AN EMPIRICAL INVESTIGATION OF THE COLOMBIAN STOCK MARKET REACTION TO THE US MARKET: EVIDENCE FROM A CASEWISE BOOTSTRAP APPROACH

1. Introduction

The potential relationship between financial markets across countries is of interest to both investors and policy makers. Investors are prone to figure out whether international portfolio diversification benefits exist. Policy markers pay attention to the way financial markets react to each other in order to be able to identify appropriate policy measures to apply in the case of financial crises. The aim of this paper is to explore the effect of the US stock market on the Colombian stock market during 1988:M1-2007:M1. It is widely agreed in the literature that financial variables are usually non-normally distributed with time-varying volatility, which calls the use of standard methods is into question. We apply a new method that is not sensitive to non-normality or time-varying volatility of the error term in the regression. Hence, our empirical results are expected to be more precise than previous studies.

The reminder of the paper proceeds as follows. Section 2 offers historical background regarding the development of the Colombian stock market. Section 3 reviews some selected published papers on the integration with other markets. Section 4 represents the econometric methodology. Section 5 describes the data. The empirical results are provided in Section 6. The last section presents summary and conclusions.

2. The development of the financial market in Colombia

Although first stages of the Colombian Stock Exchange date back to the first quarter of the twentieth century, its development was modest during that century. Depth of the market did not overpass 5% of the GDP at least since 1960 and just a small group

of firms represented almost three quarters of the transactions in 1997[1].

A number of reasons explain this scarce development. First, the existence of three isolated stock exchanges located in three principal Colombian cities. Second, a huge inflation rate during the eighties and nineties that might have concentrated the investors' preferences to fixed income instruments (Velez-Pareja, 2000). Third, government incentives to borrow money from banks rather than acquiring it via stock exchanges (Ministerio de Hacienda de Colombia *et al*., 1996). Four, legal barriers for foreign investors before the market liberalization in February of 1992 (Bekaert and Harvey, 2000). Finally, the existence of dominant economic groups and a low level of investor protection (Porta *et al*., 1998).

Although the liberalization of Colombian stock markets begun in the early nineties, this market seemed to be isolated from other Latin-American markets, highly autocorrelated (Harvey, 1995; Korajczyk, 1996) and the volatility increased after liberalization (Bekaert and Harvey, 1997). Arbelaez and Urrutia (1997) argue that thin trading was a plausible explanation for this autocorrelation, while Christofi and Pericli (1999) state that strong regulation, existence of dominant economic groups were also causes to that behavior. Colombian Stock Market reflected at that time the Bowman (1980) risk/return paradox in the sense that high beta portfolios tend to take less return than low beta portfolios (Rouwenhorst, 1999).

The merge of the three stock markets in 2001 (Gutierrez, 2009) and the improvement of the macroeconomic indicators (Ocampo, 2008) derived in a significant evolution of the market activity in terms of size and liquidity. At the same time, market liberalization in Colombia tends to diminish the cost of capital and push the market's growth (Bekaert and Harvey, 2000; Henry, 2000) and make structural changes in its behavior (De Santis and Imrohoroglu, 1997). However, concentration in few shares, lack of efficiency (Uribe Gil, 2007) and mean reversion process (Diamandis, 2009) seem to still persist.

The behavior of the stock prices in Colombia cannot be explained with traditional asset pricing models like CAPM and three factor model (Fama and French, 1998; Hwang and Satchell, 1999; Rouwenhorst, 1999; Grandes *et al*., 2010). Colombian Stock Market contradicts the expected behavior of size and price to book ratios in

[1] Depth is measured as the yearly value of transaction divided by GDP.

the Fama and French (1993) three factor model. Moreover, both size and book to market price factors seem to be irrelevant for the price formation in Colombia (Grandes *et al*., 2010).

3. Evidence on Colombian stock market linkages

Research about the Colombian Stock Market linkages with other markets is inconclusive. Some authors argue that this market was not affected by US information in the nineties. Instead, they find high influence from local information (Harvey, 1995; and Rouwenhorst, 1999). Local factors such as local interest rates, barriers to foreign investors and local inflation affect the integration of Latin American markets with other markets (Hunter, 2005). As a consequence Colombia appears to be the only Latin American country that was not affected by the 'tequila' crisis in 1994 (Chen *et al*., 2002).

Arouri *et al*. (2008) argue that Latin American markets have been going towards an integration in recent years, even though there is not such evidence of increased integration with the developed markets. On the other hand, Wong (2003) asserts that in crises periods correlations in Latin American markets become significant. He shows that in the period between 1997 and 1999 (South East Asian, Russian and Brazilian crises) the correlation between Colombian market and other major Latin American markets (Argentina, Brazil, Chile, Mexico, Peru and Venezuela) are statistically significant. Diamandis (2009) find a high interdependence beetwen the Colombia, Brazil and Argentina. Latin American markets, as other developing markets, have a time-varying integration (Bekaert and Harvey, 1995). For such reason time invariant models might be misspecified (Hunter, 2005; Jawadi *et al*., 2009).

On the other hand, some studies agree that Latin American countries are far from other regions in terms of integration of their financial markets (Jara and Tovar, 2010). This fact could be a reason why some authors failed to find linkages between Latin America and US markets (Jawadi *et al*., 2009). Grandes *et al*. (2010) argue that Colombian Stock Market seems to not be affected by global factors. Chen *et al*. (2002) assert that fluctuation in Colombia affects Mexico and Brazil. The Colombian stock exchange is slow to adjust its prices to foreign shocks.

To summarize, Colombian Stock Market seems to steadily decline its level of asymmetry with developed markets in terms of risk/return since 1986 that is the stating period of market liberalization worldwide. This behavior can be explained by a progress of

integration followed for most Latin American countries (Garcia-Herrero and Wooldridge, 2007). Nonetheless, even in the twenties the Colombian Stock Market appears to have fewer linkages with US than other Latin American markets (Araújo, 2009).

4. Methodology

To investigate the relationship between returns in both countries when the effect of one potential break is taken into account, we formulate the following regression equation:

$$R_{COL,t} = \alpha_1 + \alpha_2 D_t + \beta_1 R_{US,t} + \beta_2 D_t R_{US,t} + u_t \quad (1)$$

where

$R_{COL,t}$ = continues returns for the Colombian market.

$R_{US,t}$ = continues returns for the US market.

D_t = a binary variable that is equal to zero for the period before change in regulation and it takes value one for $t \geq 2001:M9$.

u_t = a stochastic error term, which might not be homoscedastic or normally distributed.

A bootstrap method that is robust to the presence of a heteroscedastic non-normal error term has been suggested by Hatemi-J and Hacker (2005). Since financial data is usually heteroscedastic and non-normal this method will be used to estimate and to test the significance of the estimated coefficients α_1, α_2, β_1 and β_2. It should be pointed out that the intercept coefficient α_1 represents the premium above the average US rate required by Colombian investors in order to invest in the US. Thus, the change in the premium due to September 11 terrorist attack is captured by α_2. The null hypothesis for testing a change in premium is:

$$H_0 : \alpha_2 = 0 \quad (2)$$

Thus, if the null is rejected it means a change in premium has occurred. The coefficient β_1 estimates the regression correlation between returns in the two markets and it is a measure of US systematic risk for Colombian investors that are investing in the US. The β_2 parameter embodies the change in correlation after the potential break due to September 11. Thus, the null hypothesis whether terrorist attack has resulted in a change in the regression coefficient is formulated by the following null hypothesis:

$$H_0 : \beta_2 = 0 \quad (3)$$

Thus, if the null is rejected it indicates a significant change in the correlation between the two financial markets.

Equation (1) can be represented in the matrix format as the following:

$$Y = BX + u \tag{4}$$

where

$$Y = \begin{bmatrix} R_{COL,1} \\ R_{COL,2} \\ \vdots \\ R_{COL,T} \end{bmatrix} \text{ a } (T\times 1) \text{ vector, } X = \begin{bmatrix} 1 & R_{US,1} & D_1 & D_1 R_{US,1} \\ 1 & R_{US,2} & D_2 & D_2 R_{US,2} \\ \vdots & \vdots & \vdots & \vdots \\ 1 & R_{US,T} & D_T & D_T R_{US,T} \end{bmatrix} \text{ a } (T\times 4) \text{ matrix,}$$

and

$B = [\alpha_1 \ \ \alpha_2 \ \ \beta_1 \ \ \beta_2]$ a (4×1) vector.

The OLS estimator for the parameter vector can be obtained by

$$B = (X'X)^{-1}X'Y \tag{5}$$

According to Hatemi-J and Hacker (2005) the following steps make the estimation of the regression coefficients based on casewise bootstrap method operational:

1. First, we need to resample independently Y and X, and call this resampled values as Y^* and X^*, that is perform the following:

   $Y^* = \{Y_1^*, Y_2^*, \ldots, Y_i^*\} \ \ Y_i^* \in Y \forall i$. Here $i = 1, \ldots, n$ and n is the size of the underlying bootstrap sample. Likewise, for the other variable create the following:

   $X^* = \{X_1^*, X_2^*, \ldots, X_i^*\} \ \ X_i^* \in X \forall i$. Where $i = 1, \ldots, n$
2. Next, estimate the parameter vector via Y^* and X^*, denoted by $\hat{B}_b$, via the following equation:

   $$\hat{B}_b = \left(X^{*\prime} X^* \right)^{-1} X^{*\prime} Y^*.$$
3. Replicate the above mentioned two steps N times. Where N is the number of bootstrap simulations, which is ten thousand in this particular case[2].
4. Finally, estimate the bootstrap coefficient vector (denoted by $\hat{B}^*$) as the following:

   $$\hat{B}^* = \frac{\sum_{j=1}^{N} \hat{B}_b}{N}.$$

[2] It should be mentioned that the same qualitative results were obtained when the higher simulation number was used.

It should be pointed out that the case-wise bootstrap method can also be utilized for testing whether or not any element of in $\hat{B}^*$ is statistically significant. As an example, assume that we are interested in testing $H_0: \alpha_2 = 0$. For achieving this we need first to rank the ten thousand estimated values of the parameter that are obtained via the casewise bootstrapping, i.e. the values of $\hat{\alpha}_2^*$. The p-value for $\hat{\alpha}_2$ based on the casewise bootstrap technique is then acquired as the following. In case the estimated median of $\hat{\alpha}_2^*$ is positive, the p-value is considered as the percentage of elements in the distribution of $\hat{\alpha}_2^*$ that are negative in addition to those that are higher than the double of the median. In case the estimated median of $\hat{\alpha}_2^*$ is negative, the p-value is considered to be the percentage of elements in the distribution of $\hat{\alpha}_2^*$ that are positive in addition to the percentage of elements in $\hat{\alpha}_2^*$ that are lower than double of the median. The endpoint of two times the median value of $\hat{\alpha}_2^*$ gives p-values that are analogous to those symmetric two-sided tests in a traditional hypothesis testing as stated by Hatemi-J and Hacker (2005). The p-value for any other coefficients can be estimated in a similar manner. All bootstrap simulations that are necessary for estimating the underlying coefficients as well as testing their significance are implemented via a program code written in GAUSS by Hacker and Hatemi-J (2009), which is available online.

5. The data description

The share price indexes for Colombia and the US are obtained from International Financial Statistics of the IMF (CD-ROM). The sample period is 1988:M1-2007:M1. The logarithmic returns for each market are calculated in order to have continuous returns. Tests for unit roots were also conducted. The results, not reported, reveal that each variable is stationary. Furthermore, we tested for normality and ARCH effects. The results showed that each variable is non-normal and ARCH effects exist. Thus, making use of the case-wise bootstrap method seems to be necessary in order to have robust results.

6. The results

The estimation results for risk premium (α) as well as the measure of American systematic risk for Colombian investors investing in

the US (β) are presented in Table 1. These results reveal that the risk premium, which is represented by the estimated value for α_1, is positive and statistically significant at the ten percent significance level.

TABLE 1 - *The Results Based on Hatemi-J and Hacker (2005) Case-Resampling Bootstrap Method*

Intercept (α_1)	Change in Intercept (α_2)	Slope (β_1)	Change in Slope (β_2)
0.011 (0.098)**	0.023 (0.046)*	0.565 (0.020)*	0.214 (0.522)

Notes:
1. The parameters are also estimated by Hatemi-J and Hacker (2005) case-resampling bootstrap method.
2. The p-values based on the case-wise bootstrap approach are presented in the parentheses.
3. The notation * (**) indicates that the null hypothesis can be rejected at the 5% (10%) level of significance.

Since the estimated value for the α_2 is positive and statistically significant, then an increase in the risk premium is required by the Colombian investors to invest in the US market after the September 11 terrorist attack. Before September 11 there is a statistically significant and positive regression correlation between the Colombian and the US markets (see the estimated value for β_1). However, the results do not support the null hypothesis that the regression coefficient has changed. This is the case because the change in the regression slope represented by β_2 is not statistically significant.

The potential implication of our empirical findings is the following. Since the correlation between the two markets is significant but less than one (and it has not changed because of the September 11 attack) we could conclude that there are diversification possibilities for Colombian investors to diversify into the US market in order to improve on their return/risk trade-off.

7. CONCLUSIONS

The purpose of this paper has been to empirically investigate whether or not the Colombian financial market is integrated with the US financial market. The effect of the terrorist attack on September 11 is also taken into account. Since the underlying monthly data is

non-normal with time-varying volatility we utilize a robust method that performs well in such situations. This method is more accurate compared to other existing methods in the literature because it is insensitive to the presence of non-normality and heteroscedasticity in the error term of the regression. The method is used for both estimating the parameters and testing for their significance. It is found that the Colombian financial market is integrated with the US market to some extent but it is not completely integrated with the US financial market. This is based on the empirical finding that the regression slope coefficient is less than one. There seem to be no significant change in this relationship after September 11 terrorist attack either. One potential explanation for this empirical finding might be the home biased hypothesis. Our empirical finding has an important financial economic implication. That is diversification possibilities for the Colombian investors to invest in the US exist even after September 11 terrorist attack.

Abdulnasser Hatemi-J
Department of Economics and Finance, United Arab Emirates University, Al Ain, UAE

Julio Sarmiento-Sabogal
Department of Applied Finance and Actuarial Sciences at Macquarie University, Sidney, Australia and Pontificia Universidad Javeriana, Santa Fé de Bogotá, Colombia

REFERENCES

Araújo, E. (2009), "Macroeconomic Shocks and the Co-Movement of Stock Returns in Latin America", *Emerging Markets Review*, 10(4), 331-344.

Arbelaez, H. and J.L. Urrutia (1997), "Why is there so Much Serial Correlation in Colombia's Stock Market Returns?", *Emerging Markets Quarterly*, 1(4), 77-84.

Arouri, M.E.H., F. Jawadi and D.K. Nguyen (2008),"International Stock Return Linkages: Evidence from Latin American Markets", *European Journal of Economics, Finance and Administrative Sciences*, 11(11), 57-65.

Bekaert, G. and C.R. Harvey (1995), "Time-Varying World Market Integration", *Journal of Finance*, 50(2), 403-444.

Bekaert, G. and C.R. Harvey (1997), "Emerging Equity Market Volatility", *Journal of Financial Economics*, 43(1), 29-77.

Bekaert, G. and C.R. Harvey (2000), "Foreign Speculators and Emerging Equity Markets", *The Journal of Finance*, 55(2), 565-613.

Bowman, E.H. (1980), "A Risk/Return Paradox for Strategic Management", *Sloan Management Review*, 21(1), 17-31.

Chen, G.M., M. Firth and O. Meng Rui (2002), "Stock Market Linkages: Evidence from Latin America", *Journal of Banking and Finance*, 26(6), 1113-1141.

Christofi, A. and A. Pericli (1999), "Correlation in Price Changes and Volatility of Major Latin American Stock Markets", *Journal of Multinational Financial Management*, 9(1), 79-93.

De Santis, G. and S. Imrohoroglu (1997), "Stock Returns and Volatility in Emerging Financial Markets", *Journal of International Money and Finance*, 16(4), 561-579.

Diamandis, P.F. (2009), "International Stock Market Linkages: Evidence from Latin America", *Global Finance Journal*, 20(1), 13-30.

Fama, E.F. and K.R. French (1993), "Common Risk Factors in the Returns on Stocks and Bonds", *Journal of Financial Economics*, 33(1), 3-56.

Fama, E.F. and K.R. French (1998), "Value versus Growth: The International Evidence", *The Journal of Finance*, 53(6), 1975-1999.

Garcia-Herrero, A. and P.D. Wooldridge (2007), "Global and Regional Financial Integration: Progress in Emerging Markets", *BIS Quarterly Review*, 4(4), 57-70.

Grandes, M., D.T. Panigo and R.A. Pasquini (2010), "On the Estimation of the Cost of Equity in Latin America", *Emerging Markets Review*, 11(4), 373-389.

Gutierrez, D.A. (2009), "Actividad bursátil en los mercados accionarios colombianos. Determinantes y evolución 1997-2007", *Ad-Minister Revista Escuela De Administración*, 15, 89-112.

Harvey, C.R. (1995), "Predictable Risk and Returns in Emerging Markets", *The Review of Financial Studies*, 8(3), 773-816.

Hacker, R.S. and A. Hatemi-J (2009), "ContagT: GAUSS Module to Implement a Pairwise Bootstrap Test for Contagion", Boston College Department of Economics, *Statistical Software Components*, No. G00007.

Hatemi-J, A. and R.S. Hacker (2005), "An Alternative Method to Test for Contagion with an Application to the Asian Financial Crisis", *Applied Financial Economics Letters*, 1(6), 343-347.

Henry, P.B. (2000), "Stock Market Liberalization, Economic Reform, and Emerging Market Equity Prices", *The Journal of Finance*, 55(2), 529-564.

Hunter, D.M. (2005), "What Drives Time Variation in Emerging Market Segmentation?", *Journal of Financial Research*, 28(2), 261-280.

Hwang, S. and S.E. Satchell (1999), "Modelling Emerging Market Risk Premia Using Higher Moments", *International Journal of Finance and Economics*, 4(4), 271-296.

Jara, A. and C. Tovar (2010), "Trends and Policy Trade-offs of Capital Flows in Latin America and the Caribbean: 2003-2008", *Journal of Business, Finance and Economics in Emerging Economies*, 5(1), 25-78.

Jawadi, F., N. Million and M. El hédi Arouri (2009), "Stock Market Integration in the Latin American Markets: Further Evidence from Nonlinear Modeling", *Economics Bulletin*, 29(1), 162-168.

Korajczyk, R.A. (1996), "A Measure of Stock Market Integration for Developed and Emerging Markets", *The World Bank Economic Review*, 10(2), 267-289.

Ministerio de Hacienda de Colombia, World Bank, Fedesarrollo (1996), "Misión de Estudios del Mercado de Capitales: Informe Final", Mimeo, Bogotá, D.C.

Ocampo, J.A. (2008), "El auge económico latinoamericano", *Revista de Ciencia Política (Santiago)*, 28(1), 7-33.

Porta, R.L., F. Lopez-de-Silanes, A. Shleifer and R.W. Vishny (1998), "Law and Finance", *Journal of Political Economy*, 106(6), 1113-1155.

Rouwenhorst, K.G. (1999), "Local Return Factors and Turnover in Emerging Stock Markets", *The Journal of Finance*, 54(4), 1439-1464.

Uribe Gil, J.M. (2007), "Caracterización del mercado accionario colombiano, 2001-2006: un análisis comparativo", *Borradores de Economía*, No.456.

Velez-Pareja, I. (2000), "The Colombian Stock Market: 1930-1998", *Latin American Business Review*, 1(4), 61-84.

Wong Dávila, J.C. (2003), "What Factors Explain Stock Returns in Latin America? An Analysis of the Period 1995-2000", Unpublished document at University of Frankfurt.

ABSTRACT

This paper empirically investigates the effect of returns in the US on the returns in Colombia during the period between the Black Friday and the Mortgage Crisis. Monthly data is used. A new method that is robust to non-normality and time-varying volatility is applied. Our empirical findings indicate that the Colombian financial market is significantly affected by the financial market of the US. However, the regression correlation is still less than one implying that international diversification benefits might exist. In addition, it is found that the terrorist attack of September 11 did not result in a significant change in the relationship between the two underlying markets.

Keywords: Financial Integration, Casewise bootstrap, Colombia, the US
JEL Classification: C22, F36, G15

RIASSUNTO

Un'analisi empirica della reazione del mercato azionario colombiano al mercato USA

In questo lavoro viene effettuata un'analisi empirica circa l'effetto dei rendimenti del mercato azionario USA sui rendimenti in Colombia nel periodo compreso tra il venerdì nero e la crisi dei mutui ipotecari. Si utilizzano dati mensili e si applica un nuovo metodo robusto alla non-normalità e alla volatilità *time-varying*. I risultati indicano che il mercato colombiano è significativamente influenzato dal mercato USA. Inoltre vi sono evidenze che l'attacco terroristico dell'11 settembre non ha determinato un significativo cambiamento nella relazione tra i due mercati.