

# “Modeling the segment interactions of Ukraine’s financial market”

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# MODELING THE SEGMENT INTERACTIONS OF UKRAINE'S FINANCIAL MARKET

## Abstract

This study is devoted to assessing the level of individual segments interconnectedness within the financial market of Ukraine (FMU) and their dynamics in uncertain conditions. The methodology of the systematic approach is used to investigate the dynamic relationship between individual segments of the financial market of Ukraine, namely credit (deposit-credit) market, stock market (market of securities), government securities market, currency market, and interbank market. The study of financial market dynamics focuses on the description of the price indicators of individual market segments, which are monitored using time series analysis and statistical methods. The results of the time series assessment revealed the fractal characteristics of the Ukrainian financial market as a measure of sustainability (namely inertia). It is revealed that all segments of the financial market, except credit, are characterized by persistence. It is established that the development of market segments is uneven and is characterized as bifurcation. The credit segment is addicted to insider behavior and has the highest risk concentration. It is revealed that the foreign exchange market is still in crisis. The results of modeling the correlation relationships between market segments have shown that, in the presence of such relationships, they differ in the strength and nature of the interaction. They are volatile, unstable, and situational, dependent on external conditions. The credit market has a relationship with other segments, not significantly strong but stable. The results of the analysis indicate the dynamic development of segments within the Ukrainian financial market in the presence of interconnections between them.

## Keywords

price indicators, credit market, interconnectedness, integration, correlation, fractality, market persistence, market memory

## JEL Classification

E44, E47, G14

## INTRODUCTION

During its evolutionary development, the financial market is influenced by globalization and integration processes and, thus, transformed, the connections between its individual segments become deformed, and new patterns of development and interconnections take shape. Enhancement of interconnections between financial market segments supports the convergence of financial institutes, increased mobility of capital flows that are sensitive to external influences, shocks, and threats, growing uncertainty, and hazards. Consequently, determinism gives way to market self-organization, which makes coordination of goals, formation of unified mechanisms and institutions for their regulation necessary.

As an optimal distribution mechanism, it stimulates the national economic growth, reduces financial risks and costs of capital movement, increases the efficiency of investments in terms of uncertainty. The deepening and increasing tendencies of financial integration, which are quantitatively and qualitatively complicated by the influence of the universalization and transnationalization of financial intermediation, lead to a change in the market structure, the nature of interconnections and the interaction of financial market segments with each other.

The 2007–2009 financial crisis has highlighted the importance of the interconnectedness of the financial market segments locally and internationally, mainly in the transfer of risks and the accumulation of financial system instability. The boundaries between segments are erased; there is a trend of market penetration and consolidation of instruments. Financial integration increases the financial market's ability to absorb the effects of adverse shocks in the shortest time, with minimal cost of response, reducing the amplitude, duration of recession, and negative asymmetry.

## 1. LITERATURE REVIEW

The impact of macroeconomic variables on particular segments of the financial market has been extensively discussed within researches on financial and monetary economics. Kluesens, Koze, and Terons (2011) singled out the peculiarities of the functioning and interaction of financial market segments, considering the dynamics of financial cycles, due to which the amplitude is smoothed, and the financial cycles are extended. Considering the processes of interaction of the Eurozone markets, Hartmann, Madaloni, and Manganeli (2003) found that the process of divergence of the markets of currency and deposits was observed from 1995 to 2001. On the other hand, the dynamics and structure of bond investments have become more homogeneous. According to Levine (2002) and Merton and Bodie (2005), the formation of the financial market model is due to the peculiarities of the national economy. Merton and Bodie (2005) rely on the “financial innovation spiral”, that is, on the pre-emptive development of the financial market and the financial sector as a whole under the objective conditions that result from financial engineering and the strengthening of relationships between existing and new segments of the financial market. The work of Torre, Feyen, and Ize (2013) considered a large sample of countries. It was shown that with improving institutional and functional characteristics of the market, the market imperfections (frictions) reduced, which affects the tangible differences in the growth rate of different segments of the financial market. For example, markets for government bonds, bank loans, and property insurance tend to boom earlier than the corporate bond, mutual funds, and life insurance markets. This is determined by the unequal sensitivity of different financial instruments to one or another type of frictions. Accordingly, the possibility of transition of the financial market to another level of development is primarily related to changes

in economic development. This allows us to identify the stages of financial market development, which are correlated with economic development changes. Another group of researchers links the patterns and relationships between financial risk sectors with the performance of financial institutions (Delis, 2012; Tabak, Fazio, & Cajueiro, 2012; Beck, De Jonghe, & Schepens, 2013).

A separate research group is dedicated to identifying strong relationships between global, regional, and local financial markets. That is how Asaturov and Teplova (2014) estimated the dynamic correlation of markets based on the ARMA-DCC-GARCH model (Dynamic Conditional Correlation – Generalized Autoregressive Conditional Heteroscedasticity) and obtained quantitative estimates of the interaction effects between global and local stock markets. The model was applied to 26 markets in three regions (America, Europe, and Asia) from 1995 to 2012 and included pre- and post-crisis periods. However, only a few works are devoted directly to exploring the nature of the forms and consequences of interconnectedness between different financial market segments. According to the findings of Mandelbrot and Freeman (1982), the classic postulate is that together with the increasing interconnectedness of financial market segments, the dynamic of processes and phenomena occurring in a market that takes on fractal forms increases.

The Ukrainian researchers, including Shkolnyk (2008), Ghrudzevych (2004), and Kozmenko (2010), and foreign scientists, i.e., Hartmann, Madaloni, and Manganeli (2003), prove that the level of interdependence of individual financial market segments is not the same. In particular, the money market is among the financial market segments in terms of profitability and riskiness. In the sovereign bond market, particularly in the Eurozone, the level of integration is quite high in profitability, which has quickly matched in all the

member countries. This is due to the high sensitivity of regional markets to the general news and, consequently, to the reduced impact of local risk factors. However, differences remain in the perception of credit risk on sovereign bonds issued in different countries, in assessing their level of liquidity and in maturity. Due to these factors' influence, the level of integration of this segment is not high enough. According to the findings of Bartiloro and De Bonis (2005), Byrne and Davis (2002), the corporate bond market is characterized as sufficiently interconnected with other segments, given that the level and dynamics of the instruments profitability are predominantly determined by the issuers' credit ratings and the money market rate benchmark for all segments of the financial market. In addition to global factors, the integration processes are significantly influenced by regional ones, namely the regulatory environment, rules, features, and institutional structure of the financial market (Krasnova, 2018). Therefore, the depth of integration of individual segments of regional financial markets is different.

However, despite in-depth research on the level of financial market development and its segmentation, the issue of assessing the nature and density of the interconnections of the financial market segments remains open in Ukraine and needs further study.

The study aims to identify the nature and density of interconnectedness of individual segments of the financial market of Ukraine (FMU), which will support making adequate management decisions on a macro-level to guarantee financial stability.

## 2. METHODS

The dynamic relationship between the following segments of the financial market is investigated, namely credit (deposit-credit) market, stock market (market of securities), government securities market, currency market, and interbank market. To achieve this goal, the authors proposed a dynamic modeling approach, which includes: 1) estimating the fractal and trend based on the calculation of the Hurst index (H); 2) determining the nature of the relationships by constructing regression equations; 3) formalizing the density and di-

rection of interconnections between market segments based on dynamic correlation analysis.

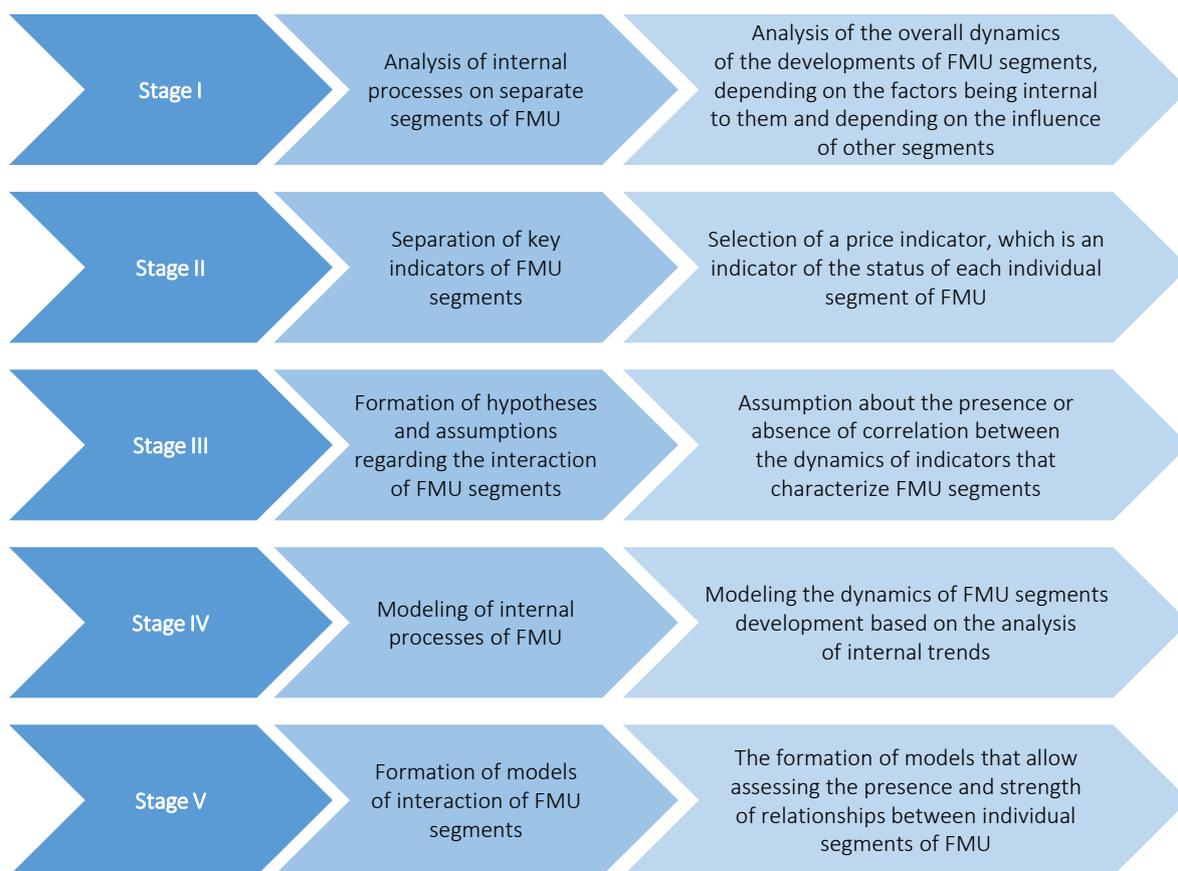
The starting data for the simulation are the time series of the interbank interest rate (as prevailing interest rate measures), USD/UAH exchange rate (as a measure of the currency market efficiency), the PFTS index – the OTC stock exchange system (as a measure of the stock exchange performance), interest rates on government bonds (as a measure of the price of speculative capital), and interest rates on the real sector of the economy (as a measure of the price of real capital). The source of the primary statistical information is official data from the websites of the National Bank of Ukraine, the Ukrainian Interbank Currency Exchange, the PFTS. The calculations are made based on daily data, which reflects the continuity of price dynamics. This creates the possibility to form a representative database.

It should be emphasized that most financial relationships are intrinsically non-linear. An econometric time series analysis was used to evaluate the effectiveness of the relationships between price indicators of individual financial market segments. Short-term price movements are more volatile because they are a consequence of the behavior of most market participants (the crowd), because if the asset is not related to the economic cycle, then changes in its prices do not show long-term trends. Besides, the techniques for determining price indicators are such that their numerical values differ by three orders of magnitude. Therefore, to provide a correct comparison and maximize the approximation of price dynamics as a time series with high frequency to normal distribution, one calculates the logarithm of the asset price's growth rate of the asset price  $y_t$  :

$$r_t = \log \frac{y_t}{y_{t-1}} = \log(y_t) - \log(y_{t-1}). \quad (1)$$

This approach allows comparing the dynamics of changes in different indicators, regardless of their absolute values. The logarithm was conducted based on daily retrospective data of the selected key indicators of the Ukrainian financial market segments. The results of the initial study based on the Dickey-Fuller test for a prolographic time series of price dynamics indicate the stationarity of the transformed series.

Source: Compiled by the authors.



**Figure 1.** Logical and structural diagram of the process of studying the interaction of segments of the financial market in Ukraine

The modeling of the relationships between the processes under study is based on the correlation function between the time series of financial market segment indicators. Monthly logarithmic data were used to investigate the short-run dynamic correlation relationships of individual segment performance. Testing for the reliability of the highest correlation coefficient showed its reliability (Table 1).

**Table 1.** Assessment of the reliability of correlation relationships between segments of the Ukrainian financial market

Indicator	Symbol	Value
Number of observation periods	n	106
Fisher's Z-conversion factor	z	0.465949
Fisher's reliability criterion	TZ	4.728867
Critical point tkp by Fisher's criterion	tkp	1.983038
Significance level	a	5.00%
Degrees of freedom	k	104

The process of identifying and evaluating the level of integration of financial market segments is completed within five stages (Figure 1).

The paper analyzes the period from January 2010 to January 2018. The selected period covers both the stage of development of the national banking system after the global financial crisis, as well as the period of “purification” of the banking system, its restructuring, and financial recovery.

### 3. RESULTS AND DISCUSSION

The study of financial markets structure allows us to consider the Ukrainian financial market (FMU) as a system where the components are characterized by different types of financial assets that are circulating on them.

*Stage I – Identification of general trends in the development of individual segments of FMU.* Analytical

research of indicators of separate segments of Ukrainian financial market development has shown that each of the segments is developing at a pace. In the evolution of Ukrainian financial market, several stable tendencies have formed: 1) in the segment of the foreign exchange market volatility of exchange rates has increased; 2) there is a tendency in the money market segment to increase the volume of liquidity and divergence; 3) there is a decline of credit activity in the credit-banking segment. It was found that the 2008 global financial crisis and national banking crisis had different effects on each segment. Some segments have recovered faster and have already reached pre-crisis levels, while others have not yet.

*Stage II – Selection of relevant key indicators for each segment of the financial market.* The selection of indicators is based on logical analysis, data availability, comparability, uniqueness (not contradiction), and sufficiency of data. Monthly data are used to calculate all variables. From the set of factors, key indicators were selected that characterize the level of business activity of each of the segments of FMU and reflect the dynamics of their development. The key indicators' selection for FMU segments is presented in Table 2.

**Table 2.** Key indicators for assessing the persistence and fractality of Ukrainian financial market segments

Source: Compiled by the authors.

Financial market segment	Indicator	Symbol	Number of observations
Currency market	Real Effective Exchange Rate (REER) of Ukrainian hryvnia to the US dollar	KURS	2260
Stock market	PFTS index	PFTS	2205
Government securities market	Government Price Index in aggregate form	GPI	5003
Credit market	The integrated (average) interest rate of Ukrainian banks on loans	KRED	2103
Interbank market	Interest rate on interbank loans as the price of money market assets	MBratio	2133

*Stage III – Formulation of hypotheses and assumptions.* Two assumptions have been formulated for the study:

- assumption 1 – the dynamics of development of each individual segment of the financial market is formed autonomously, regardless of the influence of other market segments;
- assumption 2 – the FMU components are constantly interacting, and there is a relationship between the dynamics of the indicators that characterize them.

The lack of interaction between market segments, which is the first assumption, is partly due to the existence of long-term market memory, as well as to the “spontaneous”, or accidental, behavior of market participants in the short term. The effect of long-term memory characterizes the time series of prices for financial assets. If markets are persistent, then periods of rising (or falling) prices in the past are more likely to lead to rising (or falling) current prices. If markets are not characterized by long-term memory, they do not show signs of persistence. On the other hand, periods of growth are replaced mainly by the reverse tendency of falling prices for assets. This process is called fractal Brownian motion. In the first assumption, one should check the assumption that the series of key indicators of the Ukrainian financial market segments is persistent, maintaining the current trend and having a high level of noise (a significant random component).

According to the second assumption, the segments of the Ukrainian financial market are in constant interaction and interconnection. This means that there is a close relationship between the dynamics of the indicators that characterize individual segments of the Ukrainian financial market and contain information on the impact of a set of fundamental factors on price dynamics. Adding to this the assumption of a conscious choice by investors of a convenient and attractive segment for investing, the well-known effective market hypothesis is obtained.

To prove or refute the assumptions about long-term market memory and the random behavior of market participants in the short term, one

will analyze the dynamics of key indicators of the selected segments of the FMU using statistical indicators. The segments of the Ukrainian financial market are tested from the standpoint of a self-similar fractal structure, that is, determine the presence or absence of trend and its nature. To determine the fractal dimension of FMU time series, according to Peterson (1994), the Hurst index ( $H$ ) is used, which characterizes the persistence of a series. Among the national scientists, one will note the works of Nayman (2009), Dubnitsky (2011), Plastun (2014), Bartashevskaya (2015), Kolodii (2018). If the Hurst index ( $H$ ) is more than 0.5, then the time series under study are persistent. The market has a long-term memory – the future depends on the past. If the Hurst index ranges from 0.326 to 0.674, then this means that the model of change with high probability is random. If the value approaches 0.86, then there is a growing trend. The closer  $H$  is to one, the stronger the trend. Descriptive statistics for these financial variables are presented in Table 3.

The obtained results proved that:

- 1) the credit segment is highly dependent on the behavior of individual investors, namely insiders who bring their risks to the activities of domestic banks. Thereby, the credit segment tends to be the least integrated into the overall market. It is not necessary to speak about stability, regularities, market trends. However, one may assume that the credit segment is approaching the transition phase. The market environment is gradually emerging, in which this segment appears not as a separate, with special preferences market, but as a complete,
- 2) other segments of the FMU are characterized by a trending (persistence) behavior. Primarily, this concerns the currency market (the dynamics of UAH against USD) and the stock market, where the Hurst indicator values are 0.79 and 0.70, respectively (for the PFTS index). This signals the presence in the “crowd mode” market, which is internal relationships in the system that activate the collective intentions of market participants. The combination of extremely strong manifestations of social consciousness and fundamental prerequisites results in structural shifts in the trend of price dynamics. This is especially evident in the foreign exchange market segment, which can be assumed to be in the phase of coherence. The currency segment may “lose memory”, namely to have phase and structural shifts;
- 3) for some series of indicators, including dynamics of the average interest rate of Ukrainian banks on interbank loans, the effect of chance and lack of trend in the post-crisis period were revealed. The average weighted yield on government bonds has no pronounced trend. These segments are in the phase of a chaotic market, namely, although the fundamental economic preconditions for changing the

**Table 3.** Statistical characteristics of fractality of individual segments of the Ukrainian financial market

Source: Calculated by the authors according to the data of State Statistics Service of Ukraine (2019) and National Bank of Ukraine (2019).

Characteristic	Credit rate	T-bills	Interest rate on interbank loans	PFTS	UAH exchange rate
Number of observations	1,625	1,716	1,732	1,731	1,770
Average	17.36	13.85	11.21	512.71	12.64
Standard error	0.11	0.33	0.19	33.69	0.16
Median	16.72	12.48	8.8	387.18	7.99
Fashion	12.2	12.1	2.5	348.08	7.99
Standard deviation	4.59	13.71	8.00	1401.46	6.81
Dispersion	21.10	187.89	63.92	1964088.74	46.42
Excess	276.19	1046.67	-0.32	1626.24	-0.65
Asymmetry	10.88	28.98	0.68	39.71	1.04
Hurst indicator	0.48	0.57	0.68	0.70	0.79

state of the market are not yet defined, group consciousness is already active. Generally, the calculations showed long-term memory of the dynamic series, but in the short term, they have random fluctuations;

- 4) the efficient market hypothesis has not been confirmed, as all segments of the financial market are characterized by fractality.

The obtained results allowed us to confirm the first assumption and to refute the second one. Studies have shown that the dynamics of the Ukrainian financial market at the current stage of development of the global economy is characterized by the presence of non-linear, stochastic tendencies. The inefficiencies and trendy nature of the financial market, which manifests itself in many market anomalies, can be attractive to some of its participants, as they allow them to generate speculative profits from asset trading.

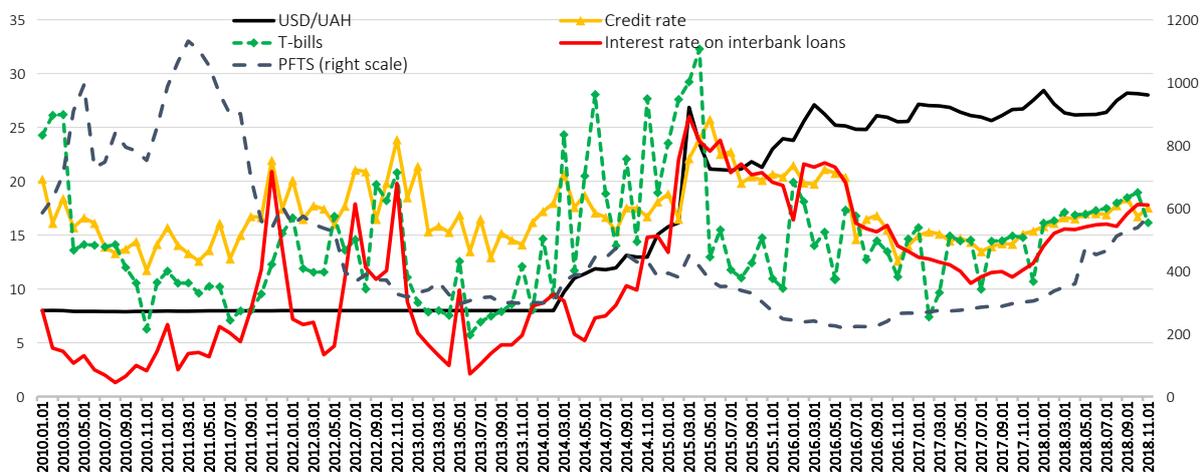
*Stage IV – Modeling of internal processes in separate segments of FMU.* For a clear comparison of the segments of the financial market and to reflect the main tendencies of their functioning, a graph of dynamics of key indicators change of the isolated segments within the financial market has been constructed that become more coherent (Figure 2).

The dynamics are not symmetrical and are characterized by segregation. This suggests that the

studied financial market segments are not interconnected. However, the spread is gradually narrowing, indicating increased competition, uniform rules, and inclusive development of these segments. Simultaneously, the segments of credit and stock markets are characterized by extraordinary pro-cyclicality and, at the same time, elasticity regarding the cyclicity of macroeconomic parameters. The failure to exert a counter-cyclical influence on these segments is primarily due to the low level of market segment functionality (or insignificant market depth). At the same time, the high volatility of key indicators is caused by external factors. Price fluctuations arise as a result of sensitivity to uncertainty and turbulent economic development (Figure 3).

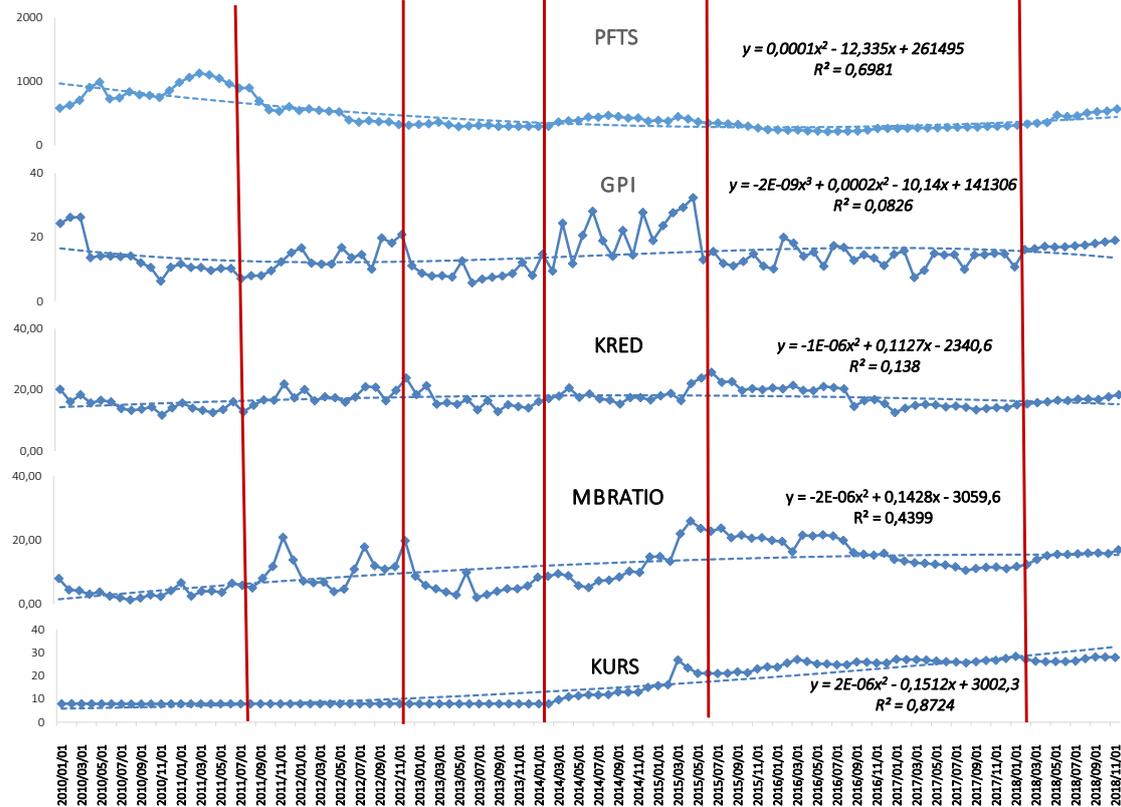
During the research period, currency and stock markets were the least sensitive. The currency market is regulated, with many currency restrictions that do not allow full functioning in this segment of the market, as well as in others. The domestic stock market remains illiquid, which is demonstrated by the dynamics of the PFTS index. Over the past five years, the PFTS index has fallen more than 70% and continues to show a downward trend, indicating, in fact, a complete stagnation of the market. Although the stock market segment has all the infrastructure elements, there are regulators, traders, registrars, exchanges, and other participants, but the market does not have enough investors, both internal and strategic external.

Source: Calculated by the authors according to the data of State Statistics Service of Ukraine (2019) and National Bank of Ukraine (2019).



**Figure 2.** Dynamics of the main price indicators of individual segments of FMU for the period 2010–2018

Source: Calculated by the authors according to the data of State Statistics Service of Ukraine (2019) and National Bank of Ukraine (2019).



**Figure 3.** Dynamics of key indicators of FMU segments

It should be noted that Ukraine's stock market does not perform its main functions – directing investments in economic development and redistribution of funds between sectors. For the citizens, the domestic stock market is not interesting. Unlike other countries, it had not become a tool for saving and increasing retirement savings. According to Iskhakova, Protsenko, and Stovbun (2016), the development of the Ukrainian stock market should be closely related to the development of other segments of the financial market (banking, insurance, pension sector, etc.). It is necessary to carry out pension reform, attract strategic foreign investors, and create conditions for the use of derivatives for hedging financial risks to strengthen the stock market and its interaction with other segments.

The government securities market demonstrated the highest level of volatility. Its importance is that this segment is a benchmark for setting market interest rates because the government securities rate is considered as risk-free.

For each indicator, using the correlation-regression analysis, the equation of the trend line according to the data for 2010–2018 was constructed (Table 4).

The values of the determination coefficients ( $R^2$ ) show the quality of the constructed regression models. If the coefficient  $R^2$  is above 0.8, then the model is considered acceptable. This is obvious that only in the currency market model, the coefficient of determination reached this value. This means that fundamental factors influence market dynamics. It is believed that the low value of the determination coefficient indicates that significant fluctuations in the index described by the model occurred during this period. Considering the importance of  $R^2$ , it is possible to concern that volatility, changeability, and instability are suitable for all other segments of the domestic financial market with varying degrees of manifestation. High volatility indicates increased risks, increased market chaos, and approaching it to the point of bifurcation.

**Table 4.** Quantitative estimation of trends of financial market segments of Ukraine using correlation-regression analysis

Source: Calculated by the authors.

Segment	Indicator	Linear trend	$R^2$	Exponential trend	$R^2$
Currency market	KURS	$y = 0.0082x - 328.73$	0.8406	$y = 1E-103x^{22.515}$	0.8447
Stock market	PFTS	$y = -0.1632x + 7277.3$	0.4466	$y = 2E+08e^{-3E-04x}$	0.4536
Interbank market	MBratio	$y = 0.0044x - 171.9$	0.401	$y = 2E-09e^{0.0005x}$	0.4829
Government securities market	GPI	$y = 0.001x - 27.145$	0.0292	$y = 0.3216e^{9E-05x}$	0.0526
Credit market	KRED	$y = 0.0003x + 4.4374$	0.0095	$y = 7.5778e^{2E-05x}$	0.0116

This tendency was especially evident in the credit and government securities markets, where higher price volatility was observed more than in the stock market. The coefficient of determination for the analytical trend of the integrated (average) interest rate on bank loans is practically approaching zero ( $R^2 = 0.01$ ), while for the stock market, it is 0.4466. This state of the credit market indicates a significant dependence on external conditions and requires immediate action to avoid the financial crisis or to reduce its effects. The most stable currency segment of the financial market resulted from its regulation and changes in approaches to currency regulation. In general, this can be considered as a positive tendency.

The models with a higher determination coefficient are more accurate. This means that in case the coefficient of determination is higher for exponential dependence, the model described by the model changes with an increasing rate.

It is established that such a pattern is inherent in all segments of the domestic financial market. Those indicators of the linear model are changing at a constant rate. If the coefficient of determination is higher for the polynomial model, then it indicates that growth occurs in a wavy (incremental) fashion (growth is replaced by recession and growth again). This is typical of most segments of the financial market (Figure 3).

Currently, the main part of banks in Ukraine has a low margin of financial stability due to the growth of non-performing loans, insufficient regulatory capital to cover risks, and the lack of effective owners. This is evidenced by a significant proportion of non-performing loans (NPL) in the

banking system, which amounted to 54.54% (as of January 1, 2018) and 48.36% (as of January 1, 2020).

Comparison of the obtained coefficients of determination for linear and exponential models shows a slight difference in their values. This allows us to state rather moderate growth rates of financial market segments. The obtained results allow concluding that all segments of FMU have been developing at different rates in the last decade.

*Stage V – Formation of models of interaction of FMU segments.* The degree of interaction of segments of the financial market in Ukraine will be determined by the results of the correlation analysis of the dynamics of price indicators of each of the segments. This allows determining the way how financial market segments are interconnected, to assess the strength and nature of communication, and to define the strength of the relationship between key indicators of FMU segments.

For the correlation analysis, the values of the selected variables for the period 2010–2018 inclusive were used, totaling 106 values for each variable. The level of correlation between individual market segments is calculated yearly. Therefore, five segments form 10 pairs. Each of them is either observable or non-existent (Table 5).

Thus, the correlation of key sectoral indicators of the financial market testifies to the unbalanced domestic market model and the vulnerability of the financial sector. The results obtained by correlation-regression analysis suggest that there is a correlation between the studied variables. The strongest interdependence is inherent in the credit market, which, according to Fohlin (2014), is consistent with international practice. The most close-

**Table 5.** Matrix of paired correlation coefficients characterizing relationships between FMU segments in 2010–2018

Source: Calculated by the authors.

Segments	2010	2011	2012	2013	2014	2015	2016	2017	2018
Stock market – currency market	-0.360	0.149	-0.333	0.000	0.250	0.841	-0.025	-0.253	0.038
Stock market – credit market	0.036	-0.270	-0.442	-0.188	-0.183	0.561	-0.567	-0.125	0.310
Stock market – government securities market	-0.052	0.073	-0.146	-0.417	0.393	0.338	-0.383	-0.380	-0.102
Stock market – interbank market	0.071	-0.404	-0.586	-0.446	0.012	0.219	-0.275	-0.052	-0.128
Currency market – credit market	0.403	0.110	-0.054	0.000	0.311	0.611	0.067	0.452	0.172
Currency market – government securities market	0.671	0.199	0.044	0.000	0.154	0.217	-0.066	-0.054	0.387
Currency market – interbank market	0.441	0.370	0.217	0.000	-0.395	0.311	0.540	0.025	0.018
Credit market – government securities market	0.602	0.013	0.082	0.283	0.516	-0.175	0.250	-0.034	0.010
Credit market – interbank market	0.745	0.597	0.466	0.447	0.088	-0.221	0.260	0.159	-0.077
Interbank market – government securities market	0.324	0.274	0.280	0.809	0.412	0.265	-0.311	-0.193	0.736
Scale	-1.000								1.000

ly interrelated with all segments of the FMU is the currency market. The stock market is the least related to other segments. The inconsistency between the financial market segments in Ukraine fully manifested itself in 2104, when markets, represented by institutions, showed an inability to absorb shocks without significant negative consequences. Probably, this specificity of the financial market of Ukraine is a consequence of the banking crises that the country has faced recently (end of 2000, 2007–2008, 2014–2016). These episodes were reflected in the well-known classification of systemic banking crises by Laeven and Valencia (2013). Consequently, the relationships differ in the closeness and nature of the interaction. This may be concerned as a prerequisite for further interaction between individual segments of the Ukrainian financial market. It is believed that the financial market of Ukraine and its segments are in a state of bifurcation development, where random, irrelevant factors and events that lead to significant and unpredictable changes in the market play a key role.

During this period, the financial market or its individual segments are destabilized, disturbances occur, deviations from the trajectory of development, which is defined as the state of bifurcation of the system. This usually occurs during times of financial instability. 2013 was a crisis year for Ukraine's financial market when almost all markets lost their interaction. Financial transactions were concentrated in government securities and interbank segments. Besides, it is revealed that the relationship between the credit and interbank

markets is gradually losing, which is anomalous. At the same time, the relationship between the credit market and the government securities market is constantly maintained. These pairs of markets are constantly competing.

Some synchronicity of fluctuations of financial market segments was observed during the period of structural reorganization changes in the banking system during 2014–2016. The Interconnection Hub has shifted toward the stock and currency segments, which are the first to experience the impact of international financial markets. Unstable dynamics is due to close direct relationship between market segments is inversely proportional, for example, in the PFTS credit market, or the interaction disappears altogether, in particular in the PFTS currency market.

At the same time, the interaction of the foreign exchange market with all other segments is increasing. This is because the dynamics of UAH against foreign currencies aggregate the influence of international currency markets on the Ukrainian market. The Ukrainian stock market should become the driver of international integration processes, but modeling the dependence of the Ukrainian stock market on the stock indices of world financial centers showed no connection between them. The development of the financial market as a whole and its individual segments should be influenced by the possible emergence of a “financial innovation spiral” (Merton & Bodie, 2005) and the policies of regulators (Torre et al., 2013).

## CONCLUSION

The results of the financial market segment analysis indicate their dynamic development in the presence of interconnections between them. Fractal analysis has shown that the credit segment is in a state of random walk, dependent on the insiders' behavior that brings their risks to the banks. As a consequence, insider lending and weak diversification of the loan portfolio are drivers of credit risk concentration. The stock market is characterized by constant price irrationality, autonomy, and a high level of risk. The foreign exchange market segment is characterized by persistence, that is, asymmetric long-term memory. The revealed fractality of market segments means that classical methods of profit forecasting, market risks, and market behavior cannot be applied to them.

Regression analysis and determination coefficients indicate non-linear development, stochastic relationships, and dependence on external influences rather than fundamental factors. Modeling the relationships between market segments based on correlation analysis confirmed their existence. However, the identified relationships differ in the strength and nature of the interaction, causing a wide range of disparities in the domestic financial market's functioning. Relationships are volatile and situational, dependent on external conditions. The credit market has a more stable relationship with other segments, although not significantly strong. It is established that the development of financial market segments as a whole is uneven and is characterized as bifurcation. The obtained results confirm the first assumption and refute the second one.

The study results allow us to consider the Ukrainian financial market as a system of interconnected segments, which differ in their close relationship and pace of development. This allows us to assert that, firstly, the basic prerequisites for the interaction of financial market segments are not yet well developed in the country; secondly, the regulatory impact on different segments of the financial market should differ in tools, methods, and direction, and this requires a change in the regulatory environment.

It should be noted that the proposed methodology is not exhaustive and may be amended to reflect the specificities of the financial market segments and key indicators of those segments. Therefore, further scientific research and practical testing are needed.

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## REFERENCES

1. Asaturov, K. G., & Teplova, T. V. (2014). Efekty peretekaniya volatilnosti i zarazheniya na fondovykh ryinkakh: opredelenie globalnykh i lokalnykh liderov (chast 2) [The effects of a spillover of volatility and contamination in stock markets: identifying global and local leaders (part 2)]. *Bulletin of Moscow University*, 6, 3-34. (In Russian). Retrieved from <https://cyberleninka.ru/article/n/effekty-peretekaniya-volatilnosti-i-zarazheniya-na-fondovyh-ryinkah-opredelenie-globalnyh-i-lokalnyh-liderov-chast-2>
2. Bartiloro, L., & De Bonis, R. (2005). The Financial Systems of European Countries: Theoretical Issues and Empirical Evidence. *Irving Fisher Committee Bulletin*, 21(2), 1-19. Retrieved from <https://www.bis.org/ifc/publ/ifcb21.pdf#page=80>
3. Beck, T., De Jonghe, O., & Schepens, G. (2013). Bank competition and stability: Cross-country heterogeneity. *Journal of Financial Intermediation*, 22(2), 218-244. <https://doi.org/10.1016/j.jfi.2012.07.001>
4. Byrne, J. P., & Davis, E. P. (2002). A comparison of balance sheet structures in major EU countries. *National Institute Economic Review*, 180(1), 83-95. <https://doi.org/10.1177/002795010218000110>
5. Claessens, S., Kose, M., & Terrores, M. (2011). Financial cycles: what? How? When? *IMF Working paper*, 11(76). <http://dx.doi.org/10.1086/658308>
6. Delis, M. D. (2012). Bank competition, financial reform, and institutions: The importance of being developed. *Journal of Development Economics*, 97(2), 450-465. <https://doi.org/10.1016/j.jdeveco.2011.05.012>
7. Fohlin, C. (2014). Financial Systems and Economic Development in Historical Perspective. Forthcoming in *Handbook of Cliometrics*. Springer Verlag. <http://dx.doi.org/10.2139/ssrn.2524109>
8. Ghrudzevych, U. Ya. (2004). *Rehionalni osoblyvosti formuvannia i rozvytku infrastruktury finansovoho rynku Ukrainy [Regional peculiarities of formation and development of Ukrainian financial market infrastructure]* (182 p.). Lviv: Banking Institute of the National Bank of Ukraine. (In Ukrainian)
9. Hartmann, Ph., Maddaloni, A., & Manganeli, S. (2003). The Euro Area Financial System: Structure, Integration and Policy Initiatives. *ECB Working Paper*, 13, 55. Retrieved from [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=411593](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=411593)
10. Henderson, D. (1994). Putting 'Trade Blocs' into Perspective. In V. Cable & D. Henderson (Eds.), *Trade Blocs? The Future of Regional Integration*. London, Royal Institute of International Affairs.
11. Iskhakova, O. M., Protsenko, K. V., & Stovbun, A. O. (2016). Stan ta perspektivy rozvytku fondovoho rynku v Ukraini [State and prospects of stock market development in Ukraine]. *Molodyi vchenyi – Young scientist*, 12(39), 752-756. (In Ukrainian). Retrieved from <http://molodyvcheny.in.ua/files/journal/2016/12/179.pdf>
12. Kozmenko, S. N., & Leonov, S. V. (2010). The development of methodological approaches to formalization of structure of domestic financial market. *Herald of University of Banking of the National Bank of Ukraine*, 2, 3-8. (In Ukrainian). Retrieved from <https://essuir.sumdu.edu.ua/handle/123456789/53170>
13. Krasnova, I. V. (2018). *Formation of investment strategies in integrated financial markets* (618 p). Kyiv: KNEU. (In Ukrainian)
14. Laeven, L., & Valencia, F. (2013). Systemic Banking Crises Database. *IMF Econ Rev.*, 1(2), 225-270. <https://doi.org/10.1057/imfer.2013.12>
15. Levine, R. (2002). Bank-based or market-based financial systems: Which is better? *Journal of Financial Intermediation*, 11(4), 398-428. <https://doi.org/10.1006/jfin.2002.0341>
16. Mandelbrot, B., & Freeman, W. H. (1982). *The Fractal Geometry of Nature* (460 p.). San Francisco. <https://doi.org/10.1002/esp.3290080415>
17. Merton, R., & Bodie, Z. (2005). *Design of financial systems: towards a synthesis of function and structure* (NBER Working Paper No. w10620). Retrieved from <https://www.nber.org/papers/w10620>
18. National Bank of Ukraine (2019). *Main indicators of Ukrainian banks activity*. Retrieved from <https://bank.gov.ua/ua/statistic/supervision-statist/data-supervision>
19. Peters, E. E. (1994). *Fractal Market Analysis: Applying Chaos Theory to Investment and Economics* (336 p.). New York: John Wiley & Sons.
20. Shkolnyk, I. O. (2008). *Finansovyi rynek Ukrainy: suchasnyi stan i stratehiia rozvytku [Financial market of Ukraine: current state and development strategy]* (348 p.). Sumy, Mriya, Ukrainian Academy of Banking of the National Bank of Ukraine. (In Ukrainian)
21. State Statistics Service of Ukraine (2019). *Main price indicators dynamics of particular segments of Ukrainian Financial Market*. Retrieved from <http://www.ukrstat.gov.ua>
22. Tabak, B., Fazio, D., & Cajueiro, D. (2012). The relationship between banking market competition and risk-taking: Do size and capitalization matter? *Journal of Banking & Finance*, 36(12), 3366-3381. <https://doi.org/10.1016/j.jbankfin.2012.07.022>
23. Torre de, A., Feyen, E., & Ize, A. (2013). Financial development: structure and dynamics. *The World Bank Economic Review*, 7(3), 514-541. <https://doi.org/10.1093/wber/lht005>