



# Spillover Effect of Official Development Assistance on Sectoral Economic Growth in West African Economic and Monetary Union Countries

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## ABSTRACT

For decades, the literature on the relationship between official development assistance (ODA) and economic growth is characterized by ambiguity. This study removes such ambiguity for West African Economic and Monetary Union (WAEMU) countries by considering gross domestic product (GDP) according to the production perspective and paying attention to spatial spillover effects. The results obtained by system generalized method of moments for the period 2000–2018 showed a link between economic growth and ODA, which manifests itself through a positive and significant impact of the latter on the value added in the secondary and tertiary sectors. In addition, the value added in the secondary sector of a WAEMU country depends positively on the aid provided to other WAEMU countries that are geographically close to that country or located on the same road corridor. Our results inform donors for an efficient allocation of development aid in the Union.

**Keywords:** Official Development Assistance, Sectoral Values Added, Spatial Spillovers Effects, West African Economic and Monetary Union

**JEL Classifications:** O1, O55, F35

## 1. INTRODUCTION

The contribution of official development assistance (ODA) to the economic growth of recipient countries has been widely studied in the literature (Amprou and Chauvet, 2004), without a consensus being reached. There are three major schools of thought regarding the relationship between aid and economic growth. The first school highlights a negative effect of aid on growth, seen in the work of Easterly et al. (2004). The second school of authors argues that there is a positive correlation between aid and economic growth; they do not necessarily show that aid is always effective, but that on average an increase in aid flows is associated with a gain in growth (Radelet et al., 2006). Finally, according to the third school, the correlation between aid and economic growth is conditional, either on the characteristics of the recipient country - in particular

good governance (Isham et al., 1997) - or on the behavior of donors with regard to aid allocation (Berg, 2003).

Despite the diversity of the different econometric methods that are used, the common feature of these studies is that they take a “holistic” approach that masks large disparities in the effects of aid on economic growth. Indeed, most studies consider the growth of the gross domestic product (GDP) as a homogeneous variable, when in fact the GDP results from the contributions of different sectors of the economy. Thus, aid could have different effects depending on the three sectors of the economy (namely, primary, secondary, and tertiary).

In addition, the aid received by a country could have an impact - positive or negative - on the economic growth not only of the

recipient country but also of other countries, through a spillover effect. Indeed, according to the theory of spillover effects, initially devoted to Foreign Direct Investments (FDI) (Ortega and Peri, 2014), geographical proximity along with commercial and cultural interactions could form the foundation of a spatial diffusion of the effect of aid on economic growth.

In particular, aid provided to a recipient country may increase the effective demand for goods, services, and labor from neighboring countries, due to income effects (Demir and Duan, 2020). Additionally, allocating aid to one country on the basis of structural reforms may lead other countries to adopt the same reforms that support economic growth (Easterly and Levine, 1998). However, aid can also have negative spillovers, such as the emigration of skilled workers from neighboring countries to the aid recipient country. The analyses of this study thus highlight a positive or negative spillover effect of aid on economic growth and consequently suggest that the spatial dimension be taken into account in studies of the relationship between development aid and economic growth.

This study contributes to previous work on two points. First, the issue of the relationship between development aid and economic growth remains topical in the West African Economic and Monetary Union (WAEMU), given the divergent results observed in the literature in general and the need for aid to achieve development goals. However, unlike most previous work, this study focuses on the components of production that comprise the value added of the primary, secondary, and tertiary sectors (rather than on GDP growth) to highlight the importance of ODA. The aim is to highlight the economic sector that responds best to development aid. For example, Rajan and Subramanian (2005) have shown that aid provided to poor countries has a negative effect on the manufacturing industry (a branch of the secondary sector), while Feeny and Ouattara (2009) have demonstrated the effectiveness of foreign aid in promoting the growth of the agricultural industry (a branch of the primary sector) in developing countries.

Second, the literature on the spillover effects of aid on economic growth remains sparse in WAEMU countries: to our knowledge, only two studies have addressed this issue. Askarov and Doucouliagos (2015), examining the spatial relationship between aid and economic growth in economies transitioning to a market economy (in Europe and Central Asia), have shown that while aid has a positive effect on the economic growth of the recipient country, it also seems to generate negative spillover effects on the economic growth of other countries. Additionally, Demir and Duan (2020) have recently shown that multilateral aid provided by the World Bank to countries in sub-Saharan Africa promotes economic growth in both recipient localities and those neighboring recipients.

We add to the work of these authors by using spatial econometrics to determine the extent to which aid provided by donors generates spillover effects on the components of production (sectoral values added) in WAEMU countries. Several forms of interactions between WAEMU countries could promote aid spillover effects. For one, an increase in development aid could stimulate economic growth in a given sector nationally but also in other WAEMU

countries, such as through trade. In addition, as Demir and Duan (2020) have pointed out, aid flows can increase the demand for goods, services, and labor in a given sector in both the recipient country and in other countries in the Union. The relative mobility of labor among WAEMU countries, due to their membership in the economic union, could facilitate this migration of employment from a given country to other countries receiving aid, thus contributing to the economic growth of the latter. Senou (2017), focusing on the migration of workers in WAEMU countries, has effectively shown that immigrant labor positively affects the economic growth of countries (with the exception of Senegal).

In terms of economic policy implications, the analysis of the spillover effects of aid in WAEMU countries can inform an efficient allocation of development aid in the Union. Indeed, highlighting the (positive) spillover effects of aid on the value added of a sector of WAEMU economies indicates the need for an orientation of additional aid flows to this sector to promote the economic growth not only of the beneficiary country, but also of the other countries in the Union.

The rest of the study is organized as follows. Section 2 reviews the literature on the link between development aid and economic growth. Section 3 presents stylized facts about development aid and economic growth in WAEMU countries. The study methodology and the data are described in sections 4 and 5, respectively. Section 6 presents and discusses the results obtained, while the conclusion and policy implications are presented in section 7.

## 2. LITERATURE REVIEW

In contrast to the abundant and ambiguous literature on the relationship between aid and economic growth, research relating to the spillover effects of aid is scarce. Like most studies of the relationship between aid and economic growth, these works look at economic growth holistically. This is the case in Askarov and Doucouliagos (2015), who examined the effects of development aid on economic growth in countries in transition (the countries of the former USSR, the former Eastern bloc, and China). The authors used the tools of spatial econometrics to highlight the spatial effects of aid on geographically close countries. The results indicated that aid has a positive effect on the economic growth of countries in transition; however, negative effects of the aid received by one country were observed on the economic growth of other neighboring countries (i.e., negative spillover effects). In addition, positive spillover effects were observed with regard to the control of public spending and inflation. The authors explained these results with the fact that successful policies in one country are copied by other countries.

Demir and Duan (2020) also studied the effectiveness of aid provided by the World Bank to 48 countries in sub-Saharan Africa during the period 1995–2014. The results obtained from their instrumental variables approach revealed that aid at the local level promotes economic growth in both beneficiary localities and in neighboring localities. In contrast, aid flows at aggregate levels (nationally/by country) have the opposite effect and reduce economic growth. Drawing on these results, the authors suggested

that donors who prefer more visible megaprojects at the national level should instead focus their efforts on well-targeted local projects.

All in all, the literature relating to the spillover effects of development aid on economic growth remains ambiguous, as is the literature relating to the direct effects of aid on economic growth. By emphasizing the spillover effects of aid on sectoral components of GDP, this study seeks to provide guidance for better allocation of development aid in WAEMU countries.

### 3. STYLIZED FACTS

#### 3.1. Sector Analysis of Economic Growth

WAEMU member states have recorded sustained economic growth for several years. As seen in Table 1 below, the average real GDP growth of these countries ranges from 2.08% (for Togo) to 6.04% (for Burkina Faso) over the period 2005–2010. Since 2011, economic growth has increased in all countries. This increase is explained by the implementation, for a period of 4 or 5 years (depending on the country), of the first phase of National Development Plans, one of the main strategic approaches through which vigorous and sustainable economic growth was promoted. It should be noted that at the end of this first phase, WAEMU countries have implemented new programs in order to consolidate the achievements of the previous ones.

Thus, all WAEMU countries were able to record economic growth greater than 5% during the period 2016–2019. The best performance was achieved by Côte d'Ivoire, with an average growth in production of 7.64%. However, this performance masks differences in economic growth within the WAEMU countries. Benin, Burkina Faso, Côte d'Ivoire, and Senegal recorded positive growth differentials compared to the average growth of the Union. The other four WAEMU countries with negative economic growth differentials did not have the same profiles over the period considered.

Table 1 also presents data on the components of production (demand approach) - i.e., sectoral value added. The primary sector includes the industries of agriculture, breeding, forestry, and fishing. The secondary sector includes manufacturing, electricity, gas, and water, as well as buildings and public works.

The tertiary sector includes commerce, transport, warehouses and communications, banks, insurance, and other services. The value added of a sector is defined by the World Bank as the value of the sector's net output of intermediate consumption.

Across the board, an increase can be noted in sectoral values added in all WAEMU countries over the period 2005–2019. In particular, in recent years, economic expansion in all the countries has been driven by the service sector, with the exception of Guinea-Bissau, Mali, and Niger. In this last group of countries, the results of economic growth are generally attributable to the primary sector, in particular to booms in the production of main export crops (cotton for Mali, cashews for Guinea-Bissau).

In addition, despite the growth of value added in all sectors, the value added of the primary sector remains higher than that of the secondary sector in all countries. This situation results from the availability of abundant labor, to the detriment of other factors of production, particularly capital. Indeed, data from the World Bank indicate that workers in the primary sector on average represented approximately 50% of the total workforce of WAEMU countries in 2018, compared 36% in tertiary sector and only 14% in secondary sector. Likewise, a weak increase can be noted in the value added of the secondary sector, which illustrates the insufficient development of this sector. This situation is characteristic of the weak structural transformation of WAEMU economies, with industry being more productive than agriculture (see Graph 1) and the latter occupying a relatively large weight in production<sup>1</sup>.

#### 3.2. Official Development Assistance Received by WAEMU Countries

Graph 2 shows the dynamics of net ODA flows received by WAEMU countries in the period 2002–2018. A relatively stable trend in development aid can be observed at 1–10% of GDP for the majority of countries. The exceptions are Guinea-Bissau and Togo, where the level of aid received reached 20.48% and 10.75% of the respective GDPs of these states. Over the period 2002–2018, ODA for all the countries in the Union fluctuated, on average, around 4.61% of GDP. Côte d'Ivoire received the least aid, a situation that can be justified by its relatively high level of

1 Structural transformation is defined as a reallocation of resources from sectors with low productivity to those with higher productivity (*Perspective Economique en Afrique de l'OCDE et al., 2013*).

**Table 1: Economic growth and sectoral values added in WAEMU countries (2005–2019)**

Country	2005–2010			2011–2015			2016–2019					
	% ΔGDP	VA (%GDP)			% ΔGDP	VA (%GDP)			% ΔGDP	VA (%GDP)		
		VAP	VAS	VAT		VAP	VAS	VAT		VAP	VAS	VAT
Benin	3.5	24.12	24.09	41.36	4.68	22.09	20.8	47.17	6.01	22.97	21.05	46.7
Burkina	6.04	33.52	17.26	41.97	5.42	31.12	20.93	39.29	6.28	28.98	19.9	42.5
Côte d'Ivoire	2.14	22.6	23.58	53.82	6.56	22.73	25.47	44.17	7.64	21.26	25.05	43.9
Guinea-Bissau	3.45	44.26	13.66	40.07	3.41	44.79	13.41	39.42	5.28	47.66	12.6	34.6
Mali	4.93	31.91	23.53	35.32	3.59	36.92	19.02	36.48	5.35	38.47	18.13	37.4
Niger	5.6	38.71	13.99	41.55	6.25	37.05	19.14	36.6	5.66	39.21	16.11	38.1
Senegal	3.91	14.31	21.49	52.99	4.02	13.64	23.35	53.14	6.55	15.67	24.97	51.1
Togo	2.08	32.98	15.99	41.55	6.14	31.99	16.98	33.25	5.04	23.72	15.91	27.9
WAEMU	3.65	30.3	19.2	43.58	5.18	30.04	19.89	41.19	6.52	29.74	19.22	40.3

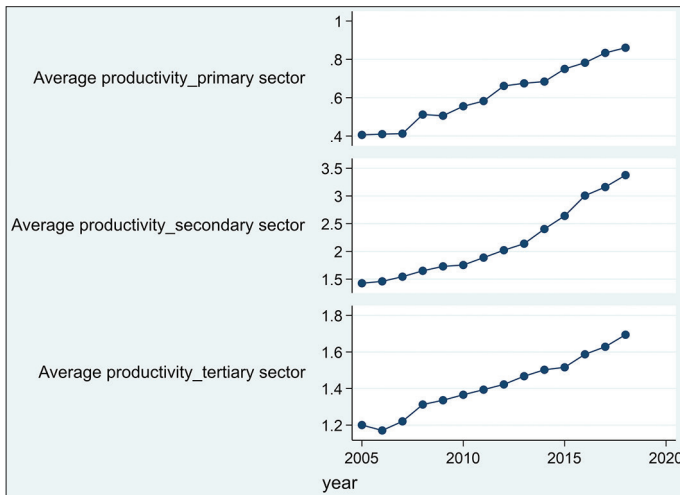
Source: Our calculations based on BCEAO and the World Bank data. Note: %ΔGDP=Growth of real gross domestic product (GDP), VA=Sectoral value added, VAP=Value added of the primary sector; VAS=Value added of the secondary sector and VAT=Value added of the tertiary sector

development compared to the other economies of the Union (with the exception of Senegal), meaning it requires less aid. Countries like Mali, Niger, and Burkina Faso, which have an aid-to-GDP ratio of over 4%, face food and nutritional vulnerability due to their unfavorable Sahelian geographic location as well as their security instability (due to the presence of armed terrorist groups in part of the territories).

#### 4. METHODOLOGY

In order to analyze the direct effects of aid on sectoral value added, we must first consider the standard panel growth model:

**Graph 1:** Sectoral productivity (sectoral value added/sectoral employment) of WAEMU economies



Source: Our calculations based on the World Bank data

$$Y_{it} = Y_{it-1} \alpha + X_{it} \beta + \vartheta_t + \mu_i + u_{it} \tag{1}$$

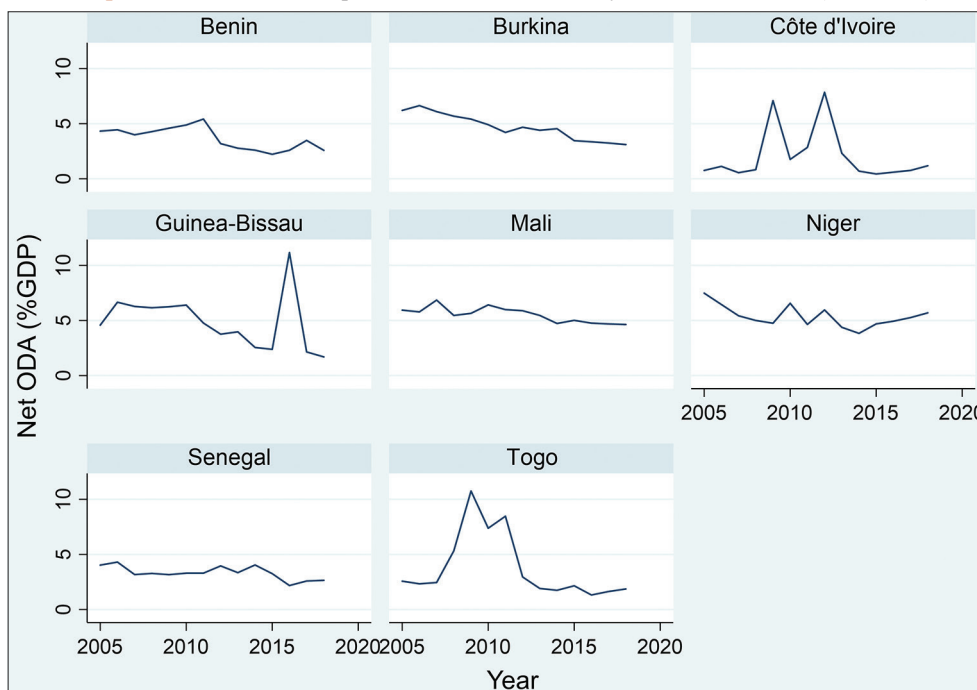
where  $Y_{it}$  is the explained variable (sectoral value added);  $\vartheta_t$  and  $\mu_i$  represent the temporal and individual effects (country), respectively;  $u_{it}$  is the error term identically and individually distributed according to a reduced centered normal distribution; and  $X_{it}$  is the vector of explanatory variables, including development aid.

A multitude of variables (other than aid) can affect sectoral values added. We retain only the variables of interest in addition to the net ODA. Thus, the value added of the primary sector is determined by rainfall (Barrios et al., 2010), agricultural labor, export prices (Mamingi, 1997), and the values added of other sectors of the economy (Gemmell et al., 2000). For the value added of the secondary sector, the considered variables are inflation, the capital obtained from investment (Mitra et al., 1998), the quality of institutions, and the values added of other sectors of the economy (Sepehrdoust and Hye, 2012). The value added of the tertiary sector is also explained by inflation and the quality of institutions, but also by credits to the economy, as well as other sectoral values added.

Next, the analysis of aid spillover effects requires the use of a spatial model. In the literature, several specifications are considered to account for spatial interactions or autocorrelations (Kukenova and Monteiro, 2009; Elhorst, 2010; Bouayad Agha et al., 2018). The first is the spatial autoregressive model (SAR), where spatial autocorrelation is observed at the level of the dependent variable. It is written as:

$$Y_{it} = \rho \sum_{i \neq j}^N w_{ij} Y_{jt} + X_{it} \beta + \mu_i + u_{it} \tag{2}$$

**Graph 2:** Net official development assistance received by WAEMU countries (% of GDP)



Source: Our calculations based on the World Bank data

The spatial dependence is modeled through a matrix of spatial interactions (or weights), also called the neighborhood matrix  $w$ , of which  $w_{ij}$  is an element of the matrix. This square matrix of dimension  $(N, N)$  summarizes the spatial links (neighborhood relations) among the countries in each year. In the literature, neighborhood relationships are most often defined by a binary matrix - e.g., a geographic contiguity matrix. In this case, the elements of the matrix take the value 1 when the countries share a common border and 0 when they do not. The literature also distinguishes among other types of neighborly relations, such as those based on geographical distances between countries.

$w_{ij} Y_{jt}$  is called the endogenous spatially lagged variable, while  $\rho$  is the spatial autocorrelation coefficient, which measures the spatial spillover effect of  $Y$ . In this study devoted to the spillover effects of aid on sectoral values added, the term  $w_{ij} Y_{jt}$  in equation (2) reflects the situation where the sectoral value added of a country depends on the same sectoral value added of the other countries in the Union.

The second specification is the autocorrelated error model or spatial error model (SEM). Here we have:

$$Y_{it} = X_{it} \beta + \mu_i + u_{it} \quad (3)$$

$$u_{it} = \rho \sum_{i \neq j}^N w_{ij} u_{jt} + \varepsilon_{it} \quad (4)$$

This model takes the spatial interrelationships into account at the error level. The SEM model is consistent with the situation where the variables omitted in the modeling of sectoral value added are spatially self-correlated.

The third specification is the Spatial Durbin Model (SDM), based on the work of Anselin (1988) and Lesage and Pace (2009). In this specification, some explanatory variables (e.g., development aid) are spatially lagged as follows:

$$Y_{it} = \rho \sum_{i \neq j}^N w_{ij} Y_{jt} + X_{it} \beta + \theta \sum_{i \neq j}^N w_{ij} X_{jt} + \mu_i + u_{it} \quad (5)$$

In equation (5), a positive (or negative) coefficient means that the variation of the variable  $X$  for a given country positively (negatively) affects the variable  $Y$  in the other countries. The direct effect of the variation of the variable  $X$  for a given country on the variable  $Y$  for that same country remains  $\beta$ . From equation (5), the exogenous interaction model Spatial Lag  $X$  (SLX) can be derived by considering  $\rho=0$ . In this last specification, spillover effects are measured only at the level of spatially lagged explanatory variables.

Other specifications are also used in spatial data econometrics - for example, the Spatial Durbin Errors model (SDEM), which is composed of a spatially autocorrelated error term and spatially lagged explanatory variables, and the SARAR model, simultaneously involving a spatial autoregressive process of the dependent variable and the error term (Bouayad Agha et al., 2018).

In this study, we use the specification that best matches the research objective. In this regard, the SDM model (equation 5) - which is

also considered in the literature as the most robust model in terms of specification (Floch & Le Saout, 2018) - better accounts for the spillover effects of aid on sectoral economic growth in WAEMU countries. In addition, as specified, the SDM model makes it possible to take into account the interdependence of sectors in the production process. For instance, industry can use products from the agriculture sector, while the latter can benefit from transport services in order to transport agricultural inputs or export production.

Still, apart from these economic considerations, we implement several spatial autocorrelation tests based on statistical analyses to choose the appropriate spatial model. In particular, the literature distinguishes between Moran's spatial autocorrelation test (1950) and Lagrange multiplier tests (Burrige, 1980; Anselin, 1988; Anselin et al., 1996). Moran's (1950) spatial autocorrelation test is used to determine the existence of a spatial relationship between variables. This test is performed with the null hypothesis of an absence of autocorrelation of errors or of spatial dependence between variables.

In contrast, the Lagrange multiplier tests make it possible to determine whether the spatial correlation takes the form of a spatial autocorrelation of errors (equations 3 and 4) or of a spatially lagged endogenous variable (equation 2). The Lagrange multiplier test for spatial error dependence (LMERR) and its robust version (R-LMERR) are used to test the null hypothesis of an absence of spatial autocorrelation of errors, while the Lagrange multiplier test for spatial lag dependence (LMLAG) and its robust version (R-LMLAG) are used to test the null hypothesis of an absence of spatial autocorrelation of the spatially lagged endogenous variable. These different tests are based on the estimation of the non-spatial model by the Ordinary Least Squares (OLS) method (here, equation 1 without the autoregressive term). The model is chosen based on the significance of the statistics calculated: if LMERR (R-LMERR) is significant, then the spatial error model is preferred with its extension to the SDEM model; if LMLAG (R-LMLAG) is significant, then the SDM model is estimated.

The different equations are estimated by the system Generalized Method of Moments (GMM) estimator. This method is flexible enough to take into account the various econometric problems generated by our specifications, and this estimator has better properties for reduced data samples (Blundell et al., 2000), as in the case of this study.

In addition, the system GMM estimator enables taking into account the potential endogeneity of the sectoral values added described above, as well as that of certain explanatory variables such as capital, credits to the economy, and development aid. This last form of endogeneity has been widely discussed in the literature (Hepp, 2008). In this study, two approaches were taken to deal with this equation. The first uses the lagged values of development aid as aid instruments in the various sectoral value added equations (a common assumption in the literature). The second approach follows the proposal by Brückner (2013): the procedure consists of first estimating the effect of sectoral value added on aid using the method of instrumental variables (previous values of sectoral value added are used here as instruments):

$$\log(ODA)_{it} = \alpha + \log(VA)_{it} \beta + \mu_i + u_{it} \quad (6)$$

The elements of equation (6) are easily defined. Then, the procedure involves obtaining a new round of aid ( $\overline{ODA}$ ) excluding the effect of the aid on sectoral value added:

$$\log(\overline{ODA})_{it} = \log(ODA)_{it} - \log(VA)_{it} \hat{\beta} \quad (7)$$

$\hat{\beta}$  corresponds to the estimated coefficient of the explanatory variable in equation (6) above.

Although the system GMM estimator appears to be suitable, we also use the instrumental variables panel data method to estimate Equation 1. This enables us to assess the stability and robustness of the direct effect of the aid on sectoral values added.

## 5. DATA

The data used in this study cover the period 2000–2018 from all eight WAEMU member states: Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo.

Several data sources were considered. Data on aid flows were taken from the OECD database. Sectoral values added and export prices were taken from the World Bank's World Development Indicators (WDI) database. The data, expressed in United States dollars, have been converted into West African CFA francs using the nominal exchange rate obtained from the same source. Agricultural labor is measured by the product of jobs and working hours in the agricultural sector. These data are also taken from the World Bank's WDI database.

Data on rainfall (in mm) are taken from the BCEAO statistical yearbooks (2017 and 2018). Inflation and loans to the economy (in West African CFA francs) come from the BCEAO database. The capital stock is obtained from Penn World Tables (PWT) and is estimated on the basis of the accumulation (previous capital stock added to current investment) and the depreciation (assuming a depreciation rate of 6%) of investments (Inklaar and Timmer, 2013). The variables are expressed in logarithm except for rainfall and Inflation.

Institutional quality data involves political and economic institutions. In the equation of the value added of the secondary sector, we consider "the rule of law", which captures the confidence in the laws and the rules of the company, especially the quality of the execution of the contracts, the property rights, the police, and the courts. This is an indicator from the World Bank of the quality of political institutions ("Worldwide Governance Indicators"). With regard to the value added of services (tertiary sector), we use a measure developed by The Heritage Foundation of the quality of economic institutions, especially the Business freedom, which measures the various regulatory constraints to which businesses are subject. Each of the variables reflecting the quality of institutions vary from 0 to 100, with the latter corresponding to a better score.

In terms of spatial interactions, two weights matrices named W1 and W2 were considered. The first (W1) is a matrix of contiguity or geographic proximity; it is a binary matrix defined by the existence or

nonexistence of a common border between the countries in the Union. The gravity model suggests that two geographically close countries are more likely to influence each other than are two distant countries (Tobler, 1979). We conjecture that the circumstance of sharing a common border within the WAEMU can be a vector of convergence of economies and can induce diffusion of the effects of aid and of sectoral values added. The second spatial weighting matrix (W2) is based on the eleven WAEMU inter-state road corridors<sup>2</sup>. This second matrix, also binary, takes the value 1 for states located on the same corridor and 0 otherwise. The idea behind the weighting matrix based on the corridors is that the spillover effect of aid or sectoral values added could occur along these corridors, given the efforts made by the WAEMU countries to facilitate free movement of people and goods (e.g., interconnection of customs IT systems, establishment of juxtaposed control posts (PCJ) that coordinate the control services of states in one location). Thus, countries on the same corridor could also expect to see their economies converge.

## 6. RESULTS AND DISCUSSION

### 6.1. Baseline Estimate: Effect of Aid on Sectoral Value Added

The analysis of the effect of aid on the sectoral values added is conducted with the estimations from the instrumental variables panel data method with fixed effect (IV-FE) and those of the system GMM estimator (GMM-SYS). The estimates also take into account the sectoral heterogeneity across the WAEMU countries through country fixed effects. We consider the fact that sectoral growth may depend on the intrinsic characteristics of each country: for example, the growth of the primary sector could be limited in countries such as Burkina Faso, Mali, and Niger due to the Sahelian climate, which is often unfavorable to agriculture, and coastal countries such as Benin, Côte d'Ivoire, and Senegal could experience a development of service activities.

Tables 2-4 present the results of the estimates for the values added of the primary, secondary, and tertiary sectors, respectively. In consideration of the validation criteria of the results obtained from the estimations of the different equations by the instrumental variables panel data method, the Kleibergen-Paap and Cragg-Donald F statistics show that the instruments used are relevant. Hansen's J statistics indicate that the equations are precisely identified.

For the system GMM estimator, the Arellano and Bond autocorrelation test AR(2) results in not rejecting the hypothesis of the absence of second-order autocorrelation. The Sargan test also allows us to accept the hypothesis of exogeneity of the instruments used in the GMM model. Furthermore, the significance of the coefficients associated with the lagged variables (Tables 2-4) justifies the use of the dynamic model.

In the results of the regression of the value added of the primary sector presented in Table 2, it emerges that the aid has no effect

2 According to the WAEMU Commission (see decision "N° 39/2009/CM/UEMOA"), the corridors are roadways crossing at least two WAEMU member states with a sea port as a point of departure or arrival. They aim to ensure the fluidity of the traffic of people, goods, and services within the Union.

**Table 2: ODA and value added of the primary sector**

Variables	Log (VA of the primary sector)			
	IV-FE		GMM-SYS	
	Aid Instrumented	Growth Instrumented	Aid Instrumented	Growth Instrumented
	(1)	(2)	(3)	(4)
Log (Primary sector VA lagged)			0.516*** (0.103)	0.511*** (0.103)
Log (Net ODA)	0.045 (0.077)	-0.032 (0.028)	-0.003 (0.013)	-0.002 (0.013)
Log (Agricultural labor)	0.278*** (0.052)	0.291*** (0.049)	0.167** (0.065)	0.169** (0.067)
Log (Export price)	0.372*** (0.071)	0.380*** (0.069)	0.170* (0.077)	0.172* (0.079)
Rainfall	0.001*** (0.000)	0.001*** (0.000)	0.001** (0.000)	0.000** (0.000)
Log (Tertiary sector VA lagged)	0.491*** (0.088)	0.520*** (0.091)	0.269** (0.085)	0.274** (0.082)
Constant			-3.387 (1.912)	-3.456 (1.899)
Country Fixed effect	Yes	Yes	Yes	Yes
Kleibergen–Paap LM-stat.	7.102***	35.240***		
Cragg–Donald Wald F stat.	8.787*	2535.360*		
Hansen J stat.	0.000	0.000		
AR (1) P–value			0.024	0.024
AR (2) P–value			0.101	0.102
Sargan P–value			0.078	0.070
Observations	144	144	144	144
R <sup>2</sup>	0.883	0.882		
Countries	8	8	8	8

Source: Our calculations. Note: Robust Standard deviations are in parentheses, \*\*\*P < 0.01, \*\*P < 0.05, \*P < 0.1 denote respectively the significant coefficients at the 1%, 5% and 10% threshold. VA: Value added

**Table 3: ODA and value added of the secondary sector**

Variables	Log (VA of the secondary sector)			
	IV-FE		GMM-SYS	
	Aid Instrumented	Growth Instrumented	Aid Instrumented	Growth Instrumented
	(1)	(2)	(3)	(4)
Log (Secondary sector VA lagged)			0.693*** (0.052)	0.693*** (0.052)
Log (Net ODA)	0.072 (0.077)	-0.007 (0.025)	0.020** (0.007)	0.020** (0.007)
Log (Capital)	0.927*** (0.125)	0.932*** (0.119)	0.257** (0.076)	0.257** (0.076)
Inflation	0.004 (0.004)	0.005 (0.005)	0.007 (0.004)	0.007 (0.004)
Rule of law	0.013*** (0.002)	0.013*** (0.002)	0.006*** (0.001)	0.006*** (0.001)
Log (Primary sector VA lagged)	0.411*** (0.088)	0.442*** (0.080)	0.174*** (0.041)	0.174*** (0.041)
Constant			0.859* (0.405)	0.821* (0.386)
Country Fixed effect	Yes	Yes	Yes	Yes
Kleibergen–Paap LM-stat.	7.145***	19.066***		
Cragg–Donald Wald F stat.	17.745*	8762.955*		
Hansen J stat.	0.000	0.000		
AR (1) P–value			0.043	0.043
AR (2) P–value			0.400	0.400
Sargan P–value			0.180	0.180
Observations	136	136	136	136
R <sup>2</sup>	0.898	0.899		
Countries	8	8	8	8

Source: Our calculations. Note: Robust Standard deviations are in parentheses, \*\*\*P < 0.01, \*\*P < 0.05, \*P < 0.1 denote respectively the significant coefficients at the 1%, 5% and 10% threshold. VA: Value added

on the value added of this sector. This result contrasts with those obtained by Kumi et al. (2017) for sub-Saharan Africa countries, who showed that development aid is an important determinant of sectoral growth, including for agriculture. However, these results are in line with the work of Ighodaro and Nwaogwugwu (2013) in Nigeria. The insignificant effect obtained here could result from the low productivity of the primary sector or from dysfunctions in the orientation of donor aid toward the sector.

With regard to the control variables, agricultural labor has a positive effect on the value added of the primary sector, regardless of the estimation method. As this sector has the largest

share of the workforce, an increase in this workforce or in the hours worked allows production to increase. The same is true of rainfall and export prices, which remain favorable to the growth of the primary sector in WAEMU countries. Furthermore, Table 2 reveals the positive effect of the tertiary sector value added on that of the primary sector. Thus, actors in the primary sector benefit from services (e.g., transport, telecommunications), which allow them to increase production and value added in this sector.

With regard to the regression of the value added of the secondary sector (Table 3), the effect of development aid is significantly positive

**Table 4: ODA and value added of the tertiary sector**

Variables	Log (VA of the tertiary sector)			
	IV-FE		GMM-SYS	
	Aid Instrumented	Growth Instrumented	Aid Instrumented	Growth Instrumented
	(1)	(2)	(3)	(4)
Log (Tertiary sector VA lagged)			0.717*** (0.054)	0.717*** (0.054)
Log (Net ODA)	0.197* (0.104)	0.022 (0.029)	0.058*** (0.020)	0.058*** (0.020)
Log (Credits to the economy)	0.184*** (0.050)	0.180*** (0.054)	0.053** (0.026)	0.053** (0.026)
Inflation	0.006 (0.005)	0.007 (0.005)	0.008** (0.003)	0.008** (0.003)
Business freedom	0.002 (0.002)	-0.001 (0.002)	0.002 (0.001)	0.002 (0.001)
Log (Primary sector VA lagged)	0.436*** (0.134)	0.513*** (0.128)	0.135** (0.057)	0.135** (0.057)
Constant			0.731 (0.501)	0.822 (0.516)
Country Fixed effect	Yes	Yes	Yes	Yes
Kleibergen–Paap LM-stat.	7.249***	33.720***		
Cragg-Donald Wald F stat.	7.927*	328.852*		
Hansen J stat.	0.000	0.000		
AR (1) P-value			0.000	0.000
AR (2) P-value			0.416	0.416
Sargan P-value			0.262	0.262
Observations	144	144	144	144
R <sup>2</sup>	0.837	0.850		
Countries	8	8	8	8

Source: Our calculations. Note: Robust Standard deviations are in parentheses, \*\*\*P<0.01, \*\*P<0.05, \*P<0.1 denote respectively the significant coefficients at the 1%, 5% and 10% threshold. VA: Value added

in the GMM regressions. This result is in line with previous studies, in particular that of Feeny and Ouattara (2009) on developing countries. With regard to the control variables, capital has the expected positive effect, and the quality of institutions has a positive effect on the value added of the secondary sector, while the effect of inflation is insignificant. In addition, a positive relationship can be observed between the values added of the primary and secondary sectors. This situation confirms the argument that the primary sector provides inputs (raw materials) to the secondary sector, especially industry.

Table 4 shows that aid has a positive and significant effect on the value added of the tertiary sector. This positive effect of aid has also been reported by Cali and te Velde (2011) and by Ferro et al. (2011). Similarly, Table 4 indicates that an improvement in the value added of the primary sector contributes to the value added of the tertiary sector. The other variables are significant, except for the Business freedom. As for the effect of inflation, it is significantly positive but remains very weak.

Overall, the basic results highlight the heterogeneity of the effect of aid on different economic sectors. Aid has a positive impact on economic growth, deriving from aid's effect on the values added of the secondary and tertiary sectors. This result remains consistent, given the weight and contribution of the two sectors to economic growth in the WAEMU (Table 1).

## 6.2. Aid Spillover Effect on Sectoral Value Added

As mentioned earlier, we implement the diagnostic tests for spatial autocorrelation. The results of these various tests for the equations of value added in the secondary sector and of value added in the tertiary sector (given the above results) are presented in Tables 5 and 6.

It can be seen in the two tables that the LM Lag statistic is higher than the LM Error statistic. In addition, the probabilities show that the LM Lag statistics are more significant than the LM Error

**Table 5: Spatial panel autocorrelation tests for the secondary sector value added equation**

Diagnostic tests	W1		W2	
	Stat.	Prob.	Stat.	Prob.
Ho: Error has no spatial autocorrelation				
Moran MI Error Test	0.291	0.771	0.031	0.975
LM Error (Burrige)	0.010	0.921	1.627	0.202
LM Error (Robust)	3.599	0.058	22.997	0.000
Ho: Endogenous variable has no spatial autocorrelation				
LM Lag (Anselin)	9.368	0.002	18.357	0.000
LM Lag (Robust)	12.958	0.000	39.727	0.000

Source: Our calculations. Note: W1 = Weights matrix based on the existence of a common border. W2 = Weights matrix based on belonging to the same WAEMU corridor

**Table 6: Spatial panel autocorrelation tests for the tertiary sector value added equation**

Diagnostic tests	W1		W2	
	Stat.	Prob.	Stat.	Prob.
Ho: Error has no spatial autocorrelation				
Moran MI Error Test	-0.308	1.242	0.381	0.703
LM Error (Burrige)	2.797	0.094	0.000	0.992
LM Error (Robust)	39.765	0.000	19.267	0.000
Ho: Endogenous variable has no spatial autocorrelation				
LM Lag (Anselin)	30.589	0.000	31.195	0.000
LM Lag (Robust)	67.556	0.000	50.462	0.000

Source: Our calculations. Note: W1=Weights matrix based on the existence of a common border. W2=Weights matrix based on belonging to the same WAEMU corridor

statistics. This suggests the rejection of the null hypothesis of the absence of spatial autocorrelation of endogenous variables, which are the values added of the secondary and tertiary sectors. Therefore, for the estimation of the two equations, we consider the spatial autoregressive model to which we add spatially lagged explanatory variables (SDM model).

However, the relative significance of the LM Error statistic in the two sectoral value added equations leads us to include



a specification that takes into account the spatial interactions at the level of the error terms. As a result, the SDEM model is also implemented so as to take into account the effect of a misspecification in our results.

Tables 7 and 8 provide the results of the estimation of the aid spillover effects from the GMM-SYS estimator on the values added of the secondary and tertiary sectors, respectively. The estimates are obtained by treating the endogeneity of the aid as described above. The same procedure is used for the endogeneity of the spatially lagged aid variable.

In Tables 7 and 8, it can be noted that, whatever the specification, the direct effect of aid on the value added of the secondary sector

and on that of the tertiary sector remains significant and positive. In addition, the control variables have the expected sign, except for inflation.

With regard to the spatially lagged variables in Table 7 the spatial interaction coefficient of the Net ODA variable is positive and significant in all specifications. Thus, the value added of the secondary sector of a WAEMU country depends on the aid provided to other countries in the Union. Therefore, a spillover effect of aid can be seen on the growth of the secondary sector. The estimate of the SDEM model (Table A1 in the appendix) confirms the positive effect of development aid on the growth of this sector. This spatial diffusion effect of aid on the value added of the secondary sector could potentially be explained by the fact

**Table 7: Spillover effect of aid on the value added of the secondary sector, obtained by the system GMM estimator (SDM model)**

Variables	Log (VA of the secondary sector)			
	W1		W2	
	Aid Instrumented (1)	Growth Instrumented (2)	Aid Instrumented (3)	Growth Instrumented (4)
Log (Secondary sector VA lagged)	0.622*** (0.062)	0.634*** (0.091)	0.620*** (0.065)	0.632*** (0.079)
Log (Net ODA)	0.030* (0.018)	0.041** (0.016)	0.032* (0.019)	0.037* (0.022)
Log (Capital)	0.351*** (0.119)	0.403* (0.198)	0.324** (0.127)	0.335** (0.167)
Inflation	0.006* (0.003)	0.005 (0.005)	0.007** (0.003)	0.006* (0.004)
Rule of law	0.006*** (0.001)	0.005** (0.001)	0.005*** (0.001)	0.005*** (0.002)
Log (Primary sector VA lagged)	0.174*** (0.059)	0.179* (0.088)	0.159*** (0.060)	0.194** (0.079)
W*Log (Secondary sector VA)	-0.033 (0.029)	-0.077 (0.050)	-0.052* (0.027)	-0.046 (0.030)
W*Log (Net ODA)	0.025** (0.012)	0.025** (0.011)	0.021** (0.009)	0.022** (0.009)
W*Log (Primary sector VA)	0.028 (0.034)	0.051 (0.049)	0.052* (0.029)	0.035 (0.032)
Constant	0.926 (0.666)	0.756 (0.525)	0.881 (0.679)	0.576 (0.866)
Country Fixed effect	Yes	Yes	Yes	Yes
AR (1) P-value	0.001	0.033	0.001	0.001
AR (2) P-value	0.120	0.147	0.199	0.171
Sargan P-value	0.105	0.108	0.174	0.357
Observations	128	128	128	128
Countries	8	8	8	8

Source: Our calculations. Note: Standard deviations are in parentheses, W1=Weights matrix based on the existence of a common border, W2=Weights matrix based on belonging to the same WAEMU corridor, \*\*\*P<0.01, \*\*P<0.05, \*P<0.1 denote respectively the significant coefficients at the 1%, 5% and 10% threshold. VA: Value added

**Table 8: Aid spillover effect on the value added of the tertiary sector, obtained by the system GMM estimator (SDM model)**

Variables	Log (VA of the tertiary sector)			
	W1		W2	
	Aid Instrumented (1)	Growth Instrumented (2)	Aid Instrumented (3)	Growth Instrumented (4)
Log (Tertiary sector VA lagged)	0.496*** (0.081)	0.504*** (0.100)	0.583*** (0.076)	0.411*** (0.104)
Log (Net ODA)	0.058*** (0.020)	0.049** (0.024)	0.043** (0.021)	0.061*** (0.022)
Log (credits to the economy)	0.070*** (0.023)	0.084*** (0.028)	0.065** (0.025)	0.089*** (0.029)
Inflation	0.011*** (0.004)	0.009** (0.003)	0.009** (0.004)	0.007** (0.004)
Business freedom	0.002* (0.001)	0.002 (0.001)	0.002 (0.001)	0.002* (0.001)
Log (Primary sector VA lagged)	0.159** (0.067)	0.092 (0.089)	0.081 (0.072)	0.065 (0.084)
W*Log (Tertiary sector VA)	-0.060 (0.037)	-0.016 (0.039)	-0.011 (0.032)	1 (0.033)
W*Log (Net ODA)	-0.018 (0.013)	-0.014 (0.014)	-0.007 (0.010)	-0.013 (0.009)
W*Log (Primary sector VA)	0.121*** (0.037)	0.093** (0.038)	0.051* (0.030)	0.047* (0.027)
Constant	2.478*** (0.714)	2.452*** (0.909)	1.976*** (0.688)	2.881*** (0.888)
Country Fixed effect	Yes	Yes	Yes	Yes
AR (1) P-value	0.000	0.000	0.000	0.000
AR (2) P-value	0.463	0.222	0.581	0.325
Sargan P-value	0.598	0.309	0.368	0.608
Observations	128	136	128	136
Countries	8	8	8	8

Source: Our calculations. Note: Standard deviations are in parentheses, W1=Weights matrix based on the existence of a common border, W2=Weights matrix based on belonging to the same WAEMU corridor, \*\*\*P<0.01, \*\*P<0.05, \*P<0.1 denote respectively the significant coefficients at the 1%, 5% and 10% threshold. VA: Value added

that WAEMU countries have adopted a common framework for industrial policy. Thus, certain countries in the Union could take advantage of the positive effects of aid on the secondary sector in other countries (e.g., through the formation of human capital in the field of manufacturing or energy industries).

Table 8 indicates the absence of an aid spillover effect on the value added of the tertiary sector. Indeed, the coefficient related to the spatially lagged aid variables not significant. This result is robust in the choice of the spatial weighting matrix and the instruments, as well as in the specification (Table A2 in the Appendix for the results obtained for the SDEM model). On the other hand, the value added of the tertiary sector in one country is positively affected by the value added of the primary sector in other countries. This result suggests a diffusion of growth at the sectoral level. For example, agricultural exports - a branch of the primary sector - of the three landlocked countries in the Union (Burkina, Mali, and Niger) pass through the ports of the five other countries with a sea front. Therefore, an increase in the value added of services for the latter group of countries cannot be excluded when the value added of agriculture (particularly agricultural production) increases in the first group of countries. The implementation of regional economic cooperation policies, especially the construction or improvement of road and rail infrastructure among WAEMU member states, has promoted the effect of diffusing the value added of the primary sector.

## 7. CONCLUSION AND POLICY IMPLICATIONS

This study analyzed the spillover effect of official development aid on the sectoral values added of WAEMU countries. The analysis considers the GDP, which is defined according to the production approach. System generalized method of moments (GMM) was used to address the problem of endogeneity of aid. Spatial links between countries are measured using two weighting matrices that are based on geographic proximity and countries' membership in the same interstate road corridor.

The results of the spatial model estimation showed that the aid provided to a WAEMU country has a direct effect on the value added of the secondary sector of the recipient country and on that of other countries in the Union. In addition, the value added of the primary sector of one WAEMU country is positively affected by that of the tertiary sector of other countries in the Union.

Thus, allocation of development aid in WAEMU countries should take into account the spillover effect in the other countries. To increase its effectiveness, part of the additional aid intended for WAEMU countries could be directed to the secondary sector, in order to stimulate the value added of the various branches in this sector for all countries. For example, several authors agree on the fact that the Industrial Revolution contributed to the emergence of what are currently called developed countries. Although the economic model is different for WAEMU countries, targeted aid programs in industry (a branch of the secondary sector) could contribute to the acceleration of industrialization, which is an

important step towards the structural transformation of WAEMU countries.

Therefore, beyond the exploitation of the extractive or mining industries, special attention should be paid to the manufacturing industry. The latter is characterized by the creation of competing production units and dependence on imported inputs; as a result, industry in the WAEMU has remained uncompetitive and weak in order to be able to fit into global value chains. Under these conditions, aid could be used to deal with the obstacles encountered by industry through financing various regional integration projects in this sector, given the expected spillover effects.

However, an industrial revolution cannot succeed without the development of other sectors of the economy. As our results showed, development aid has a positive effect on the value added of services. Upstream, the tertiary sector is essential to the development of the value added of the primary sector, which in turn constitutes an important determinant of the growth of the secondary sector. Downstream, the development of export activities - particularly industrial products (secondary sector) - to other WAEMU countries and to the rest of the world also requires commercial services (tertiary sector), such as transport, competitive warehousing, and telecommunications. Consequently, aid intended for the primary and tertiary sectors should not be reduced, despite the lack of proof of a spillover effect of such aid on the values added of these two sectors.

Furthermore, the existence of an aid spillover effect on the value added of the secondary sector highlights the positive role played by regional economic integration policies. However, the lack of a spillover effect of aid on the values added of the other sectors could be explained by the persistence of obstacles to economic integration. Thus, the pursuit of reforms - especially those relating to sectoral policies, freedom of movement, and the right of establishment - could facilitate the expected positive spillover effects of aid on the values added of the primary and tertiary sectors.

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## APPENDIX

**Table A1: Aid spillover effect on the value added of the secondary sector, obtained by the system GMM method (SDEM model)**

Variables	Log (VA of the secondary sector)			
	W1		W2	
	Aid Instrumented	Growth Instrumented	Aid Instrumented	Growth Instrumented
	(1)	(2)	(3)	(4)
Log (Secondary sector VA lagged)	0.615*** (0.067)	0.681*** (0.114)	0.621*** (0.076)	0.676*** (0.084)
Log (Net ODA)	0.037* (0.019)	0.049** (0.018)	0.030 (0.022)	0.047** (0.023)
Log (Capital)	0.375*** (0.133)	0.458* (0.223)	0.422** (0.176)	0.259 (0.168)
Inflation	0.004 (0.003)	0.002 (0.006)	0.006* (0.003)	0.004 (0.003)
Rule of law	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.002)	0.005*** (0.002)
Log (Primary sector VA lagged)	0.169*** (0.062)	0.116 (0.126)	0.165** (0.078)	0.142* (0.083)
W*Log (Net ODA)	0.026** (0.012)	0.030** (0.013)	0.019** (0.010)	0.021** (0.009)
W*Log (Primary sector VA)	-0.010 (0.021)	-0.036 (0.030)	-0.012 (0.021)	-0.002 (0.021)
W*u	-0.460** (0.184)	-0.406* (0.180)	-0.597* (0.281)	-0.329** (0.147)
Constant	1.150 (0.715)	0.876 (0.705)	1.158 (0.823)	0.140 (0.847)
Country Fixed effect	Yes	Yes	Yes	Yes
AR (1) P-value	0.001	0.034	0.000	0.002
AR (2) P-value	0.137	0.210	0.501	0.231
Sargan P-value	0.117	0.145	0.494	0.388
Observations	128	128	128	128
Countries	8	8	8	8

Source: Our calculations. Note: Standard deviations are in parentheses, W1 = Weights matrix based on the existence of a common border, W2 = Weights matrix based on belonging to the same WAEMU corridor, \*\*\*P < 0.01, \*\*P < 0.05, \*P < 0.1 denote respectively the significant coefficients at the 1%, 5% and 10% threshold. VA: Value added

**Table A2: Aid spillover effect on the value added of the tertiary sector, obtained by the system GMM method (SDEM model)**

Variables	Log (VA of the tertiary sector)			
	W1		W2	
	Aid Instrumented	Growth Instrumented	Aid Instrumented	Growth Instrumented
	(1)	(2)	(3)	(4)
Log (Tertiary sector VA lagged)	0.392*** (0.097)	0.538*** (0.111)	0.572*** (0.082)	0.487*** (0.098)
Log (Net ODA)	0.048** (0.020)	0.020 (0.026)	0.046** (0.022)	0.037* (0.022)
Log (credits to the economy)	0.090*** (0.025)	0.073** (0.034)	0.066** (0.026)	0.082*** (0.029)
Inflation	0.009*** (0.003)	0.009*** (0.003)	0.009** (0.004)	0.008** (0.003)
Business freedom	0.002* (0.001)	0.002 (0.001)	0.003* (0.001)	0.003** (0.001)
Log (Primary sector VA lagged)	0.113* (0.068)	0.066 (0.097)	0.038 (0.074)	0.045 (0.089)
W*Log (Net ODA)	-0.019 (0.013)	-0.014 (0.014)	-0.009 (0.010)	-0.010 (0.009)
W*Log (Primary sector VA)	0.101*** (0.025)	0.088*** (0.031)	0.053*** (0.020)	0.066*** (0.023)
W*u	-0.147 (0.285)	-0.153 (0.244)	0.160 (0.232)	0.115 (0.163)
Constant	3.918*** (0.865)	2.736** (1.063)	2.475*** (0.739)	2.835** (1.107)
Country Fixed effect	Yes	Yes	Yes	Yes
AR (1) p-value	0.000	0.000	0.000	0.000
AR (2) p-value	0.463	0.435	0.468	0.561
Sargan p-value	0.647	0.824	0.453	0.802
Observations	128	144	128	144
Countries	8	8	8	8

Source: Our calculations. Note: Standard deviations are in parentheses, W1 = Weights matrix based on the existence of a common border, W2 = Weights matrix based on belonging to the same WAEMU corridor, \*\*\*P < 0.01, \*\*P < 0.05, \*P < 0.1 denote respectively the significant coefficients at the 1%, 5% and 10% threshold. VA: Value added