APPRAISING TECHNOLOGY INNOVATION: A METHODOLOGICAL PROPOSAL

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Clark, J., Frank, B., and Martin, S. 1990, "Germany's Stock Market System," in E. S. Chandler and L Pratt, eds. Recent Developments in European Stock Markets, Atlantic Press,
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The ***Journal of Emerging Markets*** would like to acknowledge the help they have received in publishing the Journal for 20 years. Our thanks go to the authors, editors, deans, designers, the St. John's University's Office of Marketing and Communications, our printers and the many others who have helped this enterprise to be a success.

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Special Announcement
Re: Journal Management

Effective January 1, 2016, Dr. Ed B. Flowers, the current Managing Editor of the journal, has retired from St. John's University and will not continue in his role as Managing Editor for the journal after many years of service. We wish him well in his retirement.

Beginning with our next issue, Dr. K. Matthew Wong will serve as our new Managing Editor. Dr. Wong has been teaching corporate finance and financial markets at St. John's University for over twenty six years and is a full professor of finance at the university. He holds a Ph.D. in Finance and the CFA charter. In addition, he was a mergers and acquisitions lawyer at a top law firm in New York City.

Please forward your inquiries and manuscript submissions to Dr. Wong at his e-mail address: wongk@stjohns.edu. He can also be reached at 1-718-990-7359 at St. John's University in New York.

The Editorial Board

Erratum

In "A Game Theoretical Model for U.S.-China Cooperation on Clean Technology Innovation and GHG Emission Reduction" by P. Ben Chou, Susan C. Christoffersen, and Elizabeth Granitz, Journal of Emerging Markets, Vol.19, No.1, Spring 2014, pp. 41-64, we omitted an acknowledgement.

The first author, P. Ben Chou, wants to acknowledge the generous supports from Dr. William V. Rapp, The Henry J. Leir Professor of International Trade and Business at NJIT, and the Leir Foundation.

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January 5, 2016

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It is with great pleasure that I honor the *Journal of Emerging Markets*' twentieth anniversary issue.

The *Journal of Emerging Markets* is the first journal in the field directed entirely to the world's emerging markets, with both a practitioner focus and a theoretical focus. Besides publishing important intellectual contributions of academics from universities around the world, the journal has published papers written by practitioners from Wall Street firms like Merrill Lynch and JPMorgan Chase; staff from foreign central banks and international agencies; the United Nations, the World Bank, and the International Monetary Fund. It provides an important outlet for practitioners and academics to share their views and develop information on emerging market economies.

The Journal has developed a board of associate editors from around the U.S. and abroad to represent the various regions of the world with emerging markets.

St. John's University has been the anchoring sponsor of the *Journal of Emerging Markets* for twenty years, and there have been various private sponsorships as well through the years, which we acknowledge and thank. I believe that through global collaboration, and the junction of practice and theory, the *Journal of Emerging Markets* has made-and will continue to make for many years to come-a significant contribution to this important issue of emerging markets.

Victoria Shoaf

Victoria Shoaf, Ph.D., C.P.A.
Dean

Appraising Technology Innovation: A Methodological Proposal

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ABSTRACT

This paper suggests a change in appraising technology innovation. One of the most used approaches to the matter is based on Silva and Santiago (2009), who developed a management model of product development projects. The proposal discussed here modifies the function of sales volume of the above mentioned model based on the idea that some new products are launched in the market aiming at an initial target public. Inserting such features in the model makes it more precise in estimating form and scale parameters of the sales function, which is crucial for estimating the financial payoff function.

Key words: Innovation, Technology, Sales Function, Project Appraisal.

INTRODUCTION

Business companies have redefined competitiveness and their process of obtaining/holding their competitive advantage all through years (CASTELLS, 1999). This goal is characterized not only by the improvement and/or achievement of variables such as quality, cost, price, but mainly by technological innovation development.

Nevertheless, is not easy to quantify the relation between technology research and market return beforehand (KASH, 1997). This is mainly due to difficulty in measuring the impact eventually caused by a still maturing technology on goods and services to be offered by the business. As a matter of fact, it is difficult to forecast innovation returns, since technical and market uncertainties are involved in the development process of such goods or services. Additionally, uncertainties also befall upon production costs, revenues and even the target public..

Therefore, the present work proposes a new methodology for appraising technology innovation by taking into account uncertainties involved in the product development. This study is based on the model proposed by Silva and Santiago (2009) and attempts to contribute to it – as far as the sales volume function is concerned – by turning it into a more suitable model for market share situations.

Three issues justify this study. Firstly, several agents involved in the improvement process of new technologies put emphasis on innovation appraisal for solving feasibility and trading problems of derived products. Secondly, there is no consensus yet as for the best appraisal method to evaluate the effects of a new technology. Finally, goods/technologies derived from research and development projects are launched in the market with a predetermined least sales volume and the present appraisal models of such projects do not take this practice into account.

This study presents the following structure. Section 2 presents concepts and classifications of the kinds of technological innovations. Section 3 shows the three different appraisal approaches of innovation projects and discusses their advantages and disadvantages. A detailed procedure and a general sketch of the model can be viewed in section 4. Section 5 shows a practical application of the proposed model. Finally, final considerations can be found in section 6.

TECHNOLOGY INNOVATION

According to the Oslo Manual (OECD, 2005), an innovative enterprise is that which has implemented new technology products and processes or introduced considerable technology improvement to such products and processes during the period under analysis. An innovation process comprises scientific, technological, financial and trading activities, which also include investment and knowledge.

Research and development (R&D) is inherently tied to technology innovation. According to Lev (2001), all R&D effort is considered an innovation activity . Innovative activities comprise all those scientific, technological, organizational and trading stages, including investment in new kinds of knowledge, viewing product and/or process innovation. R&D actively affects the technology innovation process of firms and prevails in the state of the art of new technologies.

Technology innovation can be defined as the production of goods and services or processes that are technologically new or substantially improved (OCDE, 2005). A technologically new product is that whose basic characteristics differ significantly from those previously produced and traded by the company. A substantially improved product is that receiving a progressive technology development, the performance of which is greatly increased or better.

The innovation strategy through investment in R&D is liable to guarantee higher gains for business firms. The Oslo Manual (OECD, 2005) defines R&D as a distinct category that includes relevant activities for product and process innovations as well as marketing and organizational activities, in addition to basic research. Given the importance of R&D, companies tend to evaluate results and impacts of such projects (MIKKOLA, 2001). And this is because R&D projects containing positive net present value (NPV) not only maximizes the stockholder's wealth but also offers competitive advantage to their companies.

The ability to produce and manage innovation – or R&D – is a critical element for business competitiveness (WONGLIMPIYARAT, 2004). Innovation management can be understood as a twofold effort: innovation appraisal and evaluation. Appraising an innovation aims at offering – in the face of all uncertainties characterizing a technology innovation process – an expected value that somehow captures inherent risks and uncertainty in such process. Evaluating a technology innovation instead aims at foreseeing its trade potential (ZACKIEWICZ, 2005).

According to COTEC (1998), managing innovation involves any activity enabling an organization to make a better use of science and technology. A good management is to appraise innovative ability in such a way as to promote efficiency and effectiveness for a company's competitive advantage. Therefore, five crucial paths for this target should be followed (COTEC, 1998):

- Technological prospection: seeking internal and external signs of potential innovations;
- Focus: commitment to allocate resources toward the chosen target;
- Resource: acquisition of knowledge and technologies needed for producing the innovative product;
- Implementation: realizing an innovative product or internal production process, since the very first idea of the project to its launching in the market or the processing of internal methods of optimized production;

[1] According to Jung (2004), R&D means the joining of research and development in which research is used as a tool for discovering new knowledge, while development means the application of new knowledge in order to obtain practical results. Research may be divided into two types, according to AGOVINDARAJAN and TRIMBLE (2006): basic research and applied research. As for development, it may be divided into four types of activity (KHURANA, 2006): improvement of the new product; product adaptation and extension; engineering support to product and; process engineering.

[2] However, innovation comprises not only R&D. There are several kinds of innovations, which may be understood as follows (OECD, 2005): (i) product innovation, i.e., new or significantly improved products and services introduced in the market, including significant changes in their technical specifications, components, materials, incorporated software, interface with users or other functional features; (ii) process innovation, i.e., implementing new or significantly improved production processes or logistics for goods and services including significant changes in techniques, equipment and software; (iii) organizational innovation, i.e., introducing new organizational methods in business practices, labor organization and/or external relations; (iv) marketing innovation, i.e., introducing new marketing, methods that involve significant improvements in the product or packing design, price, distribution and promotion.

- Apprenticeship: this fifth element reflects the other four as it possesses its own tacit knowledge related to apprenticeship itself – including success or failure – viewing better management processes.

The integration of these elements occurs in four business management groups, which reveal how an organization can be able to increment its performance and efficiency: technology strategy, technology acquisition, new product development and process innovation. Such management processes should be worked together and integrated so as to guarantee improved effectiveness (SOUZA, 2003).

However, as far as management is concerned, this paper puts emphasis on innovation appraisal. Technology innovation faces a certain degree of uncertainty in the organizational context. Such an uncertainty ranges from the product or process idea to its market entry. Therefore, an efficient feasibility study should contribute to reduce failure risks of technology innovation projects.

APPRAISING INNOVATIVE PROJECTS

As this study focuses on a method of evaluation R&D projects, the present section follows up on describing the main project evaluation approaches traditionally used by managers: cost, market and income (SMITH and PARR, 2000; SOUZA, 2009). Each approach conveys specific methods, showing benefits and constraints.

I. Cost Method

This method is an estimation of a technology value as a function of its development cost. Depending on the negotiation viewpoint, two different ways can be used for this approach: reproduction cost and replacement cost. From a developer's viewpoint, reproduction cost is precisely the amount needed to reproduce the product. In this case, the aim is to recover an investment previously made. From a technology buyer's viewpoint, replacement cost is the amount needed for creating something which can be used in a similar way.

This method is criticized as it does not reflect a potential gain of the intangible good and disregards the so-called cost of lost opportunity, i.e., the time spent on reproducing or replacing the intangible good, which could be used for usual business operations. Furthermore, this method does not take into account all income generation potential that could be obtained by using the developed product.

Flignor and Orozco (2006) argue that this method should not be used to appraise intellectual property as, once protected, it is difficult to be replaced and an unprotected technology can be replaced by so little money. Another disadvantage associated with this method is that it assumes that its current production cost is equal to its real value, which is not true several times. Despite showing a very small production cost, this very product may have a very high demand, which ends up in an increased value. This method should only be used when there is no market information or liable earnings coming from the innovation under analysis (although it may show significant nonpecuniary aspects).

II. Market Method

The market method – also known as transactional method – assumes that the current business market value is equal to its real value. Therefore, the difference between its book value and that which would be negotiated in the market is approximately that of the company's intangible capital value. Put in this way, this kind of approach can only be really effective when the company possesses just one kind of product or service, which is not usual nowadays.

This method is more adequately used when a great amount of market data is available. However, market data are frequently unavailable or are hardly found and this makes its use disadvantageous. Market approach is more successful when the needed information comes from one of the parties involved in the appraisal. Nevertheless, agreements are mostly held in secret either wholly or in part, which makes it difficult to have access to the needed information so as to use this method (FLIGNOR and OROZCO, 2006). A great bulk of market information on the developed innovation is then necessary in order to make this method practicable.

III. Income Method

The income method is based on the idea that the value of an asset is equal to the current value of the economic benefits this asset would offer during its lifetime. This method is divided into two other approaches: Discounted Cash Flow (DCF) and Real Options Theory.

DCF is probably the most used method by decision-makers in companies of new technology evaluations. One of the reasons for this is partially due to that this approach is largely discussed and taught in higher learning programs, which makes it easier to apply.

This method is based on three crucial variables: the expected cash flow, risk and lifetime of the asset in question. The basic concept underlying this methodology is that the asset value is given by the value of its forecasted cash flows all through its lifetime, discounted by a rate representing its risk. In other words, an asset value is given by its expected return minus its risk rate .

This evaluating methodology is largely adopted by decision-makers given to its simplicity and objectiveness . Furthermore, DCF models serve as basis for estimating some indicators widely known as Internal Rate of Return (IRR) and payback.
A restraint associated to this method is that DCF takes low uncertainty environments into account. Under high levels of uncertainty, which can imply scenarios raging from a huge failure to a huge success, it is greatly difficult to estimate the value of future cash flows of new technologies.

Another NPV restraint arises when new technologies are appraised. If the inherent risk associated to this kind of asset is represented by a high rate of discount, the present value of a new technology tends to be very low. In this case, managers could be led to refuse a highly promising though risky project. On the other hand, the rate of discount may reduce a project value if a failure risk only is taken into account. The 'upside' risk – which could account for high expected gains – is frequently neglected.
A third restraint is related to the rate of discount estimation. Determining the risk premium of a technology is not trivial as available information is rarely sufficient for estimating a fair rate of return (e.g., via CAPM model).

There is still another factor limiting the use of the NPV approach in a technology project environment. A static/deterministic environment found in this kind of approach does not reflect the managerial reality in which decision-makers count on options to alter project paths conveyed by new information.

It is quite clear for most of decision-makers that managerial flexibility is highly esteemed. However, the way by which such flexibility is evaluated is not so obvious. Flexibility is associated with the right – but not the obligation – to invest in any enterprise. Managers seek to have such a right to the extent that uncertainties decrease and/or new information related to project development/market appears. Real Options Theory is indicated for problems of this kind by which decisions are made in a sequential way and uncertainty plays a crucial role.

The real options logic – just like financial options – indicates that someone having an option has a right to exercise it, but not an obligation. Therefore, if the expected value of exercising a right is positive, the owner will do it. On the contrary, the owner will not exercise it, and the following loss is to be limited to the invested value. Under such a viewpoint, a technology development project containing managerial options shows a value higher than that with no such options, the latter being usually represented by NPV.

Using the real options approach for appraising new technology projects proves to be highly advantageous. Firstly, the capital invested is only partially allotted. That is, such an approach reveals the logic of gradually investing in a given project, in accordance with the information released in each project review process. The fact that managers become able to better capture their investment project (real) options is another advantage. Furthermore, decision-makers are also able to combine several development scenarios in a single analysis. And this allows a better understanding of the matter toward decision-making, as inferring feasibility from isolated scenarios is not always possible.

[3] The Discounted Cash Flow methodology may be represented by the following formula: Asset Value = Present Value of Future CashFlows (BRIGHAM and EHRHARDT, 2008).
[4] According to Brigham and Ehrhardt (2008), a net present value (NPV) equal to zero means that the project cash flows are sufficient to recover the invested capital, in addition to guarantee the required rate of return on this capital. Therefore, a positive NPV means value added for the investor. The project should then be accepted whenever it brings a NPV equal or greater than zero.

Finally, the real options technique allows a better understanding of the investment management. Frequently, the real options appraisal makes projects economically feasible which would otherwise have been discarded by traditional approaches. In brief, appraising projects through real options changes the traditional method of deciding on and conducting projects related to new technology development.

Despite being advantageous in several ways, this approach also proves to have some restraints. First of all, analysis is more complex and time consuming as compared to other methodologies, since collecting more information is needed. Additionally, the mathematic techniques to be used are more sophisticated than those used by NPV. However, it is worth mentioning that it is precisely such additional information that makes a managerial flexibility analysis more accurate.

Another challenge for real options evaluation is how to report this analysis to decision-makers not yet accustomed to take flexibility into account and those who use other appraising methods. Surely this paradigm should be broken. For this, one of the most important elements is basically to justify the logic used in such appraisal instead of focusing on the operating technique details. Once this challenge is overcome, managers would certainly refer to this appraisal in a more strategic and safer manner, because many of their decisions do not match to the "now or never" perspective of NPV.

Table 3 summarizes the features of the three appraisal methods referred to above.

Table 3
Comparing the Three Basic Appraisals

Approaches	Cost	Market	Income
Definition	Appraisal based on cost for reproducing or replacing a technology	Appraisal based on price of comparable technologies in the market.	Appraisal based on cash flow present value.
Advantages	Easy to estimate if data on cost are available.	May be estimated if data on cost are available.	Present value is liable to be estimated in accordance with technological premises.

Source: Park and Park (2004).

[5] CAPM was firstly proposed by Sharpe (1964) and Lintner (1965) as the combination of a free-risk rate of return with the systemic-risk of a project multiplied by the systemic-risk price. The latter corresponds to the expected difference between the yields of a diversified investment portfolio and the free-risk rate (Brigham and Ehrhardt, 2008).

IMPROVING THE METHOD ACCURACY

As can be seen above, no other appraising method except for real options approach takes management uncertainties and flexibilities into account in their analyses. Therefore, this paper presents an appraising proposal based on real options approach that better captures such features, which are very common in R&D projects.

This method includes part of the model developed by Silva and Santiago (2009) and adds a modified sales volume function. Therefore, it encloses R&D projects containing guaranteed market share. This model is proposed for the management of product development projects that are characterized by sequential decisions in which uncertainties play a crucial role and a portion of the market is predetermined, in case the project research is successful.

Differently from many regular projects, some R&D projects are developed for a specific target public. Therefore, modifying these authors' model becomes necessary as the product is to be launched in the market with a guaranteed minimum demand. Additionally, as some products remain in the market surviving in parallel even after the entry of a new competing product, the sales function has also to be modified so as to make it possible to foresee a sales minimum amount at the end of the product lifetime.

As far as the managerial model is concerned, this section presents the model by Silva and Santiago (2009), including the modified sales function. Therefore, it is assumed that the project is developed in such a way as to comprise N stages, which correspond to regular reviews. In each review stage j $(j = 0, \ldots, N)$, the project is characterized by a development status which will be represented by $Y_j = (x_j, \tau_j)^t$, where x_j is the development level expected to occur after completing the project stage j and τ_j is the time of review.

It should be noted that the success of each stage – that is subject to technical and market risks – is measured by the technological performance of the product. This uncertainty is modeled by a unidimensional parameter, , which is captured by a probability distribution, p, regardless of past results.

Random variables, x_j , are independent of each other and independent of review time (τ_j), as for each review time . Values of $\tau_1, \ldots, \tau_{N-1}$, are obtained by means of random distributions that are better fitted to the project features.

Based on available information, the reviewers choose one of the following steps in each stage. The control option will have an impact on the following review stage.

- Continue: going on with the project as initially planned.
- improve: means allocating additional resources for subsequent development stages so as to achieve improved performance levels at the end of the following stage;
- Abandon: means giving up the project. In this case, no more costs and gains occur.
- Accelerate: similar to the improving option. This option is characterized by additional resources that are necessary to achieve a better development performance. In this case, better development means to complete the project in a smaller time span.

The following stage (Y_{j+1}) would be a function of the current stage (Y_j), applied control (u_j) and development uncertainties (ξ_j), as represented in equation (1). It is worth noting that decision-making is a Markov process, as the following stage depends on the current stage only.

$$Y_{j+1} = \varphi(Y_j, u_j, \xi_j) \qquad (1)$$

Furthermore, transition between stages will be an additive process and the added fraction will depend on the applied control.

$$Y_{j+1} = \begin{cases} \text{parar}, & \text{se } u_j = \text{abandonar} \\ Y_j + \begin{pmatrix} \omega_j \\ t_j \end{pmatrix}, & \text{se } u_j = \text{continuar} \\ Y_j + \begin{pmatrix} \omega_j + I_j \\ t_j \end{pmatrix}, & \text{se } u_j = \text{melhorar} \\ Y_j + \begin{pmatrix} \omega_j \\ t_j - A_j \end{pmatrix}, & \text{se } u_j = \text{acelerar} \end{cases} \qquad (2)$$

In equation 2, development uncertainties are represented by $\xi_j = (\omega_j, t_k)^t$, where ω_j is a random variable representing the development uncertainty and t_k is a random variable representing the duration of the following stage $k = j + 1$. I_j is a constant representing the expected improved development due to the "improve" control. A_j represents a constant decrease in the expected value of the stage duration. It should be noted that the stage duration should be positive and the value of A_j should be chosen in such a way as to reflect this fact. All through it, the very moment of review j is to be given by the relation $\tau_j = \sum_{k=1}^{j-1}(t_k)$, where t_k (k =1,...,N), are independent random variables representing the duration stage k.

The return of the project is given by the function $\Pi(y_N) = \Pi(x_N, \tau_N)$, which represents the expected value of a profit series predicted to come about during its life cycle. The function value will depend on the status reached by the project after the last stage is completed, i.e., the return depends on the moment the technology is launched in the market and its ultimate reached performance.

Equation (3) describes the return function. Parameters a and k are those of scale and form of this function, respectively; M is the highest value paid by the market for the project result; is the lowest value and; R is a random variable representing market requirements at the moment the product is launched (for further details, see Silva and Santiago, 2009).

$$\Pi(x_N, \tau_N) = \left[(M - m) \cdot exp\left(-\left(\frac{\tau_N}{a}\right)\right)^k \cdot P(x_N \geq R) \right] (3)$$

Values of the form and scale parameters are determined by the expected product sales, which are observed from the sales volume function. However, as many technology innovations are developed viewing a specific target public, and hence already count on the lowest sales amount, when already inserted in the market, it should be noted that the sales volume function of Silva and Santiago (2009) needs to be adapted so as to account for such a characteristic. The adapted sales function is shown in Equation (4) as follows:

$$V(t) = \left[(V(k/a)) \cdot (t/a)^{k-1} \cdot e^{-((t/a))^{k})} \right] + v(t)\ . \quad (4)$$
$$v(t) = v - (t/a)^{k}$$

Where constant V represents the highest sales volume of the product the market can absorb during its whole life cycle, and v is the lowest sales volume throughout the same period.

Development costs may vary at each stage in such a way as to lead the model to real situations of increasing costs through time. Therefore, cost may be represented by:

$$C_k(Y_j, u_j, t_k) = \begin{cases} 0, & \text{se } u_j = \text{abandonar} \\ K_k(t_k, u_j), & \text{se } u_j = \text{continuar} \\ K_k(t_k, u_j) + \alpha_k, & \text{se } u_j = \text{melhorar} \\ K_k(t_k, u_j) + \beta_k & \text{se } u_j = \text{acelerar} \end{cases} \quad (5)$$

Function $K_k(\cdot)$ represents the cost of the following phase k in stage j ($j = k - 1$), and varies according to its duration, which is represented in the model by t_k. An additional spending, α_k or β_k, will always be needed whenever a previous decision is to be improved or speeded up, respectively.

Be $G_j(y_j, u_j)$ a return function brought about by applying control u_j in stage Y_j, which is represented by the equation 6 below:

$$:(Y_j, u_j) = \begin{cases} 0, & u_j = \text{abandonar} \\ E_{tj}\left[E_{\omega_j | t_j} \left[-C_{j+1}(Y_j, u_j, t_{j+1}) + V_{j+1}(Y_{j+1}) | t_j \right] \right] & \text{caso contrário} \end{cases} \quad (6)$$

As seen in the equation above, V_{j+1} represents the development project value in stage $j+1$ of decision and it is estimated as:

$$V_j(Y_j) = \underbrace{\max}_{u_j \epsilon \Theta} G(Y_j, u_j) \quad (7)$$

where $\Theta = (\text{Abandonar, Continuar, Melhorar, Acelerar})$ represents the available set of controls. Finally, when determining $V_N(y_N) = \Pi(y_N)$ as the boundering condition, it is possible to write the dynamic programming model as follows:

Target: $V_0 = \underbrace{\max}_{u_0 \epsilon \Theta} G(Y_0, u_0)$ (8)

s.a.: $V_N(Y_N) = \Pi(Y_N)$

$$V_j(Y_j) = \underbrace{\max}_{u_j \epsilon \Theta} G(Y_j, u_j)$$

EMPIRICAL APPLICATION

With the aim to describe how this model really works, the present section attempts to apply it in an illustrative case. For this purpose, an R&D project will be analyzed. As it belongs to a company in the industrial technology field, this project is called here as HBDO (a fictitious name for preserving its industrial secret). No other information will be disclosed due to confidentiality reasons.

The technology development of HBDO was modeled in macrophases as follows:

- Administration: refers to the whole bureaucratic process;
- Prototype test: consists in initial test procedures in the product;
- Product testing: in this stage, the technology is converted into a tradable product and some tests have to be performed;
- Launching in the market: the product is launched into the market and its technology starts to yield a positive cash flow.

Investment is assumed to be a sunk cost in the Processing stage, in addition to the fact that the first decision point occurs at the end of the first stage. The control variable is the technology "reliability", which may vary from one stage to another reaching from 12% to 25% in case the technology is improved. Therefore, taking technical uncertainties in the Prototype and Product phases into account, the "reliability" performance may oscillate from exceptional values (100% improvement in relation to present value) to disappointing values (50% deteriorated as compared to present value). A $p = 50\%$ success probability was taken into account by project developers who also assumed a 7% by year risk-free interest rate.

As for payoff function parameters (Eq. 3), the highest values and the lowest values paid by the market were assumed to amount to M = R$ 77,35 million and m = R$ 13,20 million, respectively. And scale and form parameters were also assumed to be $a = 28$ and $k = 2$, respectively. The payoff function also depends on the level of market requirements, here represented by R. That is, the project will reach a $\Pi(\cdot)$ payoff as the product is launched in the market at time τ, if $x_N \geq R$. Conversely, the lowest value m will be paid. R is taken as a result of a normal distribution with a $\mu = 0.13$ mean and a

$\sigma^2 = 0.16$ variance in the project measurement unit, and performance is represented by a vector (Eq. 9). Therefore, the payoff function takes the form expressed in Equation 10.

$$x = (-0.5, -0.4, -0.3, -0.1, 0.0, 0.1, 0.3, 0.4, 0.5, 0.6, 0.8, 0.9, 1.0) \tag{9}$$

$$\Pi(x_N, \tau_N) = \left\lfloor (77.35 - 13.20) \cdot exp\left(-\left(\frac{\tau_N}{28}\right)\right)^{2} \cdot P(x_N \geq R) \right\rfloor + 13.20 \tag{10}$$

Accelerate or delaying the project development is also admitted. Therefore, the duration uncertainty in the Prototype and Product phases was modeled as being a triangular distribution containing a lower limit, an upper limit and the mode being equal to 10, 24 and 12 months. In case accelerate is considered, the lowest distribution turns to be 9 months. The software @Risk was used for simulating the project duration[6] by taking into account that its total phases could not exceed 4 years and three months. It is worth noting that, despite being a stochastic time period, decisions concerning stages are independent.

Costs were divided in accordance with the features of each phase and isolated as being deterministic or stochastic. Therefore,

- Deterministic costs of each phase: 1) Process: R$ 5 thousand; 2) Prototype: R$ 750 thousand to continue, R$ 40 thousand to improve; 3) Product: R$ 1,250 million to continue, R$ 40 million to improve; 4) Launching: R$ 1,500 million to continue.
- Stochastic costs of each phase: 1) Prototype: R$ 400 thousand fixed and R$ 29,17 thousand variable in time for continue, R$ 40 thousand fixed for improving, R$ 2 thousand variable in time for accelerate; 2) Product: R$ 700 thousand fixed and R$ 45,84 thousand variable in time for continue, R$ 40 thousand fixed for improving, R$ 3 thousand variable in time for accelerate. The Process and Launching phases did not present stochastic costs.

The result was estimated in backwardation, which is typical in dynamic programming. That is, the optimum action in future scenarios was first taken into account, and then $t = 0$ was obtained, by discounting all foreseen values by the risk-free rate (risk-neutral probabilities) and weighing the scenarios by the transition probabilities.

The expected value of the project active management amounted to R$ 18,71 million. However, the project value with no flexibility totalized R$ 13,52 million. Therefore, it worth noting that – when uncertainties and managerial flexibilities were disregarded – the value of the HBDO technology innovation project was about 30% smaller than the value estimated by the proposed approach. This result shows that other evaluation methods, as the traditional NPV, may underestimate the project value.

[6] An amount of 10 thousand random values were simulated. In this case, a graphic representation is but nonsense

FINAL REMARKS

The importance of innovation management for business competitiveness is noteworthy. However, decisions related to innovation appraisal is still in need of using adequate tools for dealing with issues of an innovation process: uncertainty, timing, flexibility, among others.

Therefore, this paper proposes modify the sales function in the model of Silva and Santiago (2009) to appraise technology innovation with guaranteed market share. The sales function needed to be adapted, since the fact that some products derived from R&D projects may be launched in the market with guaranteed minimum sales, which makes the form of sales function to change, and hence the parameters of form and scale of the payoff function.

This is a more robust appraisal method, as compared to the others (like the one based on cost or that based on discounted cash flows with no flexibilities), since it takes into account technical and market uncertainties as well as managerial flexibilities throughout the project. The model includes significant aspects. Firstly, a successful innovative project depends on the level of performance reached by the technology used. Secondly, timing is treated stochastically. Thirdly, the payoff function encompasses the greatest possible amount of uncertainties. Finally, managerial flexibilities are to be included throughout the project stages.

Despite also subject to constraints, the proposed model is adequate to appraise R&D projects under the characteristics described above. This is because traditional analyses emphasize short-run investment. Lon-run investment – whose NPVs are subject to uncertainties – ends up disregarded.

As for the model restraints, the following can be highlighted (i) estimates of some variables, such as levels of technology performance, are chosen subjectively, in accordance with the expectations of the project specialists'. However, this issue is an intrinsic element of technology appraising and the only solution to it is to consult with specialists of similar projects; (ii) some parameters, such as the highest and lowest values paid by the market, come from traditional analyses and this may bias results. Submitting such parameters to sensitivity tests may be a feasible solution for this problem.

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Adaptation Strategy as a Direction of Firm Development In an Uncertain (Variable) Environment

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ABSTRACT

This paper describes the results of research done on enterprises from the energy and biofuels market. We examined the relationships/linkages between the strategy of these enterprises and their uncertain environment in 145 Polish companies that exist in the energy market and also among five companies that produce biofuels. This is the first research using such a sample of energy firms. The research is also important because it recognizes the relations between the companies and their macro environment. The 21st century business environment has become turbulent and unpredictable, so the development strategy of enterprises has changed to be more adaptive to this environment. The business environment is also focusing more on environmental protection so that, nowadays, this environmental factors play a key role in the sustainability of a strategy. This study is based on companies from the Polish market that function under tight European Union regulations.

INTRODUCTION

Uncertainty in the business environment is represented by two factors: the influence of the variability of the environment and the complexity of firms' operations in contemporary markets. Variability can be defined as new challenges, dynamically subjecting firms to transformations in legal, economical, ecological, and technological aspects. Changeable law and new environmental requirements force firms to make decision in development strategy. Firms often choose to adapt their activity to this environment in a continuous, systematic way. Their strategies of adaptation can be either active or passive. This research was shows

that the energy market is an example of active strategy taken by large companies while passive strategy in realized by micro or small enterprises.

Review Of Literature

A review of the literature of business adaptation to a given environment is necessary to identify the elements that shape the reality and operations of the enterprises. Adaptation is one of the ways enterprises can adjust their activities to external factors. The type of adaptation strategy depends on a firm's position in the market and on its internal potential. The macro-environment consists of many components that have an influence on the functioning of the enterprises. In the case of energy market, the role played by the legal environment is very changeable, especially in its approach to green energy, biofuels and zero emissivity. In this review a variety approaches to the issue of (1) adaptation has been shown, as well as, (2) the uncertain environment, and (3) the legal aspects of the decisions. The research also mentions factors that were used to examine the relationships between enterprises and their environment.

Adaptation

A firm's adaptive model is a decision making mode characterized by the crafting of a reactive solution to an existing problem, rather than a proactive search for new opportunities. The strategy is fragmented and is developed in order to move a corporation incrementally forward [Wheelen and Hunger, 2012]. This adaptation process can be either active or passive. Firms can adjust to environmental requirements by trying to create or influence their environment or to only follow the market situation. Adaptation strategy is therefore either proactive (intended) or reactive (adaptive). There is always enough uncertainty about the future to prevent managers from planning each strategic action in advance or to allow them to pursue their intended strategy without alteration. [Strickland, 1996]. Rapid change requires that strategies be flexible, adaptable and creative. The firms have to adapt to a world of rapid, unpredictable changes. Turbulent environments are characterized by their high level of dynamism, showing nonlinear positive feedback, complexity and uncertainty.

Strategies of adaptation must satisfy the legitimate interests of stakeholders–customers, employees, shareowners, suppliers and the communities where the company operates. In fast-changing business environments it is also important that firms have adaptive ability and the ability to adjust to rapidly changing or shifting business conditions. Adaptable businesses make a point of staffing their organizations with people who are proactive, who rise to the challenge of change, and who have an aptitude for adapting [Gamble, Peteraf, and Thompson, 2014].

Adaptation is a dynamic and continuous process of adjustment to change and environmental uncertainty, of maintaining an effective alignment with the environment while preserving internal interdependencies that are efficiently managed. Adaptation, according to Webster's dictionary, is the "adjustment to environmental conditions as (a) adjustment of a sense organ to the intensity or quality of stimulation, or (b) modification of an organism or its parts that makes it more fit for existence under the conditions of its environment." From management's point of view, the company should adjust their activity to the market and modify their structure in order to fit the firm's stance to external and internal requirements. The skill of adaptation to the new reality allows companies to survive in the market and move towards a leadership position [Andries and Debackere, 2007]. For organizations seeking to operate in the new reality and to seize opportunities which appear in the market, the ability to adapt becomes a factor of competitive advantage. The adaptive ability of principal decision makers in the firm says a lot about the firm's ability to manage dynamically. Whether this leads to superior performance will then depend on the decision makers' ability to understand correctly the context and import of their decision, as well as the management and deployment of the firm's dynamic capabilities under conditions requiring sustainable development. The adaptation process is connected to sustainable development [Borowski, 2012]. If environmental challenges are not one of the central issues in the 21st century [Dess, Lumpkin, and Eisner, 2008] they soon will be. Nowadays many firms are gaining competitive advantages by being good stewards of the natural environment. No business wants a reputation as being a polluter [David, 2011].

Managers must explore new opportunities and adjust to volatile markets in order to avoid complacency and stagnancy. They must ensure that the company maintains adaptability and remains proactive in expanding or modifying their product-market scope to anticipate and satisfy new tight market condition [Dess, Lumpkin, and Eisner, 2008]. A firms' emphasis on maximizing flexibility and adaptability to continuous change becomes a key to the firm's changing successfully in the future [Perello-Marin. Marin-Garcia and Marcos-Cuevas, 2013].

Emerging strategies that show potential make adaptation and change necessary. Continuous observation and analysis are required to adapt the vision and mission of the corporation to their variable environment. [Ireland, Hoskisson, Hitt, 2011].

Table 1
Selected Concepts Related to the Adaptation Mode

Author (s)	Mode of adaptation	Source
L. Pérez-Nordtvedt, S. Khavul, D.A. Harrison, J. E. McGee	Temporal adaptation as adjust of enterprises to the reconfigured environment	Journal of Management Studies, DOI: 10.1111/ joms.12050. 2013
A. Canato, D. Ravasi, N. Phillips	Adaptation as an implementation of new solution, mutual adjust practices and organizational culture	Academy of Management Journal, Vol. 56, No.6, 2013
E. Stańczyk-Hugiet	Cooperative adaptation. Adaptation as a basic strategy in the selective environment	Zeszyty Naukowe. Organizacja i Zarządzanie, Politechnika Łódzka. z. 52, nr 1147, 2013.
P. Berłowski	Adaptation as workers adjust to the requirements of the organization	Personel i Zarządzanie 2013, nr 1.
I. Escher	Adaptation as a process of adjust of workers in culturally diverse organizations	Research Papers of Wrocław University of Economics, 2012, Nr 249
P. Magnusson, S.A. Westjohn, A. V. Semenov, A.A. Randrianasolo, S. Zdravkovic	Adaptation in marketing terms, the use of marketing mix adaptation in achieving better financial results	Journal of International Marketing, Vol. 21, No.4, 2013
H.C. Eakin, A. Patt	Adaptation in terms of social sensitivity and adaptability in the countries with different level of development	Wiley Interdisciplinary Reviews, 2011, Vol.2, Issue 2.
M. Romanowska	Adaptation as a permanent adjustment under changeable condition	Przełomy strategiczne w przedsiębiorstwie, Studia i Prace Kolegium Zarządzania i Finansów, 2010.
H. Bahrami, S. Evans	Adaptation as super flexible adjustment of the company to new realities	Super-Flexibility for Knowledge Enterprises, Springer 2010.
M. P. Ferreira, F. R. Serra, D. Li, S. Armagan	Adaptation as a value of the company in building a competitive advantage	Adaptation to the International Business Environment: A resource advantage perspective, Working paper n° 38/2009.
J.P. Macduffie	Adaptation as reducing distance to the changing environment	Academy of Management Annals, 2008.
P. Andrias, K. Debackere	Adaptation as a survival strategy for SME	Small business economics, 29 (1-2), 2007.
A. Hatum, A. Pettigrew	Adaptation as companies self-adjust to the changing environment as a dynamic process between decision-makers and environment	British Journal of Management, Volo.17, 2006.
B. Nogalski	Adaptation as a passive, reactive proactive or active behavior of companies in turbulent environment	Przedsiębiorstwo przyszłości, Warszawa 2004
J. Penc	Adaptation in dynamic term as a adjust volatility of enterprise to volatility of environment	Przedsiębiorstwo w burzliwym otoczeniu, Bydgoszcz 2002

Uncertain Environment

According to the latest forecasts, the uncertainty of the business environment will continue to increase. [Eoyang, Holladay, 2013, s.4-5; Conteh et all., 2014, s.31]. Environmental uncertainty can be determined by two parameters: the level of complexity and the degree of change. Increased levels of market globalization and technological change increase the complexity and uncertainty of managerial responses. Uncertainty can be not only a threat, but on the contrary, it may become a challenge that spurs the creative development and implementation of innovative solutions [Wheelen and Hunger, 2012]. If enterprises are efficient, an increasing level of uncertainty generates innovation in enterprise. Increased volatility of the business environment makes systematic strategic planning more difficult. In a changing, uncertain environment, firms need to reflect the dynamic, complex nature of phenomena and find answers to how the organization might identify new niches, new opportunities, how exploit them, and to adapt to new market conditions [Perello-Marin. Marin-Garcia and Marcos-Cuevas, 2013].

Considered broadly, the uncertainties in the external environment can come from the market and economy, law or politics. More specifically, problems arising from the external environment may involve technological, economical, social, legal, political. Problems coming from the macro economy may be subdivided into those of an economic, legal or political nature—all of which affect the operations of the firm. These areas of uncertainty subject the firm to continuous change. To ensure their survival, enterprises need to adapt to these changes.

The Legal Environment Affected by Eco-Regulations

The legal environment is one of the key components of the macro-environment, affecting company functioning in all sectors, including the production of energy or transportation biofuels. Changes in this legal environment can be either a stimulating or an inhibiting impetus to the development of new technologies, and to changes in supply and demand. In Europe, the first steps towards renewable energy were taken after the energy crises in the 1970's. In the last decade of the present century, there were two important directives for renewable energy: 2001/77/EC and 2003/30/EC. Due however to the low efficiency of the European Union's action for energy (including renewable energy), the Council of Europe and the European Parliament felt the need to develop a new European Energy Policy and obliged the European Commission by creating the new regulations presented on January10, 2007 in the form of the Climate and Energy Package (called 3x20). The kick-off point of this new energy policy is the reduction of greenhouse gas emissions in the EU by 20% by 2020 in relation to 1990. The unilateral adoption of this reduction should be seen in the context of the need for international action to prevent negative climate change.

The rising production of energy from renewable sources--another field of the new policy-is an important condition for achieving objectives in the energy area. In the renewable energy area the Commission proposed a commitment to increase the level of energy produced from renewable sources in the EU by 20% by the year 2020. Within this framework, countries should be able to choose the types of energy that they use: for example, electricity from renewable energy sources, biomass for heating and cooling, or biofuels. It became necessary to introduce the minimum universal target requirement that 10% of transportation fuels be biofuels (in terms of energy) for all Member States by 2020.

On April 23, 2009 the European Commission adopted Directive 2009/28/EC on the promotion of the use of energy from renewable sources [Directive 2009/28/EC, Directive of the European Parliament and the Council on the promotion of the use of energy from renewable sources, 23.04.2009 r]. The directive sets quantitative targets for the share of renewable energy consumption by individual member states in 2020. The Polish goal is 15% (the 20% in the package for Poland, was reduced to 15%), and, according to a research study, Poland was close to achieving this goal. These conditions have now changed slightly--in many sectors of the RES there are delays in achieving the objectives, there have been changes the law, and, in addition, there is no expectation of a Law on RES being passed in Poland [Borowski, Golisz and Izdebski, 2014]. Legal conditions in the biofuels transportation sector are complex and variable, and this reduces the attractiveness of the sector by making obligatory the use of quantitative indicators (National Indicative Target, National Reduction Target).

The new legal conditions forced on biofuels producers has encouraged a search for new solutions and systems in order to meet the new conditions.

Research in this area was done using five distilleries producing bioethanol of 1st generation (1G) in a double and a single-phased system. The degree of reduction of CO2 emissions, according to legal requirements, was calculated for the five distilleries operating in Poland, producing bioethanol 1G in two-phase systems (wheat) and single-phase systems (beet molasses and corn). GHG emissions resulting from the production and use of transportation fuels, biofuels and bioliquids was estimated based on the methodology set out in the EU Directive 2009/28/EC. The study of the CO2 emissions reduction method was done using Biograce 4, developed according to the guidelines contained in the directive mentioned above [Krzywonos, Borowski, Kupczyk, Zabochnicka-Swiatek 2014].

The analysis of this research allows a comparison of the reduction of CO2 emissions for different plants producing ethanol and allows important conclusions to be drawn. It turned out that the threshold of 50% emission reduction is dangerous and costly (e.g. requiring modernization) for 1G biofuel producers. For most of the manufacturers, overcoming these barriers is not possible by 2017, and may require a longer transition period, but the threat in the period up to 2020 seems to be slightly smaller than initially expected.

Methodology

According to guidelines contained in the directive, greenhouse gas emissions from the production and use of transportation fuels, biofuels and bioliquids is calculated as:

E = eec + el + ep + etd + eu – esca – eccs – eccr – eee ,

where

1. E = total emissions from the use of the fuel

eec = emissions from the extraction or cultivation of raw materials
el = annualised emissions from carbon stock changes caused by land-use change
ep = emissions from processing
etd = emissions from transportation and distribution
eu = emissions from the fuel in use
esca = emission saving from soil carbon accumulation via improved agricultural management
eccs = emission saving from carbon capture and geological storage
eccr = emission saving from carbon capture and replacement
eee = emission saving from excess electricity from cogeneration

Emissions from the manufacture of machinery and equipment is not be taken into account.

2. Greenhouse gas emissions from fuels, E, is expressed in terms of grams of CO2 equivalent per MJ of fuel, gCO2eq/MJ.
3. Greenhouse gas emission saving from biofuels and bioliquids is calculated as:
SAVING = (EF–EB)/EF,

where
EB = total emissions from the biofuel or bioliquid
EF = total emissions from the fossil fuel comparator

Results

The research was carried out using data from the five producers of biofuels. The CO2 emissions reduction data was collected in each factory. In order to calculate the reduction of gas emissions, the main information on production was the daily quantity of production and the amount of natural gas/coal used in the production. The calculations of greenhouse gas emissions from the fuels depended on the raw material used as input (wheat, molasses or corn). This data was expressed in terms of grams of CO2 equivalent per MJ emission gCO2eq and was calculated using the Biograce® calculator. All of the items of the production process (e.g. emissions from the fuel in use, emissions from transportation and distribution) were taken into account in the calculation. A final result of the calculations was the determination of the real green gas saving.

In the five factories examined, the level of CO2 saving (reduction) was between minus (-) 24% to plus (+) 46% depending on the raw material used. These details are shown in the table 1. All calculations were made in accordance with the methodology and guidelines laid down in Directive 2009/28/EC.

[1] The above-mentioned document is based on national resources and potential. There have been delays and some disappointments in the following sectors: for example, biogas, and the poor development of the domestic use of biomass (high import and use such as coconut husks, et al.). It is worth emphasizing that transportation biofuels and energy resources are in global sectors, where participants were forced into action by competition in the world market.

Table 2
Changes in Gas Emission Saving in Five Factories

No. of Factory	Raw Material	Technology Used	Default Greenhouse Gas Emission Saving	Real Greenhouse Gas Emission Saving
1	wheat ethanol	2-phase	(+) 16%	(-) 24% - (-)18%
2	wheat ethanol	2-phase	(+) 16%	(+) 1% - (+) 6%
3	wheat ethanol	1-phase	(+) 35%	(+) 27% - (+) 31%
4	sugar beat (molasses) ethanol	1-phase	(+) 52%	(+) 44% - (+) 46%
5	corn (maize) ethanol	1-phase	(+) 49%	(+) 43% - (+) 46%

Source: own research

Table 2 presents the results of the research done in particular factories. Factories No. 1 and No. 2 used 2-phase technology and the real green gas house emission reduction was at very low levels (minus values mean that there was increased in CO2 in emissions). Factories No. 3, No.4 and No.5 used 1-phase technology and CO2 emission reduction was at a higher level, but still not enough to satisfy the requirements of UE Directive.

As an example of the calculations of CO2 emission reductions for the factories, we chose the ethanol production from molasses in a 1-phase factory (Factory No. 4) and presented this calculation in table 3.

Table 3
A Sample of the Calculation of CO2 Emission Reductions

Type of Molasses	Daily Quantity of the Production in the Factory [dm^3]	Amount of Natural Gas/Coal Used in the Production [M^3] for Gas [kg] for Coal	Emission From the Production of Molasses Used to Produce Bioethanol gCO2$_{eq}$	Grams of CO^2 Equivalent Per MJ of Fuel, [gCO$_2$eq/MJ]	The Reduction of CO2 Emission Calculated According to Biograce
Molasses as waste	26400	9400	Not Included	(45,96	45%
Molasses as an intermediate (energy to produce molasses was from the combustion of natural gas)	26400	9400	1339888	48,30	42%

Table 3 Contunued
A Sample of the Calculation of CO2 Emission Reductions

Molasses as an intermediate (energy to produce molasses was from the burning of coal mining)	26400	2553	252307	49,90	41%
default greenhouse gas emission saving					52%

Source: own research

The results of the calculations for different raw materials (molasses as waste and molasses as an intermediate are found in Table 3. The Table also contains the calculations for different sources of energy (natural gas and coal mining). The calculation of CO2 emissions reduction was done for three different cases. The calculations depend on the material used with reduction ranges from 41% to 45%. The UE Directive requires 52%.

The Biograce calculator is an Excel spreadsheet into which you put the data involved in the production of bioethanol. CO2 reduction is automatically calculated and this reduction is shown in Table 4.

Table 4
Greenhouse Gas Emission Reduction--Biograce Calculator

Emission reduction
Fossil fuel reference (petrol)
83.8 g $CO_{2,eq}$/MJ
GHG emission reduction
45%

Source: Biograce calulator

This research compares the gas emissions saving on various materials, for example, the reduction of CO2 emissions for different plants producing ethanol. Important conclusions can be drawn from these comparisons. The tight legal environmental rules require reductions of gas emissions at a much higher level than enterprises are currently able to make—especially for 2-phase production. The ability of an enterprises to adapt to their macro environment depends on, among other things, the raw materials and the technology that they use. It turned out that the 50% threshold of emissions reduction is dangerous and costly (e.g. modernization is needed to do it properly) for 1G biofuel producers, but for most of the manufacturers, these problems are not insurmountable. The producers should be able to make these levels of reduction by 2017, but it is also possible that more time may be need to accomplish the transition. The threat from the emissions occurs in the period up to 2020, fortunately the risk seems to be slightly smaller than initially expected.

The Legal Environment of the Energy Sector

The European Regulations establish a framework for long-term goals that will help the EU member nations to achieve sustainable energy security. European energy regulators focus on clean energy and its final consumers. The European Commission has made clear that it favors splitting up energy firms' production and distribution activities as the best way to ensure fair competition and lower prices for consumers. The European energy regulators seek to improve their understanding of customer interests in the overall energy market. The first electricity and gas directives were adopted in the late 1990s, with the objective of opening up the electricity and gas markets by gradually introducing competition. To limit environmental pollution and to slow the rate of increase of CO2 concentration, a strategy was used that exploited the greatest possible use of non-greenhouse gas emitting energy sources. This strategy needed to be developed and implemented as soon as possible. Many power plants had to engineer, procure and construct new emissions control equipment in order to meet these emissions requirements.

The research based on energy companies shows how firms adapted to new regulations and tight requirements.

Table 5
Regulations and Eco-Requirements

Legal environments/Regulations
Directives (e.g. Directive 2009/28/EC)
Regulations (e.g. National Energy Efficiency Action Plans)
Acts (Energy Law Act)
Eco-environment/Requirements
CO2 emission reduction
Reduction of greenhouse gases (GHG) effects
Ecological footprint (carbon footprint, water footprint, nitrogen footprint)

In order to examine the relationships and linkages between the firms in the energy market, a two-stage research process was used. First, a questionnaire survey was done in January 2012, and second, a telephone interview survey was done in January 2014. A comparison of the two surveys allowed the research to specify progress in emissions control and spot new developments in this field. The questionnaires were sent to 145 Polish enterprises operating in the energy market. The survey covered three sizes of enterprises: micro, small, and large enterprises. The questionnaire covered the following issues:

1. Which elements of the environment play a significant role in emissions reduction

2. How do companies perceive the impact of emissions regulations

3. What is the level of impact of EU emissions regulations

4. Do the environmental requirements affect the way a company is managed

Limitation of the Research

The research among the energy companies were conducted as surveys. There are some disadvantages of this kind of research. Respondents may not be willing to provide accurate, honest answers. Respondents may not feel comfortable providing answers that present their company in an unfavorable light. To reduce these weaknesses of in survey-type research, a next might be to do deep interviews with the CEOs of the companies, but this would increase the cost of the research.

Investigations into biofuels were carried out on a sample of only five companies. In the future, research should use a larger sample of firms producing both 1st generation and 2nd generation biofuels in order to get a broader picture of all factories in Poland.

CONCLUSIONS AND RECOMMENDATIONS

This study has investigated the effects of a variable environment on the development of energy companies. The legal environment, in particular European Union Directives, played a key role by urging firms to adapt to new requirements and market regulations. The results of examinations can be expected to be taken into account by CEOs of energy firms through the decision making process they use to develop policies in situations involving tight and changeable environmental requirements.

This research indicated 7 significant conclusions:

1. The telephone interviews identified three distinct groups of firms based on size.

2. Different sizes of the firms produce different styles of adaptation. Large firms are more active, try to influence their legal environment, and try to cooperate with Agencies--the Energy Regulator Office or The Competition and Consumer Protection agency--while micro and small firms focus their attention on their customers.

3. The large companies are interested in their competitors to a greater extent than are the micro and small companies.

4. The firms monitor their variable environment by continuously tracing changes. The micro and small enterprises do this every day, while large firms do market research once a month.

5. Technical and technological changes in individual plants made in order to reduce emissions should cater to the individual needs of a particular installation/facility. For example, only the most competitive enterprises should invest in new production capacity in 1G biofuels, because only they can fulfill the macro environmental requirements of such added production.

6. Most of the firms are able to adapt to the changeable environment even though it involves additional capital expenditures.

7. The increasingly unpredictable environment requires companies to become more managerially active, employ tracking that makes them more alert, and to more accurately forecast expected changes.

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Hedging Emerging Market Stock Risk with Sovereign Credit Default Swaps

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ABSTRACT

This paper tests sovereign credit default swaps (CDS) as a hedge and safe haven asset against stock index returns in a sample of 18 emerging markets from 2005-2014. GARCH dynamic conditional correlation analysis indicates that CDS are an effective hedge due to the consistent inverse relationship between CDS and the stock indexes of each country. CDS are largely a weak safe haven in times of extreme stock market volatility. However, during the 2008 U.S. financial crisis and the 2010 European debt crisis, CDS provide either a strong or weak safe haven in most countries.

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INTRODUCTION

Given the increase in global market integration, identification of tradable financial assets that provide diversification benefits may be useful to stock portfolio managers. This paper examines the role of sovereign credit default swaps (CDS) in managing emerging market stock risk. CDS are bilateral agreements that insure against the risk of a government "credit event" such as a restructuring or default. Traded in over-the-counter secondary markets, these liquid financial products react immediately to new public information about the underlying economic health of a country's economy. Since a country's government and corporations are exposed to the same country specific risk factors, an increase in economic or political instability may increase both sovereign credit risk and the systematic risk of equity markets. Thus, CDS offer risk reduction properties to not only sovereign bonds, but potentially to stocks.

Using GARCH dynamic conditional correlation (DCC), this paper investigates CDS as a hedge, safe haven, or diversifier against stock risk in a sample of 18 emerging countries. Following Bauer and Lucey (2010), an effective hedge is defined as an asset that is consistently uncorrelated or negatively correlated to stock price movements. A safe haven is an asset that is uncorrelated or negatively correlated to stock price movements during times of market turmoil. A diversifier is an asset with a positive, but imperfect correlation with stock prices. As the CDS market is relatively new, the investment implications of this asset in the academic literature are sparse.

The primary investors in the CDS market include banks, investment banks, hedge funds, and mutual funds. These assets are used to reduce the default risk of current bond holdings, and for speculation by profiting from changes in the default risk of sovereign bonds. Retail investors have limited access to the CDS market through recently created ETFs that focus on CDS indexes. In the marketplace, CDS prices increase when the credit risk of the underlying bonds increases, and decrease as credit risk declines. A "naked" CDS position exists when the investor does not own the underlying bond. Investors who purchase CDS are taking a "short" position, benefiting from a decline in value of the underlying bond. Alternatively, investors who sell CDS are taking a "long" position with increasing profits as the underlying bonds improve in credit quality.

There are three main findings presented in this study. First, CDS provide a hedge against stock risk as evidenced by the significantly negative co-movement between CDS and stock index returns in all 18 countries. Second, in times of extreme market volatility, CDS are a weak safe haven in all countries and a strong safe haven in relatively few countries. Third, CDS are either a weak or strong safe haven in 14 of the 18 countries during the U.S financial crisis. During the 2010 European debt crisis, CDS are either a weak or strong safe haven in 17 of the18 emerging countries.

The remainder of this article is presented as follows. Section 2 provides a review of the literature on the CDS market and on safe haven assets. Section 3 describes the CDS data in detail, and the relationship between the CDS and stock market index of each country. Section 4 provides the methodology and specification of the models used. Section 5 contains the empirical analysis. Section 6 concludes the study.

[1] In contrast to sovereign bonds that contain both credit risk and interest rate risk, CDS reflect only credit risk.
[2] See Palladini and Portes (2011).

LITERATURE

The literature provides evidence that sovereign CDS are an effective measure of sovereign credit risk. Zhang (2008) finds that CDS capture the default risk of Argentine sovereign bonds when the default risk is moderate. Delis and Mylonidis (2011) document that CDS Granger-cause the sovereign bonds of Greece, Italy, Portugal and Spain during the 2007 financial crisis. The authors indicate that high levels of risk aversion affect the transmission mechanism between CDS and government bonds. Carr and Wu (2007) find a positive correlation structure between sovereign CDS and currency options in Brazil and Mexico utilizing a relatively short sample period (January 2002 through March 2005).

Pan and Singleton (2008) examine the term structure of sovereign CDS by investigating common threads within and among three emerging markets. Using local, regional, and global factors, the authors conclude that the sovereign CDS of Mexico, Korea, and Turkey are significantly affected by global factors more than local factors, particularly when the volatility of the U.S. stock market is used as a common factor. Ericsson et al. (2009) use linear regression and principal components analysis on a dataset of bid/ask quotes to test the theoretical determinants of corporate CDS. The study concludes that leverage, volatility, and the risk-free rate are important determinants of corporate CDS as predicted by theory.

Longstaff et al. (2011) study CDS for 26 countries using principal components analysis. They note that CDS are more highly integrated internationally than equity markets. The authors also find that CDS are more closely related to common factors in the U.S. market than local markets, which may diminish the usefulness of CDS as investment vehicles. Longstaff et al. (2011) extend research by Remolona et al. (2008), who find that global factors influence sovereign bonds. Earlier studies also link sovereign bonds to a common set of global factors including Geyer et al. (2004), who examine four EU countries, and Rozada and Yeyati (2008) who utilize a sample of 33 emerging bond markets. More recently, Wang and Moore (2012) investigate the integration of the CDS market in a sample of 38 developed and emerging markets. Using a multivariate GARCH model, the authors find increasing market integration since the failure of Lehman Brothers, and that U.S. interest rates are the main factor promoting the rise in the global CDS market correlation.

The interest in identifying effective hedge and safe haven assets is growing for two related reasons. First, rising correlations among country stock markets over time diminish the advantages of international portfolio diversification (Eun and Lee, 2010). Second, the contagion literature that examines the behavior of investors during times of crisis shows that there is excessive interdependence in stock markets during the 1987 U.S. stock market crisis, the 1994 Mexican Peso crisis, and the 1997 Asian Crisis (see Forbes and Rigobon, 2002). In addition, Markwat et al. (2009) find that global crashes are preceded by local and regional crashes as a domino effect.

Empirical studies examine the role of gold and foreign currencies as alternative assets for hedging against stock risk. Bauer and Lucey (2010) use time-varying betas to demonstrate the usefulness of gold as a hedge and safe haven against stock risk in the U.S., U.K., and

Germany. Using a related methodology, Bauer and McDermott (2010) identify the hedging and safe haven properties of gold against stock risk in a sample of developed and emerging countries. Ranaldo and Söderlind (2010) show that the Swiss franc, Japanese yen, and to a lesser extent, the euro, provide a safe haven against U.S. stock risk from 1993 – 2008. Using dummy variable regression with intra-day trading data, Kaul and Sapp (2006) find that the euro and U.S. dollar currency pair is a safe haven surrounding the Y2K millennium change. Upper (2000) notes the usefulness of government debt in pricing other securities in the marketplace, as a hedging vehicle, and as an indicator of a country's financial stability. The author finds that German government bonds are useful safe haven assets during a period of global turmoil in 1998.

Fontana and Scheicher (2010) anecdotally note the use of sovereign CDS by traders to hedge country macroeconomic risk, for arbitrage trading against government bonds, and for pure speculation. Calice et al. (2013) is the sole academic research paper investigating CDS as a potential stock hedge. The authors utilize a sample of single name corporate CDS data for U.S. firms from 2004 – 2010. The study concludes that holding a basket of CDS effectively reduces both default and capital risk. Calice et al. (2013) show that CDS are not priced as a linear combination of alternative assets; additionally, CDS are unique financial assets with strong and persistent negative correlations against stocks. The authors conclude that holding CDS without exposure to the actual reference entity (a naked CDS) is a significant partial hedge against stocks, commodities, and foreign exchange investments.

Our paper is motivated by the co-movement between sovereign credit risk and equity market systematic risk. Durbin and Ng (2005) attribute the positive correlation between corporate credit risk and sovereign credit risk to exposure to the same macroeconomic factors and transfer risk – the risk of a government, during an economic downturn, transferring its debt obligations to corporations via higher taxes and other actions. Their findings suggest that sovereign credit risk co-vary positively with stock risk in emerging markets.

DATA DESCRIPTION

Sovereign CDS and stock index data are provided by DataStream from 2005-2014. The sample starts in 2005 to maximize the number of countries with consistent sovereign CDS index data, which begins in 2004-2005 for most countries. This study includes the following 18 emerging countries: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Hungary, Indonesia, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Thailand, and Turkey. (All other emerging countries are excluded from this study due to insufficient or missing data).

Sovereign CDS data consist of midmarket prices for 5-year contracts. While CDS are largely available for sovereign bonds in the 1-5 year and 10-year maturities, the 5-year CDS is the most liquid and active market (Palladini and Portes, 2011). Equity market performance is based on the individual MSCI country stock index. Stock index prices are the total return indexes including dividends. Stock indexes are converted into U.S. dollars to correspond to the notional pricing of the CDS data, and to represent the perspective of U.S. investors.

Weekly data for all variables in this study are measured from Wednesday-to-Wednesday close. To achieve stationarity, all CDS and stock indexes are transformed into first-difference form. While test results are reported using weekly data, tests of daily and monthly frequency are also performed. Daily data suffers from two weaknesses: infrequent trading in earlier years and non-synchronous trading between CDS markets and equity markets. Monthly data frequency is too low to capture the movement between the variables.

Descriptive statistics for sovereign CDS and stock indexes are provided in Table 1. Weekly mean CDS return is highest in Argentina (1.671%) and lowest in the Philippines (0.015%). Likewise, standard deviation in CDS is highest in Argentina (17.108%) and lowest in the Philippines (8.190%). Stock index weekly mean return is highest in Peru (0.417%) and lowest in Hungary (0.095%). Standard deviation in stock indexes is highest in Hungary (5.608%) and lowest in Malaysia (2.413%).

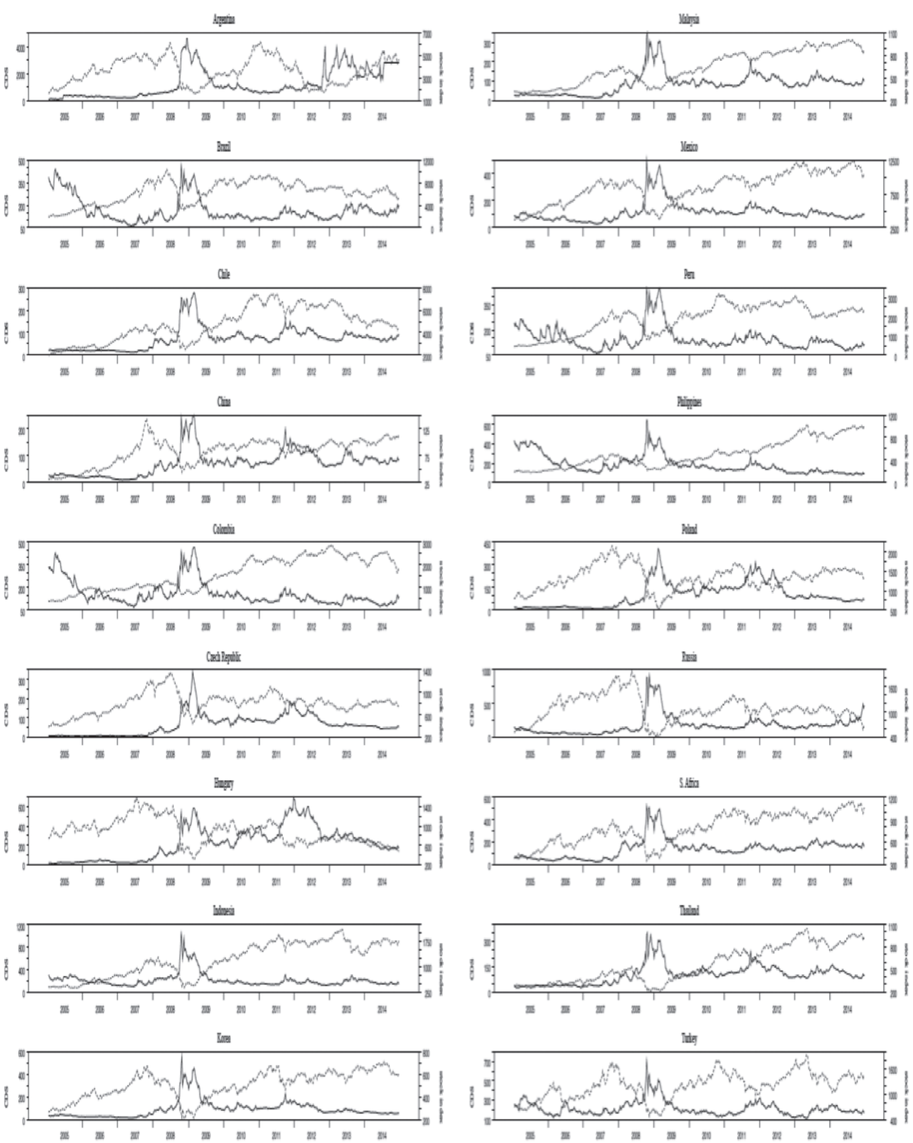
Table 1
Descriptive Statistics

	Credit Default Swaps		Stock Indexes		DCC Statistics	
Market	Mean (%)	Standard Deviation (%)	Mean (%)	Standard Deviation (%)	Mean (%)	Standard Deviation (%)
Argentina	1.671	17.108	0.314	5.156	-0.396	22.00
Brazil	0.349	9.949	0.298	4.801	-0.689	5.60
Chile	0.647	9.322	0.196	3.328	-0.420	16.20
China	0.764	11.091	0.324	3.959	-0.521	13.20
Colombia	0.309	10.013	0.357	3.822	-0.559	5.50
Czech Rep.	0.977	11.672	0.200	3.986	-0.309	12.10
Hungary	0.873	10.060	0.095	5.608	-0.539	11.00
Indonesia	0.257	9.046	0.390	4.540	-0.557	8.90
Korea	0.593	10.147	0.260	4.472	-0.547	7.40
Malaysia	0.765	10.186	0.222	2.413	-0.511	6.20
Mexico	0.473	9.703	0.272	3.782	-0.620	8.90
Peru	0.339	9.913	0.417	4.682	-0.509	3.20
Philippines	0.015	8.190	0.384	3.605	-0.544	1.20
Poland	0.819	11.312	0.209	4.799	-0.477	18.10
Russia	0.777	10.985	0.171	5.587	-0.633	8.10
S. Africa	0.593	9.239	0.266	4.173	-0.606	10.30
Thailand	0.671	9.858	0.304	3.947	-0.502	1.90
Turkey	0.262	8.448	0.310	5.462	-0.734	4.40

DCC-GARCH models: $h_t = c_0 + a_1\varepsilon_{t-1}^2 + b_1 h_{t-1} + d_1\varepsilon_{t-1}^2 I_{t-1}$
and $R_t = (1-\alpha-\beta)\bar{R} + \alpha\varepsilon_{t-1}\acute{\varepsilon}_{t-1} + \beta R_{t-1}$

Figure 1 provides a graph for each emerging market stock index against that country's sovereign CDS in non-differenced form. All stock indexes rise prior to the financial crisis period of 2007-2009, decline during the crisis period, and begin to experience a noticeable recovery in 2009. In contrast, the CDS of each market generally move in the opposite direction of the stock indexes over time. The relationship between CDS and stock indexes in all markets during the financial crisis period is similar – CDS increase while stock indexes decrease.

Figure 1
CDS and Stock Index Levels



CDS Index ——— Stock Index

METHODOLOGY

Dynamic conditional correlation (DCC) is a technique developed by Engle (2002) to examine time-varying correlation. The procedure uses GARCH to generate time-varying estimates of the conditional co-movement between assets implemented as:

$$r_t|I_{t-1} \sim N(0, H_t) \qquad (1)$$

$$H_t = D_t R_t D_t \qquad (2)$$

where r_t is the $k \times 1$ demeaned vector of variables conditional on information I_{t-1}, and is assumed to be conditionally multivariate normal. H_t is the covariance matrix where R_t is the $k \times k$ time-varying correlation matrix, and D_t is the $k \times k$ diagonal matrix of conditional standardized residuals estimated from the univariate GARCH models.

The general form equation of the likelihood function of the estimator is given by:

$$L = -0.5 \sum_{t=1}^{T} (klog(2\pi) + 2log\ (|D_t|) + log(|R_t|) + \acute{\varepsilon}_t R_t^{-1} \varepsilon_t) \qquad (3)$$

There are two steps in this procedure. The volatility component Dt is maximized in the first step by replacing R_t with a $k \times k$ identity matrix. This results in reducing the log likelihood to the sums of the log likelihoods of the univariate GARCH equations. The first order univariate GARCH models are estimated for the CDS and stock indexes of each country using the Glosten et al. (1993) model allowing for asymmetries:

$$h_t = c_0 + a_1 \varepsilon_{t-1}^2 + b_1 h_{t-1} + d_1 \varepsilon_{t-1}^2 I_{t-1} \qquad (4)$$

where ht is the conditional variance, d1 is the asymmetry term, and It-1=1 if ετ<0, otherwise I=0. The correlation component Rt is maximized in the second step:

$$R_t = (1 - \alpha - \beta)\bar{R} + \alpha \varepsilon_{t-1} \acute{\varepsilon}_{t-1} + \beta R_{t-1} \qquad (5)$$

where the values of the DCC parameters α and β are provided. If α and β are zero, then R_t reduces to $\bar{R}$, which would indicate that the constant correlation model is appropriate.

Subsequent to the GARCH estimation, the time varying correlations R_t are extracted from model (5) into a separate time series for each country. R_t are regressed on dummy variables representing market turmoil to test CDS as a hedge and safe haven asset against stock risk. The following hypotheses are formulated:

H_1: CDS do not provide a hedge against stock risk.
H_2: CDS are not a safe haven against extreme negative movements in the stock market.

The hypotheses are assessed with models (6) and (7):

$$R_t = \gamma_0 + \gamma_1 D(r_{stock}q_{10}) + \gamma_2 D(r_{stock}q_5) + \gamma_3 D(r_{stock}q_1) \qquad (6)$$

where D represent dummy variables that capture extreme movements in the underlying stock market index at the 10%, 5%, and 1% quantiles. CDS are a weak hedge if γo are insignificantly different than zero, a strong hedge if γo is significantly negative, or a diversifier if γo is significantly positive. CDS are a weak safe haven if the $\gamma 1$, $\gamma 2$, or $\gamma 3$ coefficients are insignificantly different from zero, or a strong safe haven if $\gamma 1$, $\gamma 2$, or $\gamma 3$ are significantly negative. Significantly positive $\gamma 1$, $\gamma 2$, or $\gamma 3$ coefficients indicate that CDS are not a safe haven during the extreme stock volatility.

To examine CDS as a hedge and safe haven against stock risk during a period of financial crisis, a modified version of a dummy variable regression model suggested by Baur and McDermott (2010) is empirically tested as:

$$R_t = \gamma_0 + \gamma_1 D(U.S.\,financial\ crisis) + \gamma_2 D(European\ debt\ crisis) \qquad (7)$$

where a dummy variable is set to one at the start of the U.S. financial crisis period (9/10/08) and the European debt crisis (1/13/10). CDS are a weak safe haven in specific crisis periods if the $\gamma 1$, $\gamma 2$ coefficients are insignificantly different than zero, or a strong safe haven if they are significantly negative. Significantly positive $\gamma 1$, $\gamma 2$ coefficients indicate that CDS are not a safe haven during the specific crisis periods.

EMPIRICAL RESULTS

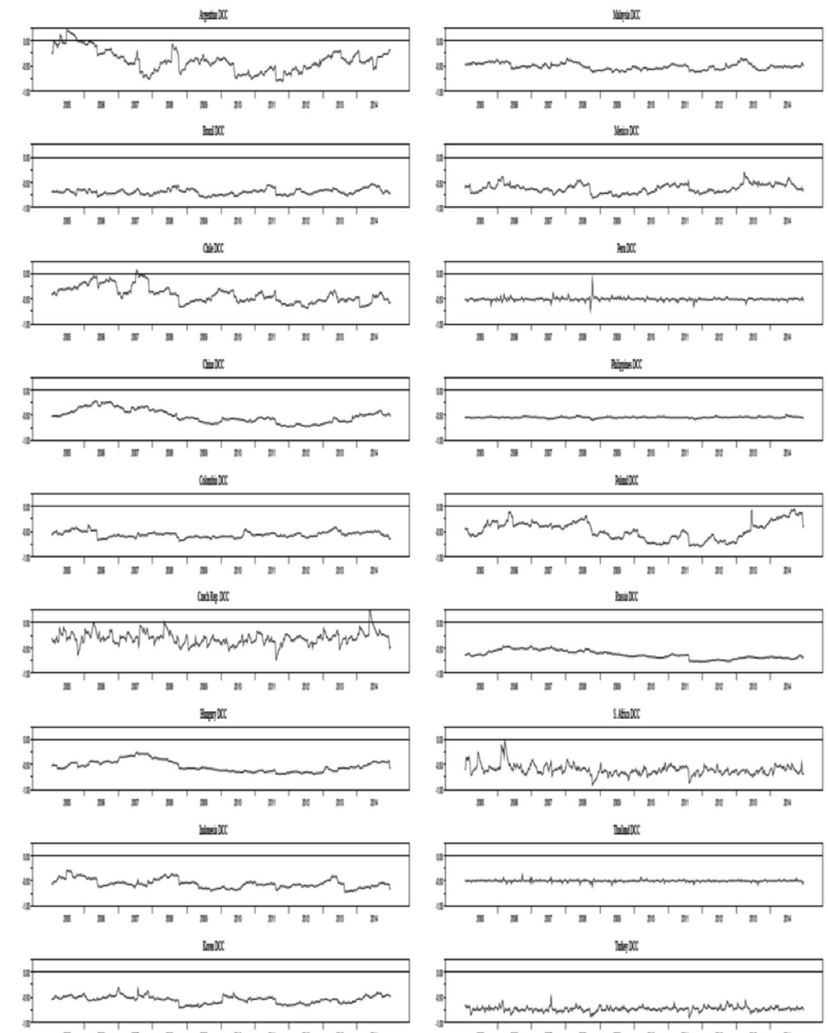
5.1. Dynamic conditional correlations

The time series of dynamic conditional correlation coefficients Rt of the CDS and stock indexes of each country are generated and extracted from the GARCH model (5) following Engle (2002). Summary statistics are provided in Table 1. The least negative mean DCC coefficient occurs in the Czech Republic (-0.309) and the most negative mean DCC occurs in Turkey (-0.734). In a static sense, this indicates that increases in CDS prices are associated with declines in stock indexes. CDS prices are the most inversely related to stocks in Turkey compared with the other countries. Although negative, a wide disparity in the mean DCC coefficients between countries is also apparent. The standard deviation of each country's DCC series demonstrates that the time varying relationships between CDS and stock indexes are not consistent across countries. Variability ranges from the lowest standard deviation in the Philippines (1.20%) to the highest standard deviation in Argentina (22.00%).

To better illustrate the time varying relationship between CDS and stock indexes, Figure 2 contains graphs of the DCC coefficients across countries. The signs of the correlation coefficients are almost universally negative for all countries, but the extent of the negativity and variability is unique to each country. Relatively brief periods of positive correlation coefficients are observed in Argentina, Chile, and the Czech Republic. Consistently low variability is evident in the Philippines and Thailand compared with high variability in Argentina, Chile, the Czech Republic and Poland. A negative correlation between assets is the cornerstone of the diversification benefits of portfolio assets.

Figure 2

GARCH DCC Estimates Between CDS and Stock Indexes



[4] The dummy variable regression is loosely based on Baur and McDermott (2010) who utilize time varying betas calculated from rolling regression to represent co-movement. We instead use GARCH-generated DCC.

[5] Identification of the U.S. financial crisis is somewhat arbitrary starting with the collapse of Lehman Brothers in September 2008. The European debt crisis involves numerous countries over a multi-year period. However, Greece is often cited at the center of the crisis; as such, the start of the crisis is set in January 2010 with the announcement by the EU European Commission of "severe irregularities" in Greek accounting procedures.

5.2. Hedge and safe haven characteristics

Two models are estimated to test CDS as a hedge and safe haven against stock risk in each country. First, the time series of the dynamic conditional correlation coefficients Rt of CDS and stock indexes are regressed on dummy variables representing three quantiles of extreme stock market volatility. Second, the DCC time series Rt are regressed on dummy variables representing the 2008 U.S. financial crisis and the 2010 European debt crisis. Both models are based on a similar methodology used by Baur and McDermott (2010).

Table 2 shows the estimates of regressions based on model (6). The DCC coefficients are regressed on a constant and three dummy variables representing levels of extreme negative stock volatility quantiles of 10%, 5%, and 1%. The "hedge" column represents the model constant $\gamma 0$, which shows a negative relationship between CDS and stock indexes in each market with significance at the 1% level. A significantly negative value indicates that CDS are a strong hedge against stock indexes in each country, and leads to a rejection of the first hypothesis (H1).

The stock quantile regression coefficients ($\gamma 1, \gamma 2, \gamma 3$) represent the safe haven characteristics of CDS and stock indexes. Significantly negative coefficients indicate a strong safe haven in the 10% stock quantile in Russia (-0.030), the Czech Republic (-0.048), Malaysia (-0.026), and Mexico (-0.035). In the more extreme 5% quantile, CDS demonstrate a strong safe haven in Brazil (-0.031), Colombia (-0.041), the Philippines (-0.010), Thailand (-0.014), and Turkey (-0.035). In the most extreme 1% stock quantile, CDS show a strong safe haven in Chile (-0.156), Korea (-0.080), Malaysia (-0.062), Mexico (-0.073), the Philippines (-0.029), South Africa (-0.132), Thailand (-0.015), and Turkey (-0.072). Insignificant coefficients indicate that CDS are a weak safe haven, which is evident for most countries. A significant and positive coefficient is observed in Russia (0.045) in the 5% stock quantile. In this instance, CDS are a hedge, but not a safe haven asset. For most countries, CDS are either a strong or weak safe haven, leading to a rejection of the second hypothesis (H_2).

Table 2

CDS as a Hedge and Safe Haven Against Stock Risk During Extreme Stock Volatility

		Stock Quantile		
Market	Hedge (γ_0)	10% (γ_1)	5% (γ_2)	1% (γ_3)
Argentina	-0.390***	-0.004	-0.092	-0.067
Brazil	-0.688***	0.009	-0.031*	-0.003
Chile	-0.416***	-0.013	-0.009	-0.156**
China	-0.521***	-0.022	0.061	-0.097
Colombia	-0.555***	-0.011	-0.041***	-0.029
Czech Rep.	-0.304***	-0.048**	0.015	-0.078
Hungary	-0.538***	0.019	-0.038	-0.040
Indonesia	-0.556***	0.002	-0.017	0.027
Korea	-0.545***	-0.012	0.002	-0.080**
Malaysia	-0.507***	-0.026**	-0.007	-0.062**
Mexico	-0.614***	-0.035**	-0.020	-0.073*
Peru	-0.510***	0.009	0.005	-0.008
Philippines	-0.544***	0.002	-0.010***	-0.029***
Poland	-0.483***	0.037	0.042	0.076
Russia	-0.633***	-0.030*	0.045*	0.008
S. Africa	-0.601***	-0.031	-0.009	-0.132***
Thailand	-0.501***	0.001	-0.014**	-0.015*
Turkey	-0.731***	-0.003	-0.035***	-0.072***

Note: ***,**,* indicates significance at the 1%, 5%, and 10% levels, respectively.

Model: $R_t = \gamma_0 + \gamma_1 D(r_{stock} q_{10}) + \gamma_2 D(r_{stock} q_5) + \gamma_3 D(r_{stock} q_1)$

The final model tests CDS as a hedge and safe haven during periods of financial crisis based on model (7), and the results are presented in Table 3. The model (7) constant γ_0 describes the hedge, and is consistent with model (6). During the 2008 U.S. financial crisis, significantly negative coefficients indicate that CDS are a strong safe haven in most countries including Argentina, Chile, Colombia, the Czech Republic, Korea, Malaysia, Mexico, the Philippines, South Africa, Thailand and Turkey. Insignificant γ_1 coefficients suggest that CDS are a weak safe haven in China, Hungary, and Poland. Significantly positive coefficients show that CDS are not a safe haven in Brazil, Indonesia, Peru, and Russia.

Likewise, during the 2010 European debt crisis, CDS also provide a strong safe haven in most countries indicated by significantly negative γ_2 coefficients in Brazil, China, Colombia, the Czech Republic, Hungary, Indonesia, Malaysia, Mexico, Poland, and South Africa. Insignificant γ_2 coefficients suggest that CDS are a weak safe haven in Argentina, Chile, Peru, the Philippines, Russia, and Turkey. Significantly positive coefficients show that CDS are not a safe haven in Korea and Thailand.

Table 3
CDS as a Hedge and Safe Haven Against Stock Risk During Financial Crises

Market	Hedge (γ_0)	U.S. Financial Crisis (γ_1)	European Debt Crisis (γ_2)
Argentina	-0.390***	-0.092**	-0.028
Brazil	-0.688***	0.041***	-0.047***
Chile	-0.416***	-0.178***	0.052
China	-0.521***	-0.046	-0.059**
Colombia	-0.555***	-0.088***	-0.047***
Czech Rep.	-0.304***	-0.107***	-0.134***
Hungary	-0.538***	-0.030	-0.094***
Indonesia	-0.556***	0.037*	-0.099***
Korea	-0.545***	-0.118***	0.057***
Malaysia	-0.507***	-0.087***	-0.043***
Mexico	-0.614***	-0.141***	-0.074***
Peru	-0.510***	0.022***	0.005
Philippines	-0.544***	-0.024***	0.002
Poland	-0.483***	-0.051	-0.126***
Russia	-0.633***	0.046***	-0.021
S. Africa	-0.601***	-0.125***	-0.046**
Thailand	-0.501***	-0.010**	0.011***
Turkey	-0.731***	-0.044***	0.016

Note: ***,**,* indicates significance at the 1%, 5%, and 10% levels, respectively.
Model: $R_t = \gamma_0 + \gamma_1 D(U.S.\, financial\ crisis) + \gamma_2 D(European\ debt\ crisis)$

CONCLUSIONS

Sovereign credit default swaps (CDS) protect against government bond losses, and serve as an indicator of a country's underlying macroeconomic risk. While the academic literature examines the causal relationship of CDS relative to both stocks and bonds, there are sparse investigations of CDS as a hedge or safe haven against stock risk. This study adds to the literature by evaluating the hedging and safe haven characteristics of sovereign CDS and stock indexes in a sample of 18 emerging countries from 2005-2014.

Empirical analysis utilizes GARCH dynamic conditional correlation (DCC) to examine the time varying relationship between sovereign CDS and country total return stock indexes. The major findings are as follows: first, negative mean DCC coefficients indicate that CDS are inversely related to stock indexes. Second, results of DCC coefficients regressed on dummy variables representing stock market volatility, and periods of financial crisis, show that CDS are a strong hedge against stock risk in all countries. Third, during periods of extreme negative stock market volatility, CDS are largely a weak safe haven against stock risk. There is evidence that CDS are a strong safe haven in a limited number of countries, and are not a safe haven in one country when stocks experience a high level of negative volatility. Fourth, CDS are a strong safe haven against stock indexes during the 2008 U.S. financial crisis in 11 countries, a weak safe haven in three countries, and no safe haven in four countries. During the 2010 European debt crisis, CDS provide a strong safe haven in 10 countries, a weak safe haven in six countries, and no safe haven in two countries.

The results support the potential role of CDS as a strong hedge against stock risk in the emerging markets. The usefulness of CDS as a safe haven asset is mixed. In periods of extreme stock market volatility, CDS generally provide only a weak safe haven. During the 2008 U.S. financial crisis and the 2010 European debt crisis, however, CDS provide a more consistently strong safe haven in many countries. In the few cases where CDS do not provide a safe haven, they are still useful as a hedge.

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Currency Substitution in Turkey: Macroeconomic Determinants

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ABSTRACT

When the legal barriers to transactions in foreign currencies were lifted in the 1980's, there was a sharp increase in the volume of foreign currency denominated deposits in Turkey. Because of an ongoing chronic inflation, stating some large value transactions, such as a house or car in dollars or Euro became common practice during the following decades. Similarly, there were dramatic increases in foreign currency denominated private and public debt (liability dollarization). In the words of a former Turkish Central Bank president, Turkey had become one of the most dollarized economies of the world by 2001(Serdengecti, 2006).

After 2001, there were significant changes in the economic and fiscal policies. The public attitude towards the foreign currencies started to change in favor of domestic currency, indicating a process which may be defined "de-dollarization" The stability of this change has been subject to numerous econometric studies.

Ourstudy employs a co-integration test for the existence of a long run equilibrium between the currency substitution and the following variables: 1) the currency substitution ratio (curr), 2) expected currency depreciation rate (expdep), 3)interest rate differential (intdiff), 4) ratio of central bank reserves to monetary aggregate M2Y (cbres, M2 plus foreign currency deposits) and 5) expected inflation rate (expinf) for the period 2000-2014

Our results indicate that that there is a co-movement among these variables and a movement in harmony, implying that there is a long run equilibrium relationship between the deposits in foreign currency and monetary aggregate M2Y.

I. INTRODUCTION

Currency substitution, sometimes referred as dollarization, is the use of a more stable foreign currency, such as dollar or euro, in place of a less stable domestic currency. In floating exchange rate economies this substitution provides a hedge for an average person against the uncertainty created by high inflation rates.

The lack of confidence in domestic currency usually starts with the use of foreign currency as an asset (asset dollarization), or payment for liabilities (liability dollarization). In extreme cases, as shown by). (Ortiz (1983) and Ramirez–Rojaz (1985).Calvo and Vegh (1992), and Vegh (1989)), the foreign currency may replace the domestic currency as unit of payment and measurement for daily transactions (full dollarization). The transition to hold foreign currency as a unit of payment and measure (full dollarization) is related to the duration and the size of inflation rate. Whatever the motives are, the foreign-denominated financial assets provide an opportunity for an average person a hedge against the depreciation of domestic currency.

Thecurrency substitution may have serious implications for monetary policy. A high degree of currency substitution reduces the effectiveness of domestic monetary policy. (Miles (1978).Prock, Soydemir & Abugri (2003) have shown that the greater the degree of currency substitution, the more sensitive the country's monetary aggregates to sudden changes in the exchange rates and interest rates.The higher the ratio of foreign currency holdings, the more difficult for the monetary authority to control domestic monetary demand and make predictions. Needless to say, the success of a monetary policy depends on finding the determinants of the currency substitution

The objective of this paper is to discover the factors that determine the currency substitution in Turkey and investigate the existence of a long run equilibrium relationship during the 2000 and 2014 period

In the following section, a brief literature review summarizes some of the empirical studies in the field. Section IV presents our cointegration test results. In section V, the policy implications of our findings are discussed.

II. CURRENCY SUBSTITUTION IN TURKEY

The dollarization issue has gained momentum with the introduction of bank deposits denominated in foreign currency in December 1983. Prior to 2001, a chronic inflation and the volatile of the exchange rates created significant credibility issues for the Turkish Lira (TL) as an asset to store value (Central Bank Note (2006). As seen in other high inflation countries, some big ticket items, such as real estate and cars, started to be quoted in foreign currency, indicating further decline in the trust for the domestic currency during the same time period.

During the 1990's, high real interest rates also became both the cause and the consequence of chronic inflation. High real interest rates fed into high inflation and in turn were fed by high inflation.

As the trust in Turkish lira continued to decrease, the foreign denominated bank balances continued to increase. However, the Turkish Lira retained its function as a unit of account and medium of exchange for daily transactions. The recovery of the Turkish economy after 2001 stopped this trend towards full dollarization

The Figure 1 below shows the dollarization rate after 2000 measured as the ratio of foreign exchange deposits in M2Y. M2Y is defined as M2 plus foreign currency deposits. As can be seen in Figure 1, this ratio has increased from 42 % in 2000 to 60 % in 2001. After 2001, as the Turkish economy improved itself, the ratio gradually fell below 20% in 2011 indicating more confidence in Turkish Lira. A process of de-dollarization was in effect.

However in 2011, this ratio started showing an upward trend again. This increase after 2011is attributed to many different factors. The "Euro debt crises", Quantitative Easing Program" of the U.S. Federal Reserve System, and geopolitical risks caused by "Arab Spring" are some of the factors mentioned for this increase. Because of weak dollar, many emerging economies with strong local currencies became beneficiary of the inflow of foreign capital. Turkey was one of those economies after 2008. During the second half of 2013, because of the U.S. Federal Reserve's move towards Quantitative Easing Exit Plan, the dollarization ratio started to increase rapidly. The ratio has continued to increase through the general elections in June, 2014.

Figure 1
Deposits in Foreign Currency/M2Y

Source: Central Bank of Turkey

The success of the Turkish monetary and fiscal policies needs de-dollarization. In the following pages we will look into some of the most significant research in this area and present our own findings.

IV. RESEARCH ON CURRENCY SUBSTITUTION IN TURKEY

In one of the earliest studies in the field, Selcuk (1994, 1997) investigated the internal dynamics of currency substitution in Turkey to shocks in economic policies for the period of 1986-1992. In this study, a high degree of elasticity of substitution was found between the Turkish Lira and the U.S. dollar. Positive coefficients for the lagged values in are interpreted as the persistence or stickiness of the currency substitution.

Because of the volatility in the dollarization rate and the dependency of the current error terms to previous error terms, Akcay et al. (1997) employed the E-GARCH Method, (Exponential Generalized Autoregressive Conditional Heteroscedasticity, Nelson (1991)) to study the currency substitution. E-Garch model assumes an autoregressive moving average for the residual error variances. The results revealed that the currency substitution in Turkey increased significantly with the volatility of exchange rates during high inflation periods.

Using the 1986-1999 quarterly Turkish data, Civcir (2003) examined the relationship between currency substitution and the economic aggregates, such as, money supply, real income, inflation, interest rate, and expected exchange rate. Using a cointegration methodology, Civcir investigated the long term equilibrium relationship between the currency substitution and its determinants. The relationship between these variables was found to be constant and stable. A negative relation exists between the currency substitution and the interest rate differentials for TL and dollar deposits. A positive relation was found between dollarization ratio and the expected exchange rate and the exchange rate risk. The dollarization ratio is defined as the ratio of foreign currency deposits in M2Y, M2Y defined as M2 plus foreign currency deposits. The short run and long run stability of the parameters of the demand for money was also shown in the same study.

In a similar study, Domac and Oskooee (2002) investigated the role of currency substitution in Turkey. They found out that a high inflation rate combined with economic instability is one of the main causes of currency substitution in Turkey. The empirical results suggest that shocks in exchange rates lead to a decline in the monetary base as the public switches from domestic to foreign currency deposits. The results seems to indicate that the fiscal authorities eliminate the part of the decline in "inflation tax" through higher regulated prices within a 5 month period in a given budget year. As expected, the exchange rate responds back positively to shocks in dollarization because of a high elasticity of substitution between domestic and foreign currencies.

Zeybek (2014) also investigated the correlation between the dollarization rate, the inflation rate, the reserve ratio and the real sector confidence index, provided by the Turkish Central Bank. Zeybek's results do not indicate a significant relationship between dollarization and the required reserve ratio. However, there is a correlation between the real sector confidence index and the dollarization. An increase in the confidence index was, as expected, associated with a lower inflation rate.

In contrast to 1990's, because of stricter economic policies there has been a considerable decrease in the inflation rate during the recent years. However, the evidence about the de-dollarization after 2001 is not clear. Using a generalized impulse response function developed by Pesaran, et al, (1997, a function that tracks the impact of a variable on other variables), Ozcan and Us (2007) concurs with Domac and Oskoosee finding, currency substitution increases in high inflation years. Though the contribution of economic instability to currency substitution was clear, there was no hysteresis , and no de-dollarization or the reverse of dollarization

Yılmaz (2005), Akıncı and Görmez (2005) did not find any evidence supporting de-dollarization. Similarly, Özcan and Us (2006) investigated the inflation and currency volatility and did not find any significant evidence of de-dollarization.

In contrast, Erbaykal, Darıcı and Kadıoğlu (2008) using monthly data between 2001 and 2006. found evidence supporting de-dollarization in Turkey. The variables used are M2 money supply, real GDP, nominal interest rate and nominal exchange rate. Their findings seems to indicate that, after the 2001 crises, the currency substitution reversed itself as the confidence in Turkish lira increased significantly and became preferable by economic agents. A co-integration test found a long run equilibrium relationship between these variables.

V. DATA AND THE MODEL

a. The Model

The monthly data for this study is obtained from the electronic data distribution system of the Central Bank of Turkey covering the2000:1 and 2014:12 period. Using the same monthly data, we constructed a demand function for foreign currency to investigate the currency substitution in Turkey.

Our model for the currency substitution in Turkey given in equation (1) employs the expected depreciation in the value of domestic currency, the interest rate differential between Turkish Lira and foreign currency deposits, the expected rate of inflation and the ratio of central bank reserves to M2Y (a proxy for measuring liquidity) as explanatory variables.

$$\ln(curr)t = \alpha + \beta(expdep)t + \gamma(intdiff)t + \delta(expinf)t + \varphi(cbres)t \quad (1)$$

Currency substitution ratio (curr) is defined as the logarithm of the ratio of foreign currency deposits to monetary aggregate M2Y.M2Yis a monetary aggregate that includes the currency in circulation, demand deposits, time deposits and the foreign currency deposits in the banking system.

Expected depreciation (expdep) of the domestic currency against foreign currency is calculated as the change between the logarithm of the nominal exchange rate in period t and the logarithm of the exchange rate in period t-1.

Since currency substitution is the response of economic agents to inflation, expected inflation is included in our model. Expected inflation (expinf) is the change between the logarithm of the consumer price index in period t and the logarithm of the consumer price index in period t-1.

Central bank reserve ratio (cbres) is the ratio of the level of central bank reserves to monetary aggregate, M2Y.

Interest rate differential (intdiff) refers to the percentage of interest rate differential between 3-month Turkish Lira deposits and 3-month foreign currency deposits.

The interest rate differential is defined as the percentage of difference between interest rates on 3-months TL deposits and 3-months foreign currency deposits.

Testing for the existence of a relationship between variables in levels which is applicable irrespective of whether the underlying regressors are I(0), purely I(1) or mutually cointegrated.

b. Unit Root Tests

Before going ahead with our regression analysis, we have to check whether all of the processes described with our variables are non-stationary. If they are all stationary, we can use the classic multiple regression analysis using ordinary least squares method. It is a well-known fact that non-stationary processes, usually described as I(1), cause spurious regression problem. If two or more non-stationary processes can be associated with each other with a constant parameter, the difference itself may also be stationary, I(0). In this case these variables are said to be "co-integrated". The estimated error term that is obtained from the regression of these two variables will also be stationary, I(0). If a process is stationary, it will revert back to its mean after a shock. If the process is not stationary, such as I(1), I(2)…., it will not return to its mean value.

In the literature there are three different co-integration tests. These are Engle-Granger test, Johansen (1996) test and Pesaran test (Pesaran et al, 2001).
The Engel-Granger test assumes that there is only one co-integration vector. It ignores the possibility of more than one co-integration solution when we have more than one variable. Because of this restrictive assumption the Engel Granger test is not frequently used in recent years.

The Johansen approach assumes that all variables are integrated in order of one, I(1). That is, all the variables must be non-stationary. This is an unnecessary requirement.
In the third approach, the Pesaran method, there is no requirement of integration in the order of one for all of the variables in the model. In the Pesaran method some exogenous variables are allowed to be stationary. Since our test results are not integrated in the order of one, I(1), we employed the Pesaran method for unit root tests with the help Augmented Dickey Fuller (ADF) tests.

The following tables are the results of integration tests using the ADF criteria. The numbers in parentheses are the lags used for the ADF test, which are augmented up to a maximum of 11 lags. The choice of optimum lag for the ADF test was decided on the basis of minimizing the Akaike Info Criterion (AIC). The letter 'd' shows that the variable is differenced once. The ADF test results are given in tables 1 and 2.

Table 1
ADF Test Results for Levels of Variables

	With trend and intercept		With intercept only	
Variables	Lags	ADF	Lags	ADF
lncurr	2	-1.70	2	-1.16
intdiff	3	-2.68	3	-1.47
expdep	2	-6.38***	2	-6.34***
expinf	11	-2.17	11	-1.82
cbres	6	-2.37	6	-1.97

Note: The critical values for the models with trend and intercept are -4.01, -3.43 and -3.14 for confidence levels of 99 percent, 95 percent and 90 percent respectively. The critical values with intercept only are -3.46, -2.87 and -2.57 for confidence levels of 99 percent, 95 percent and 90 percent respectively. Rejection of null hypothesis is shown with * for 90 percent, ** for 95 percent and *** for 99 percent confidence levels.

The test results suggest that the null hypothesis of a unit root can be rejected for expdep with both interceptcase and intercept & trendcases. As can be seen from Table 1, null hypothesis of a unit root can not be rejected for the rest of the variables with both intercept case and intercept & trendcases at all significance levels. When table 2 is examined, all variables are found to be stationary when their first differences are taken.

Table 2
ADF Test Results for First Difference of Variables

	With intercept only	
Variables	Lags	ADF
dlncurr	1	-7.35***
dintdiff	2	-8.20***
dexpinf	10	-9.99***
dcbres	5	-5.69***

Note: The critical values for the models with intercept only are -3.53, -2.90, and -2.58 for confidence levels of 99 percent, 95 percent and 90 percent respectively. Rejection of null hypothesis is shown with * for 90 percent, ** for 95 percent and *** for 99 percent confidence levels.

c. The ARDL Model Results

Since the order of integration of variables is determined previously, we can move on to determine the existence of long run relationship between variables of interest using auto regressive distributed lags (ARDL). Engle and Granger (1987) co-integration method determines whether there is one co-integrating vector between the variables or not. It does not consider the existence of more than one co-integrating vector. This method can be considered as a very restricted version of co-integration tests. On the other hand widely popular maximum likelihood based Johansen (1988; 1995) and Johansen and Juselius (1990) multivariate co-integration test can be used to test whether there exists a long run equilibrium between variables provided that the variables of interest are found to be integrated of same order.

We found that the variables of interest have different orders of integration. Therefore, we cannot apply either Engle and Granger (1987) or Johansen (1995) co-integration methods. In this paper, in order to test the existence of cointegration among the variables, bounds testing approaches developed by Pesaran and Shin (1999) and Pesaran, Shin and Smith (2001) are used. The reason for selecting this approach is that this co-integration method allows for different orders of integration of variables. Particularly, it allows the variables to be stationary, integrated order one or a combination of both. Moreover, as illustrated by Pesaran et al. (2001), bounds testing for cointegration is followed by an analysis of an autoregressive distributed lag model (ARDL) based on Pesaran and Shin (1999). This model allows examining both the short run and long run dynamics.

Let us consider the vector error correction model in Eq. (1):

$$\Delta Y_t = \mu + \lambda Y_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta Y_{t-j} + \varepsilon_t \qquad (2)$$

In Eq. (2), $Yt= [ytxt]'$ is defined as the variable vector in which yt represents the endogeneous variable $lncurr_t$, that is, the logarithm of foreign currency holdings and x_t represents the explanatory variables which are assumed to affect the foreign currency holdings in Turkey.

We can write the possible co-integration relationship as follows:

$$\Delta lny_t = \alpha + \varphi y_{t-1} + \delta x_{t-1} + \omega \Delta x_t + \sum_{j=1}^{p-1} \beta_{P,j} \Delta y_{t-j} + \sum_{j=1}^{q-1} \beta_{x,j} \Delta x_{t-j} + u_t$$

In Eq. (3), φ and δ are the long run multiplier coefficients, while Δy_{t-j} and Δx_{t-j} express the short run dynamic structure of our error correction model. The bounds testing approach requires the ordinary least squares (OLS) estimation of Eq. (3) with or without trend component, and then the absence of a long run relationship between the level values of yt and xt could be tested by use of the F-statistics in line with the hypotheses: H_0: $\varphi=0$, $\delta=0$, H_1: $\varphi\neq0$, $\delta\neq0$.

In Eq. (3), the rejection of H_0 hypothesis by the standard *F*- (or Wald-) tests leads to the acceptance of H_1 hypothesis and indicates a long run equilibrium relationship between the variables. The statistics such estimated then are compared with the non-standard distributed asymptotic critical value bounds reported in Pesaran et al. (2001). If estimated *F*-statistic falls outside of the critical value bounds, we can definitely infer whether or not there exists a cointegrating relationship between the variables, regardless of the order of integration of the variables. In this case, if *F*-statistic exceeds its respective upper critical values, this means rejection of the null hypothesis of no co-integration between the variables. If *F*-statistic is found below the lower critical value bounds, we cannot reject non-existence of a cointegrating relationship. If estimated statistic lies between the bounds, we cannot make any conclusive inference as to the existence of a possible co-integrating relationship and need to know the order of integration of the underlying regressors.

Once the existence of a potential co-integration relationship between the variables is verified, the most appropriate lag specification of the variables in the ARDL model must be determined through the mostly used lag information criteria, so that the long run equilibrium and short run dynamic error correction model coefficients can be estimated by way of employing the standard OLS methodology.In order to determine the appropriate lag length (p), following Pesaran et al. (2001), for p = 1, 2, …, 5, the conditional error correction model in Eq. (3) is estimated by OLS methodology both with and without trend components in the regression. The results are given in Table 3 for "with trend" and "without trend" cases.

Table 3
Selection of the Lag Order for Eq. (2)

With Deterministic Trend

P	AIC	SC	χ2(1)	p-value	χ2(4)	p-value
1	-4.16	-3.96	1.65	0.19	4.35	0.36
2	-4.14	-3.85	1.72	0.18	4.20	0.37
3	-4.11	-3.74	1.49	0.22	6.50	0.16
4	-4.14	-3.67	0.34	0.55	1.90	0.75
5	-4.11	-3.54	0.95	0.32	2.97	0.56

Without deterministic trend

P	AIC	SC	χ2(1)	p-value	χ2(4)	p-value
1	-4.17	-3.99	1.45	0.22	4.16	0.38
2	-4.15	-3.88	1.68	0.19	4.28	0.36
3	-4.12	-3.76	1.43	0.23	6.32	0.17
4	-4.15	-3.70	0.32	0.56	1.74	0.78
5	-4.12	-3.57	0.94	0.33	2.90	0.57

In Table 3, '*p*' shows the lag order of the underlying the conditional error correction model. AIC and SC represent Akaike and Schwarz information criterions, respectively. χ 2(1) and χ2(4) are Breusch-Godfrey error terms Lagrange multiplier serial correlation test F-statistics under the null hypothesis of no serial correlation. The lag length is chosen as one for the ARDL equation.

Table 4

ARDL Unrestricted Error Correction Model of the Dollarization

Dependent Variable: $\Delta lncurr_t$

	Coefficient	Standard Error	t-statistics	p-value
C	-0.129	0.051	-2.501	0.0133
$\Delta intdiff_t$	0.0002	0.0004	0.691	0.4903
$\Delta expdep_t$	0.108	0.060	1.802	0.0733
$\Delta expinft$	-0.480	0.295	-1.628	0.1054
$\Delta cbres_t$	0.720	1.763	0.408	0.6836
$lncurr_{t-1}$	-0.055	0.026	-6.075	0.0394
$intdiff_{t-1}$	-0.0005	0.0003	-1.853	0.0656
$expdep_{t-1}$	0.173	0.074	2.341	0.0204
$expinf_{t-1}$	-0.036	0.360	-0.101	0.9191
$cbres_{t-1}$	2.018	1.044	1.932	0.0550
trend	-2.26E-05	0.000	-0.191	0.8486

The Bounds testing approach (Pesaran et al. 2001) tests the null hypothesis of no cointegration. It is mainly a joint significance test of the one period lagged value of the levels in a conditional error correction model (ECM) in Eq. 3.The F-statistics are calculated for different lags chosen for the first differences of the variables. The existence of a potential co-integration relationship between the variables has been found for lag length one by comparing our estimates with the critical values reported in Table CI(iv), TableCI(v) and Table CII(v) m of Pesaran et al. (2001):

Table 5

F- and *t*-statistics for Testing the Existence of Co-integration

P	*Fiv*	*Fv*	*tv*
1	5.86	8.12	6.07
0.05 Table Critical Value			
I(0)	4.68	6.56	-3.41
I(1)	5.15	7.30	-3.69

In table 5 *Fιv* is the *F*-statistic calculated by applying to Wald tests that impose zero value restriction to the one-period lagged level coefficient values and deterministic trend component. *Fv* is the F-statistic calculated by applying to Wald tests that impose zero value to the only one-period lagged level coefficient values of the variables. *tv* is the *t*-statistic of the coefficient of one-period lagged level value of dependent variable, that is, *lncurr,* in Table 4. We can observe that estimation results of the *F*-statistics exceed the upper critical values and thus, infer that there exists a co-integrating relationship between the time series in the level form. The *t*-statistic of the one-period lagged level value of the dependent variable also supports these findings in favour of co-integration.In the light of Pesaran et al. (2001), since the results show that there is a cointegration, an ARDL model following Pesaran and Shin (1999) is built and the estimates of the relationship between levels is examined. We estimate that ARDL (110 0 0) is suitable for our model using the Turkish data. ARDL model is chosen according to Schwarz Bayesian Criterion. The long run relationship is given in Table 6.

Table 6

Estimated Long Run Coefficients using the ARDL Approach

Dependent Variable: $lncurr_t$

	Coefficient	Standard Error	t-statistics	p-value
$lncurr_{t-1}$	0,23	0,11	2,09	0,002
$intdiff_t$	0,0002	0,0003	0,54	0,589
$intdiff_{t-1}$	0,0009	0,0003	2,38	0,018
$expdep_t$	0,112	0.005	1,95	0,052
$expinf_t$	1,969	0,968	2,03	0,043
$cbres_t$	-0,391	0,289	-1,35	0,177
Constant	-0,128	0,046	-2,77	0,006

The estimation results reveal that in a long run period satisfying a stationary relationship between the variables of dollarization and its determinants behave in accordance with our model expectations. The dollarization ratio with a first lag, the interest rate differential with a first lag, expected depreciation and expected inflation are found to affect the dollarization ratio positively and significantly. Whereas the ratio of central bank reserves to M2Y found to have negative and significant effect. According to the estimation results one unit increase in the expected inflation affects the dollarization ratio by 1,96 units. Also one unit increase in the lagged dollarization ratio affects the dollarization ratio by 0,23. This shows that there is inertia in the foreign currency holdings.

Currency substitution is affected mainly by the lagged currency substitution variable, which suggests that there is a strong inertia in the currency substitution process in Turkey. Selcuk (1994) finds that the lagged values of currency substitution have positive coefficients suggesting persistence in the analyses of currency substitution for Turkey. Domac-Oskooee

(2002) find that the exchange rate responds positively to shocks in currency substitution as there is a high elasticity of substitution between domestic and foreign currency. Akcay (1997) argues that currency substitution renders the exchange rate more volatile and more responsive to credibility issues.

According to our estimation results as the ratio of central bank reserves to M2Y ratio increases the currency substitution in Turkey decreases by 0.39. This shows that the higher the Central Bank reserves the higher is the ability of dealing with the depreciation of the local currency. So that the economic agents will feel that the expectation of a financial crises or depreciation will be reduced. The sign of the coefficient for interest rate differential is found not to be in line with the theory. Also, it is found to be insignificant in the cointegration relation. This can be related with the suspicions about the debt stock sustainability in the short run, so that people prefer foreign currency deposits instead of high return on domestic money. The high level of debt stock and the short maturity structure causes suspicions about debt stock sustainability.Although the interest rates remained high in Turkey, economic agents prefer to hold foreign currency in the expectation of devaluation, as the exchange rate is generally overvalued after the financial opening up in Turkey.

The ARDL specification of the short run dynamics can be derived by constructing an error correction model (ECM). All coefficients of short run equation are coefficients relating to the short run dynamics of the model's convergence to the equilibrium and the coefficient of the error term represents the speed of adjustment. The short run coefficients of the variables are shown in table 8 in the error correction model. As results of the ARDL based ECM show, the error correction term (ECT) is negative and highly significant. This means that deviations from the long run equilibrium are corrected through time. Therefore, ECM supports the results of the bounds test for existence of cointegration.

Table 7

Estimated Short Run Coefficients of the Variables

Dependent Variable: $\Delta lncurr_t$

	Coefficient	Standard Error	t-statistics	p-value
$\Delta intdiff_t$	0.000209	0.000365	0.573230	0.5672
$\Delta expdep_t$	0.079834	0.048837	1.634698	0.1039
$\Delta expinf_t$	0.681223	0.229843	2.963864	0.0035
$\Delta cbres_t$	0.801773	1.631219	0.491518	0.6237
ECT(-1)	-0.059510	0.012716	-4.680084	0.0000

In the short run, the dollarization ratio mainly depends on the expected inflation and the expected depreciation. They are found to be significant in the short run. All of the variables are found to affect the dollarization ratio positively.

6. CONCLUSION

In this paper, the macroeconomic determinants of the dollarization ratio are analyzed using monthly data of Turkey for the period of 2000:1 and 2014: 12. In the empirical analysis interest rate differential between 3-month TL deposits and 3-month foreign currency deposits, expected depreciation, expected inflation and central bank reserve ratio.

We use autoregressive distributed lag (ARDL) bound testing approach of Pesaran Shin and Smith (2001), based on the fact that bound testing approach allows the variables to be stationary, integrated of order one or a mixture of both. After checking the existence of cointegration, the analyses continue with ARDL approach of Pesaran and Shin (1999) to investigate the short run and long run relations.

The results of the bound tests (Pesaran et al. 2001) suggest that there is a cointegration between the variables ofinterest. The dollarization ratio with a first lag, the interest rate differential with a first lag, expected depreciation and expected inflation are found to affect the dollarization ratio positively and significantly. Whereas the ratio of central bank reserves to M2Y found to have negative and significant effect.

We found that in the long run the currency substitution in Turkey is positively affected by the currency substitution in the previous period, expected depreciation and expected inflation. This shows that there is inertia in currency substitution in Turkey. If the expected inflation and expected depreciation is high then economic agents will assume that there is instability in the economy, so that these expectations increase currency substitution. The Central Bank would take measures to decrease inflation and depreciation rates of local currency. Currency substitution makes it complicated for the monetary authorities to conduct an efficient monetary policy. Monetary measures are not completely effective so adjustments in fiscal policy are needed as well in order to de-dollarize the Turkish economy.

We found that in the long run Central Bank reserve ratio is negatively related with currency substitution, which implies that the reserve ratio is an important constraint on monetary policy as a way of reducing the growth in money supply. Fiscal adjustment on reducing the level of public sector borrowing requirement together with macroeconomic stability is necessary for de-dollarizing the economy. According to the short run modelling the ECM term is found to be significant and small in magnitude showing that agents do not immediately and fully adjust their holdings to variations in relative rates of returns on foreign currency balances. The small and significant ECM term implies that there is a strong inertia in the process of currency substitution in the short run in Turkey, which makes it very difficult to de-dollarize the economy. Inertial factors play an important role in foreign currency holdings in Turkey.

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[1] Co-integration describe the existence of an equilibrium, or stationary, relationship among two or more time series,each of which is individually non-stationary.

[2] Nevertheless, the currency substitution is not unique to high inflation developing countries. Giovannini and Turtelboom (1993) have shown that, some developed countries with zero or low inflation can experience the currency substitution.

[3]Yazgan and Toker (2008) analysed currency substitution and exchange for the period from 1987 to 2004 and found that 1 % increase in the domestic currency’s depreciation would lead to 42 % increase in the inflation rate.

[4]Hysteresis is a situation "where one-time disturbances permanently affect the path of the economy."

[5] The model used in this paper is an extension of the model used by El-Erian (1988), Ramirez-Rojaz (1985), Rojaz-Suarez (1992) and Clements & Schwartz (1993) in modelling currency substitution. El-Erian (1988) employed the equation (1) to determine the significance of currency substitution (curr), expected depreciation in domestic currency (expdep) and interest differentials (intdiff) :

$$\ln(curr)t = \alpha + \ln(curr)t\text{-}1 + \beta(expdep)t + \gamma(intdiff)\ t + \delta\phi\ t$$

In this equations ϕ is a dummy variable measuring economic and political uncertainties in the previous time periods.

Income Inequality and the Role of Government: The Case of Mexico

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ABSTRACT

Disparities in income distribution are generally explained by economic, political and social factors. However, income inequality can be aggravated by government actions that promote privileges for some groups. Obstacles to free competition, including a low degree of development, also explain inequality. When a country tries to increase economic openness but this is accompanied by privileges granted and the use of power, the accumulation of wealth is concentrated in fewer hands. Mexico's income inequality can be explained by all these factors.

JEL: E24, E25, 131, 132, N36.

Keywords: Income distribution, income inequality, wealth concentration, capitalism, government, politics, poverty, reforms, Mexico.

I. THE RICH AND THE REST

Income inequality is a remarkable feature of Mexico.[1] On the one hand there is a small group of businessmen and a well-paid bureaucracy. On the other hand there is the rest of the population, those who pull the economy with daily work but with restricted opportunities. Mexico's income disparity is not because the rich are much more productive than the others. It is because of a political system with a few privileged groups and the political class.

Among economic factors, the wage differential is most often cited to explain income inequality. In Mexico, most workers are paid according to their training and physical abilities, while the privileged class receives wages based on factors such as level of education and friendship with capital owners, and also because of political recommendation.

The arrival of a political party to power has always been accompanied by the emergence of a new political class with privileges. The education system, which produces mainly low-quality workers, helps maintain low wages and accommodates social pressures. In fact, the excess supply of low-skilled professionals generated massively by education institutions is an important factor to consider in the study of inequality in Mexico.[2] The lack of job opportunities and limited access to education in rural and ethnic communities make those less privileged groups more vulnerable to the ups and downs of the business cycle. Another important factor related to education and correlated with the accumulation of wealth is the culture of savings in low-income people. However, we have to consider that the problem is not only that there is a lack of saving behavior or absence of financial education, but also the restriction to save faced by the poor as a result of his low income and high propensity to consume[3].

In general total income is distributed among production factors—labor and capital mainly—and another part appropriated by the government through taxes[4]. Given that the largest component of the population is employees and a smaller component is capital owners, a relative increase in the payment to capital implies a relative decrease in the payment to labor. Thus, if the return to capital is greater than the rate of growth5, income distribution changes unfavorably for labor. Hence, an acceleration in the rate of return to capital —relative to the rate of growth— could imply the worsening of income distribution not only among factors but also inside the capital sector if wealth is concentrated in few hands[6].

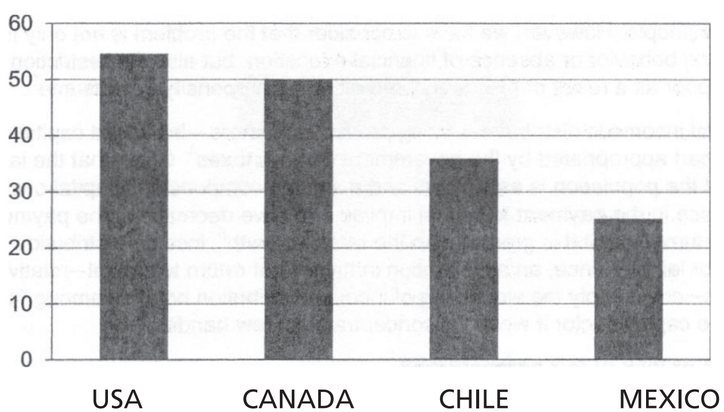
II. CAPITALISM OR LACK OF FAIR COMPETITION?

The core of the problem is not the existence of a capitalist class, but rather the existence of privileges and lack of transparency in a government that assigns contracts to particular groups, accelerating the accumulation of wealth for a few hands and leaving the rest out. As it is also mentioned for the case of the U.S., the problem is not the inherent laws of capitalism but rather "our policies and our politics"[7]. Therefore, a capitalism with weak institutions and biased policies only generates privileges for some and obstacles for others[8].

Some critics argue that capitalism by itself promotes income inequality precisely because of its philosophy of a constant search for wealth and well-being only for particular purpose[9]. However, if competition were fair, with no privileges, with rules enforcing transparency, more competitors could have the opportunity to succeed by their own merits and capacities. Letting markets work as real markets with equal opportunities for everybody should be one of the ultimate goals of public policy.

Empirical evidence shows that income distribution is better in economies with more free and fair competition. Conversely, income inequality is greater in less developed economies with long traditions of protectionism and more government intervention. For example, in the U.S. employee compensation represents a little more than 50% of national income, while in Mexico it represents only around 25% (Chart 1), illustrating an income disparity favoring capital in the less developed country. This is an indication that income inequality can be associated with the lack of competition, particularly in developing economies with some degree of government intervention.

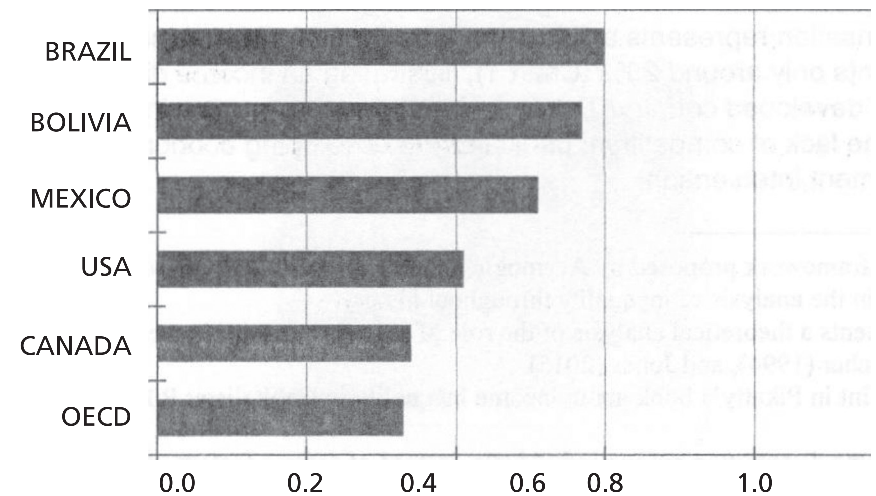
Chart 1
Labor Income Share by Country
Compensation of Employees (2000-2013), % of Nominal GDP



Source: Author with data from National Institutes of Statistics and OECD.

Income disparity and wealth concentration are more remarkable in less developed economies with deficient education and a low-quality labor force. This also promotes labor-intensive production processes and restrains technological progress. In such cases, income inequality is explained by the low productivity of a poorly trained labor force. The Gini coefficient, which indicates higher inequality as the value approaches 1, illustrates how less developed Latin American countries with more government intervention such as Brazil and Bolivia show more income inequality (Chart 2).

Chart 2
Income Inequality by Countries
Gini Coefficient (2000-2012) (1=perfect inequality)



Source: World Bank, ECLAC.

It is also said that globalization and structural reforms aggravate the concentration of wealth because they value the role of capital over labor. However, if competition were fair, more competitors could have access to the benefits of deregulation and openness. But when the government grants privileges and unnecessarily protects some industries, income concentration deteriorates and a monopoly power develops. A monopoly tends to have less incentive to train its labor force because it has no competitors who threaten its market. Prolonged market protection becomes a source of inefficiency for production and distribution processes in an economy. In fact, reforms that produce sufficient structural changes are the ones required to remove obstacles to economic and social progress. Reducing or eliminating the power of monopolies are precisely the changes that help reduce industrial concentration[10].

History also shows that income inequality has been higher in societies with high concentration of political power, particularly in dictatorship regimes. The concentration of political power is usually accompanied by the increase in economic power of small groups or elites around the political leader. In Latin America, income inequality raised during the periods of dictatorships, but also the concentration of wealth aggravated in countries where the political power was concentrated in the President's hands. Mexico is an example of irony, because the period of more industrial concentration in the last quarter of century was precisely when the country implemented important reforms. However, the problem was not reforms, but rather the way reforms were managed by either granting privileges to few groups or by allowing the concentration of activities given the lack of sufficient regulation. In fact, the privatization of the telephone company resulted solely in the change of ownership, from a state monopoly to a private monopoly. The re-privatization of the banking system, few years after the nationalization, also resulted in the concentration of the banking activity, since it only represented the transfer of banks to the private sector without increasing the competition.

III. PRIVILEGES AND NONTRANSPARENCY

A system of competition with unequal opportunities creates the conditions for its self-destruction because the biggest and most privileged players will try to destroy the rest to eliminate competitors. This way, a competitive market can become an imperfect market with the help of a nontransparent government. In this case it is not that the free market is not able to deliver for the society, it is rather the distortions introduced by the government which become the obstacles for the market to act as a genuine market.

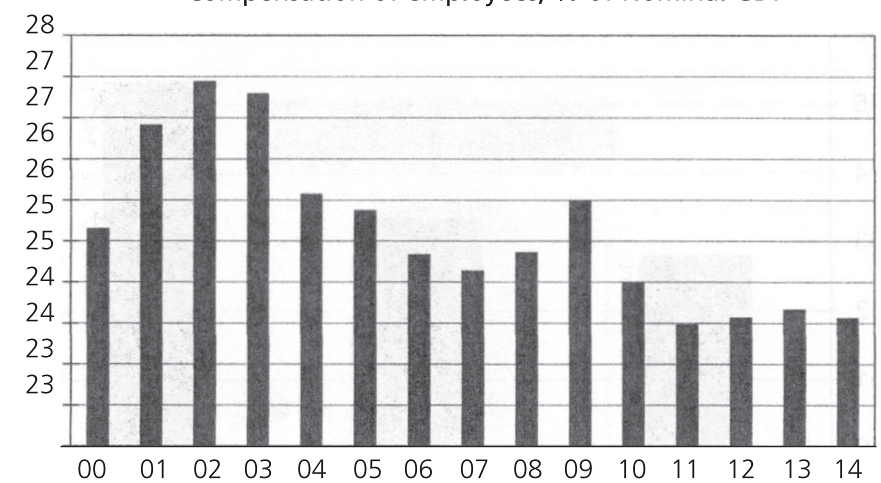
Assigning public contracts to big corporations is not bad by itself, when everybody competes under the same rules, because it can promote access to technology and capital. However, when those contracts are assigned by granting privileges and advantages to a particular firm, it becomes a problem because other qualified competitors are eliminated and inefficiencies are perpetuated. A similar distortion is generated when a government indiscriminately rescues companies or financial institutions in trouble. In this case, the traditional problem of "socializing losses"[11] —after privatizing gains— implies resolving the financial problems of the owners by using the money of the taxpayers.

In this sense, the lack of government transparency is important in explaining income inequality in countries where there is intervention in competition. A privatization process can be successful if authorities avoid the concentration of that industry in few hands. The government must be committed to implementing and enforcing long-term measures to avoid both the concentration of the industry and the increased income inequality potentially caused by that privatization. Mexico has undertaken several privatizations with the intention of promoting more competition and improving income distribution through the redistribution of the resulting proceeds. However, since governments come and governments go, and given the lack of strong institutions and mechanisms to enforce long-term commitments, the good will of one administration falls into obscurity with the next government.

The same way that a tax policy can be used for redistribution purposes[12], It can also produce the opposite results when a government tolerates or grants tax privileges to some, particularly to groups with strong economic power. Mexico's tax system has been one of the poorest systems in Latin America in terms of tax collection, not only because of the inability to capture the informal sector, but also because of the privileges and exceptions granted to some groups. On the one hand, tax forgiveness granted to big corporations, to political leaders at the state and local levels, and to people with close links with government officials promotes unequal accumulation of wealth and makes taxation more unfair. On the other hand, bureaucratic obstacles to start a business generate an unfair environment for small and medium sized companies, also aggravating income inequality.

Economic growth is an important factor that helps explain the conditions of labor income, particularly in countries where the economy is not able to generate sufficient employment ot absorb the extra labor force added to the market every year. The absence of reforms in the last fifteen years has restrained Mexico's production capacity, resulting in a potential growth rate of only 2.4%, compared with the 3.2% rate in the decade of the 90s when main reforms were implemented. This reduction in production capacity was accompanied by a deficit of employments and also by low-quality jobs. As a result, labor income decreased in the past decade and a half, from a ratio of almost 27% of GDP in year 2000 to 24% in 2014 (Chart 3). Since tax collection did not improve as a ratio of GDP, the reduction labor income was accompanied by an increase in capital income.

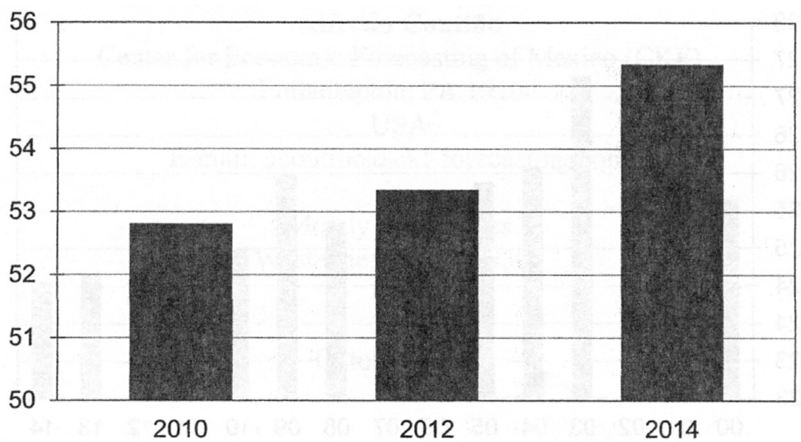
Chart 3
Mexico's Labor Income Share
Compensation of employees, % of Nominal GDP



Source: Author with data from INEGI and OECD.

Poverty is one of the perverse consequences of deteriorating income inequality, and Mexico has not escaped from the increase in the number of poor people. In the past four years alone, the amount of people in poverty increased by 2.5 million to a total of 55.3 million in 2014, representing 46.2% of total population[13] (Chart 4). Thus, Mexico's income inequality —understood as the concentration of wealth in a few hands and consequently the increase in capital income relative to labor compensation— has resulted in increased levels of poverty.

Chart 4
Mexico's Increase in Poverty
Number of People in Poverty, Millions



Source: Coneval.

IV. CONCLUDING REMARKS

All factors mentioned before explain, to a great extent, why Mexicans continue to wait for the largely promised income redistribution. If income inequality aggravated in the past decades, it was not because of the inherent laws of the economic model rather because it was the result of inconsistent regulations and the absence of strong institutions to ensure equal opportunities and fair application of justice for all. Therefore, part of the solution to improve income distribution implies the arrival of political leaders with strong commitment with social wellbeing. Mexico requires both a political system and institutions more transparent and subject to the scrutiny of the society, and also a responsible society open and willing to change for the better.

History shows that economic progress has always been accompanied by structural changes, but changes for the wellbeing of people not for the empowering of politicians and small elites. Reforms should be implemented at all levels, including institutions and also economic policy. The government and society, together, should view modernization as a way to access better standards and to adapt themselves to the changing and challenging reality. Otherwise, obsolescence will perpetuate and will obstruct the progress in politics, economics, and society.

Reforms are the best way to strengthen one of the most important fundamental sources of growth: investment. But investment is needed not only in physical but also in human capital. This implies the preparation of high-quality professionals, not a massive education to be used as the escape valve of social pressures. Indeed, the gain in productivity resulting from training the labor force takes years and even decades to materialize, which requires a government with long-term vision. The country needs a government that truly serves the society, not to be served by it.

Finally, income redistribution should not be understood as the expropriation of wealth of the wealthy, rather should be undertaken as the creation of a strong system that ensures fair rules applied to everybody, promotes equal opportunities, and grants access to justice for all.

NOTES

[1]A short essay on the topic can be found in Coutitio (2015).

[2] In the institutional framework proposed by Acemoglu and Robinson (2015), the supply of skills is a crucial determinant in the analysis of inequality throughout history.

[3] Stiglitz (1969) presents a theoretical analysis of the role of savings behavior in wealth disparities.

[4] Dornbusch and Fischer (1994), and Jones (2015).

[5] This is a central point in Piketty's book about income inequality in Capitalism: Piketty (2014) and Piketty (2015).

[6] An analysis of income distribution among individuals, instead of among factors, is presented in Stiglitz (1969).

[7] Stiglitz (2015).

[8] Acemoglu and Robinson (2015) also emphasizes the important role of institutions and politics.

[9] Piketty's book (2014) and Marx's Capital (1867) are remarkable examples about the dynamics and laws of capitalism.

[10] Acemoglu and Robinson (2015) describe how reforms promoted economic advance in the past two centuries.

[11] Also mentioned in Stiglitz (2014).

[12] Stiglitz (1969) analyses theeffects of taxation on income restribution.

[13] Figures from Coneval (2015).

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Volatility in Global Commodities Markets and Implications for Diversification Policies

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ABSTRACT

Primary commodity markets have been characterized by a succession of upward and downward price swings. The induced volatility weighs negatively on the economies of Commodity Dependent Developing Countries (CDDCs). This paper provides a commodity-level volatility analysis. It uses monthly data of 21 commodity price indices including agricultural products, minerals and metals. The study identifies whether volatility in a given commodity is primarily due to global (or systematic) risk or idiosyncratic risk. The results show that the nature of risk varies widely across commodities and their cycles, with volatility within the same group of commodities tending to display similar patterns. Volatility of metals prices seems to be primarily due to global factors while for agricultural commodities, it is mainly due to idiosyncratic factors. The policy implication is that vertical and non-primary commodity driven diversification, risk management techniques and commodity savings funds are some of the most viable options to strengthen the resilience of CDDCs to vagaries in global commodity markets.

[1] The views expressed in this paper are those of the authors and do not necessarily reflect the views of the UNCTAD secretariat.
[2] The views expressed in this paper are those of the authors and do not necessarily reflect the views of the UNCTAD secretariat.

1. INTRODUCTION

The negative effect of commodities price volatility on the economies of Commodity-Dependent Developing Countries (CDDCs) has been a recurring issue. As early as the 1950s, commodity price stabilization schemes were established under the auspices of the United Nations. For example, International Commodity Agreements (ICAs) were established on sugar in 1954, coffee in 1962, cocoa in 1972, and natural rubber in 1980. Their major objective was to stabilize international commodity prices through the management of stocks, trade and supplies. With the dominance of the laissez-faire and free market development policy paradigm starting from the 1980s, these agreements went dormant. Nevertheless, the issue of commodities price volatility did not go away. It became topical, again, in the early 2000s, as commodities prices across all commodity families reached new highs.

Commodity price volatility affects CDDCs economies through different channels. They include instabilities in terms of trade (Blattman et al., 2007) and macroeconomic volatility (Carmignani and Avom, 2010). Volatile commodities prices were found to be a major cause of the resource curse often associated with CDDCs' socio-economic under-performance (Cavalcanti et al, 2014). Volatile prices increase risk and uncertainty facing governments and private agents. During boom periods, many resource-rich countries increase their spending and engage in costly investment programmes, often with low returns (Deaton, 1999). When prices decline, countries are unable to maintain the same consumption and investment patterns. Hence, they either abandon their projects or borrow to complete them, sometimes driving their debt stocks to unsustainable levels.

At the microeconomic level, high price volatility creates uncertainty which discourages investment as investors are unable to predict the future with some degree of certainty. In the agricultural sector, volatile food prices make household budgeting difficult, leading to haphazard spending. High price instability also negatively affects the ability of farmers to sustain farming activities and take advantage of market opportunities (Fan et al., 2013). Farmers who increase their investments following a period of high commodities prices find it difficult to finance inputs when prices fall. The issue is often amplified by limited access to finance faced by farmers in poor countries and the fact that many of them do not operate on a sufficiently large scale to be able to carry over income from one season to another.

This paper provides a commodity-level volatility analysis. It identifies which commodities are associated with volatility due to global market factors or systematic risk factors and which ones are associated with volatility emanating from specific or idiosyncratic factors. Understanding the major risk components--that is systematic and idiosyncratic risk-- of specific commodities has important policy implications, for example in terms of diversification strategy for resource-rich countries. The main argument is that unlike idiosyncratic risk, systematic risk inherent in aggregate commodities markets cannot be reduced through horizontal diversification. Therefore, a better understanding of the components of commodity price fluctuations may give indications on diversification policies that should be pursued in CDDCs.

This paper attempts to analyse commodity price volatility assuming the existence of a common component, referred to as ''common innovation'' (Bidarkota and Crucini, 2000, p. 649) which contributes to explaining the dynamics in price changes. This may be interpreted as a loose Capital Asset Pricing Model (CAPM) framework (Chen, 2010) which was primarily developed for the analysis of security markets (Sharpe, 1964). Although its application to commodity markets is not uncontroversial (Holthausen and Hughes, 1978), CAPM is useful for several reasons.[3]

First, it allows identifying whether volatility in the price of a certain asset has resulted from fluctuations in the global markets (that is, global or systematic risk) or in factors that are specific to the asset or sub-group of assets (that is, specific or idiosyncratic risk). Applied to commodities, global or systematic risk is assumed to be led by movements in macroeconomic variables which affect global markets. Over the past decade, these include increased financialization of commodities markets, changes in monetary policies of advanced economies such as the European Union and the United States, patterns of global economic growth, shocks to market fundamentals, and transmission of fluctuations in energy prices to global commodity markets (UNCTAD, 2013; Collier, 2007). Second, it is simplistic to judge the evolution of volatility in commodity prices by describing price swings or relying on the standard deviation of price changes. The CAPM provides a better analytical framework as it allows a derivation of volatility through quantitative modelling.

Recent work on the nature of risk associated with commodity markets includes studies by Bidarkota and Crucini (2000) and Chen (2010). The former analyse 33 annual series of international commodities prices and find that systematic and idiosyncratic risk factors vary widely across products and that the variation in the world prices of a few key exported commodities account for a large part of the variation in the terms of trade of a typical developing country. The authors also suggest that fluctuations in national terms of trade of developing countries could be reduced substantially by altering the mix of their exports. Chen (2010) analyses the evolution in the annual prices of 21 metals over two sub-periods, 1900-1971 and 1972-2007 within the loose CAPM framework. The study attempts to differentiate between common global factors and commodity-specific factors in explaining annual price variations. The author finds that even though commodities price volatility has increasingly been attributed to global macroeconomic factors, specific factors remain the most important drivers.

This paper contributes to the literature on the dynamics in commodities price volatility and its components in two ways. First, it revisits the issue in the light of the most recent evolution in global commodity markets characterised by a boom and bust. Second, the two studies mentioned earlier relied on annual data to investigate the components of commodity price volatility. The current study differs from these two by using monthly data. This is important since commodity price volatility could differ according to the frequency of the data used (Huchet-Bourdon, 2011).

[3] The CAPM was first applied to commodity prices through futures markets in Dusak (1973). Other authors who have applied the CAPM to commodity markets include Holthausen and Hughes (1978).

The rest of the paper proceeds as follows. Section 2 reviews the different concepts used to measure volatility in commodities markets and provides general trends in volatility since the 1980s. The third section discusses the methodology and data sources used for the empirical part. Section 4 presents and discusses the empirical results and Section 5 concludes.

2 VOLATILITY IN COMMODITIES PRICES: DEFINITION AND TRENDS

2.1. Definition and Some Measures of Commodities Price Volatility

Commodities price volatility measures the degree of variability in the price of a commodity. Let us denote by P_t the price of a specific commodity and r_t, the price change[4],

$$r_t = \frac{p_t - p_{t-1}}{p_{t-1}} \qquad (1)$$

There are several measures of volatility. A simple measure of the price variability is the standard deviation of a price series given by:

$$\sigma = \sqrt{\sum_t^T \frac{(p_t - \bar{p})^2}{T}},\ \bar{p} \text{ being the average value of the price series} \qquad (2)$$

However, this summary measure of volatility is subject to two limitations. First, it depends on the unit of the price series. Second, an important part of the variation could be attributed to the variation of the trend which often characterizes price series (Dehn et al., 2005). To overcome these limitations, volatility is computed by applying equation (2) on series of price changes, that is a series of r_t (see for example Hull, 2008; Chen, 2010; Gilbert and Morgan, 2010) through the formula :

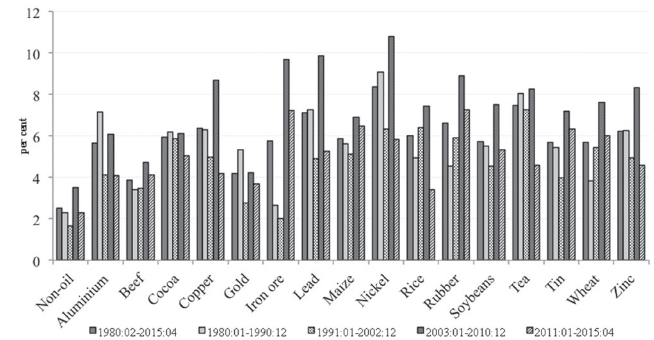
$$\sigma = \sqrt{\sum_t^T \frac{(r_t - \bar{r})^2}{T}} \qquad (3)$$

This measure of volatility is simply the standard deviation of price changes. Its advantage is that it is unitless and thus permits comparison among various commodities. Other methods such as the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) are used to generate a continuous measure of volatility (see for example Gilbert and Morgan, 2010).

2.2. Volatility Dynamics in Commodity Markets Over the Past Years : an Overview

Volatility is an intrinsic feature of commodity markets. In the recent past, it has amplified since the early 2000s with the recent price boom, recorded as the longest and broadest in history (UNCTAD, 2013). For example, the average monthly volatility of the IMF Non-fuel Commodity Price Index stood at 1.97 per cent during the period from January 1980 to June 2003 and jumped to 3.60 per cent during the boom period from July 2003 to March 2011.[5] Nevertheless, over the past few years, volatility has weakened in global commodities markets. Its average value has decreased to roughly 2.31 per cent during the period from January 2011 to April 2015. A similar pattern has been observed for many specific commodities (see Figure 1).[6]

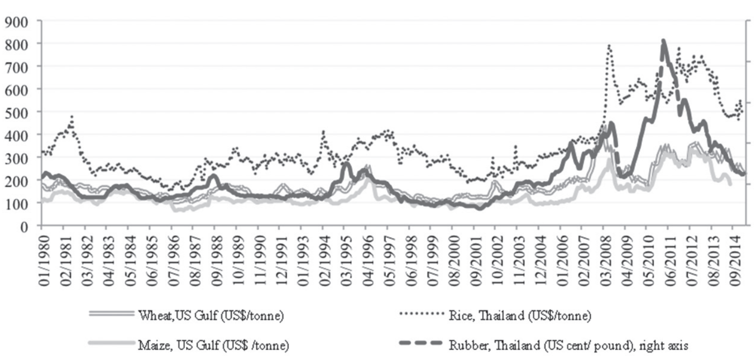
Figure 1
Average Volatility Measured as Standard Deviation of Changes in Monthly Prices of Selected Commodities, Values in Percentage



Source: Authors using data from IMF, International Financial Statistics
Notes: the graph shows the standard deviation in the changes of price indices. Changes in the indices were calculated as follows: $r_t = \ln(p_t) - \ln(p_{t-1})$ where $\ln$ denotes a natural logarithm and p_t, a monthly value of the price index. This measure is approximately equal to $r_t = (p_t - p_{t-1})/p_{t-1}$.

Increased price volatility over the past decade mirrored a succession of extreme upward and downward swings for a number of commodities. For example, the price of wheat (US Gulf Ports) increased by roughly 85 per cent from a monthly average of US$ 106 per tonne in January 2000 to US$ 196 in May 2007 before more than doubling to a peak of US$ 440 in March 2008. Afterwards, it tumbled to US$ 158 in June 2010 and rose again to reach US$ 354 in May 2011. Then, it decreased to US$ 266 in May 2012 and continued swinging over the following years albeit with lesser amplitude. Similar swings were recorded for other agricultural commodities (Figure 2).

Figure 2
Evolution in Nominal Prices for Selected Agricultural Commodities, 1980:01-2015:04



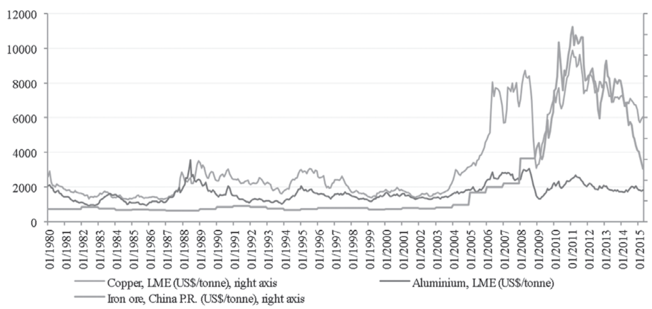
Source: Authors using data from IMF, International Financial Statistics

[4] When the price series is expressed in logarithmic values, r_t is approximated by the first log-differentiation, $r_t = \ln(p_t) - \ln(P_{t-1})$.
[5] Volatility is calculated as the standard deviation of price changes (*see equation 3*)
[6] The average volatility here is measured by a standard deviation of changes in monthly values of commodity prices or price index.

In metals markets, copper was traded under US$ 3500 per tonne until May 2005. Then, its price more than doubled in a period of one year, from an average of US$ 3530 per tonne in June 2005 to US$ 8059 per tonne in May 2006. Thereafter, copper price fluctuated within a wide band ranging between US$ 5718 US$ and US$ 8714 per tonne until July 2008. Then, owing to the 2008 financial crisis, the price retreated to US$ 3105 per tonne in December 2008. It recovered quickly as a result of strong demand from emerging economies, culminating at US$ 9881 per tonne in February 2011. Over the following years, copper prices continued easing with persisting but narrowing fluctuations. Prices of other metals also recorded high fluctuations (Figure 3).

Figure 3

Evolution in Nominal Prices for Selected Minerals, Ores and Metals, 1980:01-2015:04



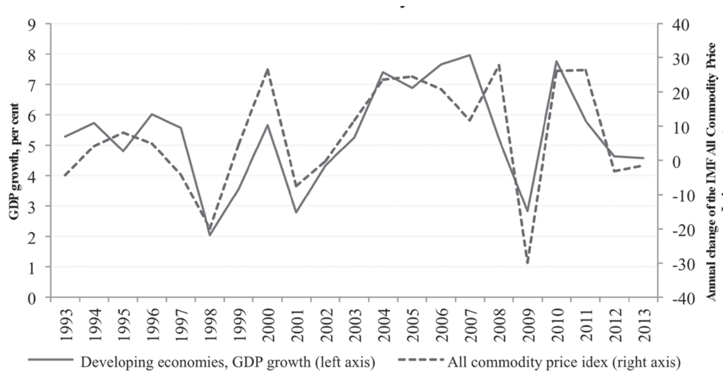
Source: Authors using data from IMF, International Financial Statistics

Source: Authors using data from IMF, International Financial Statistics

Volatile prices have affected growth in the developing world where a large number of countries depend heavily on commodity exports. Indeed, there is a strong positive correlation (the value is 0.76) between changes in annual values of the global commodity index and the economic growth rate of developing economies, from 1993 to 2013 (Figure 4).

Figure 4

GDP growth rate (constant 2005 U.S. dollars) and annual changes in the IMF All Commodity Price Index



Source: Authors using data from UNCTADStat and IMF, IFS.

The strong correlation between commodities prices and economic growth illustrates the importance of commodities price volatility for economic performance in CDDCs. Understanding the pattern of commodities price volatility could help to shape policy options to mitigate the negative impact of commodities price volatility on these countries' economies. If swings in the prices of a group of commodities are mainly driven by global factors, horizontal diversification strategies may be considered as sub-optimal, the argument being that global factor risks are theoretically non-diversifiable.

3 METHODOLOGY AND DATA SOURCES

3.1. Methodology

The analysis is carried out using the loose Capital Asset Pricing Model (CAPM) framework. It considers that a change in the price of the i^{th} commodity, r_{it} follows a process with a common component, r_{mt}, that is a change in the values of a global basket of commodities, as follows:

$$r_{it} = \alpha_i + \beta_i r_{mt} + u_{it} \quad (4)$$

In equation (4), β_i measures the sensitivity of the price of commodity *i* to a change in the value of the global index (used as a proxy for global non-oil commodity market price). As such, it serves as a proxy for volatility of an individual commodity relative to the global commodity market. A β_i value of one implies that the change in the price of the specific commodity fully reflects a change in the global market. A β_i less than one implies that the price is less volatile than the global market. Finally, a β_i exceeding one means that the price of the commodity is more volatile than the global market. The R^2 of the model in equation (4) is the portion of variation in the price of commodity i attributable to shocks in the global commodity market, that is systematic and non-diversifiable risk. On the other hand, 1-R^2 is the variation in prices arising from commodity-specific factors; this is the value of idiosyncratic and diversifiable risk.

3.2.Data Sources and Variables Description

Monthly nominal values for the IMF Non-fuel Commodity Price Index and 20 specific commodity price indices (including agricultural commodities and minerals, ores and metals) with 2010 as base year are collected from the IMF, *International Financial Statistics* database.[7] The data cover the period from January 1980 to April 2015 except for cocoa, cotton, maize and rice for which data cover the period from January 1980 to July 2014.[8] Price indices of Sorghum and Gold are considered in this study even though they are not included in the IMF Non-fuel commodity price index which we use as a proxy for global non-oil market indicator.[9] All the price indices are transformed into natural logarithm. The variables of interest, which are the changes in commodity price indices, are therefore obtained by differencing the logarithmic values.

[7] For a full description of the IMF Non-Fuel Commodity Price index, refer to http://www.imf.org/external/np/res/commod/index.aspx (accessed on 24/06/2015).

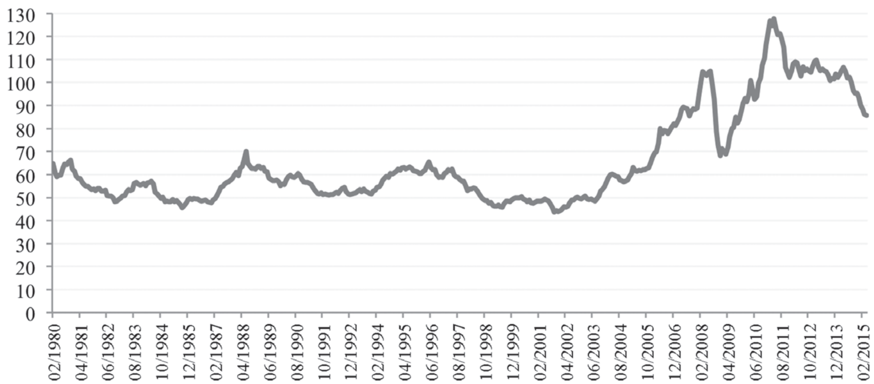
[8] Data were collected on 24 June 2015.

[9] Including the two commodities permits to investigate whether a linkage between a specific commodity and global index depends on its inclusion into the proxy used.

Three sub-periods are considered: the 1980s and 1990s associated with an overall downward trend in commodity prices; the 2000s characterized by a price boom; and, finally, the sub-period starting from 2011 which recorded a general price decline in the markets (Figure 5). As monthly data is used, the break date (month) is determined through a methodology described in Annex 1. The estimated break dates are July 2003 as the beginning of the commodity boom and April 2011 as its end. Therefore, the period under consideration is divided in three sub-periods as follows: January 1980 to June 2003; July 2003 to March 2011; and April 2011 to April 2015.

Figure 5

Evolution in the IMF Nominal Non-fuel Commodity Price Index (2010=100)



Source: Authors based on data from IMF, IFS

The summary statistics of the variables are displayed in Table 1. The overall downward trend in commodity prices in the 1980s and 1990s is confirmed by negative values of price changes for all the commodities over the first sub-period. Price volatility over the same sub-period is weaker compared to the subsequent sub-period. For example, the average volatility of the non-fuel commodity index was 1.97 per cent over the first period and increased to 3.60 per cent during the period of the boom (July 2003 to March 2011). Similarly, 17 out of the 20 selected commodities show increased volatility in their prices during the second sub-period compared with the first. Moreover, the second sub-period is associated with a broad upward movement in prices. This is confirmed by the results in Table 1 where price changes for all the 21 price indices show positive average values. Moving to the third sub-period (April 2011 to April 2015), falling commodity prices are accompanied by narrowing volatility, as clearly depicted by the results. The average change in prices is negative for all the price indices except for the cocoa price index. Furthermore, the standard deviation of the IMF Non-oil Commodity Price Index and 18 out of 20 specific price indices recorded lower values compared to the previous period.

Table 1

Descriptive Statistics of Changes in the Logarithmic Values of the Price Indices (Percentage)

	Whole period (1980:02-2015:04)		1980:01-2003:06		2003:07: 2011:03		2011:04-2015:04	
Commodity	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Non-oil commodity	0.07	2.50	-0.10	1.97	1.04	3.60	-0.83	2.14
Wheat	0.06	5.68	-0.10	4.81	1.01	7.65	-0.85	5.88
Maize	0.11	5.87	-0.02	5.31	1.27	7.04	-1.43	6.25
Rice	0.02	6.01	-0.24	5.69	0.99	7.55	-0.40	3.50
Sorghum	0.17	6.15	-0.07	5.56	1.26	7.89	-0.33	5.37
Sugar	0.00	18.00	-0.26	21.87	1.24	5.07	-1.20	2.43
Coffee	-0.10	9.02	-0.51	9.61	1.82	7.45	-1.50	7.79
Cocoa beans	0.00	5.95	-0.26	6.09	0.75	5.99	0.07	4.85
Tea	0.05	7.47	-0.06	7.57	0.50	8.37	-0.23	4.61
Soybeans	0.09	5.73	-0.02	4.99	0.92	7.59	-0.71	5.48
Soybeans oil	0.07	5.99	-0.02	5.90	1.09	7.04	-1.28	3.65
Palm oil	0.02	7.81	-0.13	7.99	1.16	8.35	-1.34	5.08
Cotton	-0.04	5.60	-0.18	4.97	1.38	6.34	-2.43	7.10
Rubber	0.01	6.62	-0.17	5.33	1.89	9.25	-2.58	6.47
Aluminium	-0.04	5.65	-0.15	5.70	0.66	6.16	-0.80	4.08
Copper	0.17	6.36	-0.20	5.59	1.84	8.81	-0.94	4.23
Nickel	0.14	8.36	0.08	7.72	1.17	10.94	-1.50	5.69
Lead	0.13	7.10	-0.33	6.09	1.79	9.95	-0.63	5.35
Zinc	0.22	6.23	-0.03	5.56	1.13	8.46	-0.14	4.63
Tin	-0.02	5.68	-0.46	4.71	2.07	7.43	-1.48	6.06
Gold	0.14	4.20	-0.22	4.21	1.55	4.14	-0.44	3.75

4. RESULTS AND DISCUSSIONS

The Augmented Dickey-Fuller (ADF) and Philip-Peron (PP) results for unit root tests reveal that all variables are stationary at 5 per cent significance level (Table 2). Hence the variables do not have a unit root.[10]

Table 2

ADF and PP Stationarity Tests for Changes in the Logarithmic Values of the Price Indices

	Whole period 1980:01-2015:04		1980:01-2003:06		2003:07-2011:03		2011:04-2015:04	
Commodity	ADF	PP	ADF	PP	ADF	PP	ADF	PP
Non-oil commodity	-8.15	-14.30	-7.72	-13.31	-4.62	-5.88	-4.29	-4.84
Wheat	-13.19	-15.58	-9.99	-12.29	-6.19	-7.38	-4.35	-5.27
Maize	-11.80	-14.91	-10.05	-11.59	-5.29	-7.50	-3.69	-4.52
Rice	-13.24	-13.38	-11.57	-12.36	-5.89	-5.22	-3.57	-3.67
Sorghum	-12.52	-15.75	-10.44	-11.81	-5.58	-8.01	-3.75	-5.39
Sugar	-19.73	-31.27	-16.36	-26.42	-4.17	-8.61	-4.47	-5.60
Coffee	-11.92	-16.81	-9.70	-13.70	-6.01	-8.72	-3.71	-4.81
Cocoa beans	-14.44	-16.11	-11.36	-13.07	-7.92	-8.10	-3.51	-4.49
Tea	-14.78	-16.45	-11.00	-12.91	-8.66	-8.60	-3.98	-4.63
Soybeans	-12.46	-14.92	-11.01	-12.96	-5.11	-6.58	-3.96	-4.57
Soybeans oil	-9.03	-14.46	-11.99	-11.96	-4.82	-6.62	-5.20	-4.96
Palm oil	-8.13	-14.45	-6.74	-12.31	-5.74	-5.65	-5.14	-5.74
Cotton	-11.24	-11.94	-9.29	-8.92	-5.17	-5.47	-3.60	-6.34
Rubber	-6.03	-16.02	-4.46	-13.29	-4.86	-7.06	-5.74	-5.91
Aluminium	-7.40	-17.24	-5.85	-14.69	-4.89	-6.58	-4.37	-6.81
Copper	-5.73	-14.01	-6.50	-12.67	-4.96	-5.71	-5.05	-5.54
Nickel	-12.29	-14.30	-10.29	-11.40	-5.55	-6.68	-3.98	-5.23
Lead	-13.27	-16.46	-11.83	-14.38	-5.76	-7.02	-4.27	-6.32
Zinc	-7.88	-15.50	-7.67	-13.20	-5.23	-6.31	-4.54	-6.90
Tin	-10.62	-15.24	-9.36	-12.56	-4.43	-7.03	-4.88	-5.35
Gold	-6.83	-18.38	-5.29	-15.26	-7.12	-9.24	-4.78	-5.71

[10] The variables are changes in the commodity price indices (r_t)

Table 3

Elasticity and Risk Components 1980:01 - 2015:04

	Coefficient β		Risk component (%)		
Commodity	Value	Std. Error	Global	Idiosyncratic	DW
Wheat	1.03***	0.104	18.70	81.3	1.985
Maize	1.06***	0.107	19.11	80.89	1.977
Rice	0.07	0.119	0.00	100	1.884
Sorghum	1.01***	0.115	15.51	84.49	1.993
Sugar	0.04	0.292	0.00	100	2.104
Coffee	0.93***	0.178	5.92	94.08	2.022
Cocoa beans	0.62***	0.113	5.41	94.59	1.953
Tea	0.46***	0.152	1.91	98.09	1.945
Soybeans	1.43***	0.092	36.50	63.5	1.965
Soybeans oil	1.36***	0.100	30.57	69.43	1.916
Palm oil	1.32***	0.142	16.82	83.18	1.855
Cotton	0.58***	0.101	7.39	92.61	1.905
Rubber	1.36***	0.114	25.36	74.64	1.985
Aluminium	1.41***	0.091	36.41	63.59	1.984
Copper	1.56***	0.097	38.06	61.94	1.928
Nickel	1.74***	0.143	25.76	74.24	1.918
Lead	1.22***	0.133	16.53	83.47	1.948
Zinc	1.35***	0.107	27.47	72.53	1.966
Tin	1.03***	0.103	19.26	80.74	2.004
Gold	0.51***	0.079	9.15	90.85	1.995

Level of significance: ***1%; **5 %; 10%;
Note: DW stands for Durbin-Watson statistics obtained after correcting the model for 1st-order autocorrelation in the error term using Cochrane–Orcutt procedure.

Changes in the prices of all selected commodities, except rice and sugar, have been to varying degrees sensitive to changes in the global markets. It is worth noting that prices of Sorghum and Gold are linked to the global commodity market index even though these two commodities are not included in the IMF Non-fuel Commodity Price Index (*β*coefficients for the two variables are statistically different from 0). This suggests that the Non-Fuel Price Index is a good proxy for global non-oil commodity markets.

The group of grains comprised of wheat, maize, sorghum and soybeans outperformed global commodities markets in terms of volatility (coefficient β greater than 1). This is also the case for all the industrial metals. Copper, for example, has a coefficient of 1.56, implying that over the sample period (that is, from January 1980 to April 2015) the price of copper increased by 1.56 per cent, on average, when the value of the non-fuel commodity price index increased by one per cent. This is illustrative of a commodity whose price is more volatile than the global market. Generally, the average value of the coefficient for metals was 1.26 (1.39 if gold is not included) compared with 0.87 for agricultural commodities. This finding suggests that judging on the basis of global risk prices of industrial metals are more volatile than prices of agricultural products. This could be due to the fact that relative to agricultural markets, metals markets are less influenced by national policies, making the latter markets less regulated and then subject to greater fluctuations.

The adjusted R^2 are generally relatively low (less than 50 per cent for all commodities), meaning that the price fluctuations are largely explained by commodity-specific factors. The adjusted R^2 for copper is the highest at 0.38, indicating that 38 per cent of fluctuations in the return of copper prices are due to variations in the global non-oil commodity markets. As a result, a larger share (62 per cent) of fluctuations in copper prices is driven by specific copper-related factors. The adjusted R2 is particularly low for rice, tropical beverages (i.e. sugar, coffee, cocoa and tea), cotton, and gold suggesting that prices for these commodities are primarily driven by factors that are specific to their markets.

For example, changes in the price of rice show no significant linkage with the global market; they are driven by factors specific to the rice market. These may include domestic government policies by major rice producing and exporting countries as well as the thinness of these markets in terms of global trade (Dawe and Slayton, 2010; p. 18). Thailand's rice stocking policy, for example, may play a major role in the fluctuation of rice prices. Similarly, the dominance of idiosyncratic factors in explaining the volatility of sugar prices may stem from the fact that about 70 per cent of sugar production is consumed domestically, implying that only 30 per cent of sugar is exposed to the vagaries of global markets. As a result, government policies in producing countries have a large effect on sugar price changes (Sariannidis, 2010).

Interesting as they may be, these results do not account for the fact that commodities prices experienced three different cycles over the study period, as discussed above. Not taking into account structural breaks may lead to empirical results which are affected by a mis-specification bias. Acknowledging this fact and estimating the model in equation (5) over each of the sub-periods yields the following results (Table 4).

There is a large variation in the value of estimated β as well as the proportion of risk explained by global factors from one sub-period to another. Generally, when the cyclical pattern of commodities prices is taken into account, changes in commodities prices display a stronger relationship with movements in global markets. Moreover, the changes in the β

Table 4

Elasticity and Risk Components over the Different Sub-Periods

	1980:01-2003:06					2003:07-2011:03					2011:04-2015:04				
	Coefficient β		Risk component (%)			Coefficient β		Risk component (%)			Coefficient β		Risk component (%)		
Commodity	Value	Std. Error	Global	Idios.	DW	Value	Std. Error	Global	Idios.	DW	Value	Std. Error	Global	Idios.	DW
Wheat	0.93***	0.14	14.02	85.98	2.01	1.09***	0.20	23.7	76.3	1.92	1.34***	0.37	20.63	79.37	1.70
Maize	1.00***	0.15	13.75	86.25	1.96	1.03***	0.18	26.41	73.59	2.00	1.42***	0.43	21.37	78.63	1.92
Rice	-0.12	0.18	0.00	100	1.92	0.17	0.21	0.00	100	1.73	-0.12	0.25	0.00	100	1.83
Sorghum	1.04***	0.16	13.33	86.67	1.95	1.06***	0.20	23.02	76.98	2.00	0.53	0.36	2.35	97.65	2.02
Sugar	-0.25	0.57	0.00	100	2.11	0.05	0.14	0.00	100	2.03	-0.04	0.15	0.00	100	1.76
Coffee	1.00***	0.30	3.6	96.4	2.02	0.71***	0.21	10.72	89.28	1.99	1.77***	0.49	21.03	78.97	1.81
Cocoa beans	0.59***	0.19	3.44	96.56	1.95	0.59***	0.17	11.41	88.59	1.96	0.64*	0.36	5.68	94.32	1.98
Tea	0.48**	0.24	1.1	98.9	1.96	0.62**	0.24	5.88	94.12	1.96	0.05	0.33	0.00	100	1.91
Soybeans	1.52***	0.13	34.49	65.51	1.97	1.44***	0.18	42.28	57.72	1.86	1.42***	0.32	28.92	71.08	2.07
Soybeans oil	1.39***	0.16	20.9	79.1	1.91	1.42***	0.15	51.2	48.8	1.79	1.04***	0.21	33.22	66.78	1.91
Palm oil	1.20***	0.24	8.2	91.8	1.86	1.50***	0.18	42.24	57.76	1.71	1.16***	0.33	20.22	79.78	1.89
Cotton	0.38***	0.13	2.78	97.22	1.84	0.64***	0.17	12.74	87.26	1.93	1.01**	0.42	11.43	88.57	1.89
Rubber	0.78***	0.16	7.85	92.15	1.98	1.74***	0.21	43.93	56.07	1.96	1.37***	0.41	18.48	81.52	1.93
Aluminium	1.66***	0.15	30.8	69.2	1.98	1.33***	0.12	57.16	42.84	1.91	0.93***	0.25	21.99	78.01	1.98
Copper	1.29***	0.15	21.52	78.48	1.95	1.89***	0.16	60.67	39.33	1.87	1.24***	0.25	34.68	65.32	1.72
Nickel	1.42***	0.22	13.2	86.8	1.91	2.23***	0.24	48.22	51.78	1.89	1.25***	0.36	19.61	80.39	1.98
Lead	0.87***	0.18	6.98	93.02	1.96	1.58***	0.26	28.25	71.75	1.89	1.36***	0.31	28.66	71.34	1.65
Zinc	1.09***	0.16	14.51	85.49	1.96	1.69***	0.18	48.05	51.95	2.05	1.11***	0.26	26.57	73.43	1.77
Tin	0.55***	0.14	4.86	95.14	2.03	1.36***	0.17	40.08	59.92	1.95	1.33***	0.37	20.79	79.21	1.95
Gold	0.57***	0.12	6.72	93.28	1.99	0.44***	0.11	13.67	86.33	2.02	0.28	0.27	0.00	100	1.97

Significance levels: ***1%; **5%; *10%.
Note: DW stands for Durbin-Watson statistics obtained after correcting the model for 1st-order autocorrelation in the error term using Cochrane–*Orcutt* procedure

coefficients suggest that responses of commodity prices to shocks in global markets vary across commodities and according to commodity cycles.

Over the first sub-period, the estimated values of β vary from as low as -0.25 for sugar to 1.66 for aluminium. Only 8 commodities fluctuated more than the global markets over the same period with aluminium prices being the most volatile. Moreover, the adjusted R2 is relatively low, with the highest value at 34.49 per cent for soybeans. A conclusion so far is that swings in commodity prices during the 1980s and 1990s were mainly driven by idiosyncratic rather than systematic risk factors.

During the second sub-period, that is from mid-2003 to early 2011, values of βcoefficients range from 0.05 for sugar to 2.23 for nickel. Thirteen commodities prices outperform the global markets in terms of volatility. Sixteen commodities in the second sub-period record increases in βcoefficients. This seems to confirm that the price boom in commodities markets was effectively characterized by increased volatility. Furthermore, as found earlier, metals are more sensitive to global markets than agricultural products. The average value of the βcoefficient which measures the sensitivity of a specific commodity's price variation to global factors was 1.50 (1.68 if we exclude Gold) for metals compared with 0.93 for agricultural commodities, although the latter group of commodities shows significant variation across specific products. In terms of risk components, this period is also associated with increased importance of systematic risk factors. That is the case of 18 out of 20 specific commodities. For copper for example, more than half of its fluctuation (nearly 61 per cent) was driven by global factors compared with 22 per cent over the period January 1980 to June 2003.

These results illustrate the increased effect of global risk factors on commodity prices during the boom period, as discussed earlier. Most specifically, for metals, the increased importance of systematic risk factors was driven by trends in world industrial production, especially from China, which drove the demand for primary commodities such as copper and iron ore at historic highs. Accommodative monetary policy the United States and low interest rates also might have played a role in increasing demand for primary commodities. For grains such as maize and soybeans, price fluctuations might have been affected by higher global demand and biofuel production (UNCTAD, 2013). Moreover, the substitutability in the use of grains implies that the changes in maize and soybeans prices led by the increasing demand for biofuels could have been transmitted to other grains such as wheat and sorghum.

On average, the adjusted R^2 for minerals and metals (0.42) is higher than the corresponding value for agricultural commodities (0.27) suggesting, again that during the boom period, metals prices were more affected by global macro-economic factors than agricultural products. Regional weather patterns and governments' policies in producing countries might have, to some extent, isolated these agricultural products from the influence of global macroeconomic factors.

In the last sub-period (that is, from April 2011 to April 2015), β coefficients range from -0.12 for rice to 1.77 for coffee; thirteen commodities outperformed the market in terms of sensitivity to changes in global market factors. However, compared to the boom period, 15 commodities experienced a reduction in their sensitivity confirming the evidence of weakening price volatility over the past few years. During the same period, metal prices remained more volatile than agricultural products. The average value of the sensitivity coefficient for metals was 1.07 (1.20 if gold is excluded) compared with 0.89 for agricultural commodities. This, as is the case in the other two sub-periods, disguises variability in the fluctuations of individual or sub-groups of agricultural commodities. For example, the prices of beverages seem to be less volatile than the prices of other agricultural commodity groups.

With regard to risk components, the importance of global risk factors is also weaker. Eighteen commodities record decreases in their systematic risk component (only 2 record increases) compared to the boom period. This suggests that the drivers of volatility in commodity markets are returning to idiosyncratic factors, at least compared to the recent boom period. However, compared to the pre-2003 period, the importance of global risk factors in explaining commodity price changes is still high. This evidence is provided by 13 of the selected commodities. In terms of leading factors, metal markets have higher adjusted R^2 compared to agricultural crops (0.25 versus 0.18), implying that metals prices remain more sensitive to global markets.

5 CONCLUSION AND POLICY OPTIONS

The results of the study have several implications. They suggest that changes in commodities prices have a strong relationship with movements in the global commodities market. The magnitude of the relationship varies not only through specific commodities but also through commodity cycles. Price changes particularly amplified in the 2000s during the recent boom compared to the 1980s and 1990s, a period characterized by quieter markets. These conclusions largely confirm those of Chen (2010) implying that the findings do not differ whether monthly or annual data are used. Furthermore, even though the magnitude of price swings has narrowed over the past few years, commodity price volatility persists and a number of commodities continue to outperform the markets in terms of instability. Key recurrent factors that would be weighing on commodity prices swings include erratic climate patterns, geopolitical tensions in some major commodity exporting regions, fluctuations in energy prices transmitted to global commodity markets, swings in the values of major currencies, in particular the American Dollar, global macroeconomic instability, the pace of global economic recovery, particularly in emerging economies, and investments in commodity derivatives. An implication of this analysis is that volatility is still a relevant development issue. National and international actions are needed to reduce it or mitigate its impact on vulnerable countries.

The results of the study also suggest that the risk components of commodities price fluctuations vary widely among commodities and across commodity cycles. Most particularly, the sensitivity of commodity prices to systematic risk increased during the recent boom period. Over the past four years, even though it remains generally high compared to the 1980s and 1990s, systematic risk has been weakening suggesting that commodity markets are returning to idiosyncratic risk-based factors. Should it be inferred that commodity prices are more sensitive to risk during boom compared to bust cycles? This is a relevant issue for future studies. This notwithstanding, among commodity groups, industrial metals appear to be most sensitive to global risk factors. The implication for CDDCs relying on a limited number of metals for their export revenue is that diversifying horizontally by adding new metals to their export basket would not reduce significantly their exposure to global risk.

The paper has also shown that prices of commodities within the same family tend to display similar risk dynamics during specific cycles. That is the case for example for grains and for industrial metals. The implication is that CDDCs should diversify horizontally through groups of unrelated commodities. However, natural constraints and technological hurdles make this difficult for most CDDCs. Moreover, most of the countries would not be able to diversify horizontally as the potential for this type of diversification depends on natural resource endowments.

Vertical diversification through the processing of raw materials and non-commodity driven diversification would be the most relevant strategy to cope with risk in global commodity markets particularly considering their cyclical pattern. This form of diversification would effectively strengthen CDDCs resilience to shocks by deriving their revenues from various sources including primary commodities, semi-finished and manufactured products. This would have the added advantage of contributing to strengthening CDDCs' capacity to build resilience against unfavourable secular terms of trade. For example, Malaysia has successfully diversified its economy both vertically and into non-primary commodity driven diversification. The country has effectively moved away from its historical dependence on agriculture and mining products to processing of crops such as palm oil and rubber and to manufacturing of electrical and electronic products. Achieving this requires an enabling environment that fosters capital investment and human capital development (Agosin and Bravo-Ortega, 2012).

Achieving economic diversification takes time. Hence, market risk management techniques and commodity savings funds could be used in the short and medium terms to alleviate the adverse impact of price volatility on resource-rich developing countries' economies. Market instruments such as forward contracts, futures options or a more complex combination of derivatives would allow CDDCs to protect themselves from fluctuations in commodity markets.[11] Some developing countries have successfully used these instruments. For example, Mexico and Chile are active in derivative markets through their state-owned oil and copper companies, respectively (Larson et al, 1998).

[11] Detailed insights on how to hedge volatility of food prices with markets-based instruments may be found in Morgan Stanley Commodities Group (2011).

Commodity savings funds may be seen as a complementary option to help reduce CDDCs' exposure to global market risk. The funds accumulate windfall revenues during boom periods and allow for transfers to be made to a government budget during bust periods. In Chile for example, a copper-backed saving fund has been successfully implemented and used to strengthen the country's resilience to fluctuations in global copper markets (UNCTAD, 2013). This mechanism helps in smoothing government intertemporal revenues and expenditures in CDDCs in a context of persisting fluctuations in global commodity markets. The funds may also contribute to reducing fiscal procyclicality and related challenges. Strategies for commodity savings funds should be tailored to suit countries' specific circumstances and these funds should be considered as complementing, not substituting for public consumption and investments.

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ANNEXE A

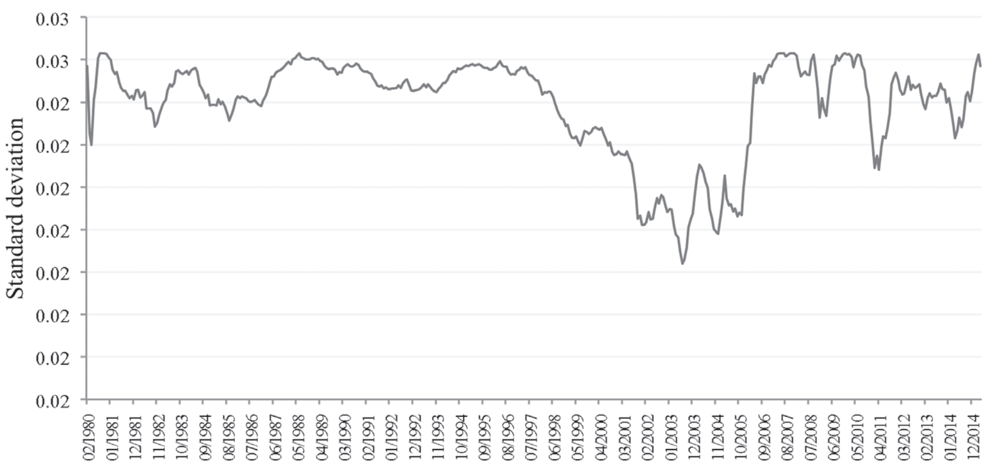
Dating Break in Price Series.

The discussion under section 3.2 implies that we date two break points: the first around 2000 and the second close to 2010. The methodology used in this paper is based on the changing growth model of Perron (1989).

Let's denote y_t, a time series characterized by a structural break occurring at T_B, the underling stochastic process is as follows:

$$y_t = \mu + \alpha D_B + y_{t-1} + \varepsilon_t, \text{with } D_B = 1 \text{ if } t \geq T_B + 1, \text{ and 0 elsewhere} \quad (5)$$

Here, y_t represents the series of the IMF Non-fuel Commodity Price Index. We assume the existence of two unknown break dates as discussed earlier. The equation below is then recursively estimated, setting T_B to move over the period of the study, that is 1980:01 -2015:04. For every step of the recursive estimation procedure corresponding to a given T_B, we calculate the residual's standard deviation depicted as a function of T_B (see figure below).



We retain the break points (month) as the ones that minimize locally the residual's standard deviation (see Chong (1995) and Bai (1997).[12] Around 2000, the local minimum value corresponds to July 2003. The corresponding value around 2010 is April 2011. The two break dates are therefore 2003:07 and 2011:04.

[12] These authors showed that a sum of squared error, as a function of the break date, can have a local minimum near each breakdate. Note that we retained the standard deviation here instead of squared error for procedural matter. The two variable leads to same results as the former is an increasing function of the latter.

Emerging Markets Smart Beta ETFs

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ABSTRACT

Smart beta ETFs have grown to more than $400 billion by yearend 2014, representing about 20 percent of the exchange-traded fund market and accounting for a majority of the money flow to the ETF sector in recent years. Several studies documented the outperformance of smart beta ETFs, while some research reports indicated that the excess returns could be explained by the additional risk factors introduced into those smart beta funds. This research extends the literature to examine the risks and returns of emerging markets smart beta ETFs. The results do not lend support to the claim of outperformance by those funds in emerging markets.

1. INTRODUCTION

Since John Bogle, founder of the Vanguard Group pioneered the concept of indexing to improve performance by minimizing costs, an ongoing debate between the efficient markets school and those who believe that the market can be beaten has lingered. If the market is efficient, then the only thing investors can do to maximize their returns is to minimize the costs of their investments through the use of low cost index funds. The costs of index funds are as low as 10 to 20 basis points as compared to 150 basis points (1.50%) or higher for actively managed funds. The savings of more than 1 percent annually can be significant to the long-term performance of investments.

Exchanged traded funds (ETFs) were originally created to provide investors with a low cost alternative to purchasing traditional index mutual funds. The first index funds followed a traditional indexing approach and covered the broad stock market, an industry sector, international stocks, and U.S. bond indexes. ETFs add the ease and liquidity of trading to the benefits of passive index investing. The traditional indexing approach is to invest in all securities in an index or market segment with weighting of each security based on its market capitalization. ETFs and index funds grew popular in part due to their low expense ratios and consistency with the efficient market hypothesis. However, the traditional capitalization-weighted indexing approach may present investors with unintended risk concentrations in overvalued securities. Capitalization-weighted approach assigns a greater weight to more expensive securities and thus can lead to a higher portion of funds invested in overvalued securities. In addition, results of select academic research identified several factors that could add additional returns to the traditional indexing approach.

Active managers seek to beat the market by using strategies intended to deliver excess returns to investors including factors other than the traditional capitalization weighting. Those active strategies have long been available to high net worth individuals and institutional investors, but not to the general public. In recent years, ETF providers have tried to add these active investing strategies into passive ETF index investing. Through ETFs, these active strategies are becoming available to smaller institutions and retail investors. Such active strategies for ETFs have come to be commonly known as smart beta. Those smart beta ETFs represented about 20 percent of the $2 trillion ETF sector and accounted for the majority of the inflows to the ETF investments in recent years. Asset managers such as WisdomTree, JPMorgan, Goldman Sachs, Morgan Stanley, Schwab, and others continue to add smart beta ETFs to their offerings.

Most smart beta ETFs are single factor strategies. These factors include value, momentum, size, volatility, and dividends. The value strategy aims to improve performance by choosing stocks that appear to be undervalued relative to their theoretical valuation. Studies have identified stocks that have low price-to-book or price-to-earnings ratios tend to outperform stocks with high ratios. Momentum factors focus on stocks with high positive price momentum, that is, stocks with steady positive monthly returns tend to predict positive future returns. Next, the size factor generally selects securities with smaller market capitalization, which researchers have found tend to outperform their large cap counterparts. Reduced liquidity and less transparent information for small company stocks may contribute to these return differences. Finally, the volatility rule is designed to invest in low volatility stocks to produce higher risk adjusted returns than those generated by the benchmark index. This could be explained by behavioral finance in that investors prefer stability over large swings of stock prices. Multi-factor strategies combine several of those factors in order to enhance performance.

Several of the reports, as reviewed in the following section, showed that the U.S. smart beta ETFs produced positive higher returns than the corresponding benchmark indexes. Other research findings showed that those "excess returns" were the risk premium for taking additional risks embedded in the risk factors, and so no risk-adjusted excess return was identified.

Most of the discussion on smart beta funds have focused on U.S. or developed markets. This research contributes to the literature by examining the risks and returns of emerging market smart beta ETFs.

The paper is organized as follows. Next section reviews the literature. Section 3 describes the data on emerging market smart beta ETFs and discusses the returns and risks of those ETFs. Section 4 discusses the investment implications and concludes the paper.

2. LITERATURE REVIEW

The concept of market efficiency is usually attributed to the work of Fama (1965, 1970). If the market is efficient, then the only thing investors can do to maximize their returns is to minimize the costs of their investments through the use of low cost index funds and ETFs.

In the 1980s, a number of researchers began to notice anomalies in the pricing of securities that indicated some inefficiencies in the market might exist. Using data from 1936—1975, Banz (1981) and Reinganum (1981) showed that small-capitalization firms on the New York Stock Exchange earned higher average returns than is predicted by the capital asset-pricing model (CAPM). Basu (1977) found that firms with high earnings – to-price ratios (low P/E) earn positive abnormal profits relative to the CAPM. Fama and French (1992, 1993) have argued that size and value represent two risk factors that are missing from the CAPM.

Smart beta strategies use quantitative methods to adjust the allocation of traditional capitalization-weighted portfolios. Most of the smart beta strategies aim to improve returns by establishing rules to incorporate factors such as value, momentum, size, volatility, and dividends. The argument for this approach is that traditional capitalization weighting tends to overweight overpriced stocks and underweight underpriced stocks, thus leading to a suboptimal allocation. Hsu, Kalesnik and Li (2012) note that these smart beta products do seem to offer superior performances relative to traditional indexes, which they attribute to fundamental investing tendencies. AlMahdi (2015) tests the smart beta strategy by forming four portfolios with different strategies. He uses a dynamic approach and finds that one of the portfolios does lead to abnormal returns. Hammond (2014) discusses the evolution of smart beta ETFs and supports the use of smart beta strategies to enhance returns. Jabara, Duggan, and Baxter (2015) discuss the potential benefits and drawbacks of smart beta strategies. Their analysis shows that about half of the smart beta ETFs beat S&P 500 Index by an average of 168 basis points, while the other half underperformed by an average of 446 basis points.

On the other hand, Dubil (2015) uses the Fama-French (1993) and the Carhart (1997) four-factor decomposition to analyze smart beta funds. Dubil (2015) finds that the majority of the reported outperformance can be explained by market, size, book-to-market and momentum tilts, with only pure style funds having some and dividend funds having a large special component. Glushkov (2015) analyzes a sample of 164 domestic equity US-domiciled ETFs from May 2003 to December 2014 and finds that roughly 60% of smart beta ETF categories outperformed their raw passive benchmarks on a total return basis, but there is no conclusive evidence to indicate that those smart beta ETFs outperform on a risk adjusted basis. Phillips, Bennyhoff, Kinniry, Schlanger, and Chin (2015) provide empirical evidence that the "excess returns" of smart beta strategies are partly, in some cases, and largely, in other cases, explained by time-varying exposures to risk factors such as size and style. They find little evidence that smart beta strategies can capture any security mispricings.

3. EMERGING MARKETS SMART BETA ETFS

Results on the performance of smart beta ETFs using data on U.S. or developed market ETFs are mixed. In this paper, we examine the risks and returns of emerging markets smart beta ETFs in order to see if greater inefficiencies in less-developed markets provide fund managers with opportunities to add value. The sample of emerging markets smart beta ETFs were selected from the complete list of smart beta ETFs in Jabara, Duggan, and Baxter (2015). We selected from the list those with assets under management (AUM) of at least $100 million. Eleven emerging markets smart beta ETFs meet the criteria and are included in the sample. Table 1 lists those 11 ETFs with their inception dates, AUM, and the average premium or discount. The largest is iShares MSCI Emerging Markets Minimum Volatility ETF with $2.60 billion of assets under management. The other to reach the $1 billion AUM is WidsomTree Emerging Markets Equity Income Fund ($1.33 billion). The smallest in the sample is First Trust Emerging Markets Alpha DEX Fund with $116.58 million AUM. WidsomTree Emerging Markets Equity Income Fund was the first to be introduced to market among those in the sample. The newest in the sample is Schwab Fundamental Emerging Markets Large Company in August 2013. Table 1 also lists the average premium or discount of those ETFs. The average premium or discount percentages are small. This is different from some of the country funds that trade at large discounts or premium.

From Table 1, we can see that the emerging markets smart beta ETFs represent a relatively new investment category and thus performance results are limited. Thus, we review the risks and returns for the recent 3-year period. Table 2 reports those statistics. As a performance benchmark we provide both the MSCI ACWI Ex USA NR USD (Price) and the category performance provided by Morningstar. The average returns are all negative, ranging from -12.38% to -2.56%. The average returns for the 11-ETFs are -7.45%. Those returns are below MSCI's 2.34% or the category average's -5.94%. PowerShares DWA Emerging Markets Technical Leaders, WisdomTree Small Cap Emerging Markets Dividend Fund, iShares MSCI Emerging Markets Minimum Volatility ETF, and FlexShares

Table 1
Summary Statistics of Emerging Markets Smart Beta ETFs

Name/Ticker	Inception Date	AUM ($ Millions)	Premium/discount (%)
Broad Markets			
PowerShares DWA Emerging Markets Technical Leaders/PIE	01/07/08	179.97	-0.17
PowerShares FTSE RAFI Emerging Markets/PXH	09/28/07	283.65	0.02
First Trust Emerging Markets AlphaDEX Fund/FEM	04/19/11	116.58	0.19
Large Cap			
Schwab Fundamental Emerging Markets Large Company/FNDE	08/15/13	312.80	0.28
Small Cap			
WisdomTree Small Cap Emerging Markets Dividend Fund/DGS	10/30/07	906.84	0.02
Custom			
iShares MSCI Emerging Markets Minimum Volatility ETF/EEMV	10/20/11	2,600.00	0.15
FlexShares Morningstar Emerging Markets Factor Tilt Index Fund/TLTE	10/02/12	197.12	0.36
PowerShares S&P Emerging Markets Low Volatility/EELV	01/13/12	135.34	0.08
Dividend			
WidsomTree Emerging Markets Equity Income Fund/DEM	07/13/07	1,330.00	-0.14
SPDR S&P Emerging Markets Dividend ETF/EDIV	02/24/11	264.50	0.11
iShares Emerging Markets Dividend ETF/DVYE	02/24/12	144.69	0.08

Notes:
1.Style classification is based on Jabara, Michael. Investment Primer: Smart Beta ETFs. Wealth Management, Morgan Stanley, July 21, 2015, pp. 1-23.
2.Inception date and AUM are from Morningstar; AUM are as of December 14, 2015.
3.The average premium/discount are from 2010 to December 14, 2015 or from inception date to December 14, 2015.

Morningstar Emerging Markets Factor Tilt Index Fund outperformed the category average. SPDR S&P Emerging Markets Dividend ETF lost investors the most money. For standard deviations, the average for the sample is 14.80%, compared to 11.61% for MSCI and to 15.02% for the category.

In other performance measures, the Sharpe ratios for the sample range from -0.18 to -0.78. The sample average is -0.44, compared with 0.25 Sharpe ratio for the MSCI benchmark. Another performance measure that captures the downside deviation, the Sortino ratio, shows similar results. The average of the sample is -0.55 while the MSCI is 0.38. The alphas are all negative. This is because emerging markets underperform the U.S. markets in recent years. While those emerging markets smart beta ETFs provide negative returns to investors, the S&P 500 index provides about 16% annual returns during the sample period.

Table 2
Returns and Risks of Emerging Markets Smart Beta ETFs

Ticker	Mean (%)	Sharpe	Sortino	Alpha (%)	Expense (%)	Turnover (%)
PIE	-3.41	-0.18	-0.23	-5.29	0.90	147.00
PXH	-10.10	-0.50	-0.64	-12.80	0.49	22.00
FEM	-6.24	-0.29	-0.41	-8.71	0.80	116.00
FNDE	NA	NA	NA	NA	0.48	13.00
DGS	-5.21	-0.33	-0.42	-7.25	0.63	42.00
EEMV	-2.56	-0.18	-0.24	-4.38	0.25	34.00
TLTE	-4.58	-0.28	-0.36	-6.73	0.65	19.00
EELV	-6.05	-0.47	-0.58	-8.12	0.29	82.00
DEM	-10.88	-0.64	-0.82	-13.74	0.63	39.00
EDIV	-13.06	-0.78	-0.94	-16.09	0.49	67.00
DVYE	-12.38	-0.74	-0.90	-15.21	0.49	59.00
MSCI	2.34	0.25	0.38			
Category	-5.94	-0.33	-0.42			
Sample	-7.45	-0.44	-0.55	-9.83	0.55	58.18

Note: Data are for recent 3-year period and are from Morningstar.

The turnover averages at 58.18%. The lowest turnover is FNDE at 13% only. The highest turnover is PIE at 147%. The expense ratios range from 0.25% to 0.90%, with an average of 0.55%. Although the average cost is 31 basis points higher than all non-smart-beta ETFs, it is lower than what active mutual funds charge.

4. IMPLICATIONS AND CONCLUSIONS

Results from the sample of smart beta emerging markets funds do not provide evidence that fund managers are able to enhance returns or lower risk by adjusting the weighting of the portfolio from the traditional capitalization weighting approach. In addition, those smart beta funds have greater costs than those funds that follow a traditional indexing approach. The small sample and short time series in which data are available have limited the analysis and left open the question as to whether managers can add value in the emerging markets ETFs by using a smart beta approach. Further research may require waiting until a longer time series is available and/or until additional funds enter this market in order to validate these results.

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Book Review

Lianne Xu, Consumption in China: How China's New Consumer Ideology is Shaping the Nation. Policy Press, 2014. 176 pages.

China is recognized as one of the highest savings nations. Consumers save at three times the rate of the United States. Recently analysts and commentators have noted that in a post crisis world the high savings rate and low consumption levels in China contribute to slower growth.

Prior to the 2008 09 crisis , China's government encouraged low consumption, wanting to allocate resources to capital investment, industrial expansion, and infrastructure development. But in recent years consumption spending has become seen as a necessary component of aggregate demand.

The Chinese government has followed a rigorous policy of mobilizing capital and encouraging control over its use. Methods followed include foreign exchange controls, directed policy loans by banks, and a careful orchestration of the privatization of large state owned companies. As a result, China enjoys high capital investment, a high growth rate, and a positive trade balance. The latter mobilizes foreign currency denominated capital.

When Thorstein Veblen coined the phrase "conspicuous consumption" he might have had wealthy young Chinese in mind. Today wealthy young Mainlanders are increasing their spending on luxury goods produced in North America, and Europe. They are better assured of high quality from French, American, Swiss, and French luxury goods.

China's one child policy produces families structured with one child--no siblings. Therefore, young Chinese born into upscale families are able to enjoy high luxury, and this includes foreign travel and luxury spending.

Nevertheless, domestic consumption within China remains at relatively low levels and this condition will persist. China needs to elevate living standards for its poor masses. These masses of poor people continue to be deprived of quality nutrition, adequate health care, and a better. environment.

Environmental issues have also become a major problem in China, and can be expected to impact the ability of the government to allocate resources in a more meaningful way. Chinese people exposed to a deteriorating environment can be expected to exert escalating pressure on the Chinese government to remedy this situation.

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