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GDAŃSK UNIVERSITY OF TECHNOLOGY
FACULTY OF MANAGEMENT AND ECONOMICS

TRACING FINANCIAL INNOVATIONS DIFFUSION AND SUBSTITUTION TRAJECTORIES. RECENT EVIDENCE ON EXCHANGE TRADED FUNDS IN JAPAN AND SOUTH KOREA.

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GUT Faculty of Management and Economics

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Tracing financial innovations diffusion and substitution trajectories. Recent evidence on exchange traded funds in Japan and South Korea.

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Abstract:
Similar to economic growth, the process of technology diffusion may well be approximated by easily Exchange Traded Funds (ETFs) are recognized financial innovations pervasively impacting and transforming financial markets (Deville 2008, Gastineau 2010, Agapova 2011, Hill et al. 2015). Easy to use they have gained rapidly growing popularity among investors (Gastineau 2010, Lechman and Marszk 2015). Asian countries are those where rapid spread of financial innovations is observed (Marszk 2014); hence our analysis covers Japan and South Korea, which allows comparing diffusion and substitution trajectories of innovative financial products between advanced and emerging economy. It also traces substitution effects between ETFs and index derivatives. Moreover, we claim that ETFs influence financial systems in various ways, and may impact their stability, due to e.g. liquidity risk (Kosev and Williams 2011, Foucher and Gray 2014), and this also constitutes a field of our research. Our research contributes to the present state of knowledge by:

- Tracing diffusion trajectories of financial innovations (ETFs) and examination of the dynamics of the process, across Japanese and South Korean stock exchanges;
- Examining the unique process of substitution between ETFs and similar investment options, i.e. stock index futures and options;
- Providing long-term predictions of financial innovations development across examined countries: trying to establish the possible future path of the ETF markets development in countries in scope;
- Examination of the impact of the ETFs on the financial systems in examined countries; identification of country-specific thresholds leading to emergence of possible threats for the financial system stability.

JEL: G10, *G15*
Keywords: *ETFs, financial innovations, financial substitution*

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1. Introduction

Exchange Traded Funds (ETFs) are recognized financial innovations pervasively impacting and transforming financial markets (Deville 2008, Gastineau 2010, Agapova 2011, Hill et al. 2015). Easy to use, they have gained rapidly growing popularity among investors (Gastineau 2010, Lechman and Marszk 2015). Asian countries are those where rapid spread of financial innovations is observed (Marszk 2014); hence our analysis covers Japan and South Korea, which allows comparing diffusion and substitution trajectories of innovative financial products between advanced and emerging economy. It also traces substitution effects between ETFs and index derivatives, considered e.g. in risk management transactions. Moreover, we claim that ETFs influence financial systems in various ways, and may impact their stability, due to e.g. liquidity risk (Kosev and Williams 2011, Foucher and Gray 2014), and this also constitutes a field of our research.

Main aim of this paper is to provide the in-depth insight into the issues associated with the development of selected financial instruments traded on the stock exchanges in two key Asian economies: emerging – South Korea, and highly developed – Japan, over the period 2003-2015, putting special emphasis on the development patterns of ETFs.

To ensure logical flow of our research we define three major empirical goals. These are:

1. Tracing diffusion trajectories of financial innovations (ETFs) and examination of the dynamics of the process, across Japanese and South Korean stock exchanges;
2. Examining the unique process of substitution between ETFs and similar investment options, i.e. stock index futures and options;
3. Providing long-term predictions of financial innovations development across examined countries: trying to establish the possible future path of the ETF markets development in countries in scope.

Additionally, we attempt to examine the impact of ETFs on the financial systems in examined countries and to identify country-specific thresholds leading to emergence of possible threats for the financial system stability. In order to achieve this aim we consider the structure of the ETF markets in the two analyzed countries.

To these aims, first we apply descriptive statistics to unveil basic changes and trends in ETF market development between 2003 and 2015; and second we deploy the methodological framework encompassing innovation diffusion models, which allows for detailed analysis of ETF market development patterns, examining the past dynamics of the process and predicting its future changes.

Until recently ETFs were considered substitutes mostly for index funds in passive investing strategies, due to their similar features and users. However, increasing popularity and complexity of available products led to growing interest among various participants of financial markets. ETFs are now compared not only to index funds but also to derivatives – discussion in this field, which focuses on the relative benefits of ETFs versus futures, was one of the key debates in the financial industry at the end of 2015 and beginning of 2016 (Eurex 2016). This constitutes also a new research perspective – to the best of our knowledge there have been no empirical works covering this subject (theoretical background has, though, been provided at least since the framework suggested by Gastineau (2010)).

This paper comprises six logically structured sections. Paper begins with introduction. Second section presents the theoretical background explaining issues associated with ETFs: their basic features, comparisons with stock index derivatives and impact on the financial systems. Third section outlines methodological settings and fourth section presents data sources. Section five is divided into three parts: first one is overview of ETF markets in Japan and South Korea, and demonstration of preliminary, descriptive evidence on ETF market development, which is followed by discussion on major empirical results obtained using diffusion models (second part) and evaluation of the impact of ETFs on financial systems in two analyzed countries (third part). The paper concludes with sixth section.

2. Theoretical background

2.1. Exchange traded funds: basic features.

Exchange traded funds (ETFs) can be defined in their basic form as baskets of securities traded on a stock exchange (similar to e.g. shares of listed companies), usually through brokerage firms (Ferri 2009). ETFs are innovative financial instruments, launched on the financial markets in the 1990s and 2000s, whose prices closely replicate (i.e. track) the prices of some financial assets, in most cases stock market indexes (Hehn 2005). Shares (units) of ETFs can be traded during the stock exchange's trading hours, at prices determined by the market participants. Prices of ETFs' shares are usually close to their net asset value (related to the prices of the tracked assets). ETF market can be divided into two segments: primary and secondary (Hill et al. 2015). Shares of ETFs are created or redeemed on the primary ETF market in the course of transactions between managing company (fund sponsor) and authorized participants (large financial institutions). Such transactions can involve delivery of the underlying assets (in case of physical ETFs) or cash (in case of synthetic ETFs, i.e. based on derivatives, popular mostly in Europe) in exchange for the shares of ETFs. As a result of transactions on the primary market, which are a part of the arbitrage mechanism, the tracking error of ETFs (deviations of returns on ETFs from returns on the tracked assets) is in most cases low. Secondary market consists of transactions on the stock exchanges involving the sale or purchase of ETFs' shares between market participants (individual or institutional investors), without any interaction with the managing company. Specific features of the trading process depend on a number of factors, including legal form of ETF, replication method applied by the fund's managers and tracked assets.

The growing popularity of ETFs in the last decade has been caused mostly by benefits offered to investors when compared with conventional financial instruments, especially subcategory of mutual funds with aims similar to ETFs – index funds. These advantages stem from the mechanisms of ETFs' creation and distribution. Key benefits in comparison to the index funds include (Agapova 2011, Aggarwal and Schofield 2014, BlackRock 2015, Lechman and Marszk 2015): lower tracking error and lower tracking costs (in some circumstances index funds are more cost-efficient – it depends on the trading frequency and investment period), higher liquidity (units of index funds are priced usually once a day and have daily buying/purchasing cycle), and higher tax efficiency in some countries (e.g. USA).

2.2. Exchange traded funds versus stock index derivatives: comparison

Exchange traded funds, stock index futures and stock index options may be regarded as competing products within the category of index (portfolio basket) financial instruments. Together with a few other instruments they constitute the equity index arbitrage complex – a group of related financial instruments based on common underlying assets (usually a basket of assets), i.e. a group of instruments with values related due to similarity of their underlying financial assets (Gastineau 2010). Underlying assets are usually stock market indexes or stock baskets determined by the index rules. Equity index arbitrage complex consists of three instrument categories (less commonly used instruments have been omitted):

1. Traditional securities: baskets of equities and ETFs;
2. Symmetric derivatives: stock index futures and equity/index swaps;
3. Convex instruments (nonsymmetric): stock index options.

In the classification presented above ETFs have been included in the first category because they are combinations and extensions of the traditional underlying assets (not because of lack of innovative features). Values of symmetric instruments are straightforward functions of the prices of the underlying assets, whereas the prices of convex instruments do not move proportionately. Further discussion covers three groups of instruments traded on exchanges: ETFs, stock index futures and stock index options. The most basic ones, i.e. stocks, have been omitted.

Instruments which belong to one arbitrage complex are perceived by investors as substitutes not only due to the similarity of the underlying assets but also because of the potential for (usually limited) arbitrage profits – it means that their prices are related. Analysis in terms of the arbitrage complex is an adequate way of the research concerning modern financial markets as the feedback between the increasing trading volumes and decreasing trading costs on the one side, and arbitrage complexes on the other, has been observed on most of the world's stock exchanges (Gastineau 2010).

Before the current dynamic development of the ETF market these innovative instruments were considered as alternatives to futures or options mostly in the field of short- and long-term risk management of large investors. Gastineau (2010) presented the results of the preliminary comparison based on data from the US market (tracked assets were S&P 500 stocks). Key compared characteristic was the cost of these two alternatives. Costs of ETFs for risk managers resulted from the cost of gathering the stocks in creation basket (it was assumed that transactions are conducted on the primary ETF market due to their size) or opposite transactions – commission fees, management fees and market impact. In case of futures main costs were roll risk (cost of extending the contracts after they end) and market impact. As a result, futures seemed to be a better choice in short-term risk management, whereas ETFs were beneficial in the long-term due to lack of rolling expenses.

In the recent years ETFs have become increasingly popular alternatives to futures or options not only as risk management tools for specific categories of investors but also for wider group of market participants. Reasons for such change in the financial landscape can be traced back to the financial crisis of 2008 and regulatory decisions undertaken in its aftermath which were aimed at reduction of systematic shocks risk (Arnold and Lesné 2015, Goltz and Schröder 2011). As a result of increased cost of capital for the investment banks, growing operational (e.g. improved transparency) as well as capital requirements and liquidity constraints (linked mostly to the Basel III regulations (Madhavan, Marchioni, Li and Yan Du 2014)), the cost of

traditional instruments such as futures or options grew and ETFs became relatively more cost-effective e.g. in obtaining long-term exposure. Moreover, due to high level of competition among ETF providers and economies of scale, the costs of investments in ETFs, especially in the equity index ETFs (most close substitutes to index futures and options), have been significantly declining – on average by ca. 40% between 2008 and 2014 in case of the largest ETFs (Arnold and Lesné 2015).

The differences between ETFs and stock index futures will be presented in next paragraphs, particularly their relative advantages and disadvantages. Despite different features, which hinder direct comparisons, most relative advantages or disadvantages of futures versus ETFs, discussed below, apply also to options (as derivatives traded on regulated exchanges which in many cases may be alternatives to futures, and even more importantly to ETFs (Thomsett 2016)).

Similarities between ETFs and stock index futures include (Arnold and Lesné 2015, Goltz and Schröder 2011):

- identical trading venue - most turnover occurs on stock exchanges,
- high liquidity,
- multiple market participants,
- intra-day pricing (on exchanges),
- minimal counterparty risk.

Table 1 presents selected main features which distinguish ETFs from stock index futures. Key difference, which influences the relative costs of these two categories of instruments, lies in the rolling costs of futures contracts, i.e. costs of entering new contract after the expiration of the previous one, which entail both explicit costs (trading commissions and bid-ask spreads) and potential mispricing (Arnold and Lesné 2015, Madhavan, Marchioni, Li and Yan Du 2014). Main relative advantages of futures can be observed in following features: required capital, leverage, and short sale possibilities, whereas the strengths of ETFs are higher accessibility, wider product range, minimal management requirements prior to exiting, no predefined maturity and easier foreign investments. To sum up, similarly to the use in risk management discussed in the preceding paragraphs, even for the broad investing audience ETFs may be considered as more efficient instruments in long-term investing, whereas futures are regarded as more suitable short-term choices (Eurex 2016). It should be noted, though, that the final choice of investor depends not only on the holding period but also on the investment strategy – according to the results of the study conducted by the CME Group (2016) in case of leveraged or short sale positions index futures are relatively more beneficial, regardless of the holding period.

Table 1. Main differences between ETFs and stock index futures.

Feature	ETFs	Stock index futures
Accessibility	Very high due to small notional requirements. Operational simplicity in most cases.	Small notional requirements. Operationally complicated (e.g. pricing).
Product range	Very high, many asset classes.	Most major equity indexes.
Required capital	Full upfront payment.	Only margin (fraction of investment notional) needs to be posted.
Position management	Minimal necessary (may include reinvestment of dividends).	Margin and cash flow management, contract rolling.
Maturity	Open-ended.	Predefined (usually one or three months).
Leverage	Only in case of leveraged ETFs.	Available, usually very high.
Short sales of securities	May be limited (with the exception of special ETF classes, e.g. inverse ETFs).	Investors may use futures to obtain short exposure.
Positions in foreign assets	No need to manage foreign exchange component.	Foreign exchange management necessary.

Source: own compilation based on Madhavan, Marchioni, Li and Yan Du (2014), Arnold and Lesné (2015), BlackRock (2015), CME Group (2016).

It should be underlined that framework presented in the preceding paragraphs applies only to equity ETFs, and currently many more types of these instruments are available such as fixed income or commodity ETFs. However, despite of the increasing heterogeneity of the ETFs, equity ETFs (based on the equity market, usually stock market indexes) is still by far the largest category. In the most important region in this study, i.e. Asia-Pacific, they accounted in October, 2015, for ca. 89% of the assets of ETFs listed in the region (Deutsche Bank 2015b), in the previous years this level had been even higher. Therefore the framework of analysis seems correct in this context.

2.3. Exchange traded funds – impact on the financial system

Impact of the surging popularity of ETFs should also be considered in a broader view, not only from the perspective of single investors or financial institutions. Growing ETF markets may influence the financial systems and have impact on their stability. There are a few potential transmission mechanisms and risk factors, listed below (Kosev and Williams 2011, Ramaswamy 2011, Rubino 2011, Diaz-Rainey and Ibikunle 2012, Foucher and Gray 2014):

1. Liquidity risk (increased volatility of assets' prices due to links with illiquid ETF markets);
2. Lack of transparency (resulting from e.g. use of synthetic ETFs);
3. Risk of shock transmissions and contagion (between ETF markets and markets for the tracked assets which may be located in different countries or even continents; this problem may be exacerbated by cross-listings and regulatory differences),
4. Increased volatility of commodities markets (for instance, food and energy, caused by growing interest in ETFs tracking their prices which may lead to increased speculation on these markets).

However, the threshold level leading to emergence of such negative outcomes has still not been identified. Most authors agree that the scale of potential threats increases with the

growth of the ETF market (Aggarawal and Schofield 2014, Naumenko and Chystiakova 2015).

3. Methodological framework

To reach the main aims of the study we adopt the methodological framework allowing for identification of the time evolution of the processes reported across examined financial markets regarding, *inter alia*, ETFs diffusion. Therefore, apart from standard descriptive statistics, we use innovation diffusion models (Geroski 2000, Rogers 2010, Kwasnicki 2013, Lechman 2015), which are applied for approximations of ETFs diffusion trajectories and exhibit projected future ETFs development patterns. Analogous approach to the identification of the ETF market evolution is reported in the study of Lechman and Marszk (2015) who analyze the ETFs diffusion paths in selected emerging markets.

To display the ETF market development patterns we use the empirical framework of innovation diffusion model provided in the influential works of, *inter alia*, Mansfield (1961) and Dosi and Nelson (1994), who analyzed the phenomenon adopting the evolutionary dynamics concept. The concept may be mathematically expressed as the logistic growth function, that if written as an ordinary differential equation is as follows (Meyer et al. 1999):

$$\frac{dY_x(t)}{dt} = \alpha\, Y_x(t)\,. \tag{1}$$

If $Y(t)$ denotes the level of variable x, (t) is time, and α is a constant growth rate, then Eq. (1) explains the time path of $Y(t)$. If we introduce e to Eq. (1), it can be reformulated as:

$$Y_x(t) = \beta e^{\alpha t}\ , \tag{2}$$

or alternatively:

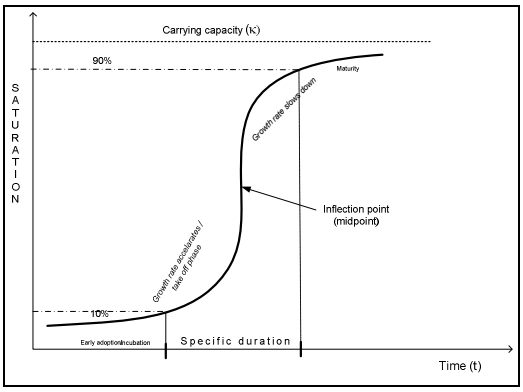
$$Y_x(t) = \alpha \exp \beta t, \tag{3}$$

with notation analogous to Eq. (1) and β representing the initial value of x at $t = 0$. The simple growth model is pre-defined as exponential; thus, if left to itself x will grow infinitely in geometric progression. Indiscriminate extrapolation of $Y_x(t)$ generated by an exponential growth model may lead to unrealistic predictions, as due to various constraints, systems do not grow infinitely (Meyer 1994). Therefore, to solve the problem of 'infinite growth', the 'resistance' parameter (Kwasnicki 2013) was added to Eq. (1). This modification introduces an upper 'limit' to the exponential growth model, which instead gives the original exponential growth curve a sigmoid shape. Formally, the modified version of Eq. (1) is the logistic differential function, defined as:

$$\frac{dY(t)}{dt} = \alpha Y(t)\left(1 - \frac{Y(t)}{\kappa}\right), \tag{4}$$

where the parameter κ denotes the imposed upper asymptote that arbitrarily limits the growth of Y.

Fig. 1. S-shaped diffusion trajectory. Theoretical specification.



Source: Lechman (2015).

As already mentioned, adding the slowing-down parameter to exponential growth generates an S-shaped trajectory. The 3-parameter logistic differential equation, Eq. (4), can be re-written as a logistic growth function, taking non-negative values throughout its path:

$$N_x(t) = \frac{\kappa}{1+ e^{-\alpha t-\beta}}, \tag{5}$$

or, alternatively:

$$N_x(t) = \frac{\kappa}{1+\exp(-\alpha(t-\beta))}, \tag{6}$$

where $N_x(t)$ stands for the value of variable x in time period t. The parameters in Eqs. (5-6) explain the following: κ - upper asymptote, which determines the limit of growth also labeled 'carrying capacity' or 'saturation'; α - growth rate, which determines the speed of diffusion; β - midpoint, which determines the exact time (T_m) when the logistic pattern reaches 0.5κ. However, to facilitate interpretation, it is useful to replace α with a 'specific duration' parameter, defined as $\Delta t = \frac{\ln(81)}{\alpha}$. Having Δt, it is easy to approximate the time needed for x to grow from 10%κ to 90%κ. The midpoint (β) describes the point in time at which the logistic growth starts to level off. Mathematically, the midpoint stands for the inflection point of the logistic curve. Incorporating Δt and (T_m) into Eq. (6), entails:

$$N_x(t) = \frac{\kappa}{1+exp\left[-\frac{\ln(81)}{\Delta t}(t-T_m)\right]}. \tag{7}$$

In our research, we aim to use the methodological framework regarding innovation diffusion model, which has been briefly presented above. During the first part of the analysis we assume that the growing value of ETF units' turnover may be regarded as diffusion of ETFs on the local financial markets. However, in the main part of our analysis, we assume that the process of growing ETFs' share in total turnover of comparable investment options (in equity index arbitrage complex) may be claimed as analogous to the process of diffusion of innovations across heterogeneous socio-economic systems. Henceforth, we claim that **ETFs are innovations**, which due to 'word of mouth' effect (Geroski 2000) and emerging network

effects, are gradually adopted by increasing number of investors (users). We also rely on basic assumption that investors (users) of financial innovations (in here – ETFs) may freely contact and, thus it leads to broader adoption of financial innovations by 'non-investors' ('non-users'), i.e. people either not using ETFs before or choosing other similar options. The process of growing adoption of financial innovations (ETFs) is effectively enhanced by unbounded access to information ensured by, for instance, broad adoption of information and communications technologies.

In short, we assume that ETFs diffuse on financial markets, gaining growing share in total turnover of comparable investment options (apart from ETFs - stock index futures and stock index options (Gastineau 2010)). Considering the basic version of 3-parameter logistic growth model as defined in Eq. (6), we presume that $N_x(t) = ETF_i(t)$ demonstrates changes of ETFs share in total turnover of comparable investment options over time (t) in i-country. Put differently, it shows changes of i-country`s financial market saturation with ETFs. The parameter κ is represented as κ_i^{ETF}, which shows the ceiling (upper asymptote/system limit) regarding the process of ETFs diffusion on financial markets. The estimated κ_i^{ETF} denotes the potential share of ETFs in total turnover of comparable investment options on analyzed financial market in i-country, however – under rigid assumption, that ETFs diffusion (development) trajectory follows sigmoid pattern generated by logistic growth equation. Next, the parameter α (as in Eq. (6)) is represented as α_i^{ETF}, which shows the speed of ETFs diffusion on analyzed financial market in i-country. Hence, the estimated parameter α_i^{ETF} presents how fast ETFs share in total turnover of comparable investment options is increasing over analyzed selected financial market. Moreover, using parameter α_i^{ETF}, we calculate 'specific duration' defined as $\Delta t = \frac{\ln(81)}{\alpha_i^{ETF}}$, which explains the time needed to pass from $\kappa_i^{ETF} = 10\%$ to $\kappa_i^{ETF} = 90\%$.

The β parameter is expressed as β_i^{ETF}, and its estimated value demonstrates the midpoint - $T_{m_i}^{ETF}$ indicating the exact time when 50% of κ_i^{ETF} is reached. Hence, the $T_{m_i}^{ETF}$ shows the time (year/month), when the process of ETFs diffusion is half-way, if we assume that it heads toward κ_i^{ETF}.

Henceforth, the modified specification of Eq. (6) is as:

$$ETF_i(t) = \frac{\kappa_i^{ETF}}{1+exp\,(-\alpha_i^{ETF}(t-\beta_i^{ETF}))}, \quad (8)$$

with notations as explained above.

The parameters in Eq. (8) can be estimated by the use of ordinary least squares (OLS), maximum likelihood (MLE), algebraic estimation (AE), or nonlinear least squares (NLS). However, suggested by Satoh (2001), NLS returns the relatively best predictions, as the estimates of standard errors (of $\kappa_i^{ETF}, \alpha_i^{ETF}, \beta_i^{ETF}$) are more valid than those returned from estimation using other methods. Adoption of NLS allows avoiding time-interval biases, which are revealed in the case of OLS estimates (Srinivasan et al. 1986). However, the main

disadvantage of the NLS procedure is that estimates of the parameters may be sensitive to the initial values in the time-series adopted.

Moreover, we use the technological substitution model framework that was initially developed Fisher and Pry (1972), and then adopted in multiple studies by, *inter alia*, Kucharavy and Guio (2011), or Miranda and Lima (2013). The process of technological substitution may be defined as gradual replacements of 'old' technologies by 'new' ones; and in a way it resembles competition between the 'old' and 'new' technology, in which the 'old' technology is initially a dominant competitor in the market and the 'new' 'invading' one fights for a growing market share (Lechman 2015, Morris and Pratt 2003).

The technological substitution model (also labelled logistic substitution model) allows explaining the competitors' changing market shares (fractions) (Wang and Lan 2007). As claimed by Fisher and Pry (1972) or Kucharavy and Guio (2011), the evolutionary process of technology diffusion passes through three characteristic phases: a logistic growth phase, when initially growth rates are slow; but then it enters an exponential growth phase which results in rapid diffusion of technology. Finally, technology enters the saturation phase when technology reaches the maximum of its market share and thus follows a non-logistic pattern. Considering the technological substitution process, once the technology reaches the maximum of its market fraction, then it may begin fading away from the market if it is gradually substituted by new emerging technology (Marchetti and Nakicenovic 1980, and Nakicenovic 1987).

Technically, the technological substitution model explains changing shares of the market that competitors take over, and it relies on the assumption that the total sum of users of the two competing technologies is fixed. In our work we follow the methodology developed by Blackman (1971) and Marchetti and Nakicenovic (1980), who formalized the original technological substitution model developed by Fisher and Pry, and use a three-parameter logistic substitution model allowing to demonstrate the behaviour of two competitors along the time trajectory.

Consider a competitive system and consider the technology substitution model where only two different technologies are replacing each other. Assume that N_i represent the users of the two technologies, so that the share of the population using *i*-technology at time *t* is (Lechman 2015):

$$f_i\,(t) = \frac{N_i(t)}{N}\,. \tag{9}$$

Additionally, we follow Morris and Pratt (2003) and assume that the number of users is fixed and each deploys one out of the two available technologies. The later implies constrain like:

$$f_i(t) + f_j(t) = 1\,, \tag{10}$$

where $'i'$ and $'j'$ are competing technologies.

As claimed by Kwasnicki (1999), analyzed technologies follow a logistic growth trajectory expressed as:

$$f_i(t) = \frac{\kappa}{1+\exp(-\alpha(t-\beta))}, \quad (11)$$

To calculate the market share $(y_i(t))$ possessed by technology $'i'$ we adopt a Fisher-Pry transform (1972) so that Eq. (10) yields:

$$y_i(t) = ln\left[\frac{f_i(t)}{1-f_i(t)}\right]. \quad (12)$$

If the following is true:

$$y_i(t) + y_j(t) = 1. \quad (13)$$

the market share of technology $'j'$ in the non-logistic saturation phase may be shown:

$$f_j(t) = 1 - \sum_{j\neq i} f_i(t). \quad (14)$$

For an economic interpretation, it is crucial to identify the time when given phases of substitution begin or end. To this aim, we follow Meyer et al. (1999), who claim that the estimate of the time when the saturation phase stops is given by:

$$\frac{y_i^{''}(t)}{y_i^{'}(t)} \rightarrow min. \quad (15)$$

Hence, once having y_i and $y_i^{'}$, it is possible to estimate the two parameters of the logistic curve for technology $'i'$, which can be expressed as:

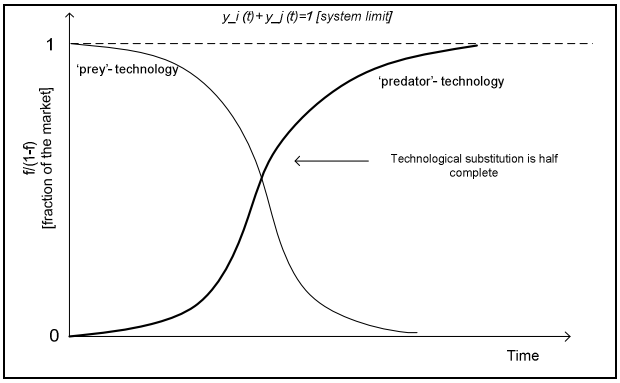
$$\Delta t_i = \frac{\ln(81)}{y_i^{'}(t)}, \quad (16)$$

and:

$$T_{m_i} = ln\left[\frac{\left(y_i(t) - \frac{\ln(81)}{\Delta t}\right)}{\frac{\ln(81)}{\Delta t}}\right]. \quad (17)$$

The Δt_i is labelled 'takeover' (Fisher and Pry 1972) and it shows the time needed for technology $'i^{'}$ to increase its market share from $y_i(t) = 0.1$ to $y_i(t) = 0.9$; while the $T_{m_{is}}$ explains the specific point in time when substitution process is half-complete; thus $y_i(t) = y_j(t) = 0.5$.

Fig.2. Technological substitution process.



Source: Lechman (2015).

Fig.2 graphically presents the mechanism standing behind the technological substitution. It explains the life cycles of competing technologies, and three distinct phases are detectable: logistic growth, saturation and logistic decline. The intersection point depicts the specific time (i.e. the year) when the technological substitution process is half complete. Thus both technologies control 50% of the total market ($\rightarrow y_i(t) = y_j(t) = 0.5$)).

Following the theoretical framework presented above, we suggest to analyze the process of financial substitution which, as we claim, may be analogously analyzed as the process of technological substitution.

Assume to have two different, and potentially competing, financial instruments where each posses certain share of the market in i- country, hence we may Eq.(13) rewrite as:

$$f_i^{\delta}(t) + f_i^{\theta}(t) = 1, \quad (18)$$

where:

$$f_i^{\delta}(t) = \frac{\kappa_i^{\delta}}{1+\exp(-\alpha_i^{\delta}(t-\beta_i^{\delta}))}, \quad (19)$$

and:

$$f_i^{\theta}(t) = \frac{\kappa_i^{\theta}}{1+\exp(-\alpha_i^{\theta}(t-\beta_i^{\theta}))}. \quad (20)$$

In Eqs.(18-20) i denotes country, while δ and θ represent two competing financial instruments on given stock exchange in i-country.

4. Data

Our analysis concentrates on two Asia-Pacific countries with the largest ETF markets (apart from Chinese which is difficult to evaluate due to various linkages between stock exchanges in Hong Kong and Mainland China), namely Japan and South Korea. The time coverage is

fully subjected to data availability, as exclusively for the period 2003-2015 the balanced data set is acquirable for both countries. Financial instruments database used for the research purposes includes the dataset provided by the World Federation of Exchanges (2016), and reports published by the Japanese and Korean stock exchanges (Japan Exchange Group 2016, Korea Exchange 2016), all of them with monthly observations. Most important financial indicators used to achieve the stated aims are values of turnover (in USD millions) of selected instruments on stock exchanges in Japan and South Korea: ETFs, stock index options and stock index futures, labeled together as 'index financial instruments'.

5. Results

This section extensively describes the results of our empirical research. First, it develops and discusses country-specific diffusion trajectories of financial innovations (ETFs) and examines the dynamics of the process, across Japanese and South Korean stock exchanges. Second, it demonstrates the unique process of substitution between ETFs and similar investment options, i.e. stock index futures and options, again in Japan and South Korea. Third, it shows long-term predictions of financial innovations development across examined countries, trying to establish the possible future path of the ETF markets development in countries in scope. Finally, we have intended to examine the impact of the ETF markets development on the financial systems in examined countries. ETF market development discussed in this text is understood twofold: as increase in the value of turnover in ETFs' units (here in USD millions) and, regarded as the main concept within the diffusion and substitution framework, increase in the share of ETFs in total index financial instruments.

5.1. ETF markets in Japan and South Korea - preliminary evidence.

As claimed in previous section, to analyze the process of diffusion of financial innovations, we use monthly data on ETFs, stock index options and stock index futures, which were listed on Japanese and South Korean stock exchanges, between the years 2003 and 2015.

Two analyzed countries are part of the Asia-Pacific region which remains a rather small part of the global ETF market – as of end of March 2016, its share was at ca. 9% in terms of assets under management, AUM (ETFGI 2016). Japanese ETF market is the largest in the region in terms of AUM (in October 2015 it constituted ca. 52% of the all ETFs' assets in the region) and one of the leading in terms of the turnover (ca. 39% share; combined Chinese stock markets accounted for ca. 48% of transactions) (Deutsche Bank 2015b). South Korean market is the third largest in both rankings yet its share in the total Asia-Pacific is much lower (7.5% in AUM, 9% in turnover (Deutsche Bank 2015b)) which can be explained by the smaller size of the South Korean economy in comparison to Japan and China.

First ETFs on the Japanese and South Korean financial markets had been launched almost in the same time – in Japan in 2001 (Seki 2007), whereas in South Korea in 2002 (Samsung Asset Management 2010). Over the first years, size of both ETF markets had been minimal, until the dynamic growth began. The lowest value of turnover in ETFs in Japan was observed at the beginning of the analyzed time period, i.e. in January 2003, when it amounted to ca. $883 million; in South Korea the minimal turnover was ca. $111 million in February 2005 (see Table 2 and Fig. 3). As in most other countries the leading index financial instruments category in the whole time period considered was stock index futures, both in terms of

turnover in million USD and their share in the total market – in Japan their maximal share exceeded 99% in December 2007, and in South Korea 97% in March 2010. The role of stock index options differed, in Japan they were less popular than ETFs over almost the whole period (with slight exceptions between 2009 and 2013 when in some months they were traded more actively than ETFs), whereas in South Korea until late 2013 market position of options had been much stronger – this issue will be analyzed in Section 5.2.

The period of fast ETF market development began in South Korea sooner than in Japan: in South Korea in the second half of 2011, whereas in Japan at the end of 2012 and beginning of 2013 (compare Fig. 3 and 4; see the discussion in Section 5.2.) which means that the adaption of these innovative instruments occurred faster in the emerging economy than in the developed one. As a consequence, turnover in ETFs' shares on the South Korean stock exchange was between 2011 and 2013 highest among all Asia-Pacific countries, even though the values of AUM or fund flows lagged behind Japan and China. However, the South Korean market seems to have reached barriers hindering further fast expansion such as lack of cross-listed ETFs. Overall, the position of ETFs among the spectrum of index financial instruments was stronger in Japan: the mean turnover value in 2003-2015 in Japan was $9.5 billion versus $5.3 billion in South Korea; in terms of market share Japan exceeded South Korea by ca. 0.3 pp (1.4% versus 1.1%).

The highest levels of the ETF market development, for values in USD millions, in Japan was achieved in September 2015, and in South Korea in August 2011. However, these results should be interpreted carefully as at those points in time the whole market for index financial instruments reached its record-high levels in both countries. More meaningful analysis is possible by considering the shares of ETFs – in both countries ETF markets reached the highest levels of their development by the end of the 2003-2015 time period (in Japan in October 2015, and in South Korea in July 2014) which indicates their growing popularity and diffusion – this process has been analyzed in detail in the next section. One notable conclusion from the results of analysis presented in Table 2 is that ETFs were the only category of instruments whose market shares have grown in 2003-2015; the shares of both stock index futures and options have declined.

In Japan the ETF market, as of October, 2015, consisted mostly of equity ETFs (99% share in terms of AUM), whereas in South Korea their share, while still the highest, was lower and amounted to ca. 76%, followed by fixed income ETFs (Deutsche Bank 2015b). Largest ETFs in South Korea were funds tracking the main index of Korean exchange, KOSPI 200, similarly in Japan, therefore their underlying assets were the same as in case of stock index options and futures. South Korean ETF market seemed more diversified considering the number of ETFs (since 2011 it was the highest among all Asia-Pacific countries), with many types of ETFs available; nevertheless the market share of such ETFs was low and the main group were ETFs tracking local stock market indexes.

Almost since the inception of first ETFs in South Korea the main group of market participants investing in ETFs were institutional investors (such as asset management companies, banks or brokers) – such market structure is common during the initial stages of the ETF market development; large financial companies are usually the first adopters of innovative financial instruments as they are involved in their creation and distribution (see the outline of the key features of ETFs in Section 2.1.). In Japan share of individual investors was initially similar to

South Korea. In both countries it started to increase sharply during the stage of rapid ETF market development, e.g. in Japan since 2013 individual investors became the second most active category (in terms of turnover), behind foreign investors; in 2015 their market share was at ca. 40% (share of foreign investors was at ca. 50%, institutional domestic investors' at only ca. 10% (Tokyo Stock Exchange 2016)).

One of the key factors, which influenced the rapid development of the ETF market both in Japan and South Korea (by increasing the turnover of innovative financial instruments), was the launch of complicated ETFs offering modified returns – leveraged and short ETFs (Hill et al. 2015). In the early 2012 there were no such ETFs listed on either Japanese or South Korean stock exchanges (Johnson et al. 2012, Urakabe 2014) but over a few years their popularity grew considerably (Deutsche Bank 2015b). Leveraged and short ETFs are subcategories of synthetic ETFs, i.e. based on derivatives, popular also in the USA (synthetic ETFs, apart from the two types mentioned above, are used more often in Europe (Marszk 2014)). The popularity of such funds in Japan is so high that some ETFs have grown too big, hindering proper management (e.g. in October 2015 sponsor of the leveraged Nikkei 225 ETF decided not to accept any new investors (Nakamura and Sano 2015)). Leveraged and short funds contributed significantly to the diffusion of ETFs as they accounted in 2015 in both countries for majority of turnover's value of these instruments, even though their share in AUM of all ETFs was between 5 and 20% (Deutsche Bank 2015b). These **two complicated types of ETFs magnify the advantages of ETFs versus index futures and options – ability to use leverage or short sales are the key relative benefits of index derivatives in comparison to ETFs and emergence of such ETFs diminishes the advantage of futures or options** (see discussion in Section 2.2.). From the perspective of the financial system's stability this may lead, though, to emergence of possible threats for the Japanese and South Korean financial systems. Discussion on this issue is continued in section 5.3.

Rapid development of the Japan ETF markets since 2013 and linked falling shares of competing index instruments can also be attributed to various country-specific events (Deutsche Bank 2015b):

- growing diversity of the ETF category (more types of ETFs, tracking different assets);
- introduction of ETFs tracking the newly-launched Nikkei 400 Index in January 2014 – such funds gathered quickly sizeable assets;
- purchases of ETFs' units by the Japanese central bank (Bank of Japan) undertaken in order to increase risk-taking activities in the economy and liquidity of the ETF market (Nakamura and Sano 2015); Bank of Japan ETF program began in 2010 yet with no significant effects, it was expanded in the early 2013 and in Autumn 2014, in both cases leading to sizeable increases in the ETFs turnover (see Fig. 3) which were caused not only by the purchases by the Bank of Japan but also by growing investors' confidence triggered by these decisions.

There are, though, still some factors hindering the development of the Japanese ETF market such as (PwC 2015): lack of incentive of Japanese banks to sell such products (due to possibility of higher profits gained from distribution of mutual funds) and conservatism of these institutions; in South Korea this problem is less severe due to alternative distribution channels, e.g. funds supermarkets.

Fast development of the South Korean ETF market and diffusion of these innovative financial instruments observed between 2011 and 2013 was followed by the slow-down in 2014-2015

which may be explained by saturation of local financial markets with these products (see the discussion of diffusion models' estimations in Section 5.2). However, South Korean financial authorities and Korea Exchange announced in Autumn, 2015, the plan to further boost the ETF market development by implementing measures such as (Deutsche Bank 2015b): liberalization of the ETF listing procedures, cross-listing of ETFs and encouraging institutional investors to purchase such products (e.g. by rising investment limits). As a result, the next phase of fast growth may begin in the upcoming years.

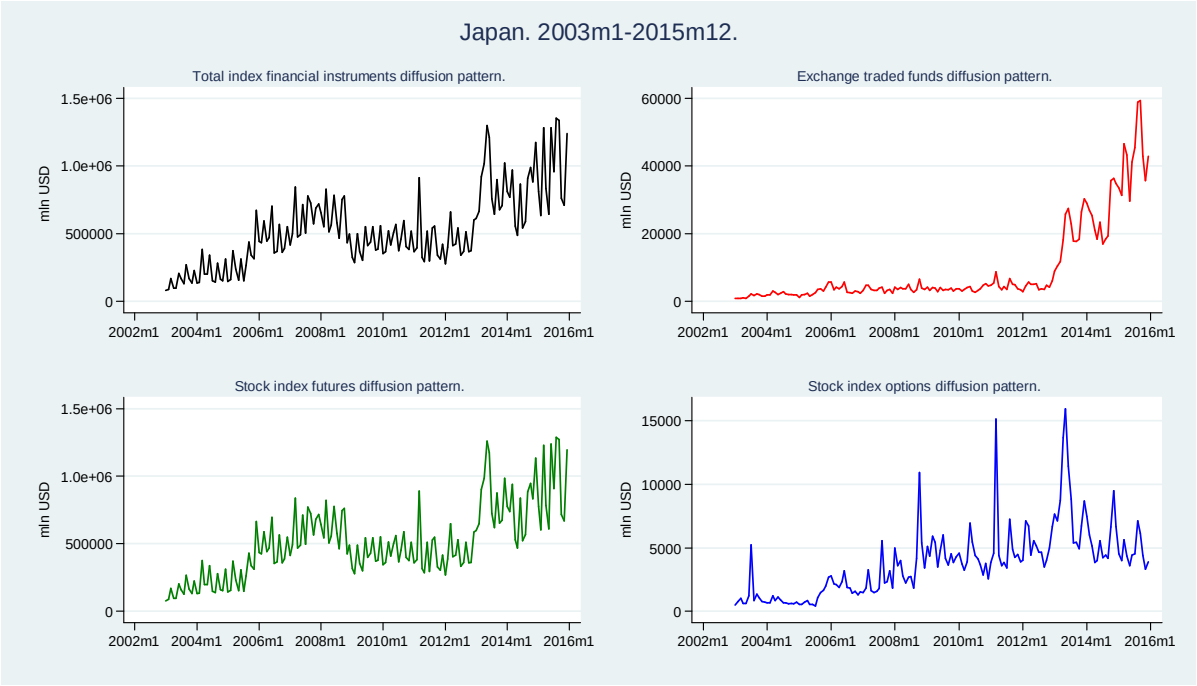
Table 2. Summary statistics for exchange traded funds, stock index options, stock index future, and total index financial instruments. Japan and South Korea. Monthly data for 2003-2015.

	Japan				**South Korea**			
	Turnover on Local Stock Exchanges **(mln USD)**							
	ETFs	Stock Index Options	Stock Index Futures	Total Index Financial Instruments	ETFs	Stock Index Options	Stock Index Futures	Total Index Financial Instruments
# obs.	156	156	156	156	156	156	156	156
Min	883.4 (2003m1)	405.1 (2005m7)	78 413.8 (2003m1)	79 823.1 (2003m1)	110.9 (2005m2)	6 344.8 (2015m5)	149 698.8 (2003m6)	158 717.5 (2003m6)
Max	59 382.1 (2015m9)	15 980.3 (2013m5)	1 288 211 (2015m8)	1 354 212 (2015m8)	18215.9 (2011m8)	50 418.3 (2011m8)	1 179 588 (2011m8)	1 248 222 (2011m8)
Std dev.	12 478.7	2 752.918	272 398.1	283 744.9	5858.05	7 399.1	198 287.7	206 710.2
Mean	9 438.4	3 837.117	509 693.2	522 968.8	5259.60	17 598.2	449 028.6	471 886.4
Absolute change in value	4 2036.2	3 409.6	1 115 485.5	1 160 931	11 581.8	48.3	145 991.3	157 621.5
Average monthly dynamic	102.5	101.3	101.7	101.7	102.1	100.0	100.3	100.3
	Share in Total Turnover of Index Financial Instruments on Local Stock Exchanges [%]							
	ETFs	Stock Index Options	Stock Index Futures	-	ETFs	Stock Index Options	Stock Index Futures	-
# obs.	156	156	156	-	156	156	156	-
Min	.33 (2007m9)	.17 (2005m6)	93.79 (2015m10)	-	.05 (2005m5)	1.82 (2015m5)	92.38 (2014m7)	-
Max	5.6 (2015m10)	3.12 (2003m7)	99.40 (2007m12)	-	4.01 (2014m7)	7.13 (2008m10)	97.14 (2010m3)	-
Std dev.	1.2	.41	1.24	-	1.24	.88	1.29	-
Mean	1.4	.74	97.77	-	1.06	3.89	95.04	-
Absolute change in share (pp)	2.35	-.34	-2.01	-	3.17	-2.39	-0.79	-

Average monthly dynamic	100.7	99.5	99.9	-	101.7	99.6	99.9	-
	Marginal Changes in Shares in Total Turnover of Index Financial Instruments on Local Stock Exchanges							
	ETFs	Stock Index Options	Stock Index Futures	-	ETFs	Stock Index Options	Stock Index Futures	-
# obs.	155	155	155	-	155	155	155	-
Min	-1.57 (2015m12)	-2.46 (2003m8)	-3.16 (2003m7)	-	-.70 (2014m8)	-1.77 (2007m9)	-1.95 (2014m7)	-
Max	1.57 (2015m4)	2.53 (2003m7)	2.52 (2003m8)	-	1.17 (2014m7)	2.17 (2008m10)	1.80 (2007m9)	-
Std dev.	.52	.39	.77	-	.23	.52	.60	-
Mean	.015	-.002	-.012	-	.02	-.015	-.005	-

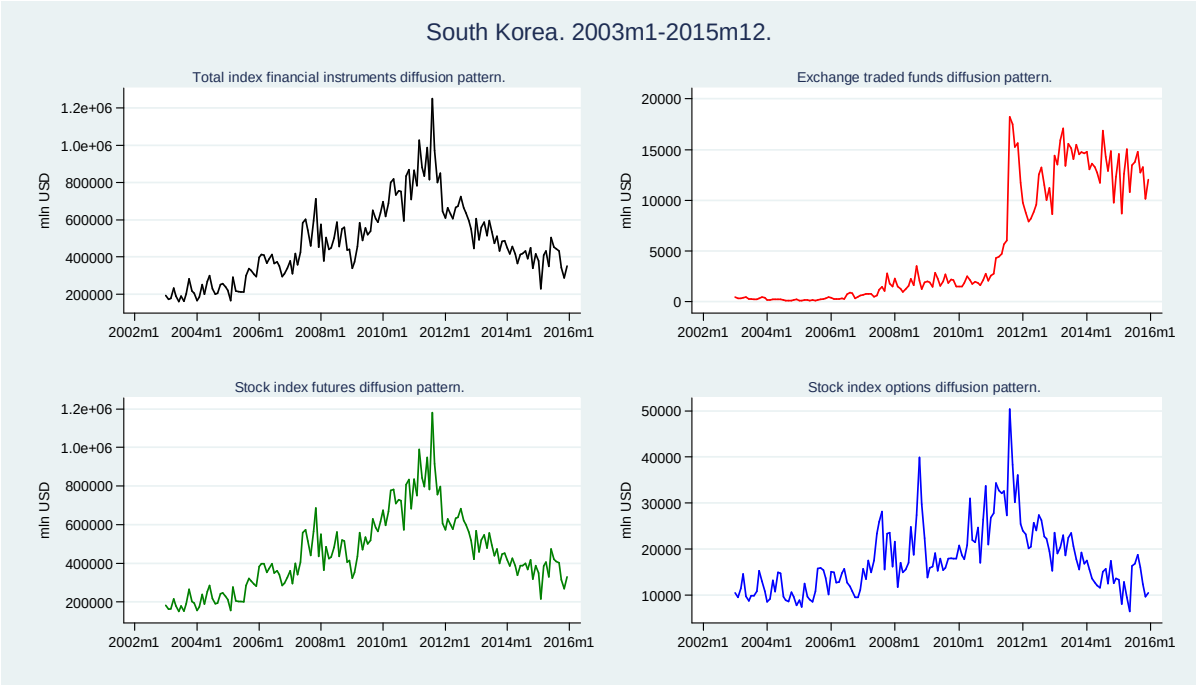
Source: Authors` calculations.

Fig. 3. Total index financial instruments, exchange traded funds, stock index options and stock index futures diffusion patterns in Japan. Monthly data for 2003-2015.



Source: Authors` elaboration.

Fig. 4. Total index financial instruments, exchange traded funds, stock index options and stock index futures diffusion patterns in South Korea. Monthly data for 2003-2015.



Source: Authors` elaboration.

5.2. Financial innovations diffusion patterns.

To stay in line with the main targets of this work, in the forthcoming sections we demonstrate and extensively discuss the results of our empirical analysis aiming to examine the process of diffusion of financial instruments and trace the emergence of financial substitution process. By convention we concentrate on Japanese and South Korean stock exchanges, between the period 2003 and 2015. Similar to the previous section we use monthly data on turnover of exchange traded funds – ETF_t^i, where i – denotes country and t – time; stock index options – Opt_t^i, stock index futures – Fut_t^i, and total index financial instruments – $TIFI_t^i$. Moreover, in our analysis we consider ETFs share in turnover of total financial instruments – $ETF_t^i\_share\_turn\_LE$; stock index options share in turnover of total financial instruments – $Opt_t^i\_share\_turn\_LE$; and – stock index futures share in turnover of total financial instruments – $Fut_t^i\_share\_turn\_LE$, with notations as above.

To shed light on the development patterns and the dynamics of the process of diffusion of financial innovation on Japanese and South Korean stock exchanges, we use a logistic growth model allowing demonstrating in-time evolution of selected variable. As clarified in the Section 3, adoption of a logistic growth model allows visualizing the continuous time path (trajectory) evolvement of given variable (Meyer et al. 1999, Kwasnicki 2013), and – relying on 'natural growth logic' (Darwin 1986), allows distinguishing between characteristic phases of this variable growth. Considering the latter, Kucharavy and de Guio (2007, 2011) also claim that the use of logistic growth model generates relatively good forecasts of future development of examined variable.

In our case, the logistic growth model is used to display the diffusion trajectory of innovative financial instruments – exchange traded funds, across both analyzed countries during the period 2003-2015. To this aim we run country-specific analysis, and express the value of ETFs' share in turnover of total financial instruments on local stock exchange. Henceforth, for Japan we define $ETF_t^{Jap}\_share\_turn\_LE$; and for South Korea – $ETF_t^{Kor}\_share\_turn\_LE$. Figs. 5 and 6 (see below), graphically present ETFs diffusion trajectories in Japan and South Korea over the period 2003-2015. Table 3 summarizes results of logistic growth models estimates, separately run for ETFs diffusion on Japan and South Korea, and consecutive Table 4 presents predictions of future country-specific ETFs diffusion patterns.

To complete the analysis, we have estimated the following country-specific logistic growth models:

$$ETF_{Jap}(t) = \frac{\kappa_{Jap}^{ETF}}{1+exp\left(-\alpha_{Jap}^{ETF}\left(t-\beta_{Jap}^{ETF}\right)\right)},$$

(21)

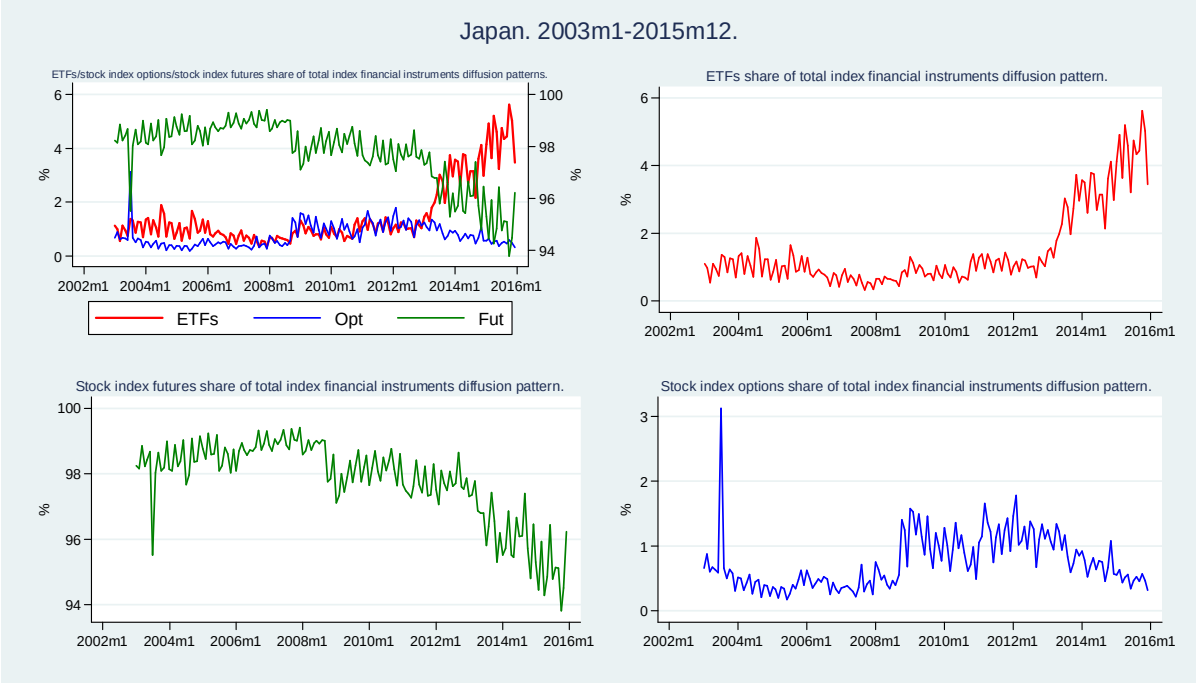
and

$$ETF_{Kor}(t) = \frac{\kappa_{Kor}^{ETF}}{1+exp\left(-\alpha_{Kor}^{ETF}\left(t-\beta_{Kor}^{ETF}\right)\right)},$$

(22)

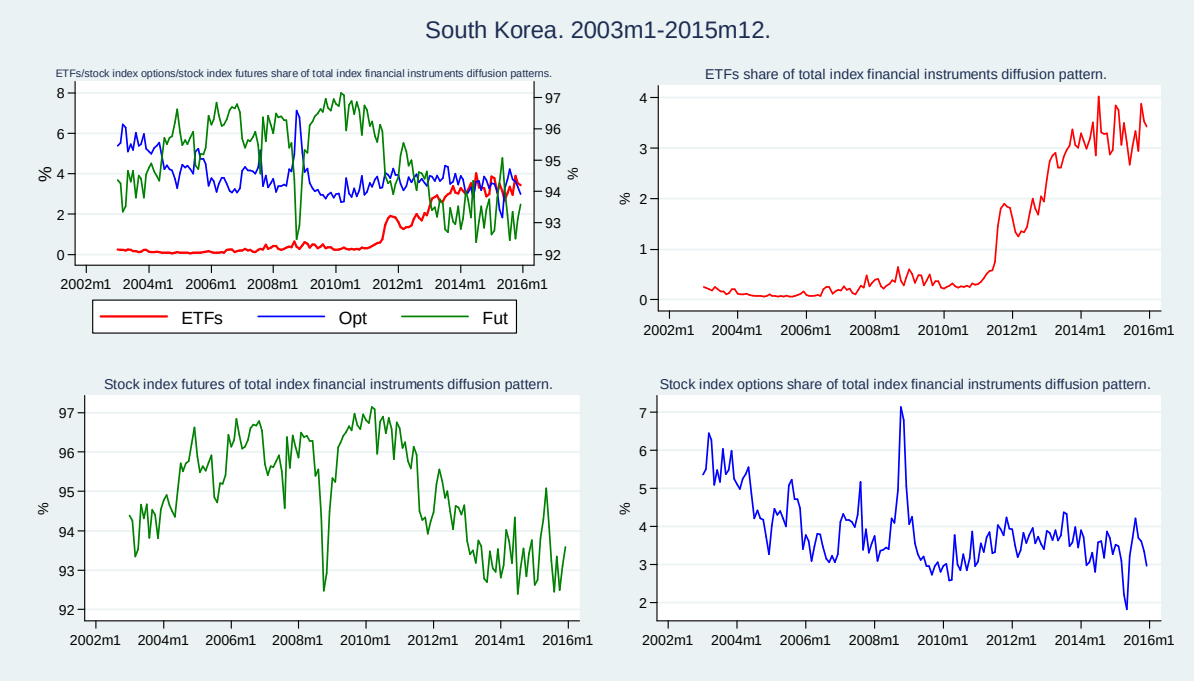
where, κ_{Jap}^{ETF} and κ_{Kor}^{ETF} demonstrate the upper asymptote, hence the growth limit of ETFs on Japanese and South Korean stock exchanges; α_{Jap}^{ETF} and α_{Kor}^{ETF} show the rate (speed) of diffusion of ETFs; while – β_{Jap}^{ETF} and β_{Kor}^{ETF} explain the midpoints along respective ETFs` diffusion patterns and determine the exact time (in here – year and month) when the 0.5κ is achieved. Additionally, the estimated country-specific α_{Jap}^{ETF} and α_{Kor}^{ETF} parameters have been used to calculate the 'specific duration' - Δt_i^{ETF}, which allows approximating the time (in here – number of months) needed to pass from 10% to 90% of estimated κ_{Jap}^{ETF} and κ_{Kor}^{ETF}.

Fig. 5. Exchange traded funds, stock index options and stock index futures diffusion patterns in Japan. Monthly data for 2003-2015.



Source: Authors` elaboration. Note: graphs present empirical diffusion patterns – for theoretical ETFs diffusion patterns – see Appendix 1.

Fig. 6. Exchange traded funds, stock index options and stock index futures diffusion patterns in South Korea. Monthly data for 2003-2015.



Source: Authors` elaboration. Note: graphs present empirical diffusion patterns – for theoretical ETFs diffusion patterns – see Appendix 1.

Figs. 5 and 6, demonstrate graphical evidence on ETFs shares in total index financial instruments – $ETF_t^{Jap}\_share\_turn\_LE$ and $ETF_t^{Kor}\_share\_turn\_LE$, diffusion patterns on Japanese and South Korean stock exchanges. In Sect. 5.1, Figs. 3 and 4 clearly display that between 2003 and 2015, ETFs were rapidly expanding over analyzed stock exchanges. Additionally, as already discussed in Sect. 5.1, both in Japan and South Korea, it is easy to observe fast growth of ETFs in terms of value (in USD millions), but also its dynamically changing share in total turnover of index financial instruments on local stock exchanges. Analyzing, displayed on Figs. 5 and 6, $ETF_t^{Jap}\_share\_turn\_LE$ and $ETF_t^{Kor}\_share\_turn\_LE$ diffusion patterns, in both cases, two characteristic phases, may be easily distinguished. First, since 2003 onward we observe a kind of 'plateau', where changes in ETFs share in total turnover of index financial instruments are negligible and remain, in most cases, below 1%. If compared to Fig.1 (see Section 3), this 'plateau' may be easily compared to the initial growth phase along the S-shaped diffusion trajectory, when changes in given variable are relatively slow and do not bring any sudden or radical shifts. In case of Japan this 'ETFs plateau' phase lasts from January 2003 till September 2012 (10 years). Next, over the period September 2012 and July 2013, an abrupt shift in ETFs share in total turnover of index financial instruments is reported. Note that $ETF_{2012m9}^{Jap}\_share\_turn\_LE$=.69%, $ETF_{2012m10}^{Jap}\_share\_turn\_L = 1.3\%$,then $ETF_{2013m6}^{Jap}\_share\_turn\_LE$=2.26% and $ETF_{2013m7}^{Jap}\_share\_turn\_LE$=3.02%; which means that between September 2012 and October 2012 the ETFs share in total turnover of index financial instruments grew at about 188%, while between September 2012 and September 2013 at 437% (sic!). **On Japanese stock exchange the period between September 2012 and September 2013 is critical**, as during these 12 months the ETFs diffusion pattern leaves the initial growth phase and enters

exponential growth phase along S-shaped time path. Since September 2019 onward, in Japan, ETFs share in total turnover of index financial instruments is steadily growing, reaching its peak in October 2015 when $ETF^{Jap}_{2015m10}\_share\_turn\_LE$=5.62%.

Similar tendencies in ETFs development may be identified along ETFs diffusion trajectory regarding South Korean stock exchange. At the beginning of the analyzed period, from January 2003 until July 2011, the $ETF^{Kor}_{2003m1-2011m7}\_share\_turn\_LE$ is below 1%, and this phase may be recognized as the initial growth phase along sigmoid ETFs diffusion trajectory (again compare Fig.1). However, over the period July 2011 and August 2011 an abrupt shift in ETFs share in total turnover of index financial instruments, as in $ETF^{Kor}_{2011m7}\_share\_turn\_LE$=.74% while $ETF^{Kor}_{2011m8}\_share\_turn\_LE$=1.46% which means growth at 197% during just one month. Henceforth, in South Korea, the period between July 2011 and August 2011 may be claimed as critical in terms of changes in ETFs share in total turnover of index financial instruments. Since August 2011 onward, on South Korean stock exchange, ETFs share in total turnover of index financial instruments it exceeds 1%, and in consecutive periods its grows are reported – the peak is reached in July 2014 when $ETF^{Kor}_{2014m7}\_share\_turn\_LE$=4.01%. Analogously to Japan, in South Korea, the ETFs development pattern, after relatively long 'plateau' period, suddenly takes off and enters the exponential growth phase along the S-shaped time path. Regarding the latter, another interesting observation may be found. In Japan, in September 2012 (the time when radical changes in ETFs share in total turnover of index financial instruments started) the absolute level of ETFs was at about 3559 mln USD, in October 2012 – 4770 mln USD and in December 2012 – 6168 mln USD. In South Korea, in July 2011 (also the critical time when radical changes in ETFs share in total turnover of index financial instruments started) the ETFs absolute value was at 6063 mln USD.

The graphical evidence presented in Figs. 5 and 6 suggest that ETFs diffusion patterns may be relatively well described by the logistic (sigmoid) growth trajectory, and in case of Japan and South Korea the characteristic phases of the S-shaped path may be distinguished. Initially slow changes in ETFs share in total turnover of index financial instruments are followed by sudden take off, and then the pattern enters the phase of rapid growth. Possible causes of the accelerated growth were discussed in Section 5.1, among them the launch and increasing popularity of leveraged and synthetic ETFs seems most critical. We use then logistic growth model to estimate its specific parameters allowing characterizing the process of ETFs diffusion on examined stock exchanges. The results of estimated logistic growth models – see Eqs. 18 and 19, are summarized in Table 3.

As reported in Table 3, in case of Japan estimated parameter of upper asymptote (growth limit) is at κ^{ETF}_{Jap}=10 084 359, and this results yields an obvious misspecification. Similar misspecifications are returned in case of each consecutive parameter, namely β^{ETF}_{Jap}, α^{ETF}_{Jap} and Δt^{ETF}_{Jap}. Japan, regarding the process of ETFs diffusion, during examined time period, was still located in the early exponential growth phase and this leads to unreliable estimates, especially regarding the upper asymptote (growth limit) – κ^{ETF}_{Jap}.

For South Korea, all estimated logistic growth models parameters resulted to be statistically significant. Moreover the R of the model is at about .96, which suggests very good fit of empirical data to the theoretical model. In South Korea, the ceiling (upper asymptote) is

estimated as κ_{Kor}^{ETF}=3.52%, and this parameter explains the potential (maximum) level of ETFs share of turnover of index financial instruments, based however on rigid assumption that the ETFs diffusion pattern follows the theoretical trajectory generated by the logistic growth model. The estimated midpoint is Tm_{Kor}^{ETF}=113.3 and this shows the exact time when $ETF_t^{Kor}\_share\_turn\_LE$ reached 0.5κ. If Tm_{Kor}^{ETF}=113.3 it suggests that the midpoint was reached exactly in May 2012 (see also Figures in Appendix 1). Next, the rate (speed) of diffusion is as α_{Kor}^{ETF}=.09, however as this parameter yields no direct economic interpretation, we use it to calculate the 'specific duration'. Henceforth, as α_{Kor}^{ETF}=.09, the Δt_{Kor}^{ETF}=47.3, which may be interpreted as number of months needed to pass from 10% to 90% of κ_{Kor}^{ETF}.

Table 3. Exchange Traded Funds' share in total turnover of index financial instruments logistic growth estimates.

	Logistic growth model estimations	
	Japan	**South Korea**
κ_i^{ETF} (ceiling/upper asymptote)	*10 084 359*	3.52
Tm_i^{ETF} (β_i^{ETF}) (midpoint)	*852.1*	113.3
α_i^{ETF} (rate of diffusion)	*.021*	.09
Δt_i^{ETF} (specific duration)	*209.2*	47.3
R of the model	*.75*	.96
# of obs.	156	156

Source: Authors` estimates. Estimates completed using IIASA software. In italics – misspecifications (over-estimates).

Next, to evaluate future prospects of ETFs development, we estimate the hypothetical scenarios of future $ETF_t^i\_share\_turn\_LE$ diffusion, both in Japan and South Korea (for visualization – see Appendix 1). Fixing the critical level of upper asymptote (κ_i^{ETF}) at 5%, 7.5%, 10%, 15%, 20%, 25% and 30%, we forecast respective logistic growth models parameters, however under rigid assumption that $ETF_t^i\_share\_turn\_LE$, in analyzed country will follow the S-shaped trajectory. The results of the forecasts are summarized in Table 4. First, we consider the results of different predicted scenarios of future $ETF_t^{Jap}\_share\_turn\_LE$ development for Japan. To remind, the estimates of logistic growth model resulted to be statistically insignificant and heavily biased, due to the fact that during analyzed period Japan was still in the early exponential growth phase along the S-shaped diffusion path. The first scenario forecasts $ETF_t^{Jap}\_share\_turn\_LE$ diffusion trajectory under the assumption that the ceiling κ_{Jap}^{ETF} is set for 5%, next is set for κ_{Jap}^{ETF}=7.5%, and then consecutive once for κ_{Jap}^{ETF}=10%, κ_{Jap}^{ETF}=15%, κ_{Jap}^{ETF}=20%, κ_{Jap}^{ETF}=25% and κ_{Jap}^{ETF}=30%. For each scenario we have predicted the specific midpoint – Tm_{Jap}^{ETF}, and 'specific duration – Δt_i^{ETF} allowing assessing how much time (in here – how many months) would be needed to pass from 10% to 90% of given fixed κ_{Jap}^{ETF}. In case of South Korea, similar assumptions have been made, and hence the forecasts are run for analogous fixed upper asymptotes.

Table 4. Predicted exchange traded funds' share in total turnover of index financial instruments development scenarios. Japan and South Korea.

κ_i^{ETF} (upper asymptote) - *fixed*	Tm_i^{ETF} (midpoint)	Δt_i^{ETF} (specific duration) – number of months	α_i^{ETF} (rate of diffusion)	R of the model
	Japan			
5%	*126.5 (June 2013)*	124.6 (approx. 10 years)	.035	.68
7.5%	*150.2 (June 2015)*	149.8 (approx. 12 years)	.029	.72
10%	167.9 (Nov 2016)	164.2 (approx. 13 years)	.027	.73
15%	192.8 (Dec 2018)	179.0 (approx. 14 years)	.025	.74
20%	209.9 (May 2020)	186.6 (approx. 15 years)	.024	.74
25%	223.0 (June 2021)	191.1 (approx. 15 years)	.023	.74
30%	233.0 (May 2022)	194.1 (approx. 16 years)	.023	.74
	South Korea			
5%	*128.1 (Aug 2013)*	89.2 (approx. 7 years)	.05	.94
7.5%	*149.7 (May 2015)*	121.0 (approx. 10 years)	.04	.91
10%	165.6 (Sept 2016)	135.7 (approx. 11 years)	.03	.90
15%	187.3 (July 2018)	149.8 (approx. 12 years)	.03	.90
20%	202.2 (Oct 2019)	156.7 (approx. 13 years)	.03	.87
25%	213.4 (Sept 2020)	160.8 (approx. 13 years)	.02	.89
30%	222.4 (June 2021)	163.6 (approx. 13 years)	.02	.89

Source: Authors` estimates.

Not surprisingly, the results for Japan and South Korea are similar. For the κ_i^{ETF} fixed at 5%, the predicted Tm_i^{ETF} is set for June 2013 and August 2013 for Japan and South Korea respectively. However, in terms of forecasted 'specific duration' – Δt_i^{ETF}, significant differences are reported. For Japan it is at about 124 months, while for South Korea – 89 months. These differences are a direct consequence of different predicted rates of diffusion, which are indicated as .035 and .05 for Japan and South Korea respectively. The latter implies that predicted speed of ETFs diffusion is relatively higher in South Korea compared to Japan. Forecast for Δt_i^{ETF}=7.5% are very similar in case of both countries. In Japan the predicted midpoint is for June 2015, while for South Korea – May 2015. Importantly to note, that these forecasts may not be treated as reliable as predicted country specific-midpoints refer to

historical dates. Similar claims should be raised regarding forecasts for Δt_i^{ETF}=10%. In Japan, predictions for Δt_{Jap}^{ETF}=15%, Δt_{Jap}^{ETF}=20%, Δt_{Jap}^{ETF}=25% and Δt_{Jap}^{ETF}=30% show that in the forthcoming years ETFs market should be rapidly growing, so that according to forecasts the κ_{Jap}^{ETF}=30%, could be potentially reached by May 2022. In case of South Korea, analogous predictions are even more optimistic, as the κ_{Kor}^{ETF}=30% may be reached by June 2021, thus one year earlier than in Japan. Regarding predicted 'specific duration' for the fixed κ_i^{ETF}=30%, both for Japan and South Korea, it may be argued that in Japan it is needed at about 16 years to pass from 10% to 90% of given fixed κ_i^{ETF}=30%; while in South Korea it is about 13 years.

Finally, it must be underlined that all these forecasts are uncertain and should be treated with caution. Predicted future diffusion paths are not purely random but rather determined to follow the S-shaped trajectory and all predictions show high sensitivity to historical data. Special attention should be paid to predictions referring to relatively high fixed ceilings, like for instance 20%, 25% or 30%, where accuracy of the forecast may be questionable and, to some point, misleading and inconclusive.

5.3. *'ETFs to stock index options'* financial substitution.

The remainder of this section presents a detailed analysis of the emerging process of financial substitution, which may be traced across both analyzed stock exchanges in Japan and South Korea, between 2003 and 2015.

Table 5. Changes in index financial instruments market shares in Japan and South Korea. 2003-2015.

	Japan			**South Korea**		
	ETFs [%]	Stock Index Options [%]	Stock Index Futures [%]	ETFs [%]	Stock Index Options [%]	Stock Index Futures [%]
2003m12	**.70**	**.31**	**98.99**	**.20**	**5.25**	**94.55**
2004m12	.63	.24	99.14	.11	3.28	96.62
2005m12	.86	40	98.74	.16	3.41	96.43
2006m12	.43	.28	99.29	.19	3.27	96.54
2007m12	.34	.26	99.40	.34	3.55	96.11
2008m12	.74	.69	98.58	.44	5.07	94.49
2009m12	.68	.77	98.55	.24	2.81	96.95
2010m12	.90	.49	98.61	.29	2.96	96.75
2011m12	.79	.93	98.29	1.82	3.94	94.24
2012m12	1.03	1.12	97.86	1.94	3.41	94.64
2013m12	2.96	.85	96.19	3.01	3.46	93.53
2014m12	2.98	.57	96.45	2.97	3.27	93.76
2015m12	**3.46**	**.32**	**96.22**	**3.43**	**2.98**	**93.59**

Source: Authors` elaboration.

As preliminary evidence, in Table 5, we demonstrate changing market shares of ETFs, stock index options and stock index futures. Interestingly, both in case of Japan and South Korea, we observe rapid expansion of ETFs, during examined period – this category of index instruments was gradually increasing its market shares. In Japan, the absolute change in market share was at 2.76 %pp., while in South Korea this change is reported as 3.23%pp. In Japanese stock exchange, growth of significance of this financial innovation is observed with parallel decreases of stock index futures. At a time, in Japan, the market share possessed by stock index options, despite observed several changes, remains relatively stable between 2003 and 2015 (compare December 2003 and December 2015). On the contrary, in South Korean stock exchange, fast evasion of ETFs was accompanied by falling market shares of stock index options, while the market shares of stock index future remained relatively unchanged (see Table 5). Hence, a preliminary conclusion may be draw that in Japan ETFs is gradually gaining growing market shares at the expense of decreasing role of stock index futures; while in South Korea at the expense of stock index options.

As clearly demonstrated in Table 5, both in Japan and South Korea between 2003 and 2015, a huge part of index financial instruments markets belonged to stock index futures. Its market share, although changing across examined period, remained at extremely high level – in South Korea exceeding 93% and in Japan 96% of total index financial instruments. Bearing in mind the latter, we claim that the process of financial substitution and its patterns should be analyzed mostly between exchange traded funds and stock index options, which, further in our work, we label as **'Selected Index Financial Instruments'**.

To this aim, we assume that **ETFs and stock index options constitute a separate hypothetical market**, and the process of financial substitution is limited to gradually changing market shares between these two index instruments. Put differently, we assume that ETFs as financial innovations are evading the stock exchange and this generates competition between ETFs and stock index options, finally leading to increases in market shares possessed by ETFs.

Adopting the theoretical framework described in Section 3, and to identify the process of financial substitution, we assume that given hypothetical market may be described as in Eq. (18): $f_i^{\delta}(t) + f_i^{\theta}(t) = 1$, where i denotes country, δ – ETFs, and θ – stock index options. Henceforth to trace financial substitution patterns we estimate the following models:

$$\frac{\kappa_{Jap}^{\delta}}{1+\exp\left(-\alpha_{Jap}^{\delta}\left(t-\beta_{Jap}^{\delta}\right)\right)} + \frac{\kappa_{Jap}^{\theta}}{1+\exp\left(-\alpha_{Jap}^{\theta}\left(t-\beta_{Jap}^{\theta}\right)\right)} = 1, \quad (23)$$

for Japan, and for South Korea:

$$\frac{\kappa_{Kor}^{\delta}}{1+\exp\left(-\alpha_{Kor}^{\delta}\left(t-\beta_{Kor}^{\delta}\right)\right)} + \frac{\kappa_{Kor}^{\theta}}{1+\exp\left(-\alpha_{Kor}^{\theta}\left(t-\beta_{Kor}^{\theta}\right)\right)} = 1. \quad (24)$$

Next, to calculate the market share $y_i^{\delta}(t)$ possessed by δ- index instrument in i-country, we use the Fisher-Pry transform, and get the following:

$$y_i^{\delta}(t) = ln\left[\frac{f_i^{\delta}(t)}{1-f_i^{\delta}(t)}\right].$$
(25)

Then, by calculating $\left[y_i^{\delta}(t)\right]$` , we get:

$$\Delta t_i^{\delta} = \frac{\ln(81)}{y_i^{\delta}(t)},$$
(26)

where Δt_i^{δ} denotes the 'takeover' and determines the time needed for $\delta -$ index instrument to increase its market share from $f_i^{\delta}(t)$=10% to $f_i^{\delta}(t)$=90%. Additionally we estimate:

$$Tm_i^{\delta} = ln\left[\frac{y_i^{\delta}(t)-\frac{\ln(81)}{\Delta t_i^{\delta}}}{\frac{\ln(81)}{\Delta t_i^{\delta}}}\right], \qquad (27)$$

which explains the specific point in time when substitution process is half-complete; thus $f_i^{\delta}(t) = f_i^{\theta}(t) = 0.5$

Table 6 (below) demonstrates summary statistics for ETFs share in turnover of selected index financial instruments, and stock index options share in turnover of selected index financial instruments, in Japan and South Korea, over the period 2003-2015. It clearly shows that both in Japan and South Korea, ETFs as financial innovations are rapidly evading the financial market *versus* stock index options. In South Korea, however, this change seems to be more radical, as the absolute change (in %pp) between December 2003 and December 2015 was at ca.49 %pp, while in Japan at only 23%pp (see Table 7).

Despite the latter, still on Japanese stock exchanges, the role of ETFs *versus* stock index options seems to be more significant – note that in Japan, between 2003 and 2015, the maximum of $ETFs^{Jap}\_share\_SIFI$ was reported as 91% in December 2015, while similar value in South Korea was much lower, $ETFs^{Kor}\_share\_SIFI$ reached 63% in May 2015.

Table 6. Summary statistics. Exchange Traded Funds' share in turnover of selected index financial instruments. Japan and South Korea. 2003-2015.

	Japan		**South Korea**	
	ETFs' share in turnover of selected index financial instruments [%] ($ETFs^{Jap}\_share\_SIFI$)	Stock index options share in turnover of selected index financial instruments [%] ($Opt^{Jap}\_share\_SIFI$)	ETFs' share of turnover in selected index financial instruments [%] ($ETFs^{Kor}\_share\_SIFI$)	Stock index options share in turnover of selected index financial instruments [%] ($Opt^{Kor}\_share\_SIFI$)
# obs.	156	156	156	156
Min	30 (2003m7)	8 (2015m12)	2 (2005m8)	36 (2015m5)
Max	92 (2015m12)	70 (2007m3)	64 (2015m5)	98 (2005m8)
Std dev.	15	15	18	18

Mean	63	37	18	81
Absolute change (pp)	28	-28	48.9	-48.9
Average monthly dynamic	100.2	99.04	101.6	99.5

Source: Authors` calculations.

Table 7. Changing market shares of ETFs *versus* options considered as total market. Japan and South Korea. 2003-2015.

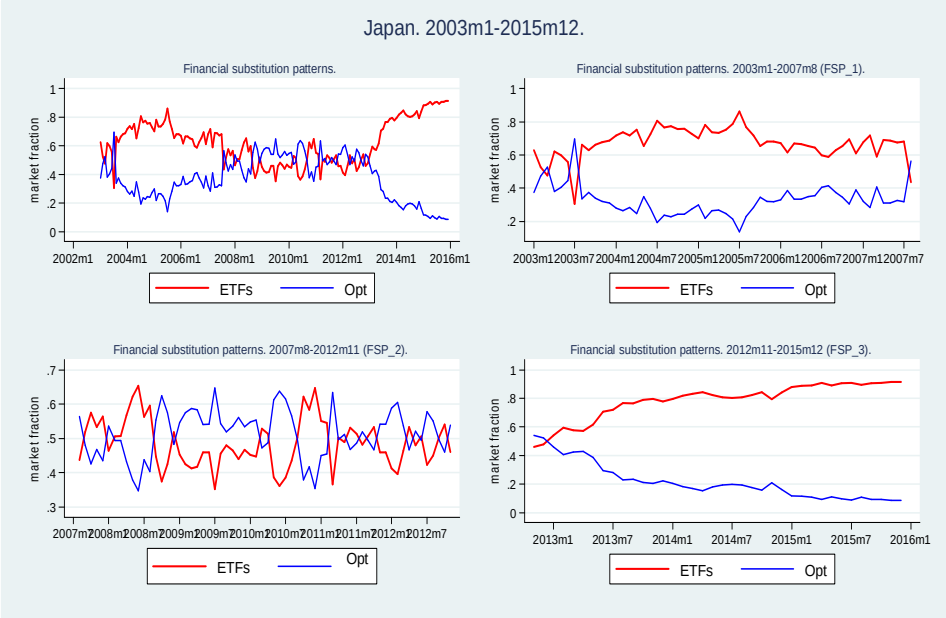
	Japan		South Korea	
	ETFs [%]	Stock Index Options [%]	ETFs [%]	Stock Index Options [%]
2003m12	**69**	**31**	**4**	**96**
2004m12	73	27	4	96
2005m12	68	32	5	95
2006m12	61	39	5	94
2007m12	56	44	8	91
2008m12	52	48	8	92
2009m12	47	53	8	92
2010m12	65	35	9	91
2011m12	46	54	32	68
2012m12	48	52	36	64
2013m12	78	22	47	53
2014m12	84	16	48	52
2015m12	**92**	**8**	**54**	**46**

Source: Authors` calculations.

The following part of this section, presents the empirical evidence on the dynamics and degree of *'ETFs to stock index options'* financial substitution, which took place in Japan and South Korea, between 2003 and 2015. Figs. 7 and 8 visualize the financial substitution effects encountered in both analyzed economies, while Table 8 summarizes the results of estimated financial substitution models and changing relative market shares of competing index instruments (in here – ETFs and stock index options).

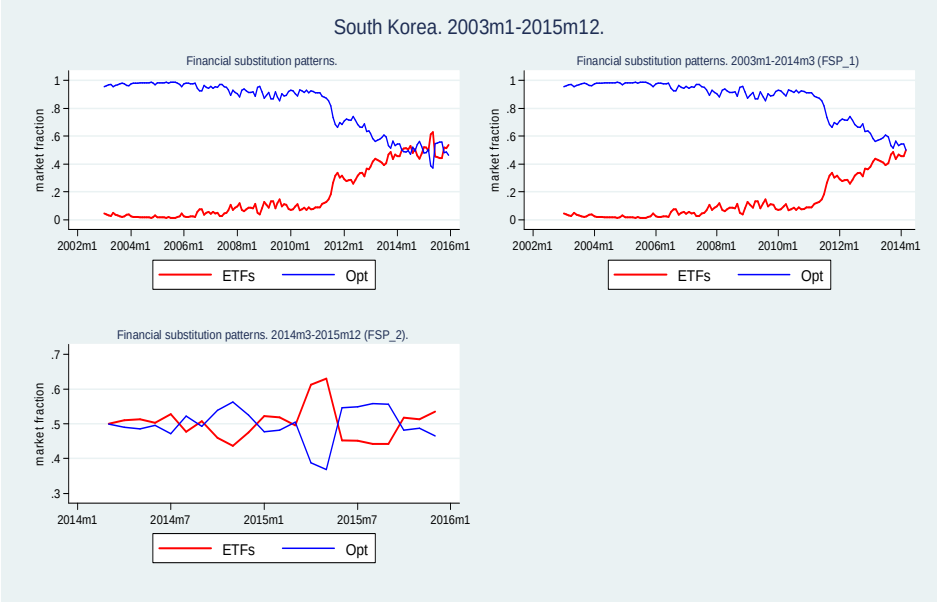
Figs. 7 and 8, clearly demonstrate that the process of 'switching' from one index instrument – stock index options, into another – ETFs, may be easily traced across both examined countries. The process of substituting stock index options by ETFs is, however, gradual and the identified financial substitution patterns are random across many periods. Regardless the latter, both on Japanese and South Korean stock exchanges, the 'ETFs to stock index options' financial substitution unveils the process of 'fight' between these two index instruments to take over the market. In each consecutive phase of the process of 'ETFs to stock index options' financial substitution, the market share of the given index instrument is different and determined by the rate of financial substitution (compare data in Table 7).

Fig. 7. Financial substitution patterns. ETFs versus stock index options in Japan. Monthly data for 2003-2015.



Source: Authors` elaboration.

Fig. 8. Financial substitution patterns. ETFs versus stock index options in South Korea. Monthly data for 2003-2015.



Source: Authors` elaboration.

Table 8. Financial substitution model estimates. Japan and South Korea. 2003-2015.

	Japan		**South Korea**	
	Exchange traded funds *versus* stock index options			
Full sample estimates				
Tm_i^{δ}	*-60.2*	Substitution not definite	148.4^{T} / 135^{E}	Substitution reported
Δt_i^{δ}	*1 028*		146.5	
Sub-samples estimates				
	2003m1 to 2007m8 (FSP_1_Jp)	Substitution not definite. Multiple takeovers reported	2003m1 to 2014m3 (FSP_1_Kor)	Substitution reported
Tm_i^{δ}	*-480.4*		150.3^{T} / 135^{E}	
Δt_i^{δ}	*3 019.8*		149.2	
	2007m8 to 2012m11 (FSP_2_Jp)	Substitution trajectories are random	2014m3 to 2015m12 (FSP_2_Kor)	Substitution trajectories are random
Tm_i^{δ}	*58.5*		122.3	
Δt_i^{δ}	*2 282.8*		*10 050*	
	2012m11 to 2015m12 (FSP_3_Jp)	Substitution reported	-	-
Tm_i^{δ}	114.4^{T} / 121^{E}		-	
Δt_i^{δ}	71.2		-	

Source: Authors` elaboration. Note: in italics – *misspecifications.* Tm_i^{δ} – time (here – month) when financial substitution is half-complete (^{T} – theoretical/modeled time of substitution; ^{E} – empirical month of substitution); Δt_i^{δ} – takeover time, refers to specific number of months. In italics – misspecifications.

In Japan, the process of *'ETFs to stock index options'* financial substitution reveals as very interesting. To some point this process may seem to be random and unclear, and considering full analyzed time series (January 2003 – December 2015), no valid conclusions could be drawn as the financial substitution is not definite. Additionally, the estimated parameters (Tm_{Jap}^{δ} and Δt_{Jap}^{δ}) of financial substitution model (see Table 8) are statistically insignificant. However, detailed analysis of financial substitution patterns **in Japan**, unveils that **three unique phases of the process may be easily distinguished** (see Fig. 7). Hence we decompose the original time series (original sample), into three sub-samples and each sub-sample we label 'Financial Substitution Phase – FSP'. Finally we get:

- FSP_1_Jp: covering the period from January 2003 to August 2007
- FSP_2_Jp: covering the period from August 2007 to November 2012
- FSP_3_Jp: covering the period from November 2012 to December 2015.

Fig.7 plots *'ETFs to stock index options'* financial substitution patterns for FSP_1_Jp, FSP_2_Jp and FSP_3_Jp, while Table 8 summarizes financial substitution models estimates for each financial substitution phase separately. During FSP_1_Jp (2003m1-2007m8), the evidence presenting market competition between ETFs and stock index options shows that in this period ETFs may be labeled 'the winning index financial instrument'. The financial substitution patterns seem to be parallel, however at the end of FSP_1_Jp ETFs lose their winning market position, and are substituted by stock index options – in August 2008 the $ETFs^{Jap}\_share\_SIFI$=43%, and $Opt^{Jap}\_share\_SIFI$=57%. Regarding financial substitution model estimates for FSP_1_Jp, returned parameters are statistically insignificant (see Table 8), which is due to the fact that during this period the substitution patterns are marked by

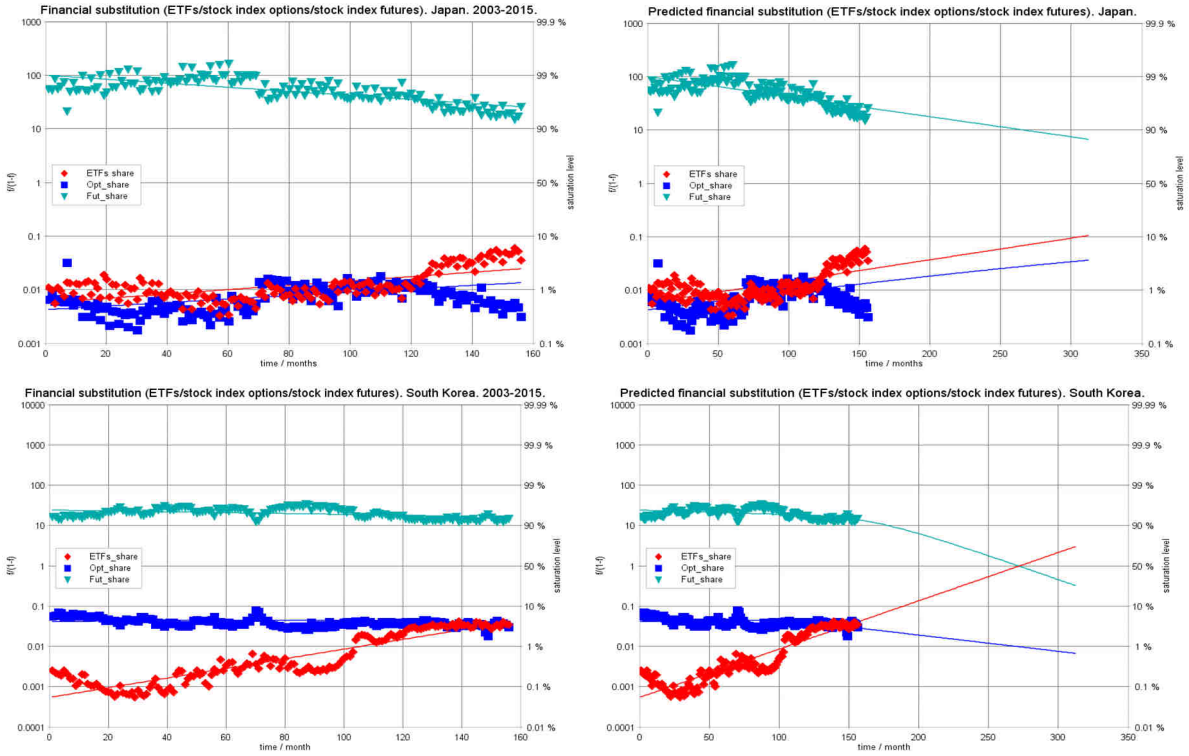
relative instability. During the next phase – FSP_2_Jp (2007m8-2012m11), the *'ETFs to stock index options'* financial substitution trajectories are totally random, and multiple 'takeovers' may be identified. Between August 2007 and November 2012 we observe permanent switching between ETFs and stock index options, and they 'lose and win' leading market position many times. Such random walk of ETFs and stock index options resulted again in statistically insignificant financial substitution model estimates. Finally, during the third period – FSP_3_Jp (November 2012 – December 2015), identified *'ETFs to stock index options'* financial substitution trajectories demonstrate sharp direction of changes. From the very beginning, since November 2012 onward, ETFs are gradually gaining growing market share, and stock index options are losing their dominant position. Between November 2012 and December 2015, *'ETFs to stock index options'* financial substitution patterns are constantly diverging, which visualizes the process of market evasion by ETFs at the expense of stock index options. Note that at the beginning of FSP_3_Jp, the $ETFs^{Jap}\_share\_SIFI$ =43% and $Opt^{Jap}\_share\_SIFI$=57%, while in December 2015 – $ETFs^{Jap}\_share\_SIFI$=92% and $Opt^{Jap}\_share\_SIFI$=8%, therefore arguably it may be stated that ETFs have totally taken over the market of selected index financial instruments in Japan by the end of 2015.
According to financial substitution model estimates (see Table 8), the Tm^{δ}_{Jap}=114.4 month (June 2012) (modelled) and Tm^{δ}_{Jap}=121 month (January 2013) (empirical), which designates the time when the process of financial substitution is half complete, hence $f^{\delta}_{Jap}(t) = f^{\theta}_{Jap}(t) = 0.5$. Moreover, the 'take-over' time is estimated as Δt^{δ}_{Jap}=71.2, determining the number of months necessary for the invading, innovative index financial instrument (ETFs) to gain market share from 10% to 90%.
Turning to South Korea, during the period 2003-2015, similarly to Japanese stock exchange, the *'ETFs to stock index options'* financial substitution process may be visually traced in Fig.8. In South Korea, the financial substitution process differed if compared to the one identified in Japan. At the beginning of the examined period, the $ETFs^{Kor}\_share\_SIFI$ was at about 4.5%, thus its share of the market was minimal. However, since 2003 onward, we observe gradual, however negligible, growth of ETFs market shares. Until the beginning of 2011 ETFs share in market was still below 10%. However, since the mid-2011, we observe abrupt shifts in the ETFs market shares. Note that in June 2011 it was $ETFs^{Kor}\_share\_SIFI$=14%, while in October 2011 – $ETFs^{Kor}\_share\_SIFI$= 33% (sic!). Then in July 2014 the ETFs share in market reached $ETFs^{Kor}\_share\_SIFI$=53%, achieving its peak in May 2015 when $ETFs^{Kor}\_share\_SIFI$=63%. Considering the financial substitution model estimates, we get statistically significant parameters as Tm^{δ}_{Kor}=148 month (April 2015) (modelled) and Tm^{δ}_{Kor}=135 month (March 2014) (empirical), indicating the time when the process of financial substitution is half complete, hence $f^{\delta}_{Kor}(t) = f^{\theta}_{Kor}(t) = 0.5$; and – Δt^{δ}_{Kor}= 146 months, which reports on the number of months needed to pass from 10% to 90% of $f^{\delta}_{Kor}(t)$. Similarly to Japan, when analyzing the *'ETFs to stock index options'* financial substitution trajectories **two distinct phases may be traced**, namely:

- FSP_1_Kor: covering the period from January 2003 to March 2014
- FSP_2_Kor: covering the period from March 2014 to December 2015.

The first phase, FSP_1_Kor, is characterized by initially slow growth of ETFs market shares, which – as already noted – abruptly began to increase in the mid-2011. However, during the whole first phase of *'ETFs to stock index options'* financial substitution we observe that $ETFs^{Kor}\_share\_SIFI < Opt^{Kor}\_share\_SIFI$, while March 2014 is the first month when ETFs market shares exceeded stock index options market shares. Estimated financial substitution model parameters for the time series covering this first phase are statistically significant, and only slightly differ from estimates returned from the full sample – see Table 8. However, during the second distinguished phase of *ETFs to stock index options'* financial substitution, demonstrated on Fig.8 financial substitution patterns are random and characterized by multiple 'takeovers', which indicates that between March 2014 and December 2015 both ETFs and stock index options were interchangeably gaining and losing its dominant market position. During the second phase of financial substitution, if considering the averages of $Opt^{Kor}\_share\_SIFI$ and $ETFs^{Kor}\_share\_SIFI$, these are 49.7% and 50.3% respectively; henceforth we may claim that both ETFs and stock index options market shares were equal between March 2014 and December 2015.

Finally, for Japan and South Korea, we demonstrate additional evidence showing this process when ETFs, stock index options and stock index futures are considered jointly; thus we graphically trace the process of financial substitution between three competing index financial instruments. Fig. 10 (below) presents financial substitution patterns in Japan and South Korea, for examined periods. Additionally, Fig.10 displays predicted financial substitution patterns until 2027. In case of Japan, the process of financial substitution is visually traced, as we observe gradually diminishing market shares possessed by stock index futures, while both ETFs and stock index options are increasing their market shares. However, bearing in mind the fact that in Japan calculated average monthly growth of ETFs share of total turnover of index financial instruments was at about .7%, this process of switching among ETFs, stock index options and stock index futures is relatively slow. Note that under rigid assumption that during consecutive periods, the rate of financial substitution will not change, by the year 2027, in Japan, ETFs should gain approximately 10% of the market. In South Korean stock exchange, future relations between ETFs, stock index options and stock index futures may potentially be different, which is mostly due to the fact, that between 2003 and 2015, ETFs share of total turnover of financial instruments, was growing much faster compared to Japan, and reached about 1.7% per month. Hence, in South Korea, the process of financial substitution is relatively more dynamic, which is also visually reflected in Fig. 10. As a consequence, of relatively rapid changes in South Korean stock exchange, according to predictions – by the year 2027, the market share possessed by stock index future should fall below 50%, and this financial instrument is prospected to be substituted by ETFs (sic!). At a time, the market share possessed by stock index options should be – hypothetically, be fast diminishing, so that by 2027 its market share would drop below 1%. However, increases in the market shares of ETFs may be slowed down due to ETF market growth barriers (discussed in Section 5.1).

Fig. 10. Financial substitution patterns. ETFs versus stock index options versus stock index futures. Japan and South Korea. 2003-2015 and predictions.



Source: Authors` elaboration. Note: estimated model - $\frac{\kappa_i^{\delta}}{1+\exp(-\alpha_i^{\delta}(t-\beta_i^{\delta}))} + \frac{\kappa_i^{\theta}}{1+\exp(-\alpha_i^{\theta}(t-\beta_i^{\theta}))} + \frac{\kappa_i^{\vartheta}}{1+\exp(-\alpha_i^{\vartheta}(t-\beta_i^{\vartheta}))} = 1$, with notations as in Eq.23, and where ϑ-stands for stock index futures. For visualization – Fisher-Pry transformation applied. For Japan – Fisher/Pry Y-axis range: .001-1000; for South Korea – Fisher/Pry Y-axis range: .0001-10000.

5.3. Exchange traded funds in Japan and South Korea: potential impact on the financial systems

ETFs may influence the financial system through a number of transmission channels, leading potentially to emergence of threats to financial stability discussed in Section 2.3. However, in case of low-developed ETF market the level of such risk is insignificant. In Japan and South Korea, for the most of the analyzed time period, ETF markets had been small. In Section 5.2. critical periods have been identified, marking the moments of the start of the rapid ETF markets development and thus the beginning of the growing impact of ETFs on the local financial systems. For Japan it was September 2012 – September 2013, while in South Korea July 2011 – August 2011.

In Section 2.3. the possible negative outcomes for the financial system linked with the development of ETF markets were divided into four categories. Below we discuss the importance of these threats with reference to Japan and South Korea.

1. Liquidity risk: Japanese and South Korean ETF markets in the final years of the analyzed time period were very liquid (at least in the largest segments) as proven by the high and growing turnover in comparison to their assets. For example, according to the October 2015 data, in Japan monthly turnover amounted to ca. 47% of the total AUM, and in South Korea it was even higher (ca. 76%) (Deutsche Bank 2015b). In the earlier years, before the critical

periods, the liquidity in Japan and South Korea was much smaller but the size of the ETF markets (and their potential impact on the financial system) had been negligible.
2. Lack of transparency: Due to the high market shares of leveraged and inverse ETFs the severity of this problem may grow in both countries but the potential threats are difficult to assess due to short presence of these instruments on the local financial markets (only ca. 3 years).
3. Risk of shock transmissions and contagion: In 2003-2015 time period there were no ETFs cross-listed in South Korea. Even though several ETFs were cross-listed in Japan (most of them by the end of the analyzed time period), turnover of their shares was very low (Deutsche Bank 2015a). Therefore, the potential of such threat can be assessed as very low.
4. Increased volatility of commodities markets: There are almost no commodity ETFs in either Japan or South Korea. Their share in the ETF market in both countries reached record-high levels in 2015 but it was still under 1% (Deutsche Bank 2015b). As a result, the level of such risk is minimal.
To conclude, ETF markets in both Japan and South Korea in the analyzed time period did not pose significant threats for the financial stability. Apart from the analysis presented above it can also be evidenced by lack of negative events in the financial systems after the critical periods which could be related to the development of ETF markets. However, in the upcoming years, further development of ETF markets (especially increasing turnover of leveraged and inverse ETFs) may influence stability of financial systems.

6. Conclusions

Main aim of this paper was to provide the in-depth insight into the issues associated with the development of selected financial instruments traded on the stock exchanges in South Korea and Japan, over the period 2003-2015, focusing on the development patterns of ETFs. The issue of potential substitution between ETFs and stock index derivatives is one of the most discussed in the financial industry. However, to the best of our knowledge, it is the first study to verify empirically the diffusion and substitution of ETFs on the market for index financial instruments. Results of the conducted analysis show that in both highly developed (Japan) and emerging (South Korea) economy ETF market has been developing (i.e. diffusion of ETFs has occurred), in terms of turnover in USD millions as well as share of the total market for index financial instruments. One of the key factors of the ETF market development in both economies was the launch of leveraged and short ETFS (subcategories of synthetic ETFs which offer investors modified returns) which gained soon high popularity. They contributed significantly to the diffusion of ETFs in relation to the index derivatives as they diminish the key advantages of futures or options in comparison to ETFs, i.e. ability to use leverage or short sale. In Japan ETF market development has also been considerably boosted by the purchases made by the Japanese central bank.
The rate of diffusion and reached phase of growth (according to the logistic growth model) differed in these two countries – in Japan ETF market by the end of 2003-2015 period was still in the early exponential growth stage, whereas in South Korea it was in the late exponential phase, closer to saturation. We have also checked the substitution between ETFs and stock index options. Results of this analysis clearly demonstrate that the process of ‘switching’ from stock index options into ETFs which may be easily traced across both

examined countries. Substitution processes of stock index options by ETFs were, however, gradual and their patterns in some periods seem random. We have also considered the potential impact of ETFs on the local financial systems. Our results suggest that it is difficult to draw conclusions about such linkages – probably the most significant (yet still rather negligible) threat was lack of transparency of new types of ETFs. On the whole, ETF markets were too small to influence the financial systems.

Future work on the analyzed processes and relationships is recommended and it should include the detailed analysis of the factors influencing the discussed changes (such as information and communication technologies). Moreover, after at least a few years of the increasing importance of ETFs on the local markets, their impact on the local financial system should also be checked.

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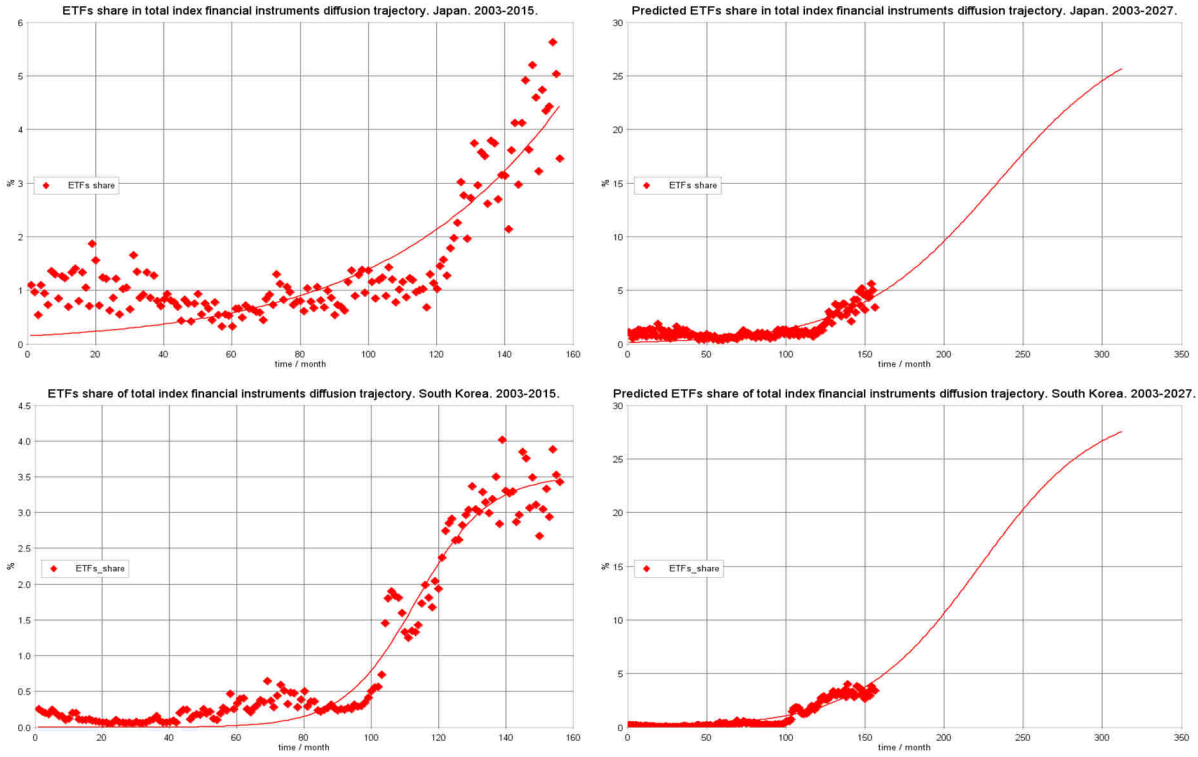
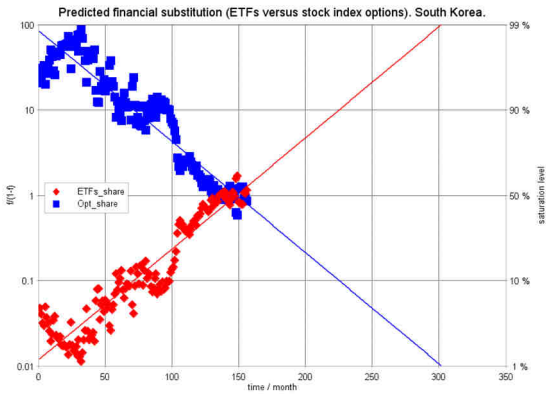
Appendix 1. ETFs diffusion patterns. Japan and South Korea. 2003-2015 and predictions.



Appendix 2. Financial substitution patterns. ETFs versus stock index options in South Korea. 2003-2015 and predictions.



Source: Authors` elaboration.

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