Economics Letters 171 (2018) 10–13

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Financial market activity under capital controls: Lessons from extreme events

Konstantinos Gkillas [a], François Longin [b,*]

[a] Department of Business Administration, University of Patras, University Campus – Rio, P.O. Box 1391, Patras 26500, Greece
[b] Department of Finance, ESSEC Business School, 1 Avenue Bernard Hirsch B.P. 50105, 95021 Cergy-Pontoise Cedex, France

HIGHLIGHTS

- We investigate the relation between extreme return and transaction volume under the restrictions on transactions.
- We use bivariate extreme value theory to model the tail dependence structure.
- We show that restrictions on transactions have an impact on the activity of market participants.
- We propose an alternative intervention policy framework in times of strict fiscal austerity based on circuit-breaker mechanism.

ARTICLE INFO

Article history:
Received 16 April 2018
Received in revised form 27 June 2018
Accepted 2 July 2018
Available online 4 July 2018

JEL classification:
C46
F38
G01
G32

Keywords:
Capital controls
Extreme value theory
Return–volume dependence

ABSTRACT

We investigate the contemporaneous relation between return and transaction volume in distribution tails under the restrictions on transactions due to the capital controls implemented on the Athens Stock Exchange in July 2015. We use bivariate extreme value theory to model the tail dependence structure. We show that restrictions on transactions have an impact on the activity of market participants.

1. Introduction

During a financial crisis of a domestic origin (like uncontrollable budget deficits), policy-makers and especially regulators for the financial sector often consider medium-term or long-term distortions prior to the implementation of strict intervention policies such as capital controls. Restrictions on capital outflows have been occasionally implemented in order to avoid a stock market crash with panic selling from investors. The existing literature on this topic has paved the way to different points of view. Krugman (1998) supports the imposition of capital controls as a crisis management tool for stabilization. Alesina et al. (1993), among others, point out that capital restrictions may harm macroeconomic performance and cause trading distortions (see Gkillas et al., 2016).

Considering the issue of the imposition of capital controls by domestic authorities to limit the extent of a crisis, it is important to understand the behavior of market participants during extreme events in financial markets. In economic models, the behavior of market participants has been measured by the transaction volume. Empirical studies have shown a positive relation between the absolute value of return and transaction volume (see Karpoff, 1987). However, a different result is obtained when focusing on extremely volatile periods, according to the studies of Balduzzi et al. (1996) and Longin and Pagliardi (2016). Such a result is consistent with the model of misinterpretation of news by market participants developed by Gennotte and Leland (1990).

In this paper, we study the impact of restrictions on transactions on the return–volume relation in equity markets. To this end, we apply bivariate extreme value theory on return exceedances and transaction volumes on the contemporaneous tail dependence structure. We investigate the effect of capital controls by studying

* Corresponding author.
E-mail addresses: gillask@upatras.gr (K. Gkillas), longin@essec.edu (F. Longin).

https://doi.org/10.1016/j.econlet.2018.07.004

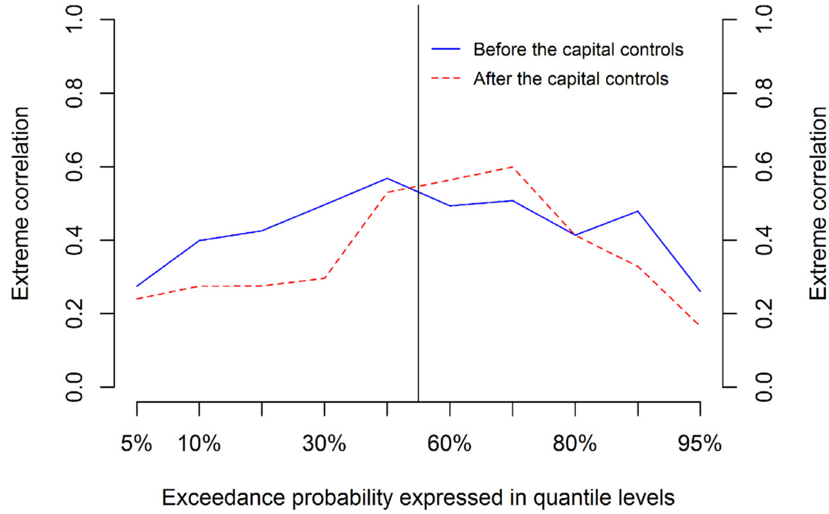

Fig. 1. Extreme correlation before and after the capital controls.

the change in the dependence structure following the implementation of restrictions on transactions due to capital controls on the Athens Stock Exchange in July 2015. We focus on Greece as it is a unique example of such austerity policies due to the EU-IMF fiscal consolidation program. We propose a parametric bootstrap bias-corrected approach comparing dissimilarly-sized samples.[1] Based on our findings we propose an alternative intervention policy framework in times of strict fiscal austerity.

2. Methodology

Firstly, we fit a general Pareto distribution (GPD) for the marginal distribution for returns and transaction volumes by using the peaks-over-threshold method. Secondly, we model the tail dependence structure via a bivariate threshold excess model by estimating the extreme correlation coefficient. We also propose a parametric bootstrap bias-corrected approach to reduce the estimation bias in this coefficient.

In the univariate case, the distribution of exceedances $(X - u)$ of a random variable X over a threshold u can be asymptotically approximated by the GPD, defined by:

$$G_{\xi,\sigma}(x) = 1 - p\left\{1 + \frac{\xi x}{\sigma}\right\}^{-1/\xi}, x > u \tag{1}$$

where x represents the exceedance variable, σ the scale parameter, ξ the tail index and p the tail probability.

In the bivariate case, following Longin and Solnik (2001), the dependence of $(X_1 - u_1, X_2 - u_2)$ exceedances can be modeled by a Gumpel copula, based on the logistic model, defined by:

$$G_\alpha(x_1, x_2) = exp\left\{-\log\left[-1/\log G_1^{u_1}(x_1)\right]^{-1/\alpha} - \log\left[-1/\log G_2^{u_2}(x_2)\right]^{-1/\alpha}\right\}^{\alpha} \tag{2}$$

where α represents the dependence parameter related to the extreme correlation coefficient ρ by $1 - \alpha^2$.

We apply an iterative algorithm of k-steps to compute the extreme correlation coefficient at different tail probability levels p. In each step, we compute the threshold u from the tail probability p for return exceedances and we obtain the corresponding contemporaneous values for the transaction volume.

[1] A R code for the bias-corrected procedure is available from the authors.

In the parametric bootstrap case, we simulate from a bivariate extreme value distribution of a logistic type model following Stephenson (2003). Applying this procedure, we avoid misleading results when comparing samples of different size and limited number of observations. Hence, we define the bias-corrected bootstrap coefficient $\tilde{\rho}^b$ for the extreme correlation by:

$$\tilde{\rho}^b = B^{-1}\sum_{j=1}^{B}\tilde{\rho}_j^b(\rho) \tag{3}$$

where B corresponds to the length of the bootstrap samples.

3. Empirical results

The dataset consists of daily returns and transaction volumes from the General Index of the Athens Stock Exchange (ASE) for the period spanning from January 1st 2001 to March 31st 2017 (4021 observations). We define two sub-periods: before and after June 27th 2015 when the Greek domestic authorities imposed capital controls on banking outflow funds and restrictions on transactions in any financial asset. As already emphasized by the academic literature (see Cronin et al., 2016; Hondroyiannis and Papaoikonomou, 2017; Legrenzi and Milas, 2013; Meghir et al., 2017; Tagkalakis, 2014), Greece is a unique example of such austerity policies due to the EU-IMF fiscal consolidation program.

Table 1 reports the parameters' estimates for the bivariate extreme value distribution: the tail probability p, the scale parameter σ, the tail index ξ for the distribution tail of each variable, as well as for the dependence parameter α and for the bootstrap bias-corrected coefficient of the extreme correlation $\tilde{\rho}^b$ using 10,000 bootstrap samples. We also apply a Wald test for the null hypothesis: $H_0 : \tilde{\rho}^b_{Before} = \tilde{\rho}^b_{After}$ to statistically compare the extreme correlation in the two sub-periods.

Panel A reports the estimates for the sub-period before the impositions of capital controls. As for the negative return exceedances (left distribution tail), the extreme correlation coefficient declines from 0.568 for $p = 40\%$ to 0.274 for $p = 5\%$. As for the positive return exceedances (right distribution tail), the extreme correlation coefficient declines from 0.468 for $p = 60\%$ to 0.262 for $p = 95\%$. Panel B reports the estimates for the sub-period after the impositions of capital controls. As for the negative return exceedances, the extreme correlation coefficient declines from 0.529 for $p = 40\%$ to 0.240 for $p = 5\%$. As for positive return exceedances, the extreme

Table 1
Estimation of bivariate distribution of return exceedances and transaction volume.

Panel A: Before capital controls

p	Return exceedances			Transaction volume			Dependence		Wald test
	u_r	σ_r	ξ_r	u_v	σ_v	ξ_v	α	$\tilde{\rho}^b_{Before}$	$H_0 : \tilde{\rho}^b_{Before} = \tilde{\rho}^b_{After}$
Negative return exceedances and positive volume									
5%	−3.06%	0.0148	0.0115	16.0892	2.3710	−0.6263	0.8550	0.2745	0.5986
		(0.0015)	(0.0716)		(0.1872)	(0.0525)	(0.0619)	(0.0360)	(0.5494)
10%	−2.15%	0.0132	0.0847	15.6043	2.7976	−0.6586	0.7870	0.3988	2.5996
		(0.0010)	(0.0657)		(0.1279)	(0.0295)	(0.0465)	(0.0262)	(0.0093)
20%	−1.26%	0.0107	0.1700	15.2662	2.8024	−0.6121	0.7885	0.4254	3.7619
		(0.0002)	(0.0344)		(0.0463)	(0.0089)	(0.0329)	(0.0183)	(0.0002)
30%	−0.73%	0.0121	0.1581	14.9647	3.0225	−0.6194	0.6810	0.4962	5.4496
		(0.0006)	(0.0442)		(0.0372)	(0.0065)	(0.0241)	(0.0147)	(0.0000)
40%	−0.32%	0.0119	0.1504	14.9647	2.7782	−0.5694	0.7053	0.5682	1.1023
		(0.0019)	(0.0241)		(0.0233)	(0.0037)	(0.0198)	(0.0119)	(0.2703)
Positive return exceedances and positive volume									
60%	0.35%	0.0105	0.1444	15.2700	2.3572	−0.4622	0.7168	0.4936	2.7698
		(0.0048)	(0.0227)		(0.0614)	(0.0131)	(0.0219)	(0.0129)	(0.0056)
70%	0.70%	0.0108	0.1300	15.4383	2.2132	−0.4469	0.7067	0.5072	2.5082
		(0.0020)	(0.0244)		(0.0661)	(0.0152)	(0.0228)	(0.0148)	(0.0121)
80%	1.16%	0.0104	0.1357	15.4383	2.4895	−0.5037	0.7665	0.4136	0.0216
		(0.0020)	(0.0286)		(0.0959)	(0.0212)	(0.0309)	(0.0184)	(0.9827)
90%	1.97%	0.0110	0.2363	15.7617	2.4169	−0.5235	0.7225	0.4789	3.0323
		(0.0021)	(0.0544)		(0.1279)	(0.0295)	(0.0424)	(0.0264)	(0.0024)
95%	2.82%	0.0132	0.1361	16.1918	2.2416	−0.5332	0.8589	0.2609	2.4934
		(0.0015)	(0.0905)		(0.1786)	(0.0471)	(0.0585)	(0.0358)	(0.0127)

Panel B: After capital controls

p	Return exceedances			Transaction volume			Dependence		Wald test
	u_r	σ_r	ξ_r	u_v	σ_v	ξ_v	α	$\tilde{\rho}^b_{After}$	$H_0 : \tilde{\rho}^b_{Before} = \tilde{\rho}^b_{After}$
Negative return exceedances and positive volume									
5%	−3.15%	0.0136	0.2820	17.5733	2.1021	−0.9452	0.8774	0.2405	0.5986
		(0.0034)	(0.2070)		(0.3564)	(0.1647)	(0.1785)	(0.0208)	(0.5494)
10%	−1.99%	0.0108	0.0738	16.4864	1.9668	−0.7954	0.8818	0.2748	2.5996
		(0.0824)	(0.1033)		(0.3018)	(0.1341)	(0.1490)	(0.0215)	(0.0093)
20%	−1.12%	0.0106	0.3113	16.4864	3.3373	−0.8621	0.8755	0.2753	3.7619
		(0.0994)	(0.1248)		(0.1649)	(0.0398)	(0.1267)	(0.0216)	(0.0002)
30%	−0.65%	0.0103	0.2922	16.4864	3.1095	−0.7941	0.8629	0.2962	5.4496
		(0.0049)	(0.1052)		(0.3040)	(0.0863)	(0.1136)	(0.0220)	(0.0000)
40%	−0.19%	0.0122	0.2356	16.4864	2.8095	−0.7200	0.6991	0.5294	1.1023
		(0.0014)	(0.1030)		(0.2206)	(0.0587)	(0.0646)	(0.0233)	(0.2703)
Positive return exceedances and positive volume									
60%	0.38%	0.0109	0.0708	15.6602	4.1103	−0.8634	0.6748	0.5634	2.7698
		(0.0042)	(0.0520)		(0.1785)	(0.0358)	(0.0582)	(0.0123)	(0.0056)
70%	0.76%	0.0108	0.0785	16.7364	2.9013	−0.8429	0.6478	0.5990	2.5082
		(0.0079)	(0.0641)		(0.2446)	(0.0750)	(0.0691)	(0.0218)	(0.0121)
80%	1.20%	0.0102	0.1106	17.5861	1.7223	−0.6644	0.7817	0.4127	0.0216
		(0.0080)	(0.0852)		(0.1891)	(0.0783)	(0.0919)	(0.0232)	(0.9827)
90%	2.10%	0.0108	0.0288	17.7041	1.8840	−0.7488	0.8375	0.3288	3.0323
		(0.0016)	(0.0847)		(0.3139)	(0.1490)	(0.1268)	(0.0231)	(0.0024)
95%	2.87%	0.0106	0.0709	18.0521	1.5058	−0.6818	0.9344	0.1659	2.4934
		(0.0040)	(0.1332)		(0.3673)	(0.2316)	(0.2208)	(0.0023)	(0.0127)

correlation coefficient declines from 0.563 for $p = 60\%$ to 0.165 for $p = 95\%$.

Comparing the extreme correlation in the tails, we find that there are differences at the 5% confidence level. We also conclude that there is a significant discrepancy before and after the capital controls. We reject the null hypothesis $H_0 : \tilde{\rho}^b_{Before} = \tilde{\rho}^b_{After}$ at the 5% confidence level, as the Wald test suggests, in majority of tail probability levels p.

From an economic point of view, we re-confirm the model of Gennotte and Leland (1990), which does not imply a positive correlation between returns and transaction volume during booms and crashes.

Fig. 1 represents the evolution of the extreme correlation for different thresholds for both sub-periods. It illustrates the impact of the restrictions to transactions due to capital controls on the dynamics of market activity.

4. Implications for intervention policy

From the viewpoint of intervention policy, taking into consideration the significant change in correlation between returns and transaction volume following the restrictions on transactions, an alternative framework could be applied to mitigate the apparition of negative extreme events. As Koulakiotis et al. (2015) point out, trading volume moderates the conditional price volatility in the ASE during the period of the Greek crisis and before the imposition of capital controls. This means that by improving liquidity conditions via transaction volume, the domestic authorities could "nudge" investors away from panic, in order to avoid the occurrence of negative extreme events as the market moves downwards. This can be achieved by an automatic short-term or intra-day circuit-breaker mechanism when the market moves downwards and exceeds a specific threshold, instead of the long-term closing of the market as happened in June 2015, thus avoiding long-term ineffective distortions ranging from financial markets to the real economy (see Booth and Broussard (1998) for an application of extreme value theory to set circuit breaker triggers).

5. Conclusion

We investigate the impact of restrictions on transactions due to capital controls in the ASE on the tail dependence structure of return exceedances and transaction volumes using bivariate extreme value theory. We propose a parametric bootstrap bias-corrected approach to obtain more accurate results comparing dissimilarly-sized samples. We find that the dependence is weaker after the imposition of restrictions on transactions due to capital controls. Finally, our findings lead us to recommend a new framework for intervention policy.

Acknowledgments

The authors would like to thank the anonymous referee for helpful suggestions. Konstantinos Gkillas also gratefully acknowledges research support by the General Secretariat for Research and Technology (GSRT) and Hellenic Foundation for Research and Innovation (HFRI).

References

Alesina, A., Grilli, V., Milesi-Ferrett, G., 1993. The political economy of capital controls. Vol. 4353. NBER.

Balduzzi, P., Kallal, H., Longin, F., 1996. Minimal returns and the breakdown of the price–volume relation. Econ. Lett. 50, 265–269.

Booth, G.G., Broussard, J.P., 1998. Setting NYSE circuit breaker triggers. J. Financ. Serv. Res. 13, 187–204.

Cronin, D., Flavin, T.J., Sheenan, L., 2016. Contagion in eurozone sovereign bond markets? the good, the bad and the ugly. Econ. Lett. 143, 5–8.

Gennotte, G., Leland, H., 1990. Market liquidity, hedging, and crashes. Amer. Econ. Rev. 80, 999–1021.

Gkillas (Gillas), K., Tsagkanos, A., Siriopoulos, C., 2016. The risk in capital controls. Financ. Res. Lett. 19, 261–266.

Hondroyiannis, G., Papaoikonomou, D., 2017. The effect of card payments on VAT revenue: New evidence from Greece. Econ. Lett. 157, 17–20.

Karpoff, J.M., 1987. The relation between price changes and trading volume: a survey. J. Finan. Quant. Anal. 22, 109–126.

Koulakiotis, A., Babalos, V., Papasyriopoulos, N., 2015. Liquidity matters after all: Asymmetric news and stock market volatility before and after the global financial crisis. Econ. Lett. 127, 58–60.

Krugman, P., 1998. Saving Asia: it's time to get radical. Fortune-European Edition 138, 26–30.

Legrenzi, G., Milas, C., 2013. Modelling the fiscal reaction functions of the GIPS based on state-varying thresholds. Econ. Lett. 121, 384–389.

Longin, F., Pagliardi, G., 2016. Tail relation between return and volume in the US stock market: An analysis based on extreme value theory. Econ. Lett. 145, 252–254.

Longin, F., Solnik, B., 2001. Extreme correlation of international equity markets. J. Finance 56, 649–676.

Meghir, C., Christopher, Pissarides, Dimitri, Vayanos, Nikolaos, Vettas, 2017. Beyond Austerity. Reforming the Greek Economy. The MIT Press, Cambridge MA.

Stephenson, A.G., 2003. Simulating multivariate extreme value distributions of logistic type. Extremes 6, 49–60.

Tagkalakis, A.O., 2014. Credit and the transmission of fiscal policy shocks: Recent evidence from Greece. Econ. Lett. 122, 263–267.