How Institutions Matter in the Organization and Regulation of Agricultural Markets after Liberalization ? an Institutional Analysis of Hog Market Integration in Vietnam[1]

by
Katell Le Goulven[2]

Abstract :

The recent literature on market integration in developing countries stresses the need for using information on institutional marketing arrangements in the interpretation of cointegration results. In the context of the Vietnamese hog market, this study examines market integration using conventional tests of cointegration between prices of spatial markets. However, to address the importance of institutions, principles from the New Institutional Economics framework are applied to augment results from the conventional approach. The results suggest that price formation and transmission between spatial markets are influenced not only by supply and demand, but also by market institutional structure.

First, we describe the Vietnamese post-liberalization context and resulting hog market organization. Second, we analyze market integration by modeling weekly pork price series in 19 provinces of the country. A VAR model of price fluctuations captures, in a reduced form, the net effects of micro-economic(,) as well as institutional structural mechanisms underlying market interdependencies. In this case, the multivariate Johansen method is applied to identify long run stable vectors in the system of pork retail prices. The associated VECM helps describe the causality between markets, and determinants of price fluctuations and information transmission through impulse analysis and forecast error variance decomposition.

The statistical findings are discussed in the third part. The results suggest that in the long run, hog markets are better integrated in the South of Vietnam, than in the North. In the short run, prices are primarily driven by the demand in the North, and by supply in the South. The economic interpretation of results are given in terms of the growing demand for pork, and the structure of pork production costs. However, some inconsistencies in the results can at least be partially explained by considering market institutions. Using field data, we show that in the North, long term contracts and private institutions contribute to market segmentation. Whereas, in the South, public institutions foster market integration.

Key words : Cointegration, Vector Error Correcting Model, Institutional Arrangements, Institutions, Vietnam.

[1] This paper is a draft, all remarks and comments are welcome.

[2] Ph.D. student in the department of Rural Sociology and Economics at INRA (Institut National de la Recherche Agronomique), legoulve@ensam.inra.fr. I am indebted to Patrick Rio for helpful suggestions and programming assistance. I would also like to thank Jean-Marie Codron, Matt Schaefer and Sophie Thoyer for their helpful comments. All errors are solely my responsibility.

Introduction

For more than a decade, the growth rate of the Vietnamese agricultural sector has been impressive. Productivity gains in the rice sector have led to food sufficiency, and Vietnam is now the second largest exporter of rice in the world. As in other Asian countries specialized in rice production, Vietnamese peasants' income has become very sensitive to world price fluctuations. To maintain agricultural stability and enhance rural development (73% of the population is engaged in agricultural activities), donors and NGOs call for agricultural diversification and the development of appropriate agro-industries.

The findings of a recent report on policy simulation for agricultural diversification stresses that in Vietnam, the livestock (mainly hog) sector is a key sector to « accelerate agricultural growth and contribute to the development of those regions where most of the poor live » (Goletti and Rich 1998, p. 48). Recent and rapid industrialization in Vietnamese cities has led to an increase in consumers needs for meat products. New events in the regional hog market (foot and mouth disease in Taiwan) have created outlets for the Vietnamese high-valued hog industry to export to Japan. A necessary condition to foster rural development and specialization is that prices are efficient in the sense they optimally reflect available information. It is straightforward that prices determined in hog marketing channels which do not efficiently convey changes in the supply and demand situation will in turn affect producers' incentives to raise hogs. Therefore, the central issue of this paper is the degree of hog market integration between consumption and production areas.

Two spatial markets for the same commodity are said to be integrated if their prices share the same long-term stochastic trend ; that is if the prices are cointegrated. On the contrary, two markets are said to be segmented if prices of the commodity in both locations do not move together over time. If two spatially separated markets are integrated, new supply/demand information represented by a price shock in market one, is transmitted to market two in the form of another price shock. Market integration can then be evaluated using the theory of cointegration in prices.

The results suggest that in the long run, hog markets are better integrated in the South of Vietnam, than in the North. In the short run, prices are primarily driven by the demand in the North, and by supply in the South. The economic interpretation of results are given in terms of the growing demand for pork, and the structure of pork production costs. However, some

inconsistencies in the results can at least be partially explained by considering market institutions. Using field data, we show that in the North, long term contracts and private institutions contribute to market segmentation. Whereas, in the South, public institutions foster market integration.

Study area and data

In Vietnam, the hog market remains domestically oriented. With an annual growth of 3.8 %, hog production generated 71 % of the animal husbandry gross output in 1995 (General Statistical Office 1996). Hog production is concentrated in Northern regions of Vietnam (63%) and in the Mekong delta (Table 1). The latter being an exception, hog production is located in poor rural areas where annual income is below the national average (Table 1). For these peoples hogs production is a form of precautionary savings and often the only way for peasants to get cash income (Le Goulven 1996). Whereas in most regions hog raising is a backyard small-scale production (80% of the households are raising one to two hogs per year (Le Ba Lich 1996)), a growing number of farms in the south are becoming specialized in intensive hog raising (80% of the industrial foodstuff produced in 1998 were sold in the south).

Leaving out self-consumption (for weddings and traditional ceremonies), 90% of fattened hogs are marketed. Half is sold at local stalls of rural areas where meat consumption consists of fat pieces and is limited to 5kg/head/year. The still low level of meat consumption in rural areas generates surplus which is supplying large cities. There, consumption is increasingly occidentalized (cooking oil, lean meat) and is rising up (up to 35kg/head/year in Ha Noi) with income (Le Goulven to be published 1999).

The two central transactions between production and consumption areas are 1) the transaction of live hogs between producers and collectors (T_1), and 2) the transaction of carcasses between collectors and retailers (T_2). In T_1, hog collectors buy live hog from producers widely dispersed in the countryside. As there is no refrigerating chain, hogs are transported alive and then slaughtered the same day close to the place where pork is sold and consumed. Transportation infrastructure is the same throughout the country. No proper meat processing plants (with slaughtering line) is supplying the domestic market with carcasses. Slaughterhouses are very basic setups where animals are killed and dressed manually. In the north, slaughterhouses privately owned facilities licensed or not by a city's People's Committee. Meat buyers are retailers, there is no specialization in meat wholesale. In the

south, slaughterhouses are owned by cities' People's Committees and located at the periphery of urban centers. Once butchered, carcasses are sold on wholesale markets to meat buyers.

How do differences in production systems and in marketing channel organizations affect hog market integration in Vietnam ? Do they convey price fluctuations from cities to production areas the same way ? In which areas do prices convey demand (supply) information from deficit (surplus) markets thereby stimulating specialization and rural development ?

To answer those questions we analyze price relationships between spatially isolated locations involved in inter-provincial trade. Weekly prices from the central market of the capital of each regional province have been collected by a local employee of the Institute for Markets and Prices. Our sample is from January 1993 to June 1998 (264 observations). Nineteen weekly retail pork series are considered in production areas, as well as in large consumption areas of several regions. The main deficit provinces are Ha Noi, Hai Phong and Quang Ninh in the North and Ho Chi Minh city is the south. The largest Northern surplus areas are located in the Red River Delta (Hai Hung, Ha Tay, Nam Dinh provinces) and in the North Central Coast (Thanh Hoa, Nghe An). In the south, the major production areas are the South Central Coast (Da Nang, Quang Ngai), the Central Highlands (Dac Lac), the North East South (Dong Nai) and the Mekong Delta (Tieng Giang, Ben Tre, Vinh Long, Can Tho, Minh Hai). Price series from these nineteen markets are modeled to investigate spatial integration.

Background and related literature

The analysis of market integration is at the core of debates on food market liberalization, price policies and parastatal reforms in developing countries. Following Timmer (Timmer 1974) and Ravallion (Ravallion 1986), studies have been conducted on food market integration in the context of famine prevention policies (Heytens 1986; Silvapulle and Jayasuriya 1994; Dercon 1995; Ismet, Barkley et al. 1998). Weak integration between spatial markets reflects the absence of product flows from surplus to deficit areas, therefore threatening local population with famine. A large body of literature also focuses on market integration of agricultural products that are strategic for development (horticulture, livestock...) (Goletti and Babu 1994; Mendoza and Rosegrant 1995; Fafchamps and Gavian 1996; Guvheya, Mabaya et al. 1998). Evaluating the impact of liberalization or other external shock effects on market integration is often the major concern of these works (Goletti and Babu 1994; Loy, Glauben et al. 1994; Dercon 1995). In this paper, we assume market liberalization as given, and examine market integration and its determinants. The objective is to determine whether there is a

relationship between institutional structure of markets, market integration and rural development.

Addressing market integration using existing price analysis methodologies is an essential step in the diagnostic process, but remains a weak descriptive tool if not complemented by systematic empirical and historical marketing research. Information about market organization and regulation can be gathered via rapid appraisal, secondary sub-sector data or large scale and representative surveys. Structural factors usually identified as affecting market integration are linked to production (inputs, technology, labor, climate), consumption (diet, elasticities, income), marketing infrastructure (transportation, communication, credit) and price policy. Following North and the New Institutional Economists, we stress markets are structured by institutions (North 1995) and that institutional marketing arrangements should be considered when analyzing market integration (Palaskas and Harriss-White 1993).

Indeed, traders resort to specific arrangements to reduce transactions costs emerging from multiple uncertainties (Williamson 1985). In Vietnam, as in other transition and developing countries, uncertainty is affecting trade more than elsewhere. In addition to traditional uncertainty, for example changes in consumers' preferences and weather, newly privatized traders have to cope with an unstable environment of changing policies and evolving marketing behaviors. Using the case study approach we show that specific marketing arrangements and associated governance structures which traders resort to in this uncertain context, may affect price formation and information flows, thus market integration.

The tools used to analyze market integration and price causality between spatial markets have significantly evolved during the last decade[3]. The idea of cointegration (Engle and Granger 1987) suggests that if prices p_x and p_y belonging to market X and market Y respectively are not stationary and are both integrated of order one, I(1), then a constant can exist so that a linear combination of p_x and p_y,

$$z = p_x - \beta p_y \qquad \textbf{(1)}$$

is stationary, I(0). If such a relation exists, p_x and p_y are said to be cointegrated. It follows that markets X and Y are linked by a long run stable economic relation, i.e. X and Y are integrated in the economic sense.

[3] see (Sarker 1995; Zapata and Gil 1999) for literature review.

The first step of the procedure is to test each individual series for integration of order 1 with the Augmented Dickey-Fuller test (Dickey and Fuller 1979). The second step is to test whether the series are cointegrated. Sarker identifies six different procedures to test for cointegration (Sarker 1995). Five are based on conventional or modified regression analysis : the Dickey-Fuller test on the residuals of the regression between two variables, the cointegration regression Durbin-Watson (CRDW) test (Engle and Granger 1987), the Park J_1 test, the Hansen fully modified regression estimator L_c test (Hansen 1992) and the test of common trend of Stock and Watson (Stock and Watson 1988). The sixth is based on a Vector Autoregressive model (VAR), it is the maximum likelihood cointegration method developed by Johansen (Johansen 1988; Johansen and Juselius 1990). The first four methods consider a unique equation whereas the last two are multivariate methods. Bivariate models of price series have been shown to lead to misinterpretation of integration since two markets « could be highly correlated via the price and trading relationship of a joint destination market »(Harriss 1979, p. 202). A multivariate model will thus be preferred.

VAR models have been advocated by Sims as a way to estimate relationships among endogenous variables « without restrictions based on supposed a priori knowledge »(Sims 1980, p. 15). Therefore, a VAR model of price fluctuations captures, in a reduced form, the net effects of **all** the structural mechanisms (production, consumption, price policy, infrastructure and institutions) underlying market interdependencies without stating or modeling them. In this paper, the Johansen method is used to identify cointegration relations among a set of variables (markets). When prices are cointegrated, the method also helps ascertain whether prices respond primarily to supply or demand shocks.

Cointegration model

Stationarity

A necessary condition for patterns of price co-movements to be a good indicator of market efficiency is that exchanged commodities only flow in the same direction between two locations ; this is (Timmer 1974). Moreover, hogs are sorted at the first step of the marketing chain to supply local urban stalls. Commodities are considered homogeneous and results of market integration analysis are thus not biased (Fafchamps and Gavian 1996).

All data are deflated using the Consumer Price Index (Department of Trade and Price Statistics 1993-1998). The first step of cointegration analysis is to test for the stationarity of

the series. Yet two types of non stationary variables exist, and the difference between them is extreme in statistical, as well as in economic terms (Tavera 1991). Nonstationarity can be due to the presence of one or more unit roots in the process or can be the consequence of an exogenous deterministic trend. In the first case, stationarity is obtained by differencing (DS processes), in the second case it is obtained by regressing the series on a temporal trend (TS processes). To test for the presence of unit roots in each individual series, we use the Augmented Dickey Fuller test[4] (Dickey and Fuller 1979). The results of the test, in Table 3, show that all the series are integrated of order 1 (DS processes). Next, cointegration is tested for using Johansen procedure.

Johansen procedure (from (Harris 1995) and (Hansen and Juselius 1995))

Johansen tests (Johansen 1988; Johansen and Juselius 1990; Johansen 1991) determine the number of cointegration equations (cointegration rank) of a multivariate process. Johansen method starts from a Vector Autoregressive expression (VAR) where z_t has *n* endogenous variables :

$$z_t = \zeta + A_1 z_{t-1} + \ldots + A_k z_{t-k} + u_t \qquad \textbf{(6)}$$

and where u_t is a serially uncorrelated error term, where z_t is (n*1) and all the A_i are (n*n) matrixes of parameters. A decomposition of the process results in an error correcting form :

$$\Delta z_t = \mu + \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-k} + u_t \qquad \textbf{(7)}$$

where $\Gamma_i = -(I - A_1 - \ldots - A_i)$, (i=1,...,k-1) and $\Pi = -(I - A_1 - \ldots - A_k)$.

The cointegration hypothesis is formulated as a reduced rank of the matrix Π :

$$H_1(r): \Pi = \alpha\beta'$$

where α and β are full rank n*r matrixes. $H_1(r)$ induces that the process Δz_t is stationary, z_t is nonstationary but βz_t is stationary (Johansen 1991).

Γ_i and Π estimates contain information on short and long run respectively. Johansen's method indicates the number of cointegration vectors that exist between the series of z_t and that correspond to the rank of the long run coefficients matrix.

[4] We also tested for a unit root allowing the possibility of a one-time structural change in the trend function (Perron 1989). Results of this test are available from author upon request.

The matrix Π can be decomposed as $\Pi=\alpha\beta'$, where α stands for the speed of adjustment to disequilibrium and β is a long term coefficients matrix defined so that $\beta' z_{t-k}$ represent up to *(n-1)* cointegration relations of the multivariate model which insure that z_t converges towards their stable long run solutions. We therefore try to identify the rank of β. Testing for cointegration amounts for finding the number *r* of linearly independent columns in Π[5], which amounts for testing that the last *(n-r)* columns of α are non-significant (effectively null).

Johansen (Johansen 1988; Johansen 1991) and Johansen et Juselius (Johansen and Juselius 1990) show how to estimate cointegration model using maximum likelihood estimation. The likelihood function is first concentrated with respect to Γ_1, ..., Γ_{k-1} parameters, with a regression of Δz_t and z_{t-k} on Δz_{t-1},..., Δz_{t-k+1} and, 1 in (7). This defines the residuals R_{0t} and R_{kt} and the residual cross moment matrices :

$$S_{ij} = T^{-1}\sum_{t=1}^{T} R_{it}R'_{jt} \qquad \text{i,j=0,k} \qquad \textbf{(9)}$$

The concentrated likelihood function has the form of a reduced rank regression :

$$R_{0t} = \alpha\beta' R_{kt} + error \qquad \textbf{(10)}$$

For fixed β, (10) can be resolved for α by regression :

$$\hat{\alpha}(\beta) = S_{0k}\beta(\beta' S_{kk}\beta)^{-1}, \qquad \textbf{(11)}$$

and the maximum likelihood estimate of β is determined by solving the eigenvalue problem

$$\left|\lambda S_{kk} - S_{k0}S_{00}^{-1}S_{0k}\right| = 0. \qquad \textbf{(12)}$$

The eigenvalue problem has *n* solutions, $1 > \hat{\lambda}_1 > \ldots > \hat{\lambda}_n > 0$, with the corresponding eigenvectors $\hat{V} = (\hat{v}_1, \ldots, \hat{v}_n)$ which are normalized by $\hat{V}' S_{kk}\hat{V} = I_n$. The maximum likelihood estimates for β are :

$$\hat{\beta} = (\hat{v}_1, \ldots, \hat{v}_r), \qquad \textbf{(13)}$$

and the maximum likelihood function is :

$$L_{\max}^{-2/T} = \left|S_{00}\right|\prod_{i=1}^{r}(1-\hat{\lambda}_i). \qquad \textbf{(14)}$$

[5] If r=n, all the vectors in β are I(0) and z_t is thus stationary, there is no spurious regression and the appropriate

Two likelihood ratio tests are used to determine the rank of Π. The trace statistic which tests for the reduced rank hypothesis ($H_1(r): \prod = \alpha\beta'$). An the λ_{max} statistic which is built on a comparison of $H_1(r)$ given $H_1(r+1)$.

The null hypothesis in each likelihood ratio test is $\lambda_{r+1} = \lambda_{r+2} = \ldots = \lambda_n = 0$, which signifies that the system has *n-r* unit roots. In order to determine the cointegration rank, we use a sequence of null hypotheses starting with the hypothesis of *n* unit roots. If this null hypothesis is rejected, its implies that $\lambda_1 > 0$ and we continue to test the null hypothesis that $\lambda_2 = \lambda_3 = \ldots = \lambda_n = 0$. Rejecting this null hypothesis implies that $\lambda_2 > 0$ and so forth. When we fail to reject the null hypothesis, we have the number of unit roots and thereby the number of cointegration vectors.

These hypotheses tests are thoroughly delineated by Johansen and Juselius (1990), and the mathematical derivations of asymptotic distributions are given in Johansen's works (Johansen 1988; Johansen 1991).

Results and analysis

A cointegration test is first applied to pairs of markets. Results show that none of the Northern markets are cointegrated with Southern markets. These results are consistent with the hypothesis that vast distances (Ha noi and Ho Chi Minh city are 1700 km apart) and poor transportation infrastructure lead to high transactions costs, hereby making arbitrage unprofitable and isolating markets (Faminow and Benson 1990). Therefore, from this moment forward, the country is split into two hog market systems : the Northern market system (including the markets of the North Midland, Red River Delta, North Central Coast regions), and the Southern market system (including the markets of South Central Coast, Central Highlands, North East South and Mekong Delta regions). The results of bivariate cointegration tests within the Northern and Southern market systems are given in Table 3.

Efficiency of information flows

First, the evidence suggests hog prices from pairs of individual markets in the south system have a greater tendency to move together in the long run than do prices from pairs of individual markets in the north system (82% against 72%). In the north system, two surplus regional markets which are cointegrated have also a cointegration relationship with Ha Noi

---

modeling of the system is a VAR in levels.

(which is connected to all the markets) : the bias of an indirect cointegration resulting from a joint destination market seems relevant here. On the contrary, in the southern system, hog prices from two supplying areas (Dong Nai and Da Nang for instance) can be co-integrated without being co-integrated to prices from Ho Chi Minh city. Ho Chi Minh is only integrated with 7 other markets, whereas Dong Nai, Ben Tre and Vinh Long, three supplying areas, are connected to all the markets.

Second, the evidence suggests that large spatial distance between supplying and demanding Northern provinces results in market isolation. For example, the supplying areas of Thanh Hoa and Nghe An which are respectively 150 and 300 km way from Ha Noi, are segmented from Red River Delta and North Midlands production areas. Such a correlation is not valid in the South. For instance, Da Nang and Quang Nai are respectively 800 and 650 km away from Ho Chi Minh city, and are integrated to Mekong Delta markets, even in the extreme case of Minh Hai.

The Southern system contain more bilateral cointegration relations than the Northern system. No surplus province is segmented from other production areas in the South. Results in the southern system are not consistent with the hypothesis that distance has a negative effect on price correlation in livestock markets of developing countries (Fafchamps et Gavian, 1996). This implies that information is transmitted more efficiently in the South than in the North.

Identification of long run leader markets

Proceeding, the Johansen multivariate method is applied separately to each market system. It has been shown that results from VAR models are sensitive to the number of lags chosen (Hafer and Sheehan 1991; Deniau, Fiori et al. 1992). In this analysis we use Sims modified likelihood ratio test (Sims 1980), the Akaike (Akaike 1974), and the Bayesian information criteria (Schwarz 1978) to determine appropriate lag length (7 for the north system and 9 for the south one[6]). Results of Johansen's test for reduced cointegration rank ($r<n$) suggest 2 cointegration vectors for both systems (see Table 4).

Identifying cointegration vectors among hog price series of the two systems has a weak explaining power for the actual dominance or causal links between markets. In other words, β is « an unknown parameter vector rather than a set of constants given by economic theory » (Engle and Granger 1987, p. 255). Nevertheless, when cointegration vectors have been

[6] Results of this test are available from the author upon request.

specified, the error correcting formulation (7) can be used as the basis for testing for weak exogeneity and exclusion among the hog price series. Exclusion will test for the contribution of specific prices series for defining the cointegration relations (i.e. long run equilibrium). Weak exogeneity will test for the adjustment to those relations each price series has in response to disequilibrium. When a price series is weakly exogenous, it does not respond to the previous period's deviation from long run equilibrium.

If we consider a model split in two groups *y* and *x*, with $z_t=(y_{1t},y_{2t},x_t)'$ and where n=3, k=2 and r=2 following (Hansen and Juselius 1995):

$$\begin{bmatrix}\Delta y_{1t}\\ \Delta y_{2t}\\ \Delta x_t\end{bmatrix} = \Gamma_1\begin{bmatrix}\Delta y_{1t-1}\\ \Delta y_{2t-1}\\ \Delta x_{t-1}\end{bmatrix}+\begin{bmatrix}\alpha_{11} & \alpha_{12}\\ \alpha_{21} & \alpha_{22}\\ \alpha_{31} & \alpha_{32}\end{bmatrix}\begin{bmatrix}\beta_{11} & \beta_{21} & \beta_{31}\\ \beta_{12} & \beta_{22} & \beta_{32}\end{bmatrix}\begin{bmatrix}y_{1t-1}\\ y_{2t-1}\\ x_{t-1}\end{bmatrix}+\begin{bmatrix}\varepsilon_{1t}\\ \varepsilon_{2t}\\ \varepsilon_{3t}\end{bmatrix} \qquad \textbf{(15)}$$

The weak exogeneity hypothesis is based on the columns of α when studying the long run parameters α and β. The condition for x_t to be weakly exogenous for β in (15) is that $\alpha_{31}=\alpha_{32}=0$ since this implies that the equation for Δx_t does not contain information about the long run parameters β. If $\alpha_{3i}=0$, where i=1,2, then x_t is a weakly exogenous variable.

In a VAR model, it is possible that only a subset of the variables of vectors z_t are necessary to define the cointegration space. Therefore, we can test for the exclusion of some endogenous variables from the cointegration space. If we consider that x_{t-1} is not necessary to obtain the stationary long run relations in (15), then $\beta_{31}=\beta_{32}=0$: x_t is excluded from the group of variables involved in the long run stable relations.

The results from exclusion and weakly exogeneity tests for each price series are given in Table 5. They suggest the following classification of markets :

i) *Long run segmented markets*. They are identified when associated price series are excluded and weakly exogenous from the cointegration relations (Hog price series which are excluded from long run relations are not expected to respond to any disequilibria) : Hai Hung, Nam Dinh, Hai Phong and Nghe An in the North and Vinh Long and Minh Hai in the South. Part of the explanation comes from the distance or the weak supplying flows between production areas and large cities centers (Nghe An is far away from Ha Noi, Minh Hai is mostly autarkical, and two ferryboat crossings separate Vinh Long from Ho Chi Minh city). The long run segmentation of Hai Hung, Nam Dinh and Hai Phong in the North remain unexplained.

ii) *Long run leader markets*. They are identified when associated price series are non excluded and weakly exogenous from the cointegration relations : Ha Tay, Quang Ninh in the North and Ho Chi Minh, Ben Tre, Tieng Giang and Quang Ngai in the South. Price series contribute to the definition of cointegration vectors, but do not respond to a previous period deviation from long run equilibrium. Part of the explanation lies in the fact that hog prices are responding more to local growing demand signals than to cointegration relations. If the gross output of industry and/or its growth rate are used as proxies of the growth of local demand for meat (see Table 6), one can observe that weakly exogenous and non excluded price series are often associated with markets where demand is growing (industrializing areas). Demand growth in Ben Tre and Quang Ninh is fostered by tourism.

iii) *Long run follower markets*. They are identified when associated price series are non excluded and non weakly exogenous : Ha Noi, Vinh Phu in the North and Dong Nai, Dac Lac and Can Tho in the South. Prices series play an important role in determining cointegration vectors but are responding to any disequilibria in the long run.

iv) *Long run regulator markets*. They are identified when associated price series are excluded and non weakly exogenous : Thanh Hoa in the North and Da Nang in the South. These two areas act as regulators of Ha Noi and Ho Chi Minh supply respectively. They do not constantly supply the big consumption areas, but help adjusting supply when demand is affected by random shocks : if a sudden increase in demand is observed in Ha Noi (Ho Chi Minh), hogs will be purchased from Thanh Hoa (Da Nang).

Short run analysis : Downstream versus upstream driven price movements

In this section we try to ascertain whether prices respond primarily to supply or to demand shocks in the short run. If markets which are located upstream, close to hog production areas, Granger cause[7] prices in downstream markets, one can say that price movements are driven by supply shocks and vice versa. Provinces « that Granger-cause more than they are Granger - caused are points from which prices shocks spread to other markets » (Fafchamps and Gavian 1996, p. 385). This is very similar to defining dominant and satellite markets. Dominant markets « are preeminent in the price discovery process and make little use of prices formulated elsewhere. Satellite markets rely on dominant markets as the primary source of

[7] A series y_t is said to Granger Cause a series x_t if x_{t+1} is better forecast if information on y_t is used than if it is not (Granger 1969).

information (lagging dominant markets and having limited influence on prices in dominant markets). » (Koontz and alii 1990, p. 124-125).

This issue is addressed by studying short run causal relations between price series using impulse analysis and forecast error variance decomposition (FEVD). To determine the effects of innovation shocks on one specific price series, the error correction formulation (7) is inverted into a moving average process[8]. In the context of this model, « impulse responses capture the effects of deviations from the long run equilibrium on the dynamic paths followed by each variable in response to initial shocks » (Sarker 1993, p. 105). The results of impulse response analysis are given in Tables 7 and 8[9].

To conclude whether these responses are large enough to explain a substantial fraction of the short run variation in the data, we decompose the forecast error variance attributed to innovations in the common stochastic trends of the econometric model of the market system. While non-zero impulse responses indicate the presence of Granger causality, variance decompositions yield measures of Granger causal priority : « A natural measure of the degree to which Granger causal priority holds is the percentage of FEV accounted for by a variable's own future disturbances in a multivariate linear autoregressive model...A variable that is optimally forecast from its own lagged values will have all its FEV accounted for by its own disturbance » (Sims, 1982) quoted by (Sarker 1995, p. 20). The results of the FEV decompositions are given in Tables 9 and 10 and suggest the following classification :

i) *Dominant markets*. They are markets which price series' FEV are mostly explained by their own innovations at the 4 weeks horizon. Moreover, all prices respond within 4 weeks to a shock in dominant markets' prices : Ha Noi in the North, and Can Tho, Dong Nai, and Quang Ngai in the South. In a 4 to 8 weeks lag-time, Hai Phong and Hai Hung in the North as well as Tieng Giang in the South are becoming dominant markets.

ii) *Satellite markets*. They are markets which respective price series' FEV is mostly explained by dominant markets' prices. Their prices respond to initial shocks in other series with a time lag : Nam Dinh, Nghe An, Quang Ninh, Ha Tay, Thanh Hoa and, Vinh Phu in the

[8] For a detailed explanation of this procedure see (Hamilton 1994, pp 318-319).

[9] As errors are never uncorrelated, they are first orthogonalized by a Cholesky decomposition (Hamilton 1994, p. 322). This method is widely used but is very sensitive to the ordering of the variables within the system which can affect the results of both the impulse and the FEVD analysis. Here, variables have been ordering according to the significance of their Γ_i in (7) as it contains information on the short run behavior of the series in the system. Γ_i values are available upon request.

North and Vinh Long, Minh Hai, Ben Tre, Ho Chi Minh, Dac Lac and, Da Nang in the South.

In the short run, prices are primarily driven by demand in the North and by the supply in the South. Most of the results from the short run analysis are consistent with the long run tests. Long run segmented, follower, and regulator markets are satellite markets in the short run. Nevertheless, some long run segmented (Hai Hung and Hai Phong) and follower markets (Ha Noi and Can Tho) are dominant on the short run. Some long run leaders (Quang Ninh, Ha Tay, Ben Tre and Ho Chi Minh) are short run satellite markets.

An explanation for such a difference would be linked to the structure of production and mostly production costs. When hog production costs remain opportunity costs (animals fed with crop residuals), prices changes tend to evolve from shifts in demand. On the contrary, when a market exhibits an advanced level of industrialization in the hog production process, which results in fixed (buildings) and variable (feedstuff) costs which must be covered, price changes tend to evolve from supply shocks. As a consequence, long run leader (follower) markets can be short run satellite (dominant) markets depending on long term production investments and short term patterns of demand. Nevertheless, the situation of some markets, particularly Hai Hung and Hai Phong, remain unexplained. In the next section, we show that more explanation on previous results and contradictions is possible in terms of the underlying structure of the institutional arrangements in the Vietnamese hog marketing channels.

Market institutions[10]

Because slaughterhouses are located in urban areas and no refrigerating facilities are available to store carcasses, prices are negotiated on the basis of a quality evaluation performed on live animals for T_1. Quality evaluation is complex and generates high *ex-ante* measurement costs. The evaluation process depends on the individual competencies and on the knowledge of production parameters. Thus, T_1 is affected by information asymmetries between transacting parties.

Under the behavioral hypothesis of bounded rationality of actors, two types of uncertainty affect transactions. First, state-contingent uncertainty arises « from random acts of nature and

[10] The section presents results from the analysis of primary data collected through surveys led in 1997 and 1998 in 10 provinces with 100 producers, 37 collectors (Hai Hung, Ha Bac, Vinh Phu, Nghe An, Dong Nai, Can Tho), 23 slaughtermen and 72 retailers (Ha Noi, Hai Phong, Quang Ninh, Ho Chi Minh). The main findings will be presented in a forthcoming paper.

unpredictable changes in consumer's preferences » (Koopmans 1957 quoted by Williamson 1985, p. 57). Second, behavioral uncertainty is linked to human action and its unpredictability in some specific contexts (Williamson, 1985). Potential opportunism may arise when traders don't reveal their information on the characteristics of the product, or when they cheat their partner. For instance, hog producers in Vietnam have a better knowledge of the sanitary aspect of their animals and may not reveal it to the buyer. They may also feed their hogs before selling to increase their weight.

To reduce information costs and attenuate potential opportunism, actors build or use institutions modeling a structure that govern their transactions (Williamson 1996).

In northern Vietnam, most transactions are governed by relational contracts (Macneil 1974). Repeated transactions allow parties to build inter-individual trust and reputation which are used to enhance cooperation and reduce potential opportunism. However, as Milgrom and alii emphasize, when information is widely spread and shared within a community, transactions do not need to be repeated for the loss of reputation to be a credible threat (Milgrom, North et al. 1985). In the case of T_1 in north Vietnam, reference communities are villages and collector networks. When producers and collectors are from the same village, none will try to cheat the other on the quality for fear of loosing their social rank. There, social status is based on fulfilling the traditional roles within the community. Northern villages are described as closed corporate communities by anthropologists: « they are corporate organizations, maintaining a perpetuity of right and membership ; and they are closed corporations because they limit these privileges to insiders, and to discourage close participation of members in the social relations of the larger society » (Rambo 1973, p.28). Incentives for opportunism are higher when collectors buy hogs from other villages. To prevent opportunistic situations, collectors get information on the past conduct of potential sellers from other members of their networks. Vietnamese trader networks help collectors economize on information and screening costs, and also provide a multilateral-reputation-based enforcement mechanism to prevent reneging risk[11] when not trading inside their villages. Networks also work as a price regulator. Indeed, several times a week, members of the same network gather to negotiate a benchmark buying price. Surveys show that 73 % of them always (22% sometimes) respect this benchmark when buying hogs from producers.

[11] Identical mechanisms exist in a lot of developing and transition countries (Greif 1996).

In the south of the country, even if collectors work together and help each other during transportation (Palama 1994), nothing like a benchmark price mechanism exists among them. For T_1, exchanges are governed by bilateral trust resulting from ongoing trade relationships. The same repeated purchase, bilateral type of enforcement exists within a village or when contractors belong to distinct villages. Southern villages are characterized as open peasant communities where social status is derived from wealth, and power alliances with outsiders. « Physical dispersal, frequent redrawing of village boundaries by central government, and the relatively high rate of in-migration of settlers from other areas all militate against the development of any sense of village solidarity » (Rambo 1973, p.44).

T_2 is a spot transaction in the North and in the South. Nevertheless, for hogs to supply large city centers, T_2 has to be associated with two inter-linked services.These are slaughter and supply gathering : services which are provided by private actors in the North and by public institutions in the South.

- In the north, each collector is affiliated to a specific urban intermediary (slaughterman) who connects him to buyers. Each collector is bound to his slaughterman with a long term supplying contract enforced by mutual bilateral trust. One slaughterman is working with many collectors from different supplying areas. Relational contracts allow for credit exchanges between actors. The difficult access to credit for small entrepreneurs in Vietnam (Ronnas 1992; McMillan and Woodruff 1999) is compensated by inter-linked transactions in the hog marketing chain. In the north, 83% of the collectors get credit or advanced payments from slaughtermen when transacting hogs. When bilateral trust is no longer a credible threat for collectors, slaughtermen hire « debt collectors » (mainly former criminals) who also enforce oral contracts and property rights. Therefore, in the North, Slaughtermen are central economic agents, whereby providing all services, concentrating information, and providing credit without buying animals. They get high returns from their key position in the chain, and the power to be price makers (Le Goulven 1998).
- In the South, slaughtering services are provided by local legal authorities (People's Committees). In T_2, collectors sell carcasses to retailers on spot wholesale markets. The price is negotiated on the basis of observable carcass and meat characteristics. In the two wholesale markets of Ho Chi Minh city, collectors from all supplying areas sell their meat by auction every morning. In the South, usury is not concentrated in the hands of one actor in the chain and credit supply is more diversified.

In the South, institutional arrangements (spot contract for T_2) allow for collector arbitrage between deficit markets. Moreover, wholesale markets enhance competition and price uniformity among suppliers (even for distant ones). Thus, the market institutions of the southern system favor prices at spatial locations to reflect market information, and therefore enlarge the extent of market integration.

In the North, long term (often violently enforced) contracts between collectors and slaughtermen result in high search costs for alternative trading partners. These costs reduce arbitrage opportunities between alternative destination markets, thereby segmenting market prices across spatial locations. Moreover, urban price makers (slaughtermen) determine dominant markets in consumption areas. Due to the benchmark price system created by collector networks, prices in rural areas don't have informational advantage, and will therefore reflect dominant prices with time-lag (satellite markets).

Conclusion

In every region of Vietnam, irrespective of the marketing chain structure, urban stalls are provided with fresh and lean meat everyday. One could therefore claim that market structure is efficient as it satisfies consumers' needs. Nevertheless, we show that markets are more integrated in the South than in the North, and that price shocks are only demand driven in the north. As a result, hog prices in southern Vietnam more efficiently reflect available supply and demand information, whereby providing proper information to producers enhancing development and specialization in the hog industry as a whole.

Different market institutions, as well as demand and supply characteristics, are explanatory variables for market integration. On the one hand, in the North, market institutions are private : private trader networks reduce information costs and attenuate potential opportunism in rural areas, and private, violent institutions enforce contracts and prevent reneging risks in cities. On the other hand, in the South, market institutions are mainly public : slaughter houses are all ruled by local authorities that provide public services, and carcasses are sold in wholesale auction markets.

Those findings carry a double paradox. First, considering that Vietnamese collectivization has been stronger and existed longer in the North than in the South, one could expect more public good to be provided in the North. Second, where public institutions structure markets, price

transmission and market integration is better than cases where private institutions structure markets.

Showing that « institutions matter » is no novelty as donors themselves have acknowledged it since the Asian Miracle (The World Bank 1993), and praised it in following Annual Conferences on Development Economics (Stiglitz 1999). In the broad « institutions matter » frame of mind, one could be tempted to transfer the southern institutional structure of the hog market to the north. But it would overlook differences in market embededness in both locations. Following national directives, the Ha Noi People's Committee also aims at centralizing slaughter to better switch to public plants. Forums are also organized with slaughtermen and retailers in an attempt to create wholesale markets in the capital. However, our surveys show that in Ha Noi, slaughtermen have no personal incentive to gather. In a tradition where disputes are solved in a family or community context, they do not trust the intervention of a local administration which hardly has power to enforce new rules (Schwarz 1995; Fforde and de Vylder 1996).

What is emerging from our case study is that « what institutions ? » and « how do they matter ? » should be the central questions guiding research. Then, the first step to de-isolate markets and foster integration in northern Vietnam is to provide credit to small traders to bring them away from slaughtermen's control and foster arbitrage between provinces. NGOs have a tradition to develop micro credit programs for producers, but they should also target small traders. To do so, middlemen shouldn't not only be seen as rent seekers but also as risk takers promoting long distance trade.

References

Akaike, H. (1974). "A New Look at the Statistical Model Identification." I.E.E.E. Transaction on Automatic Control **19**(6): 716-723.

Deniau, C., G. Fiori, et al. (1992). "Sélection du nombre de retards dans un modèle VAR, conséquences éventuelles du choix des critères." Economie et Prévision **5**(106): 61-70.

Department of Trade and Price Statistics (1993-1998). Today's price index. Thông Tin Magazine**:** 19.
Dercon, S. (1995). "On market integration and liberalisation: Mathod and application to Ethiopia". The Journal of Development Studies **32**(1): 112-143.

Dickey, D. A. and W. A. Fuller (1979). "Autoregressive time series with a unit root." Journal of the American Statistical Association **74**(366): 427-431.

Engle, R. F. and C. W. J. Granger (1987). "Cointegration and error correction: representation estimation and testing." Econometrica **55**: 251-276.

Fafchamps, M. and S. Gavian (1996). “The spatial integration of livestock markets in Niger.” Journal of African Economies **5**(3): 366-405.

Faminow M. D. and Benson B. L. (1990). “Integration of spatial markets.” American Journal of Agricultural Economics **72**(1): 49-62.

Fforde, A. and S. de Vylder (1996). From PLan to Market : The Economic Transition in Vietnam. Boulder (Colorado), Westview Press.

General Statistical Office (1996). Impetus and present situation of Vietnam society and economy after ten years of Doi Moi. Ha Noi, Statistical Publishing House.

Goletti, F. and S. Babu (1994). “Market liberalization and integration of maize markets in Malawi.” Agricultural Economics **11**: 311-324.

Goletti, F. and K. Rich (1998). Policy Simulation for Agricultural Diversification. Washington, IFPRI.

Granger, C. W. J. (1969). “Investigating causal relations by econometric models and cross-spectoral methods.” Econometrica **37**: 424-438.

Greif, A. (1996). Contracting, Enforcement, and Efficiency : Economics Beyond the Law. Annual World Bank Conference on Development Economics, Washington, D.C., The World Bank.

Guvheya, G., E. Mabaya, et al. (1998). Horticultural Marketing in Zimbabwe: margins, price transmission and spatial integration. Agricultural, Ressource and Managerial Economics. Ithaca, Cornell**:** 30.

Hafer, R. and R. Sheehan (1991). “Policy inference using VAR models.” Economic Inquiry **29**: 44-52.

Hamilton, J. D. (1994). Time series analysis. Princeton, Princeton University Press.

Hansen, B. E. (1992). “Test of parameter instability in regressions with I(1) process.” Journal of Economic and Business Statistics **10**: 321-335.

Hansen, H. and K. Juselius (1995). CATS in RATS Cointegration Analysis of Time Series. Evanston, Il, Estima.

Harris, R. I. D. (1995). Using Cointegration Analysis in Econometric Modelling. Hemel Hempstead, Prentice Hall/Harvester Wheatsheaf.

Harriss, B. (1979). “There is method in my madness : or is it vice versa ?
Measuring Agricultural Market Performance.” Food Research Institute Studies **17**(2): 197-218.

Heytens, P. J. (1986). “Testing Market Integration.” Food Research Institute Studies **20**(1): 25-41.

Ismet, M., A. P. Barkley, et al. (1998). “Government intervention and market integration in Indonesian rice markets.” Agricultural Economics **19**: 283-295.

Johansen, S. (1988). “Statistical analysis of cointegration vectors.” Journal of Economic Dynamics and Control **12**: 231-254.

Johansen, S. (1991). “Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models.” Econometrica **59**: 1551-1580.

Johansen, S. and K. Juselius (1990). “Maximum likelihood estimation and inference on cointegration - with applications to the demand for money.” Oxford Bulletin of Economics and Statistics **52**: 169-210.

Koontz, S., Garcia, P. et al (1990). “Dominant-satellite relationships between live cattle cash and futures markets. ” The Journal of Futures Markets **10**: 123-136.

Le Ba Lich (1996). Livestock production of Vietnam in the passing year and development orientations toward 2000. National Seminar on Animal Sciences and Development to year 2000, Ha Noi.

Le Goulven, K. (1996). Les formes de coordination de la filière de viande porcine dans le delta du Fleuve Rouge. Economie Rurale. Montpellier, ENSA.M**:** 110.

Le Goulven, K. (1998). Performance of markets in a context of liberalization: the case of hog industry in Northern Vietnam. Agricultural Markets beyond Liberalization, Wageningen.

Le Goulven, K. (To be published 1999). “Commercialisation d'un produit agricole dans un contexte économique "de transition". La filière de viande porcine de Nam Thanh à Hai Phong (Vietnam).” Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux: 19.

Loy, J. P., T. Glauben, et al. (1994). Testing regional and national market integration: an application to the Polish wheat market. Food Policies and the Food Chain: Structures and the Inter-Relations, Reading.

Macneil, I. R. (1974). “The many futures of contracts.” Southern California Law Review **47**: 691-816.

McMillan, J. and C. Woodruff (1999). Interfirm relationships and informal credit in Vietnam. Graduate School of International Relations and Pacific Studies. San Diego, University of California**:** 38.

Mendoza, M. S. and M. W. Rosegrant (1995). Pricing behavior in Philippine corn markets : implications for market efficiency. Washington, D.C., International Food Policy Research Institute.

Milgrom, P. R., D. C. North, et al. (1985). “The Role of Institutions in the Revival of Trade : the Law Merchant, Private Judges, and the Champagne Fairs.” Economics and Politics **2**(1): 1-23.

North, D. C. (1995). The New Institutional Economics and thirld world development. The New Institutional Economics and thirld world development. J. Harriss, J. Hunter and C. M. Lewis. London, Routledge**:** 17-26.

Osterwald-Lenum, M. (1992). “A note with quantiles of the asymptotic distribution of the cointegration rank test statistics.” Oxford Bulletin of Economics and Statistics **54**: 461-472.

Palama, A. V. (1994). Etude de filières et de mise en marché du riz, de l'igname et du porc dans la province de Long An. ITARC. Montpellier, CNEARC**:** 82.

Palaskas, T. B. and B. Harriss-White (1993). “Testing market integration: new approaches with case material from the West Bengal food economy.” Journal of Development Studies **30**(1): 1-57.

Perron, P. (1989). “The great crash, the oil price shock and the unit root hypothesis”. Econometrica 57: 1361-1401.

Rambo, T. (1973). A comparison of peasant social systems of Norhtern and Southern Vietnam : a study of ecological adaptation, social succession, and cultural evolution. Carbondale, Center for Vietnamese Studies, Southern Illinois University.

Ravallion, M. (1986). “Testing Market Integration.” American Journal of Agricultural Economics **68**(1): 102-109.

Ronnas, P. (1992). Employment Generation through Private Entrepreneurship in Vietnam. New Delhi, SIDA ILO.

Sarker, R. (1993). “A maximum likelihood cointegration analysis of Canadian lumber exports.” Canadian Journal of Agricultural Economics **41**: 97-110.

Sarker, R. (1995). “Causality analysis in agricultural economics : review of theoritical and empirical issues.” Cahiers d'Economie et de Sociologie Rurales(34-35): 6-43.

Schwarz, A. (1995). “Nation Builders.” Far Eastern Economic Review(November 16): 22.

Schwarz, G. (1978). “Estimating the Dimension of a Model.” The Annals of Statistics **6**(2): 461-464.

Silvapulle, P. and S. Jayasuriya (1994). “Testing for Philippines Rice Market Integration: A Multiple Cointegration Approach.” Journal of Agricultural Economics **45**(3): 369-380.

Sims, C. A. (1980). “Macroeconomics and Reality.” Econometrica **48**(1): 1-48.

State Planning Committee and General Statistical Office (1994). Vietnam Living Standards Survey. Ha Noi, State Planning Committee - General Statistical Office.

Stiglitz, J. E. (1999). Quis custodiet ipsos custodes. ABCDE "Governance, equity and global markets", Paris, France.

Stock, J. and M. Watson (1988). “Testing for common trends.” Journal of the American Sattistical Association **83**: 1097-1107.

Tavera, C. (1991). “Tests de racine unité et stationnarisation des séries non stationnaires: présentation générale et aplication au cas des séries agricoles.” Economie et Prévision **99**(3): 67-80.

The World Bank (1993). The East Asian Miracle.

Timmer, P. C. (1974). “A model of rice marketing margins in Indonesia.” Food Research Institute Studies **13**(2): 145-167.

van Potten, A. J., J. M. E. Jonker, et al. (1996). Food and Agribusiness in Vietnam. Utrecht (The Netherlands), Rabobank International.

Williamson, O. E. (1985). The Economic Institutions of Capitalism, The Free Press.

Williamson, O. E. (1996). The Mechanisms of Governance. Oxford, Oxford University Press.

Zapata, H. O. and J. M. Gil (1999). "Cointegration and causality in international agricultural research." Agricultural Economics **20**(1): 1-9.

Tables

Table 1
Hog production and household income in 1993

Zones	Share of total hog production	Average annual growth of production (1985-1995)	Annual income per head (1,000 dongs*)	Share of agricultural income	Share of income from livestock production
North	**63.0%**				
North Mountains & Midland	25.5%	4.6%	800.9	63.1 %	34 %
Red River Delta	21.5%	3.2%	1095.8	39.9 %	44 %
North Central Coast	16.0%	2.8%	762.9	46.9 %	33 %
South	**37.0%**				
South Central Coast	11.0%	1.7%	853.4	21.2 %	49 %
Central Highlands	5.0%	4.8%	851.9	64.5 %	8 %
North East South	4.5%	5.0%	1892.3	11.3 %	33 %
Mekong Red Delta	16.5%	3.3%	1265.7	40.7 %	24 %
Vietnam	100%	3.8%	1105.1	36.3 %	34 %

Source : computed by authors based on data from Vietnam Living Standard Survey (State Planning Committee and General Statistical Office 1994) and GSO (General Statistical Office 1996).
*In July 1993, 1US$=10,500 dongs (Department of Trade and Price Statistics 1993-1998, p. 9 from n°4).

Table 2
Results of unit root test on individual series

Province	Step 1		Step 2		Critical Values of the test		
	ADF statistic (ϕ)	Optimal lag length	ADF statistic (ϕ)	Optimal lag length	1%	5%	10%
HN	-1.63	6	-6.46**	6	-3.457	-2.872	-2.572
HH	-1.94	1	-11.46**	1	-3.457	-2.872	-2.572
HP	-2.13	5	-5.18**	5	-3.457	-2.872	-2.572
VP	-2.53	0	-18.21**	0	-3.457	-2.872	-2.572
QN	-1.68	2	-10.58**	2	-3.457	-2.872	-2.572
HT	-2.25	8	-4.01**	8	-3.457	-2.872	-2.572
ND	-2.18	1	-12.86**	1	-3.457	-2.872	-2.572
TH	-1.34	4	-8.29**	4	-3.457	-2.872	-2.572
NA	-2.15	0	-5.77**	8	-3.457	-2.872	-2.572
BT	-2.07	3	-8.51**	3	-3.457	-2.872	-2.572
CT	-2.22	9	-5.68**	9	-3.457	-2.872	-2.572
DL	-2.61	4	-7.85**	4	-3.457	-2.872	-2.572
DN	-2.18	8	-6.19**	8	-3.457	-2.872	-2.572
DNA	-2.41	8	-5.97**	8	-3.457	-2.872	-2.572
HCM	-2.25	5	-6.63**	5	-3.457	-2.872	-2.572
MH	-2.35	4	-8.35**	4	-3.457	-2.872	-2.572
QNA	-2.78	3	-9.70**	3	-3.457	-2.872	-2.572
TG	-2.20	5	-6.67**	5	-3.457	-2.872	-2.572
VL	-2.45	4	-8.72**	4	-3.457	-2.872	-2.572

Note : Akaike and Schwarz's information criterion are used to determine the appropriate lag length truncation in each case.
Step 1 is testing the hypothesis of I(1) versus I(0). Step 2 is testing the hypotheis I(2) versus I(1)

Table 3
Bivariate cointegration test

NORTH									
TH	NA	HN	HH	HP	VP	QN	HT	ND	
-	20.98*	20.49*	11.17	22.07*	17.32	22.79*	18.26	15.29	TH

-	20.91*	16.56	24.19*	19.85	26.07**	20.00*	18.93	NA
	-	42.61**	23.59*	51.98**	21.41**	24.57**	25.13**	HN
		-	38.82**	45.23**	31.56**	40.58**	34.37**	HH
			-	34.36**	14.29	19.24	29.01**	HP
				-	26.48**	56.01**	42.26**	VP
					-	19.10	26.05**	QN
						-	27.47**	HT
							-	ND

SOUTH

BT	CT	DL	DN	DNA	HCM	MH	QNA	TG	VL	
-	24.3**	23.5*	45.6**	30.8**	37.0**	34.2**	20.3*	23.3*	30.8**	BT
	-	22.8*	18.9	20.5*	19.48	21.5*	15.2	21.7*	31.2**	CT
		-	20.9*	29.2*	20.5*	21.7*	21.6*	17.5	29.7**	DL
			-	29.0**	30.1**	39.7*	26.3**	18.1	37.5**	DN
				-	30.8**	33.5**	21.4*	34.0*	40.0**	DNA
					-	30.4*	22.6*	18.6	33.9**	HCM
						-	26.7**	14.9	28.1**	MH
							-	13.9	25.2**	QNA
								-	23.9*	TG
									-	VL

Note : In the cointegration equation, we just include a constant (as we showed that there is no deterministic trend). H_0 : r=0. * (**) signifies reject of H_0 at 5%(1%), critical values being respectively 19.96 et 24.60.

Table 4
Test for cointegration ranks

NORTH

Eigenvalues	H_0	Trace statistic	Trace (0.90)	Trace (0.975)	λ_{max} statistic	λ_{max} (0.90)	λ_{max} (0.975)
0.2216	r=0	251.26**	196.66	208.81	64.37**	54.35	60.50
0.1816	r≤1	186.89**	159.74	171.28	51.50*	48.91	54.71
0.1133	r≤2	135.39*	126.71	136.49	30.90	43.25	48.99
0.0991	r≤3	104.48*	97.17	106.74	26.82	37.45	43.22
0.0968	r≤4	77.66*	71.66	80.06	26.15	31.66	36.90
0.0804	r≤5	51.51	49.92	56.06	21.55	25.56	30.32
0.0697	r≤6	29.96	31.88	7.61	18.56	19.77	24.07
0.0239	r≤7	11.40	17.79	22.05	6.21	13.75	17.63
0.0200	r≤8	5.19	7.50	10.80	5.19	7.52	10.80

SOUTH

Eigenvalues	H_0	Trace statistic	Trace (0.90)	Trace (0.975)	λ_{max} statistic	λ_{max} (0.50)	λ_{max} (0.90)	λ_{max} (0.975)
0.1968	r=0	257.29**	237.35	250.858	55.89	50.21	60.25	66.24
0.1756	r≤1	201.41*	196.66	208.81	49.25	44.97	54.35	60.50
0.1520	r≤2	152.15	159.74	171.28	42.03	39.70	48.91	54.71
0.1224	r≤3	110.12	126.71	136.49	33.31	34.73	43.25	48.99
0.0902	r≤4	76.81	97.17	106.74	24.11	29.08	37.45	43.22
0.0747	r≤5	52.70	71.66	80.06	19.80	23.78	31.66	36.90
0.0549	r≤6	32.90	49.92	56.06	14.39	18.70	25.56	30.32
0.0399	r≤7	18.51	31.88	37.61	10.39	13.47	19.77	24.07
0.0208	r≤8	8.12	17.79	22.05	5.35	8.27	13.75	17.63
0.0108	r≤9	2.77	7.50	10.80	2.77	3.40	7.52	10.80

Note : critical values of the tests from (Osterwald-Lenum 1992).

Table 5
Test for exclusion and weak exogeneity

LR test for exclusion

NORTH

r	χ^2 5%	HN	HH	HT	HP	TH	QN	NA	ND	VP
1	3.84	1.51	2.33	8.31	0.83	0.91	0.33	0.54	2.60	11.49

2	5.99	18.53*	5.75	16.18*	1.23	1.92	11.67*	0.54	3.74	31.99*	
SOUTH											
r	χ^2 5%	HCM	BT	CT	DL	DN	DNA	MH	QNA	TG	VL
1	3.84	5.65	5.68	2.71	5.90	1.35	1.10	0.46	6.10	1.37	2.18
2	5.99	6.92*	6.31*	8.42*	6.55*	6.08*	4.84	5.68	9.48*	6.16*	2.29

LR test for weak exogeneity

NORTH										
r	χ^2 5%	HN	HH	HT	HP	TH	QN	NA	ND	VP
1	3.84	1.33	0.22	0.03	0.02	4.96	0.18	0.51	1.22	11.78
2	5.99	10.75*	3.57	0.58	2.40	12.14*	1.75	5.20	2.31	29.84*
SOUTH										
r	χ^2 5%	HCM	BT	CT	DL	DN	DNA	MH	QNA	TG	VL
1	3.84	2.15	3.13	5.18	4.86	1.89	0.75	0.41	1.58	0.01	1.11
2	5.99	4.68	3.14	6.67*	6.93*	7.00*	7.14*	1.36	4.96	4.81	1.74

Table 6
Gross output of industry by provinces

Provinces	QN	VP	HN	HP	HH	HT	ND	TH	NA	DN	QN	DL	Dna	Hcm	TG	BT	VL	CT	MH
Growth rate (%) from 1993 to 1995	47.5	59.8	46.6	65.2	31.0	72.6	30.1	15.9	17.7	44.0	40.1	99.7	32.2	15.3	51.6	-22	22.9	34	20.1
Distance to national average/head (%) 1995	-37	-60	28	18	-60	15	-48	-55	-67	14	-48	-67	-21	378	-32	-17	-3	30	124

Source : computed by authors based on data from GSO (General Statistical Office 1996).

Table 7 Impulse responses for the VECM[12] (North)

Weeks ahead	One shock in the innovation of :									Responses of :
	HN	HH	HP	QN	HT	ND	TH	NA	VP	
1	388.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4	176.99	87.99	155.05	20.68	96.53	51.10	74.01	115.21	75.17	HN
8	111.88	196.15	148.85	60.55	143.38	77.82	235.11	138.26	0.27	
1	39.82	482.34	53.16	18.48	0.00	0.00	0.00	0.00	0.00	
4	63.44	410.92	135.19	100.02	21.16	16.00	147.08	45.08	100.49	HH
8	-55.50	371.42	155.90	68.78	54.57	74.06	275.32	80.56	46.29	
1	85.78	0.00	287.22	0.00	0.00	0.00	0.00	0.00	0.00	
4	67.03	76.80	224.43	83.85	48.43	23.26	25.57	27.53	-43.05	HP
8	121.27	248.09	57.21	57.21	76.80	69.86	154.18	106.47	-15.16	
1	59.58	0.00	106.65	332.58	0.00	0.00	0.00	0.00	0.00	
4	125.22	79.81	137.23	209.86	52.47	48.76	72.52	57.59	-7.49	QN
8	139.28	195.79	136.87	164.83	43.47	6.40	189.47	77.89	0.65	
1	208.83	-23.49	10.71	-18.27	248.81	0.00	0.00	0.00	0.00	
4	140.90	86.72	125.81	-7.78	188.56	19.92	46.08	103.79	73.60	HT
8	111.60	216.62	146.60	5.25	206.09	103.08	209.49	150.34	8.11	
1	138.25	75.80	19.22	-14.90	-3.85	462.97	0.00	0.00	0.00	
4	68.29	168.25	140.58	-45.63	56.09	219.84	38.49	16.55	49.80	ND
8	6.69	245.13	122.63	0.64	122.86	200.20	131.13	83.86	41.95	
1	30.26	46.33	64.24	-21.77	13.82	-4.64	369.71	0.00	62.98	
4	58.71	84.68	3.42	-39.86	6.59	97.90	256.89	39.89	-21.25	TH
8	92.38	152.91	13.90	-97.11	31.42	53.23	260.67	101.15	-67.14	
1	18.10	-12.18	14.52	-11.99	66.23	42.68	127.79	372.62	172.93	
4	58.71	79.82	-21.93	19.93	59.73	85.23	181.47	353.15	80.86	NA
8	93.82	147.53	39.01	-117.09	37.86	125.27	276.11	334.99	75.04	
1	40.40	14.52	54.11	-31.72	31.45	105.86	0.00	0.00	389.87	
4	16.37	152.73	30.22	19.01	116.96	88.14	43.36	24.58	56.77	VP
8	112.61	186.79	148.96	-43.79	137.84	63.03	98.04	93.24	8.69	

[12] variables are ordering as follow : Ha Noi, Hai Phong, Qhang Ninh, Hai Hung, Ha Tay, Nam Dinh, Vinh Phu, Thanh Hoa, Nghe An.

Table 8 Impulse responses for the VECM[13] (South)

Weeks ahead	One shock in the innovation of :										
	BT	CT	DL	DN	DNA	HCM	MH	QNA	TG	VL	Responses of :
1	285.16	105.69	-3.99	46.21	12.34	-2.57	1.49	11.02	0.08	66.45	
4	111.52	187.80	-52.17	8.33	74.77	70.39	-65.05	50.67	34.93	29.01	BT
8	130.53	189.32	40.21	149.38	93.75	114.07	-16.78	103.63	106.59	44.00	
1	0.00	395.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4	27.27	389.90	-32.99	19.25	7.90	-5.52	83.24	134.55	-13.56	108.97	CT
8	123.68	374.02	-107.77	102.17	-24.73	-76.56	77.03	241.20	117.97	94.13	
1	0.00	122.42	405.71	107.25	181.60	59.25	-4.49	229.17	23.16	72.07	
4	82.57	125.58	232.52	122.48	0.33	82.05	111.32	255.17	186.93	-12.01	DL
8	165.76	91.04	185.86	108.73	159.28	55.97	10.94	211.47	149.91	62.72	
1	0.00	191.30	0.00	505.27	177.68	151.63	0.27	442.93	103.53	26.43	
4	69.76	125.89	-23.76	213.62	-7.92	-8.97	117.88	282.14	221.95	30.70	DN
8	251.44	98.12	39.08	164.15	134.11	83.34	12.25	242.16	147.57	42.63	
1	0.00	43.73	0.00	0.00	469.55	0.00	0.00	0.00	0.00	-3.96	
4	73.33	46.63	-85.30	-29.58	367.26	42.46	29.16	-4.04	11.04	-74.24	DNA
8	27.04	74.97	-23.36	14.95	171.26	81.57	10.36	102.42	99.86	9.36	
1	0.00	83.22	0.00	0.00	138.09	283.12	0.00	130.43	0.00	51.58	
4	41.60	109.15	-37.65	-14.21	42.92	129.85	49.37	99.89	55.96	89.00	HCM
8	53.45	156.94	-2.50	63.01	103.45	76.75	24.16	233.34	82.24	136.49	
1	0.00	54.12	0.00	0.00	-7.37	4.98	383.00	-38.01	47.26	-22.70	
4	6.77	112.75	98.30	54.28	41.65	66.87	304.36	168.71	111.34	120.56	MH
8	70.62	142.37	118.97	130.12	0.58	38.47	134.60	235.46	147.36	142.95	
1	0.00	167.15	0.00	0.00	178.15	0.00	0.00	520.20	0.00	21.91	
4	73.16	38.96	-28.50	107.41	-24.82	-13.60	109.31	462.11	109.59	-5.69	QNA
8	105.32	34.46	3.01	-5.70	164.49	-19.54	18.99	393.81	108.03	33.78	
1	0.00	72.37	0.00	0.00	9.96	44.37	0.00	50.64	303.13	1.52	
4	70.62	70.62	42.69	49.75	24.16	43.84	64.30	152.06	195.15	15.36	TG
8	82.94	82.94	48.32	140.50	31.05	31.74	30.13	241.44	207.91	65.06	
1	0.00	113.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	438.58	
4	0.53	230.11	34.42	-71.76	21.78	95.05	144.33	38.43	53.98	210.33	VL
8	70.30	233.45	44.72	81.55	82.89	74.72	44.40	162.90	7.61	141.33	

Table 9 Decomposition of forecast error variance for the VECM (North)

[13] Variables are ordered as follow : Can Tho, Vinh Long, Dong Nai, Ho Chi Minh, Tieng Giang, Minh Hai, Da Nang, Dac Lac, Ben Tre.

FEV of :	*Weeks ahead*	Explained by :								
		HN	HH	HP	QN	HT	ND	TH	NA	VP
HN	1	100	0	0	0	0	0	0	0	0
	4	66.67	5.82	9.54	1.39	7.92	1.51	1.39	3.91	1.81
	8	37.39	10.97	12.21	1.83	12.35	2.84	10.47	10.22	1.69
HH	1	0.66	97.99	1.19	0.14	0	0	0	0	0
	4	0.60	84.75	5.59	1.6	0.18	1.00	4.57	0.46	1.21
	8	0.63	66.4	10.12	2.7	0.33	1.53	14.7	1.83	1.48
HP	1	8.19	0	91.81	0	0	0	0	0	0
	4	10.52	3.5	75.93	4.02	1.31	1.67	0.34	0.29	2.38
	8	9.27	16.9	58.17	4.38	1.76	2.12	3.69	2.77	0.89
QN	1	2.82	0	9.06	88.11	0	0	0	0	0
	4	11.31	2.60	11.86	68.34	0.46	0.62	1.33	1.61	0.09
	8	9.02	15.46	12.5	49.73	2.72	0.56	7.92	1.91	0.13
HT	1	40.94	0.51	0.10	0.31	58.11	0	0	0	0
	4	32.07	4.78	7.4	0.32	47.59	0.65	0.61	3.91	2.60
	8	17.2	13.36	12.08	0.40	33.38	3.29	8.03	9.65	1.95
ND	1	7.97	2.39	0.15	0.09	0	89.38	0	0	0
	4	5.61	16.46	7.73	0.80	1.66	65.67	0.51	0.05	1.47
	8	3.31	22.63	10.48	0.50	5.71	49.20	3.30	1.37	3.46
TH	1	0.61	1.44	2.77	0.31	0.12	0.01	92.02	0	2.67
	4	1.90	4.39	1.12	1.16	0.12	2.53	85.81	1.88	1.05
	8	4.79	9.40	0.59	2.29	0.50	5.81	69.24	5.18	2.16
NA	1	0.17	0.07	0.10	0.07	2.28	0.94	8.50	72.26	15.56
	4	3.27	1.38	0.56	0.31	1.53	3.53	14.79	68.45	6.15
	8	3.33	4.95	0.53	1.65	1.41	3.57	23.61	57.52	3.39
VP	1	0.96	0.12	1.72	0.59	0.58	6.59	0	0	89.42
	4	1.25	11.75	3.07	0.85	8.79	14.48	2.50	0.45	56.84
	8	5.15	22.13	7.89	1.34	15.07	10.95	4.24	3.72	29.46

Table 10 Decomposition of forecast error variance for the VECM (South)

FEV of :	*Weeks ahead*	Explained by :									
		BT	CT	DL	DN	DNA	HCM	MH	QNA	TG	VL
BT	1	81.85	11.24	0.01	2.15	0.15	0.00	0.00	0.12	0	4.44
	4	59.99	24.64	1.76	0.91	3.03	1.90	2.64	1.20	1.04	2.84
	8	30.26	30.63	1.39	6.92	6.50	6.55	3.41	6.77	4.82	2.70
CT	1	0	100	0	0	0	0	0	0	0	0
	4	0.40	88.53	0.29	0.27	0.10	0.15	3.31	4.41	0.36	2.14
	8	2.66	71.24	2.01	2.95	0.09	0.62	2.13	12.41	2.12	3.71
DL	1	0	5.24	57.58	4.02	11.53	1.22	0	18.37	0.18	1.81
	4	2.69	4.88	43.65	7.91	4.33	1.97	1.88	26.59	5.41	0.62
	8	4.66	6.24	32.04	8.31	5.17	2.11	1.45	29.92	8.87	1.19
DN	1	0	6.60	0	46.07	5.69	4.15	0	35.40	1.93	0.12
	4	1.22	5.22	0.42	40.97	3.16	4.42	1.11	34.24	9.02	0.17
	8	7.65	5.36	1.10	33.91	4.17	4.29	1.44	30.97	10.82	0.24
DNA	1	0	0.86	0	0	99.1	0	0	0	0	0
	4	0.96	0.58	2.27	0.17	92.02	1.72	0.24	0	0.38	1.6
	8	1.13	3.03	2.04	0.15	83.05	3.72	0.50	2.62	2.13	1.58
HCM	1	0	5.50	0	0	15.15	63.70	0	13.52	0	2.11
	4	0.54	12.66	0.78	0.24	8.4	46.57	0.77	18.32	2.00	9.66
	8	2.19	18.39	0.39	1.70	8.29	28.96	0.69	23.53	4.01	11.80
MH	1	0	1.90	0	0	0	0.01	96.31	0.93	1.45	0.33
	4	1.11	4.90	1.95	1.09	0.39	1.68	74.58	6.07	4.79	3.39
	8	2.68	7.23	2.80	3.64	0.64	1.48	46.10	16.4	10.17	8.78
QNA	1	0	8.44	0	0	9.59	0	0	81.81	0	0.14
	4	0.95	3.07	0.87	2.13	3.31	0.20	1.21	87.28	0.69	0.24
	8	2.42	1.97	0.57	2.15	4.81	0.33	1.31	83.62	2.56	0.21
TG	1	0	5.14	0	0	0.09	1.93	0	2.52	90.29	0
	4	1.98	13.39	1.16	1.18	2.56	6.26	2.22	12.91	57.23	0.06
	8	4.70	11.93	1.72	7.51	1.33	5.38	1.78	22.15	42.36	1.09
VL	1	0	6.24	0	0	0	0	0	0	0	93.75
	4	1.08	19.37	0.25	1.28	0.14	5.46	8.53	0.34	0.99	62.51
	8	1.03	29.34	1.40	2.04	3.73	5.81	5.60	7.31	1.82	41.85