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The Relationship Between IPO and Macroeconomics Factors: An Empirical Analysis from UK Market

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The purpose is to analyze the short and long run equilibrium relationship between the external factors and the IPO for UK market over the period of 1996 to 2016, in order to provide: i) how macroeconomic conditions influence IPOs activities and ii) how long the effects last (shock). The results of the correlation analysis show that the hypothesis that the business cycle, volatility and interest rate have explanatory power for the number of IPOs is supported by empirical evidence. On the other hand, we found no evidence that the stock market return affects the IPO activities.

Key Words: UK IPO; Long-run relationship; External factors; Cointegration; VECM.
JEL Classification Numbers: G10, G32, E44.

1. INTRODUCTION

The number and frequency of Initial Public Offerings (IPOs) have gone through fluctuations over time during these years. For example, during the first few years of the 21th century, dotcom bubble (2000–2003), only 657 firms in the UK went public, contrary during 2004–2006 when 1,027 IPOs. Moreover, during global financial crisis (2007–2008) just 294 IPOs. We can see how the number of firms that decide to going public switch over time, due to time variation in macroeconomics environment, in the other words the frequency is not stable can vary from year to year. The hypothesis of economists is that the variations in IPO activities could move together with changing economic conditions. Macroeconomics conditions would affect the economic climate thus affecting firms and industry performance (cash flow and discount rate as well as), namely the decision to go public. There would be higher probability of firm demanding funds for growth, in a positive and

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upward trend economy. Therefore, this would increase the chances of IPOs as a way of financing.

On the other hand, if investor sentiment is destabilized by the economic and political environment (climate) then companies seeking investment will have little choice but to pursue alternative ways to raise capital, consequently put off IPO activity. Despite variation in the IPO frequency is studied by different approach (theoretical and empirical), but the underline mechanisms of such variation from the macroeconomic view have not been investigated in depth especially in the context of cointegration. We try to bridge that gap.

The aim of this paper is to analyze the short and long run equilibrium relationship between the external factors (volatility, stock market return, industrial production, and interest rates) and the IPOs for UK market over the period of 1996 to 2016 — during critical financial conditions (Global financial crisis, 2007-2008), in order to point out how macroeconomic changes cause IPO frequency. Specially we want to examine which are the key factors and their dynamics (impulse response to shock) that influence the going public decision. On the other hand, this paper examines the effects of volatility of stock market, interest rates and the industrial production on IPOs frequency to uncover the relative importance of different macroeconomic determinants of IPOs.

To understand these relationships, we adopt different time-series econometrics methods, which have become standards techniques for examining cointegration among financial variables, such as Johansen's cointegration, Vector error-correction model (VECM) and Granger-causality, following Tran and Jeon (2011) approach. One methodology novelty of this paper, is the extended Vector Auto-regression (VAR) model by Toda and Yamamoto (1995) — hereafter T-Y. There are two advantages to apply this methodology. The first is it can be used independently of order of integration and the second is that the variables can be cointegred or not. These cointegration methods are able to provide the existence of dynamic equilibrium between the variables and to predict the future state of IPOs frequency, and to highlight these interactions.

The results of simultaneous correlation analysis can be resume along these lines. First of all, the empirical evidence supports the hypothesis that the volatility, business cycle and long-term interest rate have explanatory power for the number of IPOs. On the other hand, we found no evidence that the stock market return rate affects the IPOs activities. At first, we apply Johansen's cointegration for investigate existence of cointegration relationship. The test shows that there is two cointegration between number of IPOs and four-macroeconomics variables. Second, the VEC model, confirms that there is a long run equilibrium between these factors. It is interesting to note how the speed of adjustment is very rapid (about 5 months to one year), i.e. the UK market is very efficient in terms of response to external shocks, respect for example US market[1]. The variance decomposition and the impulse response plots are reported to complete the analysis. In conclusion, we find that volatility has significant effect on IPO frequency, as evidence by both causality test (Granger-causality and T-Y test). This work concentrates upon UK market for two reasons: (1) is the primary equity market in Europe in term of capitalization, (2) it is the largest stock exchange in Europe in term in number of IPOs[2].

The rest of papers is organized as follows. Section 2 provides an overview of the literature, section 3 the data, in section 4 we present the methodology used to investigate the relationship, and then we discuss the results (section 5). Section 6 offers the main conclusion.

2. A BRIEF LITERATURE REVIEW

A limited number of works have been examination the relation between IPOs and macroeconomic variables, i.e. external factors.

One of the first is the work of Lougran et al. (1994), that analyzed the relation among the timing of IPOs with inflation-adjusted stock price indexes and GDP growth rates in 15 countries. Their results exhibit a positive correlation between number of IPOs and stock price, but not relationship with the business cycle. Rydvist and Högholm (1995) comparing 11 European countries (1980-1989) and family-owned enterprises in Sweden (1970-1991), finding that the going public activity is not correlated to cycle movement, while it is related with the stock price return. The results suggest the going public activity is not correlated to business cycle, while it is related with the stock price return, in particular after a sharp rise in stock price. As regard Germany, Ljungqvist (1995) indicates that frequencies of IPOs are correlated positively with high stock index level and good business condition.

For UK market, Rees (1997), by OLS estimation, shows that the frequency of IPOs exhibits a positive correlation with the stock market level (low and high) and cycle indicator, in spite of interest rates, over the period from 1972 to 1994. Moreover, La Porta et al. (1997, p. 1143) study the impact of economics condition on the number of IPOs, for 49 countries. They find that "the GDP growth rate has a statistically significant effect on the number of IPOs in specifications that control for legal origin; the coefficient estimates indicate that a one percentage point higher historical growth rate raises the number of IPOs by about 0.2". Breinlinger and Glo-

[1]See Tran and Jeon (2011).

[2]In 2015 there were 83 number of IPOs (UK main market; AIM) with a total market value of over 24,923 (£m).

gova (2005) investigated — using an annual panel dataset for 6 continental European countries over 18 years (1980-1997) — the explanatory power of macroeconomic factors IPOs frequency. Their results show how IPOs volume is not explained by GDP growth rate, as well as the interest rates that have not able to "influence demand for raising equity through IPOs".

Lately, the macroeconomic determinants of timing of IPOs, have increase attention of academics. For example, Gleason, Johnston and Madura (2008), measure how risks affect the going public decision. Their findings state that companies going public with high level of volatility, the IPOs risk is much high, especially for firm in the technology sector that decided to be listed on the NASDAQ.

Recently Erel et al. (2011) examined, for US market, how the capabilities of firms to raise funds in the market are affect by macroeconomic conditions, finding that the "influence likely occurs primarily through the effect of macroeconomic conditions on the supply of capital". Considering the macroeconomic condition, the work of Tran and Jeon (2011) investigated this issues in IPO contest. The authors study the impact of macroeconomics variables on IPO activities in US market from 1970 to 2005, by cointegration analysis. By Vector Error Correct model (VECM) and Granger causality, they highlighted a long run relationship between IPO activities and macroeconomic series such as S&P500 performance, monetary policy stance, Treasury bond yield rates. Also, their VEC model is reasonably good in predicting IPO activities (R-squared = 0.75). Furthermore, they provide a useful policy implication for policymakers. To forecast the future wave of IPO activities, they could adopt "adjustment mechanisms that complement or counteract with future IPO-induced consequences in the economy". A similar study is the work of Ameer (2012) for Malaysia market during 1990-2008. Using different methodologies, VECM and Markov switching regression, the author finds that the interest rate has some negative relations between the number of IPOs, while a positive relationship with the business cycle, namely industrial production. The results point out the existence of "hot" and "cold" IPO's regimes depending on how the interest rate changes.

More recently, Meluzín and Zinecker (2014), concern the Czech Republic and Poland markets, investigate the micro and macro aspect of going public. They remark suggest, using a Spearman correlation, a positive and significant association amid the GDP growth rate and the number of IPOs (R-squared = 0.547; p-value = 0.015), as well as with industrial production growth rates (R-squared = 0.504; p-value = 0.028), but they cannot find statistically significant relationships with the reference interest rate in Poland.

2.1. Theoretical Hypothesis

The preceding literature suggests that macroeconomics factors and the IPO frequency are in a relationship. Therefore, we present the following hypothesis that we want to test.

1 Hypothesis:

There is a negative relationship between volatility and the number of IPOs. The general idea is that the uncertainty in stock market can be a disincentive to conduct an IPOs. Theory suggests a positive correlation between volatility (see Schill, 2004; Pastor and Veronesi, 2005), and consistent empirical evidence (Lowry and Schwert, 2002; Bruce, 2014).

2 Hypothesis:

There is a positive relationship between stock performance and IPO frequency. Usually, pessimism market investor sentiment predicts downward pressure in price and viceversa. This is orientation with the timing and sentiment theory, namely the price incorporates the investor's inclination to invest or not, then the frequency of IPOs varies consequently (Baker and Wurgler, 2007). Firms are more likely to going public when the stock market promises higher returns.

3 Hypothesis:

There is a positive correlation between IP growth and number of IPO. Our idea is that the relationships with the number of IPO follow closely with the economic cycle. In fact, when the GDP is high we expect that the volume of IPO will also be high because an increase in output leads to expansionary demand shocks in the economy (Choe et al.,1993).

4 Hypothesis:

There is a negative relationship between interest rate and the number of IPOs. This could be attributed to the fact that firms going to public when the interest rate is high — to reduce the debt cost — and the opposite when it is low (Jovanovic and Rousseau, 2004).

3. DATA AND VARIABLES

The sample is composite of the firm listed on London Stock Exchange (Main Market and Alternative Investment Market) over the period January 1996 — December 2016.

The monthly number of IPOs (N_IPO) were obtained from London Stock Exchange statistics. We select four macroeconomic and financial variables. As a proxy for real economy we choose the Industrial production index (IP)[3]. For financial environment, we selected FTSE100 index (FTSE_100) as a measure of stock market performance, and the market volatility (VOL)

[3]We used a IP instead of GDP because the GDP data is not available on a monthly basis.

for investment risk. Finally, as a measure for long-term financing cost in liabilities we selected the Long-term interest rate (LT). Industrial production index, and 10-years bond yield have been taken from the OCED database, while the FTSE100 index from Datastream. We estimate the annualized market volatility by GARCH (1,1) model. Table 1 shows the source and the unit measure of each variable.

TABLE 1.

Variables

Variable	Unit	Source	Sing Expectation
Number of IPOs	Frequency	London Stock Exchange	
Industrial Production	Index	OECD	+
London Stock market index — FTSE100	Index	Datastream	+
Long-term interest rate on government debt	Percent	OECD	−
Volatility of stock prices	Level	Own calculation on data from Datastream	−

Table 2 gives an overview of descriptive statistics of monthly IPOs and macroeconomic-financial series. During the period 1996-2016, 2973 firms were listed on London Stock Exchange (LSE). We find that the mean of N_IPO is 11.79. It's interesting to note that in the year 2005, there was a record of 405 new firms being listed on LSE, with a maximum in number of monthly IPOs (61). This seems to be driven by a substantial economic upswing during 2004 to 2005 and the good outcome of AIM. After the collapse of Lehman Brothers and the beginning of Global Financial Crisis, there was a very decrease in the number of IPOs. Only in 2013, the N_IPO started to growth. The upward movement of the reference interest rate (LT) displays dramatic changes in default risk during the global financial crisis (2007-08) and reached its peak level of 5.057% in 2012. The average of industrial production index is 104.57, while the highest low values was registered in 2000 (112.52). Finally, regarding the return of financial market was affected from global financial crisis as well as the level of volatility. High levels of this have affected negatively on stock price index, namely on number of IPOs. Figure 1 shows the trend and the evolution of number of IPOs and the volatility of stock market.

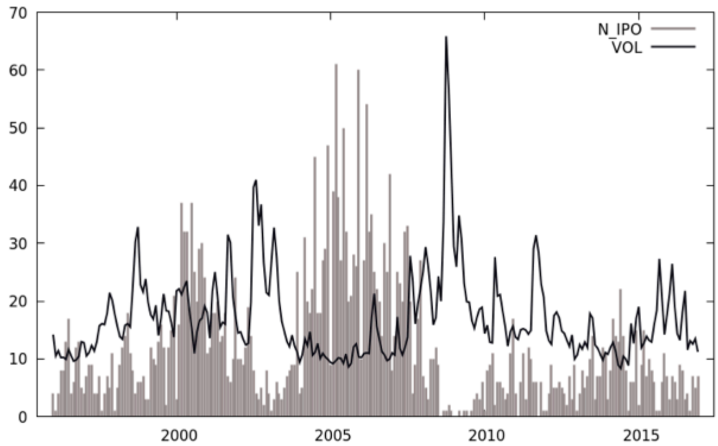
It is interesting to note as there are different periods of IPOs frequencies. There are periods of high activity from 2000 to 2003 and again from 2004 to 2007, and other periods of weaker, such as in 2002-2004 (dotcom bubble) and from 2008 (Lehman-Brothers collapse) onwards. These IPO waves correspond to "hot market and cold market periods" (Pastor and Veronesi, 2005). Furthermore, looking the plot, we can see how the cyclical trend

TABLE 2.

Summary Statistics

	N_IPO	VOL	FTSE_100	IP	LT
Mean	11.797	17.014	5526.8	104.573	4.24178
Median	8.0000	15.956	5719.9	104.57	4.54870
Maximum	61.000	65.851	7011.2	112.521	8.08710
Minimum	0.0000	8.3223	3637.9	93.7995	0.74210
Std. Dev.	11.118	7.6203	911.71	5.41117	1.64078
Skewness	1.7703	2.3942	−0.4313	−0.39556	0.10219
Kurtosis	3.5805	9.2647	−0.9181	−1.42643	−0.24185

FIG. 1. IPOs frequency and volatility



Notes: Monthly Number of IPOs and Annualized Volatility from 1996 to 2016. Source: Own elaboration from London Stock Exchange and Datastream

between the N_IPO (gray line) and the volatility (black line). In fact, moments of elevated level of number of IPOs alternate with periods of low volatility of stock market and vice versa. The volatility shows an upward trend from 2007 onward with a decrease in N_IPO. The global financial crisis affected a high impact of number IPOs. As we can see, the peak of volatility corresponds to minimum value of IPO (zero). This suggest an inverse correlation to these variables. Generally speaking, during periods characterized by economic uncertainty, the number of IPOs fall, as firm decide not to going public (Bruce, 2014; Lowry et al., 2010, Latham and Braun, 2010).

4. METHODOLOGY

This section details the econometrics models utilized to study the linkages between frequency of IPO and macroeconomics variables. We use the classical cointegration analysis. Johansen cointegration approach (2001) to investigate the existence of a cointegration relationship, Vector Error Correction model (VECM) to analyse the dynamic relationship, Granger-causality test (1987) and Toda-Yamamoto causality test (1995), to examine the direction of causality. Our aim is to find some existence of short and long-term relationship between number of IPOs and external factors (market volatility, stock market return, business cycle and interest rate).

4.1. Stationarity test

Economic time series are usually non-stationary, i.e. give a spurious regression and incorrect estimates. For identify the non-stationary condition of variables, we performed Augmented Dickey-Fuller (ADF) unit root test (1979). ADF estimation equation is given as follows:

$$\Delta y_t = \alpha_0 + \alpha_1 t + \delta y_{t-1} + a_i \sum_{i=1}^{p} \Delta y_{t-i} + \varepsilon_t \tag{1}$$

where y_t is the time series variable to be tested (N_IPO), α_0 is the constant, t capture the time trend, δ is the estimated coefficient, ε_t represent the error term, p the maximum lag length. The test relates the null hypothesis of non-stationary ($\alpha = 0$) against the alternative hypothesis of stationary ($\alpha \neq 0$). The number of appropriate lag length is selected using Schwarz Bayesian criterion (SC).

4.2. Cointegration test

Johansen test is used to verify the null hypothesis of no cointegration among IPO frequency and macro factors, against the alternative hypothesis of cointegration. The Johansen tests are likelihood-ratio tests. There are two tests: the trace and the max eigenvalue. The trace (2) and maximum (3) test can be written as

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\lambda_i) \tag{2}$$

$$\lambda_{max}(r, r+1) = -T \ln(1-\lambda_{r+1}) \tag{3}$$

where r is the cointergration vector, T is the size of sample, and λ_i is the largest canonical correlation.

4.3. The VEC model

The Vector Error Correction model is used to examine the short and long-run dynamics relationship. The linear expression can be shown as:

$$\Delta Y_{t,i} = \alpha_i + \gamma_i \beta_i Y_{t-1} + \sum_{z=1}^{n} \Gamma_{j,i} \Delta Y_{t-j,i} + \varepsilon_{t,i} \qquad (4)$$

where $Y_{t,i} \equiv (X_i, M_j)$ is a vector of variables (X_i =N_IPO and M_j = (VOL, FTSE_100, IP, and LT), α is a vector of constant stand for linear trend, Γ is matrix that reflect the short-run relationship, while β_i is the cointegration vector. The error correction coefficient (γ), that should have a negative sign with range $-1 < \gamma < 0$, provide information about the speed of adjustment to the long equilibrium path. This information is very used to understand how the variable react to shock.

4.4. Causality of Granger

By the Granger causality (Engle and Granger, 1987), we want to test that there may exist co-movements i.e. we want to investigate the causality direction between number of IPO and macroeconomics variables and that they have will trend together in finding long run stable equilibrium. Formally, to test causality between economic IPOs activity and external factors and its direction in Granger sense, the following equation to be estimated are specified:

$$X_t = \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{n} \beta_i X_{t-j} + \mu_{1t} \qquad (5)$$

$$Y_t = \sum_{i=1}^{m} \lambda_i X_{t-i} + \sum_{j=1}^{m} \delta_i Y_{t-j} + \mu_{2t} \qquad (6)$$

where X_t, is the number of IPOs, Y_t is the four-macroeconomics variable (VOL, FTSE_100, IP, LT), $\alpha_i, \beta_i, \lambda_i, \delta_i$ are the coefficients, and $\mu_{1;2t}$ are the error terms assumed uncorrelated, and m and n indicate the maximum number of lags. Equation (5) shows how variable X is determinate by lagged value of Y and X, while equation (6) expresses the opposite, that is, how the variable Y is influenced by itself and lagged X variable. On the other hand, Granger-causality signify the lagged Y influence X and the lagged X influence Y (equation 5 and 6 respectively).

4.5. Toda-Yamamoto approach

Toda and Yamamoto method (1995) is a causality test, alternative to Granger causality, to analyse the causation, using Wald statistic (an asymptotic χ^2-distribution) The test is implemented use extra lags and be used independently of order of integration. In fact, the variables can be cointegreted or not. A multivariate VAR($n + z_{max}$) that included the N_IPO and four macroeconomics variables, can be express as follow:

$$X_t = \omega + \sum_{j=1}^{n} \theta_i X_{t-1} + \sum_{j=n+1}^{n+z_{max}} \theta_i X_{t-1} + \sum_{j=1}^{n} \delta_i Y_{t-1} + \sum_{j=n+1}^{n+z_{max}} \delta_i Y_{t-1} + \mu_1 \quad (7)$$

$$Y_t = \psi + \sum_{j=1}^{n} \phi_i Y_{t-1} + \sum_{j=n+1}^{n+z_{max}} \phi_i Y_{t-1} + \sum_{j=1}^{n} \beta_i X_{t-1} + \sum_{j=n+1}^{n+z_{max}} \beta_i X_{t-1} + \mu_2 \quad (8)$$

where X = N_IPO and Y = IP, FTSE_100, VOL, LT respectively; $\omega, \theta, \delta, \psi, \phi, \beta$, are the coefficients; z_{max} is the maximum (optimal number) order of integration, and $\mu_{1;2t}$ are the white-noise errors. The Toda-Yamamoto methodology made of two steps: first the choice of lag length (m) and second the maximum order of integration (z_{max})[4].

5. EMPIRICAL RESULTS

Before testing the linking between macroeconomics variable and the number of IPO, we perform unit-root test for each variable using Augmented Dickey-Fuller (ADF), to ensure the no presence of unit roots. The null hypothesis (H_0) is that the variables are not stationary, namely they have a unit root. For this reason, we perform ADF test (all variables are expressed in natural logarithm). The results (Table 3) show that presence of unit-root at the level (except for VOL that is stationary), and then we use a first difference. On the other hand, these variables are integrated of order 1, and they may evidence any long run combination, according to Engle and Granger (1987). We have to check for the potential existence of long-run relation among them by means of a cointegration test.

For getting the optimal lag, we have use three criteria, the Akaike Information Criteria (AIC), the Schwarz Bayesian Criteria (BIC), and the Hannan-Quinn Criteria (HQC). According to them, the appropriate number of lag should be 2 (see Table 4).

Thus, if all series are stationary then we will reject the hypothesis of no relationship between them even when none exists. For there to be a long-run relation between the variables, them must be cointegrated. For this reason, we perform the Johansen and Juselius (1990) test of cointegration between number of IPOs and the four macroeconomics series.

Table 5 summaries the results of Johnson test, performed with 1 to 2 number of lags. The trace and maximum test suggest the existence of two cointegration relationship between number of IPO and the four macroeco-

[4]In according to FPE, AIC and HQ test we selected 2 number of lags, then for T-Y causality the maximum order of integration $z_{max} = 3$.

TABLE 3.

Augmented Dickey-Fuller (ADF) test

Variables	Log level	Log differences
N_IPO	$-3.36[3]$	$-15.88[2]^{***}$
VOL	$-4.92[0]^{***}$	
FTSE_100	$-2.18[0]$	$-13.79[0]^{***}$
IP	$-2.09[1]$	$-19.01[0]^{***}$
LT	$-2.50[2]$	$-11.23[0]^{***}$

Notes: T-statistics are reported. (*) stand for statistical significance at 10%; (**) stand for statistical significance at 5%; (***) stand for statistical significance at 1%

TABLE 4.

Lag structure

Lag	LogL	FPE	AIC	SC	HQ
1	1463.235	$5.44e-12$	-11.74783	-11.31785^{*}	-11.57466
2	1521.691	$4.14e-12^{*}$	-12.02205^{*}	-11.23376	-11.70457^{*}
3	1540.583	$4.35e-12$	-11.97199	-10.82538	-11.51020
4	1561.365	$4.51e-12$	-11.93742	-10.43249	-11.33132
5	1583.040	$4.64e-12$	-11.91017	-10.04692	-11.15975
6	1605.110	$4.77e-12$	-11.88614	-9.664583	-10.99142
7	1622.859	$5.08e-12$	-11.82671	-9.246832	-10.78768
8	1635.708	$5.64e-12$	-11.72711	-8.788918	-10.54377

Notes: (*) indicate the best value of the respective information criteria. FPE = Final Prediction Error, AIC = Akaike criterion, SC = Shawarz Bayesian criterion, HQ = Hannan-Quinn criterion.

TABLE 5.

Johansen's cointergration results

Hypothesized	Trace	Max-Eigen	Critical Value (5%)	
No. of CE(s)	Statistic	Statistic	Trace	Max
$r = 0$	140.9619	90.08466	69.81889^{***}	33.87687^{***}
$r \leq 1$	50.87726	35.21404	47.85613^{***}	27.58434^{***}
$r \leq 2$	15.66322	10.92590	29.79707	21.13162
$r \leq 3$	4.737322	3.596574	15.49471	14.26460
$r \leq 4$	1.140748	1.140748	3.841466	3.841466

Notes: Trace and Max eigenvalue indicate 2 cointegration equation at 1%; (***) indicate the rejection of null hypothesis at 1%.

nomic variables. The implication is that even though the series (N_IPO, VOL, FTSE, IP and LT) are not individually stationary, but their linear combination is stationary. This imply that exist a long-run equilibrium relationship among the variables.

5.1. Dynamic relationship

After having identified the existence of long-run equilibrium, we perform the Vector Error Correction model (VECM) in order to explore the dynamics relationship among number of IPOs and the macroeconomics variables. Thanks this method, we can check if there is any correction mechanism when the IPO's number diverge from long-run equilibrium path. Table 6 reports the final estimated equation.

TABLE 6.

Summary results from VECM

$ECT_1(-1)$	-0.69^{***}
$ECT_2(-1)$	-0.97^{***}
Adjusted R^2	0.35
Durbin-Watson	2.03
Heteroskedasticity Test	0.13
LM Test	0.14

Notes: 1 shows the VECM with 2 lags; 2 shows that VECM with 3 lags; (*) stand for statistical significance at 10%; (**) stand for statistical significance at 5%; (***) stand for statistical significance at 1%

The estimation results of error-correction models indicate that the all error term coefficients have correct sign (negative) and they are statistically significant at 1%. The corresponding adjustment speeds to equilibrium is about 69% and 97% respectively. Large absolute values of the coefficient show equilibrium agents remove a large percentage of disequilibrium in each period. The ECT imply that 69% negative deviations in time period $t-1$ in the N_IPO is correct in monthly t. It is interesting to note that the coefficient of error-term is very large in contrast to other studies[5]. This imply that the speed of adjustment is very rapid, i.e. the UK market is very efficient in terms of response to external shocks. We use the estimated coefficient of error-correction (ECT), for computed the time required of halfway adjustment, following Tran and Jeon (2011). The disequilibrium from long-run values are corrected approximately in 5

[5]For example, Tran and Jeon (2011) find that coefficient of error-term is -0.13, for US market, while Ammer (2012) for Malaysia market, finds that is -0.17. This suggest a very low adjustment for these markets respect to UK.

months[6]. The explanatory variables explain about 35% of the variations in number of IPOs. Furthermore, there is no serial autocorrelation as provide by Durbin-Watson test (2.035), LM test that rejects the hypothesis of serial correlation and the Breusch-Pagan-Godfrey test that indicate the absence of heteroskedasticity. The results support that the variables constitute a cointegrated set. For obtain more insight into the structure of the linkages between number of IPOs and the macroeconomic variables, we computed the forecast error variance decompositions (FVD) and impulse response functions (see Table 7 and Figure 2). This allows us mainly to determine the pertinent magnitude of each macroeconomic variable in generating variations in N_IPO, principally one, fifteen and twenty-five month ahead forecast error variances. It shows that the volatility, the FTSE 100 stock price index and the business cycle are the most powerful part to spread the variance in the forecast error of the number of IPOs, which accounts for 22.72%, 9.89%, 14.34% respectively, after two years. Specially the volatility growths month-to-month until the 25th period, where the decline begins, while IP continues to be increasingly important, (such as LT), of the variation in the forecast error.

TABLE 7.

Variance Decomposition

Period	N_IPO	VOL	FTSE_100	IP	LT
1	100.0000	0.000000	0.000000	0.000000	0.000000
2	93.82323	5.144232	0.000635	0.132341	0.899565
3	86.56032	10.82273	1.328472	0.432445	0.856035
4	79.45283	14.88113	3.000652	1.816353	0.849038
5	74.54006	17.57136	4.206864	2.821774	0.859945
10	62.56483	22.58106	7.372707	6.486375	0.995036
15	57.21395	23.28659	8.650234	9.486173	1.363048
20	53.65914	23.11198	9.379252	12.06833	1.781291
25	50.84660	22.72832	9.893929	14.34067	2.190480

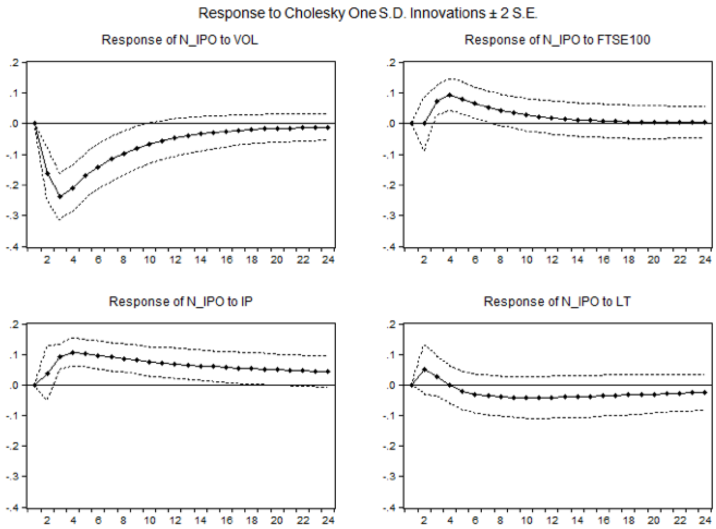
Notes: Multivariate VEC estimates of N_IPO and four macroeconomic variables. The number of lags (in first differences) in the VAR specifications are 1 to 2.

The Impulse Response Functions (IRFs) consent us to explore how the shock of a variable impacts on the other, i.e. the response of a variable to a shock in the other. More specifically, we employ IRF to investigate how the number of IPOs respond to one standard deviation shock of volatility, stock market return, business cycle and interest rate. IRFs are computed for a horizon of 24 month (2 years). Figure 2, shows the dynamic response

[6]In formula $\ln(1-0.5)/\ln(1-\alpha)$, where α is the coefficient of error correction in the VECM.

of N_IPO to a shock in VOL, FTSE_100, IP and LT, suggests that the series do not show volatile comportment. In fact, mostly effects are erase within 24 months, except for industrial production. Also, on inspecting these graphs, it would seem that the FTSE100 and IP index play a crucial role of the IPO frequencies and, the negative influence of volatility and the positive influence of IP and market return are confirmed. In the first 3-5 month, a shock in the FTSE100 and IP cause an increase in the number of IPO. The positive effect of FTSE100 and business cycle on IPOs could be attributed to the fact that when the macroeconomic conditions increase, as well as good performance of financial market then the firms are encouraged to going to public. Obviously, the opposite when it comes to a shock in volatility. Finally, a shock in LT affect positively the IPOs in the short period. This result could be attributed to the fact that firms going to public when the interest rate is high (to reduce the capital cost), and the opposite when it is low.

FIG. 2. The impulse Response



Notes: The figures plot the impulse response with respect to a one standard deviation shock. The dotted red lines indicate one standard deviation error at 95% confidential interval.

To test the direction of the long run causal relationship between number of IPOs and macroeconomics variables, we report in Table 8 the result of Granger causality test (Engle and Granger, 1987). The Granger test supports the results, that three macroeconomic variables granger causes the N_IPO. Volatility (VOL), Industrial production (IP) and the 10-year interest rate (LT) have a causal relationship with the number of IPOs. These variables play an important part in Granger-causing the number of IPOs. Furthermore, the return of stock market return has not influenced the number of IPOs. This result is contrary with Ress (1997), who have provided a positive relationship between equity market returns and IPOs, rather to business cycle. In addition, in the Ress (1997) study, the interest rate is influential ("no significant link can be established between the value of IPOs in a quarter year with the business cycle, nor with interest rates") in disagreement with our results. It seems that from 1996 the companies are much more attentive to the performance of the bond market, since in the low interest rate age they find it cheaper to be indebted than to trade. This is a very important achievement that makes it possible to understand how in recent years the listing is a function of corporate policies (marketing, international visibility), rather than a policy aimed at reducing the cost of financing capital.

TABLE 8.

Granger causality

Null Hypothesis:	F-Statistic	Prob.
VOL does not Granger Cause N_IPO	8.1568	0.000^{***}
FTSE_100 does not Granger Cause N_IPO	1.4811	0.229
IP does not Granger Cause N_IPO	5.2023	0.006^{***}
LT does not Granger Cause N_IPO	5.1694	0.006^{***}

Notes: (*) stand for statistical significance at 10%; (**) stand for statistical significance at 5%; (***) stand for statistical significance at 1%

The T-Y test show, first that it is possible to reject the null hypothesis of no causality at 1% significance level, from VOL to N_IPOs. Second, we cannot reject the null hypothesis concerning the stock market return, industrial production (business cycle), and the interest rate. On the other hand, as Granger test shows, is the volatility that plays the most role for explain the IPO frequency. This mean that UK firms are more likely to going public when volatility ceteris paribus are very low.

6. CONCLUSIONS

In this work, we studied the determinants of IPOs in UK. We investigated the dynamic link between Initial Public Offerings and macroeconomic variables in UK market during the period from 1996 to 2016. In order to understand these relationship, we have adopted different time-series econometrics techniques. After establishing the non-stationarity and the order of integration of each series (as results show all data series are integrated of order one), Johansen's cointegration technique was applied to investigate the

TABLE 9.

Toda-Yamamoto: modified Wald tests

Dependent variable: N_IPO			
Excluded	Chi-sq	df	Prob.
VOL	8.2444	2	0.016***
FTSE_100	0.9179	2	0.631
IP	0.3733	2	0.829
LT	2.7116	2	0.257
All	32.516	8	0.000

Notes: Dependent variable: N_IPO; (*) stand for statistical significance at 10%; (**) stand for statistical significance at 5%; (***) stand for statistical significance at 1%

long-run relationship between frequency of IPOs and four macroeconomics variables. The findings show that there are two cointegration relationship among these variables, in particular the volatility of stock market plays the most important role for going public time decision. Furthermore, we performed a VECM for tested the stability of equilibrium and to capture the dynamic interdependencies among the macro environment. The coefficients of the error-correction term of number of IPO are statistically significative at 1% and it carries the correct negative sign, showing that any case of disequilibrium, the system will convergence very fast for restoring the long run equilibrium position. Finally, we used two methodologies to analyse the direction and the causal relationship between macro variables and number of IPOs: the Granger-causality — conventional approach — and the Toda-Yamamoto test. The results show that there is a significant causal between variables and point out that volatility, industrial production, and interest rate Granger cause with number of IPOs, differently for T-Y where only the volatility cause the N_IPO. Thus, firms who are interested to going public in UK should pay more attention to the above mentioned macroeconomic variables.

An improvement of this work, involves the possibility to extend the dataset, for example add different countries (European countries, such as Germany, France, Spain), to explore possible spillovers effect between different markets. Second a modification of the methodology and the explanatory variables (IPOs proceeds, exchange rate, changes in savings deposits) through Principal Component Analysis in order to provide — from a macro and micro point of view — which variables (components) are most important for going public decision.

REFERENCES

Ameer, Rashid, 2012. Macroeconomic factors and initial public offerings (IPOs) in Malaysia. *Asian academy of management journal of accounting and finance* **8(1)**, 41-67.

Baker, Malcolm and Jeffrey Wurgler., 2007. Investor sentiment in the stock market. *The Journal of Economic Perspectives* **21(2)**, 129-151.

Bollerslev, Tim, 1986. Generalized Autoregressive Conditional Heteroscedasticity. *Journal of Econometrics* **31**, 307-327.

Breinlinger, Luise and Evgenia Glogova, 2002. Determinants of Initial Public Offerings-A European Time-Series Cross-Section Analysis. *Financial Stability Report* **3**, 87-106.

Bruce, Alex AA, 2014. IPO Stocks Performance Imperfection: A Review of Models and Empirical Works. *American Journal of Industrial and Business Management* **4**, 155-166.

Choe, Hyuk, Ronald W. Masulis, and Vikram Nanda, 1993. Common stock offerings across the business cycle: Theory and evidence. *Journal of Empirical finance* **1(1)**, 3-31.

Dickey, David A. and Wayne A. Fuller., 1979. Distribution of the Estimates for Autoregressive Time Series with Unit Root. *Journal of the American Statistical Association* **74(366a)**, 427-31.

Engle, Robert F., 1982. Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica* **50**, 987-1007.

Engle, Robert F. and Clive WJ Granger, 1987. Co-integration and error correction: representation, estimation, and testing. *Econometrica* **55**, 251-276.

Erel, I., B. Julio, W. Kim, and M. S. Weisbach, 2012. Macroeconomic conditions and capital raising. *Review of Financial Studies* **25(2)**, 341-376.

Gleason, Katherine, James Johnston, and Jeff Madura, 2008. What factors drive IPO aftermarket risk?. *Applied Financial Economics* **18(13)**, 1099-1110.

Johansen, SØren and Katarina Juselius, 1990. Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics* **52(2)**, 169-210.

Jovanovic, Boyan and Peter L. Rousseau, 2004. Interest rates and initial public offerings. National Bureau of Economic Research w10298.

La Porta, R., F. Lopez-De-Silanes, A. Shleifer,and R. W. Vishny, 1997. Legal determinants of external finance. *The journal of Finance* **52(3)**, 1131-1150.

Latham, Scott and Michael R. Braun, 2010. To IPO or not to IPO: Risks, uncertainty and the decision to go public. *British Journal of Management* **21(3)**, 666-683.

Ljungqvist, Alexander P., 1995. When do firms go public? Poisson evidence from Germany, Working paper, University of Oxford.

Loughran, Tim, Jay R. Ritter, and Kristian Rydqvist, 1994. Initial public offerings: international insights. *Pacific Basin Finance Journal* **2(2)**, 165-200.

Lowry, Michelle and G. William Schwe, 2002. IPO market cycles: Bubbles or sequential learning? *The Journal of Finance* **57(3)**, 1171-1200.

Lowry, Michelle, Micah S. Officer, and G. William Schwert, 2010. The variability of IPO initial returns. *The Journal of Finance* **65(2)**, 425-465.

Meluzín, Tomáš and Marek Zinecker, 2014. Macro-and Microeconomic aspects of going Public in the Czech Republic and Poland. *Procedia-Social and Behavioral Sciences* **156**, 558-563.

Pástor, Luboš and Pietro Veronesi, 2005. Rational IPO waves. *Journal of Finance* **60(4)**, 1713-1757.

Rees, William P., 1997. The arrival rate of initial public offers in the UK. *European Financial Management* **3(1)**, 45-62.

Rydqvist, Kristian and Kenneth Högholm, 1995. Going public in the 1980s: Evidence from Sweden. *European Financial Management* **1(3)**, 287-315.

Schill, Michael J., 2004. Sailing in Rough Water: Market Volatility and Corporate Finance. *Journal of Corporate Finance* **10(5)**, 659-681.

Toda, Hiro Y. and Taku Yamamoto, 1995. Statistical inference in Vector Autoregressions with possibly integrated processes. *Journal of Econometrics* **66(1)**, 225-250.

Tran, Anh L. and Bang Nam Jeon, 2011. The dynamic impact of macroeconomic factors on initial public offerings: Evidence from time series analysis. *Applied Economics* **43(23)**, 3187-3207.