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Devaluation and Cattle Markets Integration in Burkina Faso

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Abstract

The aim of this paper is to highlight an aspect of devaluation that is generally ignored in the literature, namely, its positive impact on domestic trade. We develop a parity bounds model for cattle markets of Burkina Faso with two regimes of prices, autarkic and integrated, consistent with spatial and inter-temporal arbitrage conditions. When markets are autarkic, prices follow a random walk and when markets are integrated, prices are equal up to transaction costs. The integrated regime is more likely when transaction costs are low. In our model, the 1994 franc CFA devaluation reduces transaction costs relatively to cattle prices, thereby promoting markets integration. The model is tested using a switching regression with exogenous selection variables. The results show that the probability of market integration significantly increased after the devaluation.

Keywords : Market integration, inter-temporal arbitrage, cattle, franc CFA devaluation, Burkina Faso, switching regression model, panel data.

JEL classification: O12, Q13

Résumé

Dévaluation et intégration des marchés de bétail au Burkina-Faso.

Dans cet article nous nous intéressons à l'effet de la dévaluation du FCFA sur le commerce intérieur de bétail au Burkina Faso. Notre analyse théorique distingue deux régimes de prix, autarcique et intégré. Dans le régime autarcique, la condition d'arbitrage inter-temporel est respectée et les prix du bétail suivent une marche au hasard. Dans le régime intégré, la condition d'arbitrage spatial est respectée et les prix sur deux marchés ne diffèrent que par le montant des coûts de transaction. Le régime intégré est donc plus probable quand les coûts de transaction sont faibles. Notre hypothèse est que la dévaluation des FCFA de janvier 1994 a entraîné une diminution des coûts de transaction favorable à l'intégration des marchés de bétail. Les données disponibles sur les prix du bétail ont une dimension spatiale (7 marchés de bétail) et temporelle (rythme mensuel de 1991 à 1997). Le test empirique de cette hypothèse est mené à l'aide d'un modèle à changement de régimes. Le changement de régime dépend de variables de sélection exogènes comprenant le taux de change réel. Nos résultats montrent que la probabilité de l'intégration des marchés a augmenté de manière significative après la dévaluation.

Mots-Clés : Intégration des marchés, arbitrage inter-temporel, bétail, dévaluation des francs CFA, Burkina Faso, modèle changement de régimes, panel.

I. Introduction

Cattle's breeding is a major activity in Burkina Faso. This activity benefits from an ancient and well-developed domestic and regional marketing network. A cattle is a durable good that may be inter-temporally held for asset building, consumption smoothing or precautionary saving [*Motel Combes, 1996*]. A cattle has also the characteristic of being an internationally tradable good. Thus, the devaluation of the franc CFA that occurred in January 1994 created new opportunities for regional cattle trade towards coastal markets [*Ancey, 1998*]. The devaluation also modified the domestic relative price structure. Especially, transaction costs were reduced relatively to cattle prices. The effects of devaluation on international trade are now well known. In this paper, we want to focus on its impact on domestic trade *i.e.* on the spatial integration of local cattle markets of Burkina Faso.

The issue of spatial integration in developing countries has been extensively addressed in the literature [*e.g. Baulch, 1997b*; *Fafchamps and Gavian, 1996*; *Ravallion, 1986*]. Earlier approaches used bivariate correlation coefficients between prices. They have been progressively improved with the development of linear cointegration methods that deal with the existence of common trends [*Dercon, 1995*]. The validity of these approaches is however questionable since cointegration is neither necessary nor sufficient for market integration [*Alexander and Wyeth, 1994*; *Barrett, 1996*]. These methods ignore the central role of transaction costs and of non-linearities implied by the spatial arbitrage condition [*Baulch, 1997a*]. These problems led to the elaboration of a new methodology for market integration *i.e.* the parity bounds model [*Sexton et al., 1991*; *Baulch, 1997a, 1997b*]. This model relies on different econometric tools *e.g.* frontier models [*Spiller and Huang, 1986*], non-linear cointegration methods [*Goodwin and Piggott, 2001*] and switching regressions [*Sexton et al., 1991*].

The parity bounds model provides a microeconomic framework in which trade opportunities depend on transaction costs. In this model, the spatial arbitrage condition determines different regimes of prices depending on whether trade occurs or not. However, this model does not take into account inter-temporal arbitrage, which is a major weakness in the context of storable goods. This argument is particularly relevant in the context of sahelian countries where cattle are the main store of wealth. Thus, one originality of our approach is to introduce price dynamics. We further argue that transaction costs depend on macroeconomic variables. In particular, the real depreciation that followed the January 1994 franc CFA devaluation modified arbitrage conditions on local markets of Burkina Faso, through its impact on transaction costs, and thus created new domestic trade opportunities.

This paper implements an exogenous switching regression model. This specification relies on two mutually exclusive regimes of prices depending on whether cattle trade occurs (integrated regime) or not (autarkic regime). The switching between the price regimes is determined by a set of exogenous variables that influence transaction costs. Furthermore, a panel data structure is preferred to a time series approach for catching the global effect of devaluation on cattle markets.

We first set our theoretical model. We then present the cattle sector in Burkina Faso and finally the econometric analysis.

II. The theoretical model.

Local traders make an efficient use of their information network to temporally and spatially arbitrate cattle markets. Arbitrage activities consist of selling and purchasing operations that remove excess profits from holding cattle. Two regimes of prices, integrated or autarkic, are considered. Markets are said to be autarkic when trade does not occur and prices move independently of each other. Markets are said to be integrated when trade takes place between them and the price spread is equal to transaction costs. For given local market conditions, the level of transaction costs determines the price regime.

TWO REGIMES OF PRICES.

According to the spatial arbitrage condition there is no excess return from trading cattle from a market to another. The spatial arbitrage rule is given by [*Baulch*, *1997b*]:

$$\left|P_{i,t} - P_{j,t}\right| \leq K_{ij} \tag{1}$$

Transaction costs K_{ij} are the maximum price differential between two markets locations *i* and *j* [*Spiller and Huang*, *1986*]. Transaction costs include all market use costs: information, monitoring and transportation costs, trade margins, formal or informal taxes, bribes, price equivalent to trade restrictions. Moreover, transaction costs can include traders' normal profits as well as mark-up margins, which is consistent with imperfect competition.

The spatial arbitrage condition implies two price regimes depending on the existence of trade between markets. Indeed, when transaction costs between two markets are greater than the price spread, there are no opportunities for trade. Prices on each market vary independently and markets are said to be autarkic.

$$\left|P_{i,t} - P_{j,t}\right| < \overline{K}_{ij}$$

When transaction costs are low, trade occurs between two markets *i* and *j*, the price differential is equal to the transaction costs $\underline{K}_{ij}$ and markets are integrated:

$$\left|P_{i,t} - P_{j,t}\right| = \underline{K}_{ij} \;\; , \;\; \overline{K}_{ij} > \underline{K}_{ij}$$

The switching between the two price regimes depends on the level of transaction costs and on local supply and demand conditions. In unchanged local market conditions, a reduction in transaction costs promotes inter-market trade flows and thus the integrated regime of prices.

THE AUTARKIC REGIME OF PRICES.

In this case, the price differential is strictly less than transaction costs and prices are only driven by the inter-temporal arbitrage condition. The inter-temporal arbitrage condition is fulfilled whenever there is no excess return from holding cattle from a period to another. Under the efficient market hypothesis, cattle keepers are willing to hold cattle as long as they earn a constant rate of return r [*Cuthbertson*, *1996*]:

$$E_{t-1}P_t - P_{t-1} + d = r \cdot P_{t-1} \;\; ; \;\; E_{t-1}\left(E_{t-1}P_t - P_t\right) = 0 \; ; \; \forall t \qquad (2)$$

Where P_t are cattle prices at date t, d are constant live cattle by-product incomes (milk, calves, prestige, etc.) or cattle dividends. E_{t-1} is the expectation operator conditional on information at t-1. Assuming rational expectations, the expectation error is non-systematic.

Equation (2) means that the expected marginal return is equal to the opportunity cost $r.P_{t-1}$ from cattle holding. The expected marginal return is the sum of the expected change in cattle prices (capital gain) and of cattle dividends. The constant rate of return r includes alternative assets returns, physical storage costs as well as risk and liquidity premia.

Under the hypothesis that cattle prices reflect their 'fundamental' values, the capital gain is zero:

$$E_{t-1}P_t = P_{t-1} \text{ thus } P_t = P_{t-1} + \varepsilon_t \qquad (3)$$

Equation (3) means that expected prices are equal to their present values plus unforeseen ‘news’. It follows that cattle prices are equal to the discounted present value of dividends in all future periods[i]:

$$P_{t-1} = d / r \, ; \forall t \qquad (4)$$

THE INTEGRATED REGIME OF PRICES.

In this case, the price differential is equal to transaction costs, and trade flows are determined by the sign of the price differential. We thus have two equations depending on the direction of trade flows:

$P_{i,t} = P_{j,t} + \underline{K}_{ij}$, the exporting market is *j* when $P_{i,t} > P_{j,t}$ (5a)

$P_{j,t} = P_{i,t} + \underline{K}_{ij}$, the importing market is *j* when $P_{i,t} < P_{j,t}$ (5b)

Since the inter-temporal arbitrage condition applies everywhere, prices are determined simultaneously by equations (3) and (5a)-(5b) that become (6a)-(6b):

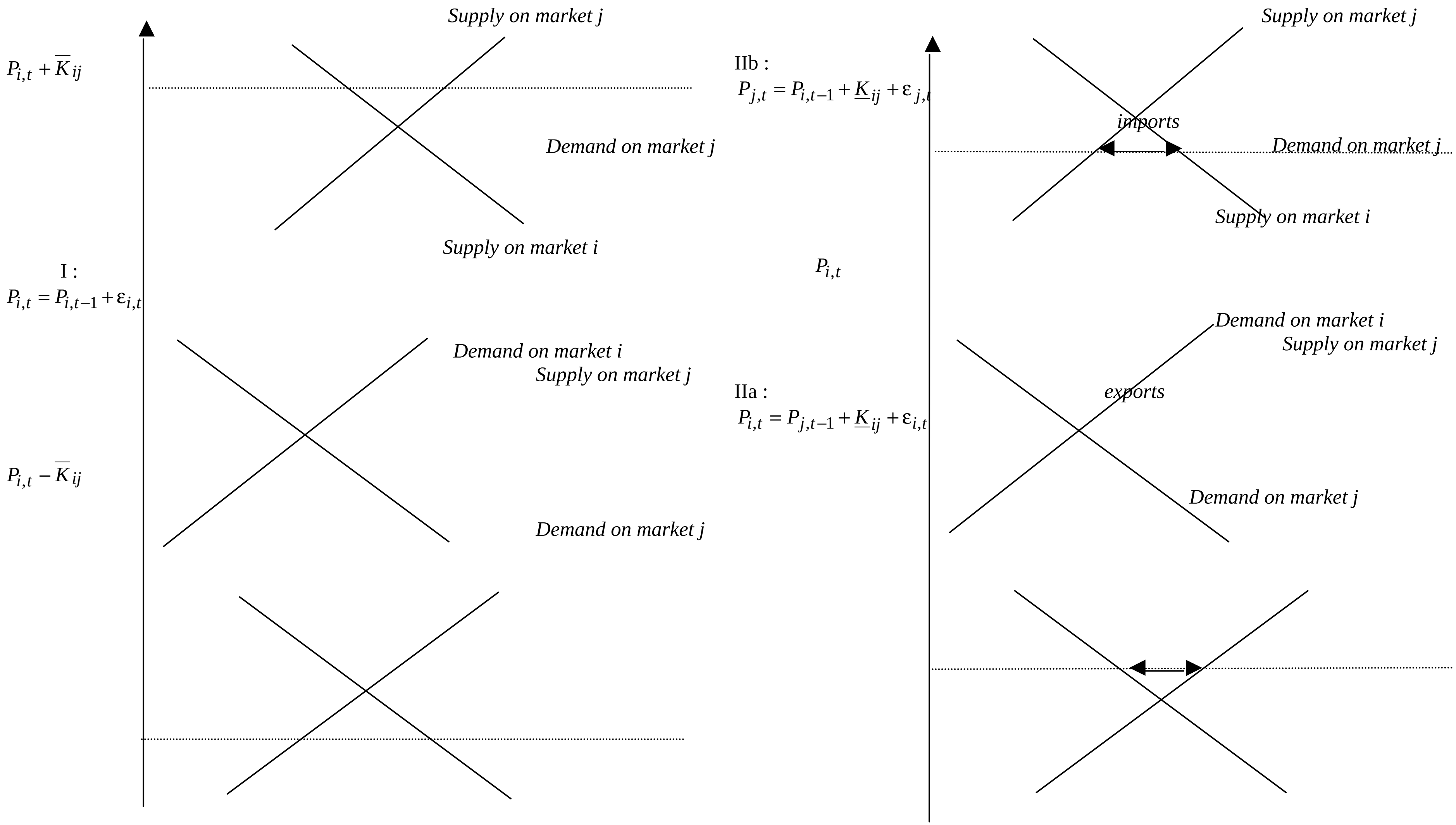
$$P_{i,t} = P_{j,t-1} + \underline{K}_{ij} + \varepsilon_{i,t} \, , \; P_{i,t} > P_{j,t} \qquad (6a)$$

$$P_{j,t} = P_{i,t-1} + \underline{K}_{ij} + \varepsilon_{j,t} \, , \; P_{i,t} < P_{j,t} \qquad (6b)$$

Figure 1 depicts the autarkic (I) and the integrated (II) regimes of prices. In the former (I), the price differential is strictly less than transaction costs between *i* and *j*. No trade occurs and prices vary independently of each other within the band determined by transaction costs. Prices are hence driven by the inter-temporal arbitrage condition.

In the integrated regime of prices (II), price differentials between *i* and *j* are equal to transaction costs. $P_{j,t}$ is at its import parity bound (case IIb): trade flows go from market *i* to market *j*. Symmetrically, $P_{j,t}$ is at its export parity bound (case IIa): trade flows go from market *j* to market *i*.

Figure 1. The autarkic (I) and integrated regimes of prices (IIa)-(IIb).



THE IMPACT OF REAL EXCHANGE RATE DEPRECIATION ON TRANSACTION COSTS.

The devaluation is expected to increase the prices of traded goods relatively to the prices of non-traded *i.e.* to induce a real depreciation of the exchange rate. As cattle are internationally traded goods, their prices are expected to increase in the same proportion as the rate of devaluation. Besides, the impact of the devaluation on transaction costs depends on the relative importance of traded and non-traded goods that make up transaction costs. In sahelian countries, labour is the main input in transaction costs since most cattle are herded throughout the country [*Fafchamp and Gavian*, *1996*]. As labour is a non-traded good, transaction costs are expected to become cheaper relative to cattle prices and so, devaluation is expected to promote inter-market trade.

When local cattle markets are initially autarkic, the real depreciation is expected to favour markets integration. When local markets are initially integrated, the real depreciation is expected to reduce the price spread between markets. Since the price band is narrowed, the price fluctuations generated by idiosyncratic shocks are reduced. So, in both cases, the real depreciation improves welfare through generating efficiency gains.

III. The cattle sector in Burkina Faso.

Livestock is a major sector of Burkina Faso: its contribution to GDP and exports is respectively 12 % and 30 % (it is the third export after cotton and gold). Livestock is however a traditional sector characterised by a low productivity, as a result of climatic and institutional factors. On the one side, production conditions are extensive and highly dependent on rains. On the other side, demographic pressure coupled with poor developed property rights exacerbates conflicts about land access between cattle breeders and farmers.

The marketing system is highly decentralised and operates quite independently from public interventions. Transactions mostly occur on organised markets with numerous local traders, who act as intermediaries between cattle herders and buyers. Local traders have an arbitrage activity as they may guard the stock when sales and purchases are not simultaneous. They facilitate transactions and information diffusion between and within markets [*World Bank, 1982*]. Local traders receive fees per head for their services, which adds to transaction costs. Transportation costs, grazing and passage fees that have to be paid to local authorities in addition to other unofficial charges also increase transaction costs. All these costs appear to be proportional to the number of traded cattle and not connected with cattle prices.

Source : Encarta

The traditional flows of exchange run from the north-east towards the consumption markets of Bobo-Dioulasso, Ouagadougou and coastal cities. Transport infrastructures are generally poor despite public investments. Most cattle are herded within the country between producing regions and major consumption and export markets. There are five main cattle markets: Pouytenga, Djibo, Bobo-Dioulasso, Gorom[ii] and Ouagadougou. Pouytenga and Bobo-Dioulasso are important export markets, Djibo belongs to the main producing region, and Bobo-Dioulasso and Ouagadougou are the major consumption markets. After the devaluation, the Ivoirian demand (nearly 60 % of exports) for Burkinabe cattle increased because of a substitution effect, at the expense of European imports [Chambas *et al.*, 1999]. The exports toward other African markets, outside the Franc Zone, have also been boosted by the franc CFA devaluation (Ghana: 34 % of exports).

In this paper, we consider one category of animals, namely, «fattened bulls» («taureaux en bon état d'engraissement»), for which long price series are available. Cattle prices are collected on a monthly basis (Ministère de l'agriculture et des ressources animales, various issues) from January 1991 to December 1997[iii]. Prices are expressed per unit of livestock and deflated by the national consumer price index (IMF).

Figure 2 highlights the increase in cattle real prices after the 1994 devaluation. It also shows transitory reversals in the price spreads between markets. A descriptive statistic analysis reveals that the temporal and spatial price variability tends to decrease after the devaluation (table 1 and figure 3). This phenomenon can be explained by narrower price bands, which is the consequence of the reduction of transaction costs.

Figure 2: The evolution of the real prices of cattle on four markets (real thousand francs CFA per head, base 100 in 1995)

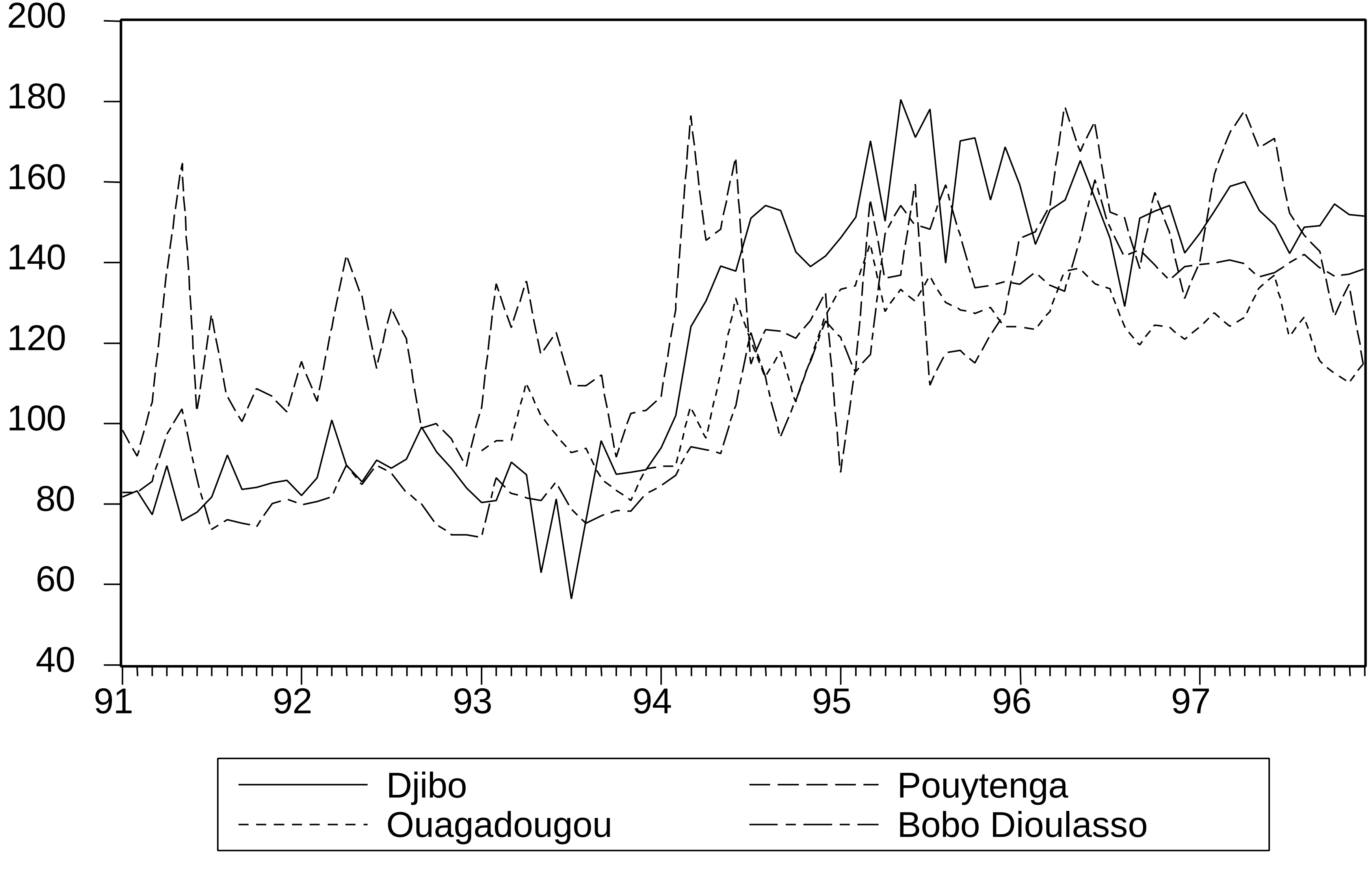
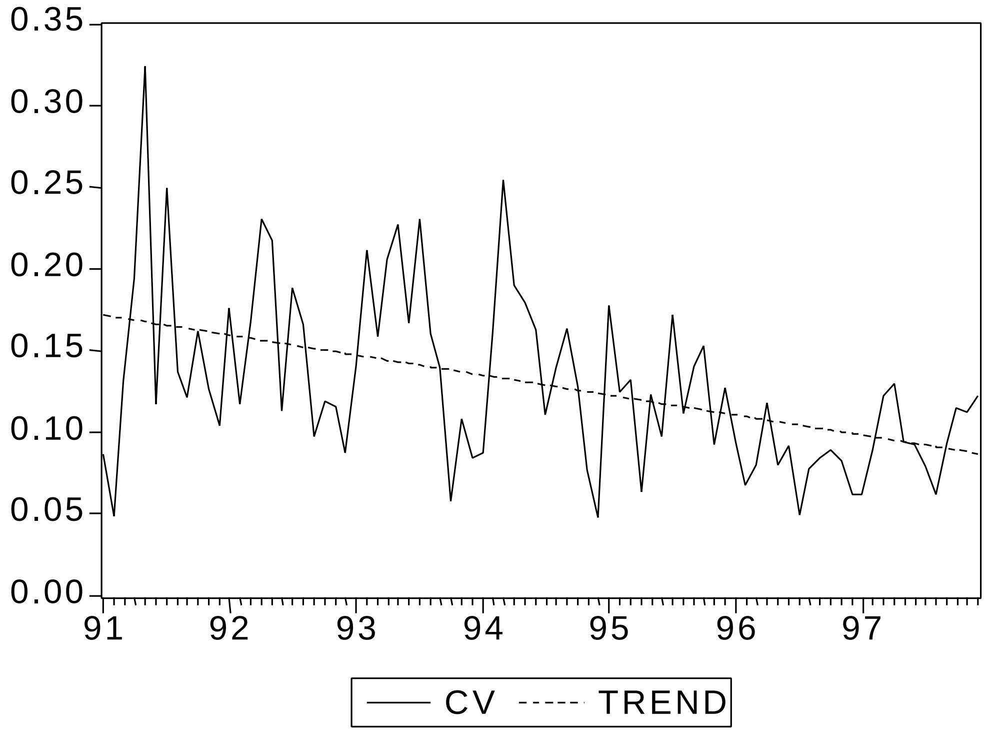


Table 1. Spatial and temporal prices variability.

	January 1991 to December 1993	January 1995 to December 1997
Real cattle prices in Pouytenga	0.15	0.15
Real cattle prices in Djibo	0.10	0.07
Real cattle prices in Bobo-Dioulasso	0.08	0.07
Real cattle prices in Ouagadougou	0.09	0.06
Spatial price variation	0.15	0.10

Figure 3. Spatial variability of cattle prices.



CV is the spatial coefficient of variation of cattle prices. In each point of time it is calculated as: $\frac{1}{\overline{P}_t}\sqrt{\frac{1}{4}\sum_i \left(P_{i,t}-\overline{P}_t\right)^2}$ with i =1 to 4. $P_{i,t}$ is the price on market i at time t , and $\overline{P}_t$ is the mean price at time t.

IV. The econometric analysis.

THE PANEL STRUCTURE.

The data cover four markets and seven years from 1991 to 1997. One of the main differences compared to previous analyses on market integration is that the data are organised in a panel structure with twelve bilateral markets combinations on 84 months (1008 potential observations). For our purpose, this structure is more interesting than a temporal-bilateral structure in many ways. First, it provides more degrees of freedom. Second, it is a parsimonious approach that enables to test for the global effect of devaluation on market integration. Third, a panel structure is better suited to capture the variability of transaction costs with the latter depending on the distance between markets.

The panel structure implies close cattle traders' behaviours in each market. A within estimator controls for market heterogeneity in the two price regimes. Moreover, dummy variables catch the heterogeneity in transaction cost, for each pair of markets, in the integrated regime. This estimator implies that the slopes are the same on the whole sample, which is consistent with our theoretical model. Stability coefficient tests do not invalidate this hypothesis (LR-tests in appendix).

The sample is divided in two sub-samples, A and B, to take trade reversals into account [*Spiller and Huang, 1986*]. Sub-sample A comprises all the observations for which the price on the market *j* is greater than the price on the market *i*. Conversely, sub-sample B comprises all the observations for which the price on the market *i* is greater than the price on the market *j*.

THE EFFICIENCY HYPOTHESIS TEST.

Our model relies on the spatial and temporal arbitrage hypotheses. When transaction costs are unknown, it is not possible to test the spatial arbitrage condition. In particular, price correlations between markets and the more recent linear cointegration tests are not informative [*Barrett, 1996*][iv].

The efficient market hypothesis is tested with a panel data unit root test, that is, a Dickey-Fuller test for dynamic heterogeneous panels based on the mean of individual unit root statistics [*Im*, *Pesaran and Shin*, *1997*]. The test is conducted on the whole sample since the inter-temporal arbitrage condition always holds. The equation test is the following:

$$\Delta P_{i,t} = \rho_i \cdot P_{i,t-1} + \alpha_i + \varepsilon_{i,t}$$

The null hypothesis is $\rho_i = 0$ and $\alpha_i = 0$, for all i, and is not rejected at the 1% level. Hence, the efficient cattle market hypothesis cannot be rejected[v].

THE SWITCHING MODEL.

Our theoretical model defines two regimes of prices depending upon the level of transaction costs and local market conditions. A reduction in transaction costs increases the number of integrated markets *ceteris paribus*. Transaction costs are unobservable, which means that the sample separation between integrated and autarkic regimes is unknown. The real transaction costs are assumed to be an increasing function of the real effective exchange rate (*REER*)[vi] with the latter being a proxy for the real wage[vii]. The transaction costs are also supposed to be an increasing function of the distance between markets as well as of the real oil price expressed in local currency (*FUEL)*[viii].

The econometric tool corresponding to our model is thus an exogenous switching regression model with unknown sample separation [*Maddala*, *1983*]. The selection rule between the two regimes is given by the following conditions:

Autarkic regime if: $\kappa' \cdot Z_{ij,t} + \omega_{ij,t} > 0$ (7)

Integrated regime if: $\kappa' \cdot Z_{ij,t} + \omega_{ij,t} \leq 0$ (8)

The exogenous transaction costs depends on $Z_{ij,t}$ variables: the fuel price ($FUEL_t$) and the real effective exchange rate ($REER_t$) with positive signs. The transaction costs are also an increasing function of the distance (D_{ij}) between markets *i* and *j*. $FUEL_t$ and $REER_t$ can play multiplicatively with D_{ij}. Transaction costs are supposed to depend on an intra-annual quadratic trend ($Month_t$ and $Month_t^2$).

The residuals $\omega_{ij,t}$ capture chocks that affect the markets. Those residuals are normally distributed with a nil mean and a standard error equal to one [*Maddala 1983*]. The constant coefficient in the selection equation is set to one, so that the other coefficients are calculated only up to a positive scale factor [*Maddala and Nelson, 1975*].

The two regimes equations can be written as follows:

Autarkic regime: $$P_{i,t} = \phi \cdot P_{i,t-1} + \gamma \cdot S_t + \mu_{i,t} \quad (9)$$

Integrated regime: $$P_{i,t} = \underline{K}_{ij} + \beta \cdot P_{j,t-1} + \eta \cdot S_t + \zeta_{i,t} \quad (10)$$

Where $P_{i,t}$ is the real price of cattle on market *i* (*i* = 1 to 4) at time *t*; $P_{j,t}$ is the real price of cattle on the market *j* ($i \neq j$) at time *t*. According to the efficient market hypothesis tested earlier, ϕ is equal to one. The β coefficient is equal to one according to our theoretical model. In equation (10) lagged prices eliminate a possible source of simultaneity bias. S_t is a seasonal variable equals to 1 from may to october[ix]; $\mu_{i,t}$ and $\zeta_{i,t}$ are disturbance terms distributed according to the bivariate normal density with zero means, standard errors σ_μ and σ_ζ and not identifiable covariance [*Maddala, 1983*; *Quandt, 1988*].

The integrated regime (equation 10) holds if $I_t = 1$ and does not otherwise (equation 9). The two regimes can then be combined into the following equation:

$$P_{i,t} = (\phi \cdot P_{i,t-1} + \gamma \cdot S_t + \mu_{i,t}) \cdot (1 - I_t) + I_t \cdot \left(\underline{K}_{ij} + \beta \cdot P_{j,t-1} + \eta \cdot S_t + \zeta_{i,t}\right) \qquad (11)$$

The probit function approximates the probability of the integrated regime I_t that is:

$$\hat{I}_t = \int_{-\infty}^{-\kappa' \cdot Z_{ij,t}} \left(\frac{\exp\left(-\omega_{ij,t}^2 / 2\right)}{\sqrt{2\pi}} \right) \cdot d\omega \qquad (12)$$

Equations (11) and (12) are estimated by a maximum likelihood procedure[x]. An increase in *FUEL,* distance or *REER* implies higher transaction costs and then lowers the probability of market integration given by the selection equation. Thus, we expect that these variables enter with negative signs in the selection equation.

THE RESULTS.

The results are compiled in table 2. Two models are estimated: model 1 and model 2. In the model 1, the selection equation includes D_{ij}•$REER_t$. The latter is not significant and is removed from model 2. Both models are estimated on each sub samples A and B. Table 3 gives the probabilities of the integrated regime. Table 4 gives the marginal impact of distance and of the real effective exchange rate on the probability of market integration. Table 5 (in appendix) presents various likelihood-ratio (LR) coefficients stability tests that are mostly successful at the 5% level.

Table 2. Exogenous switching regression with unknown sample separation (robust t-statistics and within estimator)

Sample			Sub-sample A: $P_i < P_j$						Sub-sample B: $P_i > P_j$					
Model			Model 1			Model 2			Model 1			Model 2		
Number of observations			470			470			387			387		
			Estimate	*t-stat*		*Estimate*	*t-stat*		*estimate*	*t-stat*		*Estimate*	*t-stat*	
Selection equation		*Distance•Fuel$_t$*	-1.65×10^{-06}	-2.22	**	-1.17×10^{-06}	-3.28	**	5.22×10^{-07}	0.46		-4.38×10^{-08}	-0.08	
		Distance•REER$_t$	-7.32×10^{-05}	-0.87					7.61×10^{-05}	0.62				
		Month$_t$	0.88	2.32	**	0.91	2.69	**	1.34	2.08	**	1.19	1.77	*
		(Month)²$_t$	-0.08	-2.35	**	-0.08	-2.70	**	-0.12	-2.40	**	-0.11	-2.07	**
		Distance	0.02	1.63	*	0.01	2.87	**	-0.01	-0.47		1.65×10^{-03}	0.32	
		REER$_t$	-0.05	-3.41	**	-0.06	-4.35	**	-0.08	-2.48	**	-0.07	-1.95	*
Autarkic equation		*$P_{i.t-1}$*	0.96	62.98	**	0.95	64.48	**	0.90	34.61	**	0.90	31.70	**
		Season$_t$	-2.84	-2.32	**	-2.83	-2.47	**	-3.60	-1.84	*	-3.36	-1.69	*
Integrated equation		*$P_{j.t-1}$*	0.98	8.44	**	0.99	9.37	**	0.37	2.24	**	0.38	2.24	**
		Season$_t$	-7.39	-1.29		-7.15	-1.33		-1.83	-0.43		-0.95	-0.23	
	Fixed transaction costs	*Bobo-Djibo*	-11.46	-2.00	**	-11.50	-2.04	**	27.07	5.56	**	26.90	5.09	**
		Bobo-Pouytenga	-20.50	-1.05		-20.16	-1.17		22.73	3.48	**	22.48	3.06	**
		Dijbo-Pouytenga	-11.05	-1.46		-11.37	-1.53		36.38	5.62	**	36.35	5.33	**
		Djibo-Ouagadougou	-17.63	-2.66	**	-17.91	-2.76	**	29.55	6.57	**	28.93	6.22	**
		Pouytenga-Ouagadougou	-17.96	-2.73	**	-18.52	-2.92	**	29.70	4.62	**	28.60	3.86	**
		Ouagadougou-Bobo	-4.73	-1.01		-4.79	-1.04		26.34	5.20	**	25.54	4.51	**
		Log likelihood	*-1642.79*			*-1643.21*			*-1474.76*			*-1475.11*		
		Pseudo R²	*0.26*			*0.26*			*0.21*			*0.21*		

Significance level : **5 %. * 10 %. The pseudo R² is calculated following *Mac Fadden* [*1974.* in *Davidson and Mac Kinnon. 1993*. p. 522]. The LR test rejects at the 10% level the hypothesis of nullity of all coefficients.

The estimated selection equations show that, as expected, the fuel price and the real effective exchange rate affect negatively the probability of market integration (table 2). In the autarkic regime, the lagged price coefficient is near one as expected and tested before. In the integrated regime, the lagged price coefficient is close to one in the first sub-sample as predicted by the theoretical model[xi]. In the second sub-sample this coefficient is low with respect to the theoretical restriction. This result may be explained by the existence of delays in prices adjustments. Fixed transaction costs have the expected sign: negative on sub-sample A and positive on sub-sample B[xii].

Table 3. Probabilities of the integrated regime

	Model 1		Model 2	
	$P_i < P_j$	$P_i > P_j$	$P_i < P_j$	$P_i > P_j$
Overall	0.14	0.25	0.14	0.25
Before devaluation	0.08	0.06	0.09	0.06
After devaluation	0.18	0.34	0.17	0.33

Table 4. Marginal impact of distance and real effective exchange rate on the integrated regime probability.

	Model 1		Model 2	
	$P_i < P_j$	$P_i > P_j$	$P_i < P_j$	$P_i > P_j$
Distance	-1.66×10^{-3}	ns	-1.24×10^{-3}	ns
REER	-7.3×10^{-2}	-5.8×10^{-2}	-5.5×10^{-2}	-7.1×10^{-2}

When examining overall probabilities (table 3), we can notice a strong increase in the probability of market integration after the devaluation: the probability of integrated market is at least twice greater after devaluation. Although the devaluation increased the real fuel price expressed in local currency, the potential negative impact on the transaction costs was overcompensated by the reduction of real labour costs. This result supports the hypothesis that transaction costs consist mainly of labour costs. Despite the devaluation, the probability of market integration remains low (between 17% and 34%). This result is consistent with previous analyses on other Sahelian countries using alternative methods [*Araujo Bonjean and Azam*. *1996*; *Fafchamps and Gavian*. *1996*; *Ravallion*. *1986*] and does not contradict the usual observation of segmented markets in developing countries.

The marginal impact of distance on the probability that markets are integrated is negative or non-significant (table 4). This result is consistent with our assumption that distance positively affects transaction costs, *ceteris paribus*. The marginal impact of the real effective exchange on the probability of market integration is negative.

V. Concluding remarks.

The effect of real depreciation of the franc CFA on local market integration has been largely ignored. Our empirical analysis does not reject our main hypothesis that the real depreciation of the franc CFA favoured local market integration in Burkina Faso. This positive effect on welfare provides an additional support to the devaluation decision.

The usual justification for the devaluation of the franc CFA was the positive impact on the Ivoirian economy which in turn was expected to benefit the Burkinabe economy [*Chambas et al., 1999*]. Indeed, the Burkinabe real effective exchange rate had never shown obvious overvaluation before 1994. Our theoretical model and econometric results highlighted another positive impact of devaluation: devaluation favours local market integration through a fall in real labour costs.

This result is due to the predominance of traditional systems of marketing within the country. An interesting extension of this work would be to test the devaluation impact on

West-African markets integration. Our results may not be obviously generalised when markets are more distant. Indeed, means of transport can be less labour intensive and thus the effect of devaluation on market integration less perceptible.

VI. Appendix.

Table 5. Log-likelihood ratio stability tests

Sub-Sample	Model	H0	LR ratio	Number of restrictions	Decision at the 5% level	Decision at the 1% level
A	*Model 1*	I	14.17	6	*H0 rejected*	
		II	0.34	3	*H0 not rejected*	
		III	11.89	3	*H0 rejected*	*H0 not rejected*
		IV	0.81	2	*H0 not rejected*	
		V	4.52	2	*H0 not rejected*	
		VI	5.17	2	*H0 not rejected*	
		VII	1.29	2	*H0 not rejected*	
	Model 2	I	13.07	6	*H0 rejected*	*H0 not rejected*
		II	0.36	3	*H0 not rejected*	
		III	10.69	3	*H0 rejected*	*H0 not rejected*
		IV	0	2	*H0 not rejected*	
		V	3.49	2	*H0 not rejected*	
		VI	4.98	2	*H0 not rejected*	
		VII	1.15	2	*H0 not rejected*	
B	*Model 1*	I	11.29	6	*H0 not rejected*	
		II	4.77	3	*H0 not rejected*	
		III	6.04	3	*H0 not rejected*	
		IV	0	2	*H0 not rejected*	
		V	0.70	2	*H0 not rejected*	
		VI	6.05	2	*H0 not rejected*	
		VII	5.20	2	*H0 not rejected*	
	Model 2	I	11.02	6	*H0 not rejected*	
		II	4.65	3	*H0 not rejected*	
		III	5.79	3	*H0 not rejected*	
		IV	1.15	2	*H0 not rejected*	
		V	0.91	2	*H0 not rejected*	
		VI	6.40	2	*H0 rejected*	*H0 not rejected*
		VII	5.76	2	*H0 not rejected*	

H_0	Significance of the H_0 hypothesis.
I	The prices coefficients in both regimes for all markets are equal.
II	The prices coefficients in the autarkic regime for all markets are equal.
III	The prices coefficients in the integrated regime for all markets are equal.
IV	The prices coefficients for the Bobo market in both regimes are not different from the others.
V	The prices coefficients for the Djibo market in both regimes are not different from the others.
VI	The prices coefficients for the Pouytenga market in both regimes are not different from the others.
VII	The prices coefficients for the Ouagadougou market in both regimes are not different from the others.

VII. Bibliography

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Notes

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[i] Formally, after successive substitutions we can write the contemporaneous price as $P_t = d/r + E_{t-1}P_{t+n} \cdot (1+r)^{-n}$. The transversally condition implies that the last term is zero as time goes to infinity.

[ii] We do not have reliable data on the Gorom market so this market is not included in our sample.

[iii] Excepted for Ouagadougou where data are available since January 1993. There are no other missing data in our sample.

[iv] Cointegration is not a necessary condition for market integration since transaction costs can be non stationary. Cointegration is neither a sufficient condition since, for instance, trade flows between markets are often discontinuous. So, at break points, the correlation between prices is zero. In other words, trade discontinuity introduces potential coefficient instability.

[v] The average LM statistic is 5.59 with a critical value of 6.05 at the 1% level. The average t-statistic is –2.24 with a critical value of –2.40 at the 1% level (see Im and al, 1997).

[vi] Our own calculation. The real effective exchange rate is calculated as the ratio between the national consumer price index and a weighted price index of the main trade partners expressed in the same currency. An increase in the real effective exchange rate means an appreciation of the local currency.

[vii] This does not imply that the labour market is unified. We simply assume that the real depreciation induced a common downward shift in local real wages.

[viii] The *FUEL* variable is measured by the average crude price of petroleum (IMF). We consider that the international fuel price reflects the evolution of the effective fuel price in Burkina Faso because of the importance of informal trade with Nigeria. This price is then expressed in CFA and deflated by the consumer price index.

[ix] Data on climatic shocks are not available. An annual dummy variable capturing severe droughts was introduced without success.

[x] Estimations are run on TSP using a combination of analytic second derivatives and the Berndt, Hall, Hall and Hausman algorithm. We use a robust standard errors matrix to control for possible heteroskedasticity [*White, 1982*].

[xi] A Wald statistic does not reject this hypothesis at the 1% level.

[xii] We notice that these transaction costs do not only reflect the distance between markets. They are also influenced by many other factors such as the quality of infrastructures, the cultural differences, etc.