiency equations applying the method of maximum likelihood proposed for estimation. The likelihood function is also expressed in terms of the variance parameters, $\sigma^2 \equiv \sigma_v^2 + \sigma_u^2$ et $\gamma \equiv \sigma_u^2 / \sigma_2$. Moreover, the negative sign associated with the function of inefficiency is indicative because any parameter considered negative represents a reduction of inefficiency corresponding to a technical performance. The compared analysis of the estimated coefficients and technical efficiency effects of both banking firms and microfinances lead to conclude about the relative efficiency of micro intermediation. Table 1 hereafter displays the descriptive statistics of the variables of the study, those related to the production process on one hand and those that are specific to the micro intermediation on the other hand.

Table 1 : Descriptive statistics

Variables	Mean	Maximum	Minimum	St-Deviation.
<i>Y_WORKER</i>	5315,34127	17117,3946	1625,38132	5011,04751
<i>K_WORKER</i>	975,847556	713,406354	465,357525	449,768127
<i>R_EDUC</i>	20,4049475	31,1897423	10,3116667	6,57477731
<i>R_OPEN</i>	64,5188503	92,1034587	32,8809597	20,8032482
<i>R_SAVING</i>	11,5833598	16,70035	8,43	2,98135944
<i>CBANK_GDP</i>	82,1973672	119,136828	18,1502373	35,2159041
<i>CIMF_RATE</i>	0,1464556	0,31716571	-0,0563849	0,11285332
<i>CIMF_GDP</i>	6,3800387	16,2760104	0,5176851	5,40094951
<i>CIMF_SHARE</i>	0,06374625	0,15100859	0,01777932	0,04209456
<i>DIMF_DBANK</i>	5,8186687	14,0276103	0,4665707	4,31483537
<i>R_INFL</i>	2,04851346	2,6906697	1,52816665	0,40880557
<i>S_BUDG</i>	-2,1938055	0,08604729	-9,6260987	3,23818928
<i>DEF_EXT</i>	-8,1994508	2,05901706	-11,753599	4,38033863

Source: Computed from some variable statistics established with the mean per country over the study period. *Y_WORKER* measures the output by worker, *K_WORKER* measures the physical capital by worker, *R_EDUC* is the average schooling rate like a proxy of the human capital. Among other variables included, count the degree of openness (*R_OPEN*), the saving rate (*R_SAVING*), *CBANK_GDP* measures outstanding bank credit reported to the GDP, *CIMF_RATE* measures the growth rate of microcredit, *CIMF_GDP* measures the outstanding MFI loan

⁸ We take as a starting point the first pioneers work in the field which measure education by the gross schooling rates. In particular, Barro (1991) distinguishes primary and secondary education while Mankiw, Romer and Weil (1992) use an average over the period of the ratio of secondary schooling brought back to the labor force. The effects are significantly positive for the OECD countries studied.

reported to the GDP, *CIMF_SHARE* measures the share of the microcredit in the total financing of the private sector, *DIMF_DBANK* measures the agent preference for the decentralized deposits (reported to the bank deposits): the four variables make it possible to appreciate the financial dualism deepening in the area. Among the specific variables also count, the inflation rate (*R_INFL*), the budget deficit expressed as a percentage of the GDP (*S_BUDG*) and the external deficit also expressed as a percentage of GDP (*DEF_EXT*).

4- Empirical Analysis

The parameters of the stochastic frontier production model (β_k) and those of the technical inefficiency model (δ_i) are estimated simultaneously by the method of maximum likelihood using FRONTIER 4.1 Program (Coelli, 1996). In addition to these estimates, the program gives the estimators of likelihood function variance parameters: $\sigma^2 = \sigma_v^2 + \sigma_u^2$ et $\gamma = \sigma_u^2 / \sigma^2$. More

specifically, the parameter γ is used to conclude whether the frontier production is stochastic or deterministic tendency. The rejection of the null hypothesis $H_0: \gamma = 0$, implies the existence of a stochastic frontier production; otherwise, the least squares ordinary (OLS) remains applicable. In addition, the second technical inefficiency equation can be estimated only when the technical inefficiency U_j are absolutely stochastic with specific distribution properties (Battese & Coelli, 1995). This is why it is necessary to carry out the following test of hypotheses: i) the technical inefficiency effects are not stochastic⁹ with $H_0: \gamma = 0$; ii) the technical inefficiency effects are absent with $H_0: \gamma = \delta_0 = \delta_1 = \dots \delta_5 = 0$; and iii) the specific identified variables do not have effect upon the technical inefficiency with $H_0: \delta_1 = \dots \delta_4 = \delta_5 = 0$. All these assumptions are tested with the likelihood ratio statistic¹⁰. Likelihood Ratio statistic test are closely related to the measurement of the model adjustment quality.

The different estimators of maximum likelihood of both stochastic frontier production function and technical inefficiency are displayed in table 2.

Given the four specific variables of the micro intermediation measurement selected, we consider successively four canonical models by including only one of the variables (*CIM_RATE*, *CIMF_GDP*, *CIMF_SHARE* and *DIMF_DBANK*) in the technical inefficiency model. After estimation both stochastic frontier and technical inefficiency model, including successively these four specific variables of financial dualism deepening measurement, the first relevant results found by comparison test is that the estimators of parameters δ_2 relative are not statistically different. Also it allow us to conclude for an identical effect of specific variables included upon the productivity or the technical efficiency: the ratio of microcredit relative to GDP, the growth rate of microcredit, the share of microcredit in the economy financing by the private sector and the agent preference for the decentralized deposits.

⁹ Under this hypothesis, the stochastic frontier model is reduced to an ordinary function, the explanatory variables in the technical inefficiency model being then included in the production function.

¹⁰ The statistics of the likelihood ratio test is computed by $\lambda=2 \{ \log [\text{likelihood} (H_0)] - \log [\text{likelihood} (H_1)] \}$ which follows approximately under the null hypothesis, a Khi-square distribution, the degree of freedom being equal to the number of parameter presumed equal to zero.

Table 2 : Estimation results of stochastic frontier production function

Variables	Parameters	Model 1	Model 2	Model 3	Model 4
Stochastic frontier production function					
Constant	β_0	4.15***	2.50**	3.01**	2.47**
Ln(K_WORKER)	β_1	-0.24*	-0.47*	-0.20*	-0.44*
Ln(R_EDUC)	β_2	0.59***	0.719***	0.81**	0.52***
Ln(R_OPEN)	β_3	0.66***	0.53**	0.49***	0.64***
Ln(R_SAVING)	β_4	0.039	0.032*	0.011	0.092*
Technical inefficiency model					
Constant	δ_0	0.28**	0.012**	0.85**	0.37**
CBANK_GDP	δ_1	-0.32***	-0.41***	-0.23**	-0.29***
CIMF_RATE	δ_2	-0.76***			
CIMF_GDP	δ_2		-0.63***		
CIMF_SHARE	δ_2			-0.45***	
DIMF_DBANK	δ_2				-0.64***
S_BUDG	δ_3	-0.37	-0.29*	-0.056	-0.74*
DEF_EXT	δ_4	0.051**	0.043**	0.061*	0.05**
LN(TX_INFL)	δ_5	-0.026	-0.22*	-0.206	-0.036**
Variance	σ^2	0.107**	0.213**	0.172***	0.217**
Gamma	γ	0.79**	0.091**	0.93**	0.36**
Log Likelihood	LR	0.712	0.211	0.451	0.922

Source: Built starting from the results of FRONTIER 4.1. application. (*), (**) and (***) indicate the significance of the parameters at the level 10%, 5% and 1% respectively.

In connection with the stochastic frontier production function, all the parameters are elasticities. All the coefficients estimated except the saving rate parameter are statistically significant at 5% level. Nevertheless, all the signs are not in conformity with the theory. The physical capital per worker appeared to influence negatively the economy productivity¹¹. This is significant at 10% level. In clear term, since this coefficient represents the productivity elasticity, any increase of 10% in the factor reduces the productivity by 2.0% or 4.0% depending on the specific variable selected. In addition, the schooling rate - indicating the human capital variable - and the degree of openness present positive and significant coefficient at 1% level and therefore in conformity with the economic theory. These two variables show significant and positive effect on the economy productivity with an estimated average elasticity of 0.6 and 0.5. Thus, an increase by 10% of the schooling rate and degree of openness contribute to increase in labour productivity respectively by 6% and 5% on average. If the saving rate shows an expected positive sign, it is therefore not significant. We confirm thus for WAEMU countries, the human capital theory prediction on the economy productivity whereas the impact of the physical capital stock is invalidated.

¹¹ We suppose that the computation process of this variable could certainly explain this anomalous result.

As it was highlighted in table 2 above, the value of the variance γ and its statistical significance at 5% level implies that the technical inefficiency effects are enough to justify the specification of the stochastic frontier production function retained in the analysis. The ordinary production function estimated with OLS method in the absence of technical inefficiency effects is thus not a good representation within the framework of the data used. Table 3 shows different likelihood ratios (LR) of the three hypotheses tests indicated beforehand, which imply some restrictions on parameters γ and δ relating to the technical inefficiency model. The first two assumptions which suppose that i) the technical inefficiency effects are not stochastic and that ii) the technical inefficiency effects are not present are rejected at the end of the test based on the likelihood ratio test statistic following the Chi-square at 5% level. Under these assumption associated to the stochastic frontier model with technical inefficiency effects, the rejection of the third hypothesis which suggests that iii) the specific identified variables do not have effect on the technical inefficiency confirms the model specification, i.e. the model with composite standard errors is not appropriate for a truncated normal distribution retained related to technical inefficiency effects.

Table 3 : Hypothesis test with Likelihood Ratio (LR)

<i>Null Hypothesis</i>	<i>Log likelihood</i>	<i>Statistic (λ)</i>	<i>Critical Value</i>	<i>Decision</i>
Model 1				
$H_0 : \gamma = 0$	0.7124	21.64**	5.99	Reject de H_0
$H_0 : \gamma = \delta_0 = \delta_1 = \dots \delta_5 = 0$	0.7124	21.64**	14.07	Reject de H_0
$H_0 : \delta_1 = \dots \delta_4 = \delta_5 = 0$	-1.23	7.75*	5.99	Reject de H_0
Model 2				
$H_0 : \gamma = 0$	0.821	19.61**	5.99	Reject de H_0
$H_0 : \gamma = \delta_0 = \delta_1 = \dots \delta_5 = 0$	0.821	19.61**	14.07	Reject de H_0
$H_0 : \delta_1 = \dots \delta_4 = \delta_5 = 0$	0.231	6.75*	5.99	Reject de H_0
Model 3				
$H_0 : \gamma = 0$	0.457	16.47**	5.99	Reject de H_0
$H_0 : \gamma = \delta_0 = \delta_1 = \dots \delta_5 = 0$	0.457	16.47**	14.07	Reject de H_0
$H_0 : \delta_1 = \dots \delta_4 = \delta_5 = 0$	-0.531	7.50*	5.99	Reject de H_0
Model 4				
$H_0 : \gamma = 0$	0.922	16.55**	5.99	Reject de H_0
$H_0 : \gamma = \delta_0 = \delta_1 = \dots \delta_5 = 0$	0.922	16.55**	14.07	Reject de H_0
$H_0 : \delta_1 = \dots \delta_4 = \delta_5 = 0$	-2.033	8.17*	5.99	Reject de H_0

Note: (*) and (**) on the value of the test statistic indicate that it exceeds the 90th and 95th percentile for the corresponding Khi-square distribution and the null hypothesis is reject consequently.

The stochastic status of the frontier production and the existence of technical inefficiency effects which rise from these hypotheses state ultimately that the different specific variables relative to the banks and the microfinance institutions sectors included in the technical inefficiency model explain overall the technical inefficiency in the productivity of economies studied. There exist however differences in individual significance. The volume of the bank outstanding loan

expressed as a percentage of GDP and the four specific variables of financial micro intermediation measurement are significant at 1% level with a negative sign. Consequently, bank credit and microcredit have negative impact (positive) on the technical inefficiency (efficiency). Any increase in these different financial variables generates an increase in the labor productivity in the WAEMU countries. More specifically, a positive change in microcredit relative to GDP, in the growth rate of microcredit, in the microcredit share on financing due to the private sector and in agent preference for decentralized deposits, influence positively the productive efficiency of WAEMU economies. Otherwise, the more developed are economies from the point of view of financial micro intermediation, the more they are productive and technically efficient because the more these variables increase, the more the economies are efficient in the productivity.

Contrary to the coefficients related to the stochastic frontier model, the coefficients relating to the technical inefficiency model represent semi-elasticity given the model specification. Thus, table 2 allows a comparative static of the coefficients estimated for the different specific variables. The semi-elasticity of the bank loan expressed as a percentage of GDP is on average -0.3 whereas that related to the variables of micro intermediation is on average -0.6. In clear term, any positive change by 10 points in percentage of ratio bank credit to GDP induces a change by 3% of productivity or technical efficiency whereas the same change in the decentralized credit relative to the GDP (as well as the other specific variables) induces an increase of 6% of productivity or technical efficiency. We conclude consequently with a greater technical efficiency from the financial micro structures compared to the traditional banks in the WAEMU countries. Otherwise, the more the financial micro intermediation is developed, the more technical efficiency is improved. This relative performance of the MFI is on average, the double of the bank loan effect upon technical efficiency.

Among the variables explaining the technical inefficiency effects, we included in the analysis the budget and current external deficit in the spirit of the convergence criterion and the inflation rate. Whether the budget deficit shows the expected negative sign, meaning the positive effect on technical efficiency, it is not statistically significant. In addition, the current external deficit is negative and significant at 5% level with 0.05 as the semi-elasticity on average. This budgetary variable thus contributes to reduce the technical inefficiency effects by 0.05% for an increase by one point of percentage, which remains weak nevertheless. Lastly, the inflation rate which appears to reduce the technical inefficiency effects does not show a significant coefficient estimated.

The descriptive statistics of the technical efficiency indices estimated for the whole of the economy permit to characterize the technical inefficiency model. The average value of these indices is estimated at 94.54 varying between a maximum value of 99.99 and one minimal value of 88.15. Then, it is possible to increase the productivity level of the economies on average of 5.46% taking into account the specific variables included in the model.

5- Conclusion

The last dynamic of the Decentralized Structures of Financing (DSF) activity in WAEMU region explained the financial dualism deepening of the economies and the micro intermediation development in the union. This particular dualistic financial architecture answers well to a specific logic of financial operation, which improve some consequences upon the real sphere. Our objective in this paper is to identify the technical effectiveness and efficiency of the micro intermediation within the economic financing framework in WAEMU area during the period

2002 - 2007 using the two complementary models: the stochastic frontier production analysis and technical inefficiency model. For this purpose, in addition to the bank credits, we define four specific variables of the micro intermediation measurement and thus of the financial dualism deepening as the ratio of microcredit relative to GDP, the growth rate of microcredit, the share of microcredit in the financing due to the private sector and the agent preference for the decentralized deposits.

The hypothesis of non-stochastic frontier production and the absence of technical inefficiency effects were rejected, which imply that, within the framework of the data used, the traditional production function estimated by ordinary least squares could not explain the productive process enough correctly. The estimation of the stochastic frontier production made it possible to highlight the positive and significant influence of the human capital - whose proxy is the average schooling rate - and the trade openness on the labor productivity in WAEMU countries. These two variables give an account of a significant and positive effect on the economy productivity with an estimated elasticity of 0.5 and 0.6 respectively. On the other hand and in contrast to the theory, the physical capital by worker influences this productivity negatively, whereas saving rate was not significant. We confirm thus for WAEMU countries, the human capital theory prediction on the economy productivity but the positive impact of the physical capital stock is invalidated.

The stochastic status of the frontier production and the existence of technical inefficiency effects which rise from hypothesis test, state ultimately that the different specific variables to the banks and the microfinance institutions included in the technical inefficiency model explain overall the technical inefficiency in the productivity of economies studied. Notably, there does not exist a significant difference in the coefficients estimated for each of the four specific variables of the micro intermediation; what results lead to conclude that one or the other of the variables produces similar technical inefficiency effects on the economies. The volume of the bank outstanding loan expressed as a percentage of GDP and the four specific variables of financial micro intermediation measurement selected, are significant at 1% level with a negative sign. Consequently, bank credit and microcredit have negative impact (positive) on the technical inefficiency (efficiency): any increase in these different financial variables generates an increase in the labor productivity in the WAEMU countries. More specifically, a positive change in microcredit reported to GDP, in the growth rate of microcredit, in the microcredit share on financing due to the private sector and in agent preference for decentralized deposits influence positively the productive efficiency of WAEMU economies studied. Otherwise, the more developed are economies from the point of view of the micro financial intermediation, more they are productive and technically efficient because the more these variables increase, the more the economies are efficient in the productivity.

The scope of the technical efficiency effects was measured by estimating semi-elasticities and it appeared that the microfinance institutions have better technical efficiency effects compare to the traditional banks. The semi-elasticity of the bank loan expressed as a percentage of GDP is on average -0.3 whereas that related to the variables of micro intermediation is on average -0.6. In clear term, any positive change by 10 point of percentage in the bank credit relative to GDP induces a change by 3% of productivity or technical efficiency whereas the same increase in the decentralized credit relative to GDP (as well as the other specific variables) induces an increase by 6% in productivity or technical efficiency. We conclude consequently with a greater technical efficiency from the micro-financial structures compared to the traditional banks in the WAEMU

countries. Otherwise, more it financial micro intermediation is developed, more technical efficiency is improved. This relative performance of the MFI is on average, the double of the bank loan effect upon technical efficiency.

The average value of these indices is estimated at 94.54 varying between a maximum value of 99.99 and one minimal value of 88.15. Then, it is possible to increase the productivity level of the economies by an average of 5.46% taking into account the specific variables in the model. Lastly, these results which could be treated with the Generalized Moments Method (GMM) taking into account the endogeneity skew to show that the economies productivity can be significantly enhanced by a better technical efficiency of the productive processes, given the specific variable of micro intermediation defined.

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