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Price clustering and economic freedom: The case of cross-listed securities

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ABSTRACT

This study develops and tests the hypothesis that economic freedom in a particular country can explain the level of price clustering in financial markets. The hypothesis is motivated by the idea that the lack of economic freedom may create uncertainty, which motivates investors to settle on round prices. Using a broad sample of American Depositary Receipts (ADRs), we find that the level of price clustering in ADRs is decreasing in the economic freedom of the home country. The economic freedom components that have the largest effects are the level of regulation and the stability of monetary policy in the ADR home country. To make stronger causal inferences, we examine the price clustering of Japanese, vis-à-vis non-Japanese, ADRs in response to an event that tightened regulation in Japanese money markets. Results show that, relative to non-Japanese ADRs, the price clustering of Japanese ADRs meaningfully increases in response to this change.

1. Introduction

The foundation of microeconomic theory is based on the formation of equilibrium prices. In financial economics, the efficient markets hypothesis posits that changes in asset prices follow a random walk (Malkiel and Fama, 1970). One of the implications of the random walk model is that changes in prices should be distributed randomly across all pricing increments. However, a number of studies show that prices tend to cluster on round increments. The notion that asset prices cluster on round increments is not new. For instance, Osborne (1962) and Niederhoffer and Osborne (1996) first documented that stock prices cluster more heavily on integers than other pricing increments. Similar results are found in Ball et al. (1985), who propose that the observed clustering can be explained by price resolution. They argue that when trading, counter parties face costs associated with continued negotiations. In order to mitigate the costs of further negotiations, the counter parties will settle on round prices. To the extent that enough market participants behave in such a way, observed prices will tend to cluster on round prices. Harris (1991) finds evidence of the price resolution hypothesis when examining equity

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markets. Several studies have attempted to identify factors that influence the level of price clustering. For instance, a broad literature examines price clustering associated with the quoting behavioral of market makers both generally and in response to trading-rule changes (Christie and Schultz, 1994; Christie et al., 1994; Bessembinder, 1999, 2003; Chung et al., 2004, 2005). Other studies show that tick sizes and short-sale constraints also explain the presence of price clustering (Ahn et al., 2005; Ikenberry and Weston, 2008). Using data from the Toyko Stock Exchange, Ohta (2006) shows that price clustering is greatest when markets open. Chiao and Wang (2009) find that orders submitted by individual investors tend to cluster more on round increments than those submitted by other types of investors.

Broadly speaking, the existing research on the topic of price clustering tends to use stock-specific characteristics or exchange characteristics to explain the presence of clustering. In this study, we take a unique approach to this problem by focusing our attention on macroeconomic characteristics. In particular, we develop and test the hypothesis that macroeconomic frictions, such as regulatory burdens or the lack free trade policies, can explain the presence of price clustering. We obtain measures of these macroeconomic frictions from the Fraser Institute, which has developed an index that captures, what they denote as the economic freedom index. This index is made up of several components that include a country's openness to free trade, the soundness of money, and the lack of restrictive regulations. The idea behind our hypothesis is that the lack of economic freedom may create a sense of political uncertainty, which can increase the negotiation costs faced by counter parties trading in financial markets. In a related study, Blau et al. (2014) show that economic freedom is negatively associated with the volatility of stock prices indicating that economic freedom provides some stabilizing influence on security prices. Similarly, Blau (2017) shows that countries with lower levels of economic freedom experience higher probabilities of financial market crashes. Our hypothesis is based on the notion that when volatility is high, negotiation costs are higher given the noise that volatility adds to the negotiation process. As negotiation costs increase, prices will tend to cluster on round increments more frequently.

Testing our hypothesis is difficult for a couple of reasons. First, our tests require us to have cross-sectional variation in the amount of economic freedom. So, using only U.S. stocks is not an option. Instead, we use a broad cross-section of countries with varying degrees of economic freedom. Second, when using a sample of countries, estimating, and then comparing price clustering may be troublesome given the difference in both market structures and in currencies across countries. In fact, the market structure in a particular country may be endogenously related to the level of price clustering. To overcome this issue, we follow Eleswarapu and Venkataraman (2006) and Blau et al. (2014) and focus our tests on a sample of American Depositary Receipts (ADRs), which represent shares of foreign stock but trade on U.S. exchanges. Allowing cross-sectional variation in the level of economic freedom while holding constant the market structure allows us to better isolate the effect of economic freedom on the tendency for prices to cluster on round increments.

While the use of ADRs can help alleviate the potential endogeneity between market structures and price clustering, another type of endogeneity also exists. Our hypothesis predicts that economic freedom affects the level of price clustering suggesting that causation flows from economic freedom to price clustering. However, it is possible, though not probable, that causation flows the other way. To address this second type of endogeneity, we use difference-in-difference tests to determine whether exogenous changes to the level of economic freedom influence the level of ADR price clustering.

We first gather economic freedom data from the Fraser Institute for a number of different countries and then estimate the level of price clustering for the ADRs from those countries. In our first set of tests, we estimate the relationship between price clustering and economic freedom while controlling for ADR-specific characteristics, such as liquidity and volatility, and country-specific characteristics, such as GDP per capita and unemployment rates. Our tests show that, after controlling for a number of characteristics, economic freedom is negatively associated with the level of price clustering, which is the percent of days during a particular year that prices close on round increments of $.05. In economic terms, our multivariate tests suggest that a one standard deviation increase in economic freedom in the ADR home country is associated with a 61 basis point decrease in price clustering. These results are robust to a variety of Tobit regressions that control for the censoring of the dependent variable.

The economic freedom index, obtained from the Fraser Institute, is made up from five broad based categories: regulatory environment, the freedom of international trade, property right protection, the soundness or stability of money, and the size of the home country's government. In our second set of tests, we attempt to identify which, if any of these economic freedom components drive the observed relationship between economic freedom in the ADR home country and the level of ADR price clustering. When including the indexes of each of the five components of economic freedom in our multivariate tests, we find that the components that appear to drive our initial set of findings is the regulation index and the sound money index. These findings are again robust to the two-tailed Tobit specifications and suggest that ADRs from countries with lower regulatory burdens and more sound money tend to cluster on round prices less than ADRs from other countries.

Though it is unlikely, perhaps the clustering of ADR prices is somehow endogenously related to the level of economic freedom in the ADR home country. To control for this possibility, our third set of tests examine an (arguably) exogenous change in the level of economic freedom in a particular country. On the last day of March 2007, the Financial Services Agency (FSA) of Japan implemented Basel II regulations. These regulations increased the requirements for Japanese banks when disclosing credit risk, operational risk, and capital ratios (among other things). Using the Basel II implementation as a natural experiment, we examine the price clustering of Japanese ADRs, vis-à-vis the price clustering of non-Japanese ADRs, both during the six-month period surrounding the event using a difference-in-difference test.

Our final set of results show that, relative to non-Japanese ADRs, the likelihood that prices close on round increments of $.05 for Japanese ADRs is markedly higher during the post-implementation period. These results hold after controlling for a number of ADR-specific characteristics. To the extent that the Basel II implementation represents a meaningful decrease in economic freedom, these findings tend to support the idea that stricter regulation in credit/money markets in a particular country is associated with a significant increase in price clustering in ADRs from that country.

The results from these tests have important implications. First, the existing literature focuses on how rule changes and firm-specific characteristics influence the degree of price clustering. Our results seem to indicate that much broader factors, such as macroeconomic frictions or economic freedom, might affect the level of price clustering. Second, as mentioned earlier, the formation of equilibrium prices is a central tenet of microeconomic theory. Prices in equity markets specifically, and all other markets generally, play an important role in society. Hayek (1945) and Friedman (1977) discuss how prices efficiently aggregate information from disperse market participants. The price system, therefore, conveys information to those participating in markets. The discreteness of prices and their tendency to cluster is worrisome and, if both Hayek (1945) and Friedman (1977) are correct, price clustering in equity markets could make prices less informative. Our results suggest that policies that reduce the level of economic freedom in a particular country, may also reduce the informativeness of prices.

The rest of this paper follows. Section 2 describes the data used throughout the analysis. Section 3 provides an overview of empirical methods and presents our results. Section 4 offers some concluding remarks.

2. Data description

The data used throughout this study come from a variety of sources. From the Center for Research on Security Prices (CRSP), we obtain daily prices, returns, trading volume, etc. From the CRSP data, we calculate the number of different variables used throughout the analysis. Spread is the difference between the ask and the bid price scaled by the spread midpoint. Price is the closing share price on a particular day. Size is the market capitalization and is calculated as the product of closing share prices and shares outstanding. Turnover is the daily trading volume scaled by shares outstanding. Beta is the slope coefficient from estimating a daily CAPM model, where the risk-free rate is the yield on one-month U.S. T-Bills and the market return is the CRSP value-weighted market index. IdioVolt is the standard deviation of residual returns, where residuals are obtained from a daily four-factor model (Fama and Kenneth, 1996; Carhart, 1997). From CRSP, we also obtain the exchange listing and create an indicator variable capturing ADRs that are listed on the NYSE.

Table 1 present statistics that summarize the data. Panel A shows the summary statistics for these variables obtained for each ADR. We aggregate this information to the annual level for the period from 2001 to 2012. Our choice for beginning in 2001, is based on important regulatory changes for U.S. exchanges. Beginning at the start of 2001, U.S. exchanges reduced the minimum tick-size from $1/16^{ths}$ of a dollar to decimals ($.01). Given that this regime change is going to affect our definition of the round prices (increments of $.05), we start our sample time period in 2001. Our final sample includes 366 ADRs and 3563 ADR-year observations. Panel A shows that the average ADR closes on round increments of $.05 about 82.5 days per year or 34.4% of days. We also find that the average ADR has Spread of 1.1%, an average share Price of $29.56, market capitalization (Size) of $1.7 billion, Turnover of 18.45%, a Beta of .9031, and IdioVolt of 2.61%. We also find that about 72% of ADRs are listed on the NYSE.

Panel B shows the summary statistics for a group of variables that capture economic freedom and its components as well as other macroeconomic characteristics. EconFreedom is the Fraser Institute index measuring economic freedom from zero to 10, with 10 being the highest level of freedom. EconFreedom is the average of the component indexes. Regulation measures the stringency of regulation in a country. FreeTrade measures the freedom to trade internationally. PropRights measure the level of property right protection. SoundMoney is the index that measures the stability or soundness of money in a particular country. GovSize is an index that measures the size of a particular country's government. Each of these five components are measured from zero to 10. We note that Regulation and GovSize are inverse measures of economic freedom. Therefore, countries with a Regulation score of 10, are countries with the least regulation. Similarly, countries with the GovSize score of 10 are countries with the smallest governments. We also obtain some additional macroeconomic information from the World Bank. GDP/Capita is the gross domestic product per capita. Consumption is the amount of consumer expenditures as a percent of GDP. Unemployment is percent of the total labor force that is unemployed.

As seen in Panel B, the average home country has an EconFreedom score of 7.36, a Regulation score of 7.06, a FreeTrade score of 7.91, a PropRights score of 6.96, a SoundMoney score of 8.94, and a GovSize score of 5.95. We also find that the average country has GDP/Capita of $25,155, Consumption of 17.46%, and Unemployment of 6.7%.

Table 2 also provides some statistics that summarize the data. Table 2 reports several key variables by ADR home country. Column [1] reports the number of ADRs per country while columns [2] and [3] shows that level of clustering for the average ADR from a particular country. Column [4] presents the economic freedom score for each country while the remaining columns show other macroeconomic characteristics for the ADR home countries. Austria, Chile, and Venezuela seem to have the most price clustering while Sweden, Spain, and New Zealand have the lowest price clustering. From column [4], we see that Singapore, Switzerland, and New Zealand are the most free (economically) while Argentina and Venezuela have the lowest economic freedom.

Table 1
Summary Statistics.

	MEAN [1]	STD. DEVIATION [2]	25th PERCENTILE [3]	MEDIAN [4]	75th PERCENTILE [5]
Panel A. ADR Characteristics					
Cluster Days	82.4516	34.6057	59.0000	74.0000	101.0000
Cluster%	0.3443	0.1376	0.2421	0.3056	0.4127
Spread	0.0110	0.0219	0.0016	0.0042	0.0110
Price	29.5653	30.9760	9.6000	21.0500	40.1200
Size	1743714	4852013	63864.46	328501	1330681
Turnover	18.4543	92.8550	3.7767	6.9910	13.7909
Beta	0.9031	0.5765	0.5247	0.8581	1.2486
IdioVolt	0.0261	0.0179	0.0154	0.0211	0.0303
NYSE	0.7224	0.4479	0.0000	1.0000	1.0000
Panel B. Country Characteristics					
EconFreedom	7.3640	0.7613	6.7469	7.5134	7.8999
Regulation	7.0614	0.9730	6.3722	7.1633	7.7823
FreeTrade	7.9138	0.9624	7.1698	8.1003	8.7051
PropRights	6.9605	1.3838	5.9545	7.1892	8.1088
SoundMoney	8.9352	1.0175	8.1845	9.4471	9.5780
GovSize	5.9489	1.3182	4.9809	6.0835	6.9235
GDP/Capita	25154.82	16839.11	7289.118	32812.56	37185.23
Consumption	17.4606	4.7633	13.2949	18.2683	20.7527
Unemployment	6.7104	3.9960	4.3000	5.3000	8.2000

The table provides statistics that describe the sample used throughout the analysis. Panel A shows the summary statistics for various characteristics of ADRs. Panel B presents the summary statistics for some characteristics of the ADR home country along with the macroeconomic characteristics. Data for the components of Economic Freedom is gathered from the Fraser Institute. While the macroeconomic characteristics have been obtained from the World Bank. Cluster Days is the total number of days during a year when the daily closing ADR price closes on a round increment of $0.05. Cluster% is Cluster Days divided by the total number of days traded in that year. Spread is the relative (percent) bid-ask spread and is calculated as the difference between the ask price and the bid price scaled by the spread midpoint. Size is the market capitalization for each ADR on the last trading day of the year. Price is the closing price for each ADR at the end of the each year. Turnover is the ratio of total trading volume scaled by the shares outstanding. Beta is the slope coefficient obtained from estimating a daily CAPM model for each stock in each year. IdioVolt represents the idiosyncratic volatility calculated by estimating the standard deviation of daily residual returns obtained from the CAPM estimation. NYSE is an indicator variable capturing whether ADR *i* is listed on NYSE – zero otherwise. Panel B reports different home country characteristics Regulation, FreeTrade, PropRights, SoundMoney, and GovSize are the five components of Economic Freedom provided by the Fraser Institute. EconFreedom is the average of each of these five components. GDP/Capita is the GDP per capita in the home countries of the sample of ADRs. Consumption is the annual consumption expenditures for each of the home countries for the ADRs in our sample while Unemployment is the unemployment rate for each of the home countries. Our final sample includes 366 ADRs and 3563 ADR-year observations.

3. Empirical results

3.1. Price clustering and economic freedom

In this section, we test our hypothesis that economic freedom is associated with lower levels of price clustering in ADRs. We begin by estimating the following equation using pooled ADR-year data.

$$\begin{aligned} Cluster\%_{i,t} &= \beta_0 + \beta_1 EconFreedom_{i,t} + \beta_2 GDP/Capita_{i,t} + \beta_3 Consumption_{i,t} + \\ &\beta_4 Unemployment_{i,t} + \beta_5 NYSE_i + \beta_6 Ln(Price_{i,t}) + \beta_7 Ln(Size_{i,t}) + \beta_8 Ln(Turnover_{i,t}) \\ &+ \beta_9 Spread_{i,t} + \beta_{10} Beta_{i,t} + \beta_{11} IdioVolt_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (1)$$

The dependent variable Cluster% is the total number of daily ADR closing prices that clustered on $0.05 divided by the total number of days traded in that year. As independent variables, Econfreedom refers the Economic Freedom which is calculated as an equally-weighted average of the following five components: Regulation, FreeTrade, PropRights, SoundMoney, GovSize. In addition, we include the following control variables: GDP/Capita refers to the GDP per capita of the ADR home country. Consumption is the annual consumption expenditures while Unemployment is the annual unemployment rate for the home country. NYSE is an indicator variable equal to one if the ADR is listed on the NYSE – zero otherwise. Ln (Price) denotes the natural log of the closing price for each ADR at the end of each year. Similarly, Ln (Size) is the natural log of market capitalization for each ADR on the last trading day of the year. Ln (Turnover) is the natural log of average ratio of daily trading volume scaled by the shares outstanding. Spread refers to the relative (percent) bid-ask spread and is calculated as the difference between the ask price and the bid price scaled by the spread midpoint. Beta is the slope coefficient obtained from estimating a daily CAPM model for each stock in each year. IdioVolt represents the idiosyncratic volatility calculated by estimating the standard deviation of daily return residuals obtained from the CAPM estimation. We also include year fixed effects. We do not, however, include stock fixed effects given that the indicator variable NYSE does not vary across the time series. The results from estimating Eq. (1) are reported in Table 3. We also note that robust p-values that account for two dimensional clustering are reported in parentheses below each coefficient estimate.

Table 2
Summary Statistics by ADR Home Country.

	No. of ADRs [1]	Cluster Days [2]	Cluster% [3]	Econ Freedom [4]	GDP Capita [5]	Consumption [6]	Unemployment [7]
Argentina	10	94.6724	0.3805	6.0317	5328.93	11.5118	11.1828
Australia	12	88.4220	0.3829	8.0075	34118.47	17.4607	5.3661
Austria	1	117.2857	0.4895	7.7241	36829.30	18.4176	4.4429
Belgium	1	94.6667	0.3956	7.3943	36083.81	23.2018	7.6833
Brazil	9	86.8469	0.3527	6.3174	5054.02	20.3133	8.2724
Chile	17	106.7189	0.4368	7.8618	7873.54	11.3269	8.1076
China	29	76.8667	0.3270	6.1836	2206.63	13.9730	4.2480
Denmark	3	79.9000	0.3287	7.8332	47006.96	26.9050	5.2133
Finland	4	77.9714	0.3153	7.8233	37052.61	22.3645	8.2371
France	25	80.8153	0.3520	7.2926	33732.99	23.6474	8.7108
Germany	18	85.5409	0.3527	7.6109	34449.43	18.8837	8.8528
Greece	3	78.9118	0.3314	7.0860	21281.53	18.3101	11.0588
HongKong	11	78.6296	0.3343	8.9485	26407.93	9.6407	5.5691
Hungary	1	88.4000	0.3542	7.1152	10620.75	22.3246	7.4600
India	11	79.3008	0.3296	6.3881	828.47	11.2631	3.9504
Indonesia	2	85.3333	0.3394	6.4612	1378.68	8.3943	8.6500
Ireland	12	83.4661	0.3360	7.9028	46780.58	17.2628	6.9093
Israel	6	77.9683	0.3184	7.0924	20189.58	25.2275	8.4016
Italy	11	95.2727	0.3965	7.1164	30554.60	19.7604	8.2205
Japan	29	81.8708	0.3420	7.6588	35612.10	18.7051	4.6330
Luxemberg	3	79.0769	0.3588	7.7421	80015.54	16.2197	4.1308
Mexico	18	86.3158	0.3566	6.7082	7936.15	11.1896	3.8284
Netherlands	17	73.0000	0.3085	7.6879	39610.24	24.9980	3.6467
NewZealand	1	66.9167	0.2763	8.3591	27339.08	18.6321	5.0917
Norway	4	78.5000	0.3500	7.5245	64840.17	20.5997	3.6867
Papua NG	1	82.9000	0.3391	6.3926	839.39	15.5361	2.5600
Peru	1	75.3333	0.2997	7.4654	2997.19	11.1212	4.6917
Phillipines	2	85.2000	0.3424	6.9793	1234.39	9.7484	9.0400
Portugal	2	75.8421	0.3096	7.3760	18326.39	20.1967	7.7263
Russia	5	87.2076	0.3669	6.2748	5718.37	17.9560	7.2245
Singapore	2	77.5625	0.3095	8.7373	28652.31	10.7769	4.0688
South Africa	9	69.6522	0.2956	6.8204	5361.01	19.8182	24.3859
South Korea	10	81.6900	0.3492	7.4398	19556.04	15.3278	3.5020
Spain	5	63.7600	0.2568	7.4885	25616.26	18.5857	12.4920
Sweden	2	60.4211	0.2411	7.4579	40771.90	26.4865	6.6895
Switzerland	9	73.5357	0.3242	8.3725	52391.67	11.3656	3.7667
Turkey	1	85.8333	0.3415	6.4815	7219.89	13.0658	10.5917
USA	3	84.5000	0.3451	8.1745	43701.13	15.3785	5.9364
U.K	49	81.4514	0.3380	8.1264	37656.92	20.9454	5.6965
Venezuela	1	98.2857	0.4130	4.8064	5294.53	12.4727	12.7143

The table reports some additional summary statistics regarding Cluster days and Cluster% for ADR by home country obtained from CRSP. The table also reports Economic Freedom calculated from the components obtained from the Fraser Institute by ADR home country. We also report the number of ADRs for each of the home countries. Macroeconomic indicators, such as GDP per capita, consumption and unemployment data, obtained from the World Bank is also reported.

In Table 3, we report variants of Eq. (1) by including the control variables and the independent variable of interest. For brevity, we discuss the estimated coefficients on the control variables generally. We find that Cluster% is inversely related to consumption while we do not observe an economically significant and statistically significant relation with GDP per capita and unemployment, respectively. We observe a direct relation between Cluster% and volatility in the full specification. Further, Cluster% is negatively associated with market capitalization, share turnover, spread and beta. We find that the indicator variable NYSE generates a positive and significant estimate in each of the specifications. In column [1], we include Economic Freedom as the independent variable of interest. The coefficient on Economic Freedom is -0.0108 (significant at 1% level). Not only is the negative relation of the estimate statistically significant, but the estimate is also economically meaningful as a standard deviation increase in economic freedom results in a reduction of price clustering by approximately 1.08 percent. Consistent with our hypothesis, these results indicate that as the economic freedom increases in a particular country, the price clustering of ADRs decreases. Column [6] shows the results from our full specification that includes all of the control variables. Again, we find consistency with our hypothesis as the level of economic freedom in the home country is associated with a reduction in the price clustering of ADRs (estimate = -0.0080, p-value = 0.0090). These results are also economically significant as a standard deviation increase in economic freedom results in a reduction in price clustering by approximately 80 basis points. These findings support our hypothesis that economic freedom can decrease price clustering in financial markets.

Table 3
Price Clustering and Economic Freedom – OLS Regressions.

	$Cluster\%_{i,t}$					
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	0.3112***	0.2625***	0.5237***	0.3318***	0.3932***	0.4988***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
EconFreedom	−0.0108***	0.0034	−0.0154***	−0.0110***	−0.0152***	−0.0080***
	(0.0000)	(0.3880)	(0.0000)	(0.0000)	(0.0000)	(0.0090)
GDP/Capita		0.0000***				0.0000*
		(0.0030)				(0.0690)
Consumption		−0.0022***				−0.0020***
		(0.0000)				(0.0000)
Unemployment		−0.0003				0.0004
		(0.6210)				(0.3400)
NYSE			0.0405***			0.0433***
			(0.0000)			(0.0000)
Price			0.0470***			0.0549***
			(0.0000)			(0.0000)
Size			−0.0265***			−0.0254***
			(0.0000)			(0.0000)
Turnover				−0.0100***		−0.0124***
				(0.0000)		(0.0000)
Spread				0.2093		−0.2488
				(0.1820)		(0.2650)
Beta					−0.0419***	−0.0220***
					(0.0000)	(0.0000)
IdioVolt					−0.3879***	0.8392***
					(0.0010)	(0.0000)
Adj. R^2	0.4669	0.4799	0.6224	0.4758	0.4966	0.6538
Year Fixed Ef	Yes	Yes	Yes	Yes	Yes	Yes
Robust SEs	Yes	Yes	Yes	Yes	Yes	Yes

The table reports the results from estimating the following equation using pooled ADR-year data. $Cluster\%_{i,t} = \beta_0 + \beta_1 EconFreedom_{i,t} + \beta_2 GDP/Capita_{i,t} + \beta_3 Consumption_{i,t} + \beta_4 Unemployment_{i,t} + \beta_5 NYSE_i + \beta_6 Ln(Price_{i,t}) + \beta_7 Ln(Size_{i,t}) + \beta_8 Ln(Turnover_{i,t}) + \beta_9 Spread_{i,t} + \beta_{10} Beta_{i,t} + \beta_{11} IdioVolt_{i,t} + \varepsilon_{i,t}$ The dependent variable Cluster% is the total number of daily ADR closing prices that clustered on $0.05 divided by the total number of days traded in that year. As independent variables, *EconFreedom* refers the Economic Freedom which is calculated as an equally weighted average of the following five components: *Regulation, FreeTrade, PropRights, SoundMoney, GovSize*. *GDP/Capita* refers to the GDP per capita of the ADR home country. *Consumption* is the annual consumption expenditures while *Unemployment* is the annual unemployment rate for the home country. *NYSE* is an indicator variable equal to one if the ADR is listed on the NYSE – zero otherwise. *Ln (Price)* denotes the natural log of the closing price for each ADR at the end of each year. Similarly, *Ln (Size)* is the natural log of market capitalization for each ADR on the last trading day of the year. *Ln (Turnover)* is the natural log of average ratio of daily trading volume scaled by the shares outstanding. *Spread* refers to the relative (percent) bid-ask spread and is calculated as the difference between the ask price and the bid price scaled by the spread midpoint. *Beta* is the slope coefficient obtained from estimating a daily CAPM model for each stock in each year. *IdioVolt* represents the idiosyncratic volatility calculated by estimating the standard deviation of daily return residuals obtained from a standard market model. Additionally, we report robust standard errors and we also include year fixed effects for each of the regression while Adjusted R-squared for the model are also reported. Corresponding p-values are reported in parentheses below each coefficient estimate. *,**, *** denote statistical significance at the 0.10, 0.05, and the 0.01 levels, respectively.

3.2. Price clustering and economic freedom-tobit model

We extend our analysis by next focusing on a censored regression model to further test the robustness of the relationship between price clustering and economic freedom. To do so, we estimate Eq. (1) using a Tobit Model with our sample of pooled ADR-year data. As before, the dependent variable Cluster% is the total number of daily ADR closing prices that clustered on $0.05 divided by the total number of days traded in that year, we control for possible censoring in the dependent variable (lower and upper bound of the dependent variable is zero and one respectively) using a two-tailed Tobit Model. The independent variables have been defined previously. As before, we include year fixed effects.

Table 4 reports the results from estimating the Tobit model. The estimated coefficients on the control variables are similar in sign to those in the previous table. Additionally, the remaining control variables produce coefficients with similar signs to those in the previous table and in prior research. Results in Table 4 are generally similar to those in Table 3. For instance, column [1] shows that Economic Freedom produces a negative and reliable estimate (estimate = -0.0108, p-value < 0.0001). Similarly, in column [6] we include all stock and country specific control variables and find that the censored regression improves the statistical significance of the variable of interest slightly. In economic terms, the coefficients are similar in magnitude to the corresponding coefficients in the previous table. Additionally, the coefficient on economic freedom is negative and significant in each of the six specifications in Table 4. The conclusions we are able to draw in Table 4 are similar to those in Table 3 and indicate that our previous results are robust to a variety of specifications.

Table 4
Price Clustering and Economic Freedom – Tobit Regressions.

	Cluster%$_{i,t}$					
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	0.3113***	0.2624***	0.5237***	0.3318***	0.3932	0.4988***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
EconFreedom	−0.0108***	0.0034	−0.0155***	−0.0110***	−0.0152	−0.0080***
	(0.0000)	(0.3320)	(0.0000)	(0.0000)	(0.0000)	(0.0060)
GDP/Capita		0.0000***				0.0000*
		(0.0020)				(0.0620)
Consumption		−0.0022***				−0.0020***
		(0.0000)				(0.0000)
Unemployment		−0.0002				0.0004
		(0.5930)				(0.2680)
NYSE			0.0405***			0.0433***
			(0.0000)			(0.0000)
Price			0.0470***			0.0549***
			(0.0000)			(0.0000)
Size			−0.0265***			−0.0254***
			(0.0000)			(0.0000)
Turnover				−0.0100***		−0.0124***
				(0.0000)		(0.0000)
Spread				0.2091**		−0.2489***
				(0.0100)		(0.0080)
Beta					−0.0419***	−0.0220***
					(0.0000)	(0.0000)
IdioVolt					−0.3882***	0.8389***
					(0.0000)	(0.0000)
Pseudo. R^2	−0.5612	−0.5940	−0.8680	−0.5770	−0.6126	−0.9635
Year Fixed Ef	Yes	Yes	Yes	Yes	Yes	Yes

The table reports the results from estimating the following TOBIT Model using pooled ADR-year data. $Cluster\%_{i,t} = \beta_0 + \beta_1 EconFreedom_{i,t} + \beta_2 GDP/Capita_{i,t} + \beta_3 Consumption_{i,t} + \beta_4 Unemployment_{i,t} + \beta_5 NYSE_i + \beta_6 Ln(Price_{i,t}) + \beta_7 Ln(Size_{i,t}) + \beta_8 Ln(Turnover_{i,t}) + \beta_9 Spread_{i,t} + \beta_{10} Beta_{i,t} + \beta_{11} IdioVolt_{i,t} + \varepsilon_{i,t}$ The dependent variable Cluster% is the total number of daily ADR closing prices that clustered on $0.05 divided by the total number of days traded in that year, we control the dependent variable for truncation (lower and upper bound of the dependent variable is zero and one respectively) using a two-tailed Tobit Model. As independent variables, *EconFreedom* refers the Economic Freedom which is calculated as an equally weighted average of the following five components: *Regulation, FreeTrade, PropRights, SoundMoney, GovSize*. *GDP/Capita* refers to the GDP per capita of the ADR home country. *Consumption* is the annual consumption expenditures while *Unemployment* is the annual unemployment rate for the home country. *NYSE* is an indicator variable equal to one if the ADR is listed on the NYSE – zero otherwise. *Ln (Price)* denotes the natural log of the closing price for each ADR at the end of each year. Similarly, *Ln (Size)* is the natural log of market capitalization for each ADR on the last trading day of the year. *Ln (Turnover)* is the natural log of average ratio of daily trading volume scaled by the shares outstanding. *Spread* refers to the relative (percent) bid-ask spread and is calculated as the difference between the ask price and the bid price scaled by the spread midpoint. *Beta* is the slope coefficient obtained from estimating a daily CAPM model for each stock in each year. *IdioVolt* represents the idiosyncratic volatility calculated by estimating the standard deviation of daily return residuals obtained from a standard market model. Additionally, we include year fixed effects for each of the regression, while Pseudo R-squared for the model are also reported. Corresponding p-values are reported in parentheses below each coefficient estimate. *,**, *** denote statistical significance at the 0.10, 0.05, and the 0.01 levels, respectively.

3.3. Price clustering and economic freedom components

Next, we extend our analysis by examining the individual components of Economic Freedom Index. We analyze each of them separately in order to identify whether any have more influence on our previously reported result. We begin by estimating the following OLS equation using pooled ADR-year data.

$$\begin{aligned} Cluster\%_{i,t} &= \beta_0 + \beta_1 \text{Regulation}_{i,t} + \beta_2 FreeTrade_{i,t} + \beta_3 \text{PropRights}_{i,t} + \beta_4 SoundMoney_{i,t} \\ &+ \beta_5 GovSize_{i,t} + \beta_6 GDP/Capita_{i,t} + \beta_7 Consumption_{i,t} + \beta_8 Unemployment_{i,t} + \beta_9 NYSE_i \\ &+ \beta_{10} Ln(Price_{i,t}) + \beta_{11} Ln(Size_{i,t}) + \beta_{12} Ln(Turnover_{i,t}) + \beta_{13} Spread_{i,t} + \beta_{14} Beta_{i,t} \\ &+ \beta_{15} IdioVolt_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

The dependent and independent variables are the same as those in the previous equation with one exception. Instead of including EconFreedom as the independent variable of interest, we include each of the five components separately and then include all of the components in the full specification. We report these results in Table 5.

In column [1], we include Regulation as the independent variable of interest. The coefficient on Regulation is -0.0084 (p-value < 0.001). Not only is the estimate statistically significant, but the estimate is also economically meaningful. For example, a one standard deviation increase in the variable Regulation (as mentioned above, the higher the Regulation index, the lower the level of regulation) results in a decrease in relative price clustering by 84 basis points. Consistent with our hypothesis, these results indicate that as the regulatory burden decreases in a particular country, the price clustering of ADRs from that country decrease. Column [2] shows the results when the variable of interest is FreeTrade. We find that

Table 5
Price Clustering and Economic Freedom – OLS Regressions.

	Cluster%$_{i,t}$					
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	0.5014***	0.4267***	0.4662***	0.5116***	0.4327***	0.5228***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Regulation	−0.0084***					−0.0101***
	(0.0000)					(0.0000)
FreeTrade		0.0017				0.0120***
		(0.4570)				(0.0000)
PropRights			−0.0050**			−0.0026
			(0.0100)			(0.2550)
SoundMoney				−0.0086***		−0.0112***
				(0.0000)		(0.0000)
GovSize					0.0007	0.0018
					(0.6550)	(0.2890)
GDP/Capita	0.0000*	0.0000***	0.0000*	0.0000**	0.0000***	0.0000
	(0.0900)	(0.0000)	(0.0730)	(0.0470)	(0.0000)	(0.9190)
Consumption	−0.0020***	−0.0017***	−0.0016***	−0.0014***	−0.0015***	−0.0015***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0010)	(0.0010)
Unemployment	0.0004	0.0003	0.0002	0.0003	0.0003	0.0000
	(0.3610)	(0.4840)	(0.6210)	(0.4610)	(0.4800)	(0.9880)
NYSE	0.0419***	0.0435***	0.0433***	0.0439***	0.0434***	0.0420***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Price	0.0549***	0.0548***	0.0551***	0.0550***	0.0548***	0.0559***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Size	−0.0254***	−0.0251***	−0.0254***	−0.0257***	−0.0252***	−0.0259***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Turnover	−0.0126***	−0.0124***	−0.0120***	−0.0124***	−0.0124***	−0.0123***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Spread	−0.2705	−0.2500	−0.2665	−0.2511	−0.2548	−0.2943
	(0.2240)	(0.2690)	(0.2360)	(0.2540)	(0.2600)	(0.1800)
Beta	−0.0224***	−0.0213***	−0.0218***	−0.0219***	−0.0214***	−0.0226***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
IdioVolt	0.8591***	0.8666***	0.8651***	0.8229***	0.8617***	0.8799***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Adj. R^2	0.6547	0.6530	0.6538	0.6546	0.6530	0.6576
Year Fixed Ef	Yes	Yes	Yes	Yes	Yes	Yes
Robust SEs	Yes	Yes	Yes	Yes	Yes	Yes

The table reports the results from estimating the following OLS equation using pooled ADR-year data. $Cluster\%_{i,t} = \beta_0 + \beta_1 \text{Regulation}_{i,t} + \beta_2 FreeTrade_{i,t} + \beta_3 \text{PropRights}_{i,t} + \beta_4 SoundMoney_{i,t} + \beta_5 GovSize_{i,t} + \beta_6 GDP/Capita_{i,t} + \beta_7 Consumption_{i,t} + \beta_8 Unemployment_{i,t} + \beta_9 NYSE_i + \beta_{10} Ln(Price_{i,t}) + \beta_{11} Ln(Size_{i,t}) + \beta_{12} Ln(Turnover_{i,t}) + \beta_{13} Spread_{i,t} + \beta_{14} Beta_{i,t} + \beta_{15} IdioVolt_{i,t} + \varepsilon_{i,t}$

The dependent variable Cluster% is the total number of daily ADR closing prices that clustered on $0.05 divided by the total number of days traded in that year. As independent variables, we use the five components of Economic Freedom that are *Regulation, FreeTrade, PropRights, SoundMoney and Gov Size,* these five components of Economic Freedom are provided by the Fraser Institute. Additionally, we include the following control variables: *GDP/Capita* which refers to the GDP per capita of the ADR home country. *Consumption* which is the annual consumption expenditures while *Unemployment* represents annual unemployment rate for the home country. *NYSE* is an indicator variable equal to one if the ADR is listed on the NYSE – zero otherwise. *Ln (Price)* denotes the natural log of the closing price for each ADR at the end of each year. Similarly, *Ln (Size)* is the natural log of market capitalization for each ADR on the last trading day of the year. *Ln (Turnover)* is the natural log of average ratio of daily trading volume scaled by the shares outstanding. *Spread* refers to the relative (percent) bid-ask spread and is calculated as the difference between the ask price and the bid price scaled by the spread midpoint. *Beta* is the slope coefficient obtained from estimating a daily CAPM model for each stock in each year. *IdioVolt* represents the idiosyncratic volatility calculated by estimating the standard deviation of daily return residuals obtained from a standard market model. Additionally, we report robust standard errors and we also include year fixed effects for each of the regression while Adjusted R-squared for the model are also reported. Corresponding p-values are reported in parentheses below each coefficient estimate. *, **, *** denote statistical significance at the 0.10, 0.05, and the 0.01 levels, respectively.

Regulation and Sound Money are driving the majority of the relation between price clustering and economic freedom and observe that the level of free trade in the home country is insignificantly associated with price clustering (estimate = 0.0017, p-value = 0.4570) in ADRs after including all the control variables. The results found in column [3] are similar to those in column [1] as the estimate for Property Rights is -0.0050 (p-value = 0.01). In economic terms, a one standard deviation increase in Property Rights is associated with a reduction in the price clustering of ADRs by 50 basis points.

Column [4] shows the results when we include Sound Money as the independent variable of interest. The estimated coefficient on Sound Money is -0.0086 (p-value = <0.001), which is similar in sign and greater in magnitude than the coefficient on Property Rights. In economic terms, a one standard deviation increase in Sound Money results in a decrease in relative price clustering by 86 basis points. Column [5] presents the coefficient on Government Size (estimate = 0.0007, p-value = 0.6550). Here, we find evidence consistent with our prediction, as the size of the government in the ADR home country decreases (higher Gov Size scores indicates smaller government). Although we observe an increase in price clustering, the coefficient is not significantly different from zero. Column [6] shows the results when we include economic freedom – or the

Table 6
Price Clustering and Economic Freedom – Tobit Regressions.

	Cluster%$_{i,t}$					
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	0.5014***	0.4267***	0.4662***	0.5117***	0.4327***	0.5228***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Regulation	−0.0084***					−0.0101***
	(0.0000)					(0.0000)
FreeTrade		0.0017				0.0119***
		(0.4380)				(0.0000)
PropRights			−0.0050***			−0.0026
			(0.0050)			(0.2190)
SoundMoney				−0.0086***		−0.0112***
				(0.0000)		(0.0000)
GovSize					0.0007	0.0018
					(0.6570)	(0.3010)
GDP/Capita	0.0000*	0.0000***	0.0000*	0.0000**	0.0000***	0.0000
	(0.0970)	(0.0000)	(0.0600)	(0.0460)	(0.0000)	(0.9140)
Consumption	−0.0020***	−0.0017***	−0.0016***	−0.0014***	−0.0015***	−0.0015***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0020)	(0.0020)
Unemployment	0.0004	0.0003	0.0002	0.0003	0.0003	0.0000
	(0.2910)	(0.4110)	(0.5590)	(0.3870)	(0.4110)	(0.9970)
NYSE	0.0418***	0.0435***	0.0433***	0.0439***	0.0434***	0.0420***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Price	0.0549***	0.0548***	0.0552***	0.0550***	0.0548***	0.0559***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Size	−0.0254***	−0.0251***	−0.0254***	−0.0257***	−0.0252***	−0.0259***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Turnover	−0.0126***	−0.0124***	−0.0120***	−0.0124***	−0.0124***	−0.0123***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Spread	−0.2706***	−0.2501***	−0.2666***	−0.2513***	−0.2550***	−0.2944***
	(0.0040)	(0.0080)	(0.0040)	(0.0070)	(0.0070)	(0.0020)
Beta	−0.0224***	−0.0213***	−0.0218***	−0.0219***	−0.0213***	−0.0226***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
IdioVolt	0.8588***	0.8662***	0.8648***	0.8225***	0.8614***	0.8795***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Pseudo. R^2	−0.9660	−0.9617	−0.9636	−0.9657	−0.9616	−0.9747
Year Fixed Ef	Yes	Yes	Yes	Yes	Yes	Yes

The table reports the results from estimating the following Two Tailed TOBIT equation using pooled ADR-year data. $Cluster\%_{i,t} = \beta_0 + \beta_1 \text{Regulation}_{i,t} + \beta_2 FreeTrade_{i,t} + \beta_3 \text{PropRights}_{i,t} + \beta_4 SoundMoney_{i,t} + \beta_5 GovSize_{i,t} + \beta_6 GDP/Capita_{i,t} + \beta_7 Consumption_{i,t} + \beta_8 Unemployment_{i,t} + \beta_9 NYSE_i + \beta_{10} Ln(Price_{i,t}) + \beta_{11} Ln(Size_{i,t}) + \beta_{12} Ln(Turnover_{i,t}) + \beta_{13} Spread_{i,t} + \beta_{14} Beta_{i,t} + \beta_{15} IdioVolt_{i,t} + \varepsilon_{i,t}$

The dependent variable Cluster% is the total number of daily ADR closing prices that clustered on $0.05 divided by the total number of days traded in that year, we control the dependent variable for truncation (lower and upper bound of the dependent variable is zero and one respectively) using a two-tailed Tobit Model. As independent variables, we use the five components of Economic Freedom that are *Regulation, FreeTrade, PropRights, SoundMoney and Gov Size,* these five components of Economic Freedom are provided by the Fraser Institute. Additionally, we include the following control variables: *GDP/Capita* which refers to the GDP per capita of the ADR home country. *Consumption* which is the annual consumption expenditures while *Unemployment* represents annual unemployment rate for the home country. *NYSE* is an indicator variable equal to one if the ADR is listed on the NYSE – zero otherwise. *Ln (Price)* denotes the natural log of the closing price for each ADR at the end of each year. Similarly, *Ln (Size)* is the natural log of market capitalization for each ADR on the last trading day of the year. *Ln (Turnover)* is the natural log of average ratio of daily trading volume scaled by the shares outstanding. *Spread* refers to the relative (percent) bid-ask spread and is calculated as the difference between the ask price and the bid price scaled by the spread midpoint. *Beta* is the slope coefficient obtained from estimating a daily CAPM model for each stock in each year. *IdioVolt* represents the idiosyncratic volatility calculated by estimating the standard deviation of daily return residuals obtained from a standard market model. Additionally, we include year fixed effects for each of the regression while Pseudo R-squared for the model are also reported. Corresponding p-values are reported in parentheses below each coefficient estimate. *, **, *** denote statistical significance at the 0.10, 0.05, and the 0.01 levels, respectively.

average of all of the economic freedom components. The results are consistent with our individual specifications that include the independent components. These findings support our hypothesis that economic freedom can reduce price clustering in financial markets. Furthermore, the effect seems to be driven by Regulation, Property Rights and Sound Money in the home countries while the Free Trade and Government Size components are insignificantly related to the level of price clustering. These results are robust to both the macroeconomic and ADR level controls.

3.4. Price clustering and economic freedom components-tobit model

Similar to earlier robustness tests, we estimate a censored regression model that examines the individual components of Economic Freedom index. In particular, we estimate Eq. (2) using a Tobit model where the dependent and independent variables have been defined previously. The results from these tests are reported in Table 6. As shown in the table, the coefficients on the economic freedom components are very similar to those in Table 5. In general, we find that Regulation

Table 7
Price Clustering and Economic Freedom – Event Study (Probit Regressions).

	$Cluster_{i,t}$			
	[1]	[2]	[3]	[4]
Intercept	−0.5403***	−0.5379***	0.0534	0.0583
	(0.0000)	(0.0000)	(0.5860)	(0.5520)
BASEL JAPAN	−0.0152	−0.0202	−0.0082	−0.0161
	(0.2470)	(0.1390)	(0.5380)	(0.2440)
	−0.0746***	−0.1081***	−0.1518***	−0.2061***
	(0.0020)	(0.0020)	(0.0000)	(0.0000)
BASEL × JAPAN		0.0658		0.1045**
		(0.1830)		(0.0370)
NYSE			0.0294*	0.0294*
			(0.0910)	(0.0910)
Ln(Price)			0.1361***	0.1363***
			(0.0000)	(0.0000)
Ln(Size)			−0.0601***	−0.0601***
			(0.0000)	(0.0000)
Ln(Turnover)			−0.0154***	−0.0152***
			(0.0060)	(0.0070)
Spread			2.3238*	2.3168*
			(0.0970)	(0.0970)
GARCH(1,1)			1.7788***	1.7757***
			(0.0020)	(0.002)
Pseudo. R^2	0.0002	0.0003	0.0088	0.0089
Robust SEs	Yes	Yes	Yes	Yes

Event study around BASEL II implementation in Japan, 31 st of March 2007
$Cluster_{i,t} = \beta_0 + \beta_1 BASEL_t + \beta_2 JAPAN_i + \beta_3 BASEL_t \times JAPAN_i + \beta_5 NYSE_i + \beta_6 Ln(Price_{i,t}) + \beta_7 Ln(Size_{i,t}) + \beta_8 Ln(Turnover_{i,t}) + \beta_9 Spread_{i,t} + \beta_{10} Garch(1,1)_{i,t} + \varepsilon_{i,t}$ The dependent variable is Cluster, which is equal to one if the daily closing ADR prices clustered on \$0.05, and zero otherwise. The independent variables include BASEL which equals one on 31st March 2007 and onwards corresponding to the implementation of BASEL II in Japan. JAPAN is an indicator variable which assigns a value of one to the ADRs belonging to JAPAN. BASEL*JAPAN is an interaction term which equals one after BASEL implementation for ADRs that belong to JAPAN. *Ln (Price)* denotes the natural log of the closing price for each ADR at the end of each day. Similarly, *Ln (Size)* is the natural log of market capitalization for each ADR each day. *Ln (Turnover)* is the natural log of average ratio of daily trading volume scaled by the shares outstanding. *Spread* refers to the relative (percent) bid-ask spread and is calculated as the difference between the ask price and the bid price scaled by the spread midpoint. GARCH(1,1) represents daily estimates of volatility calculated by estimating GARCH(1,1) model. Additionally, we report robust standard errors and Pseudo R-squared for the model are also reported. Corresponding p-values are reported in parentheses below each coefficient estimate. *,**, *** denote statistical significance at the 0.10, 0.05, and the 0.01 levels, respectively.

and Sound Money are driving majority of the inverse relation of price clustering and economic freedom. The results are consistent whether we include each component separately or include the components collectively. These findings contribute to our earlier results that economic freedom can reduce price clustering in financial markets and this effect is driven by lower regulatory burdens and more sound money. These results are robust to both the macroeconomic and stock level controls and to tests that employ a Tobit specification.

3.5. How do changes in economic freedom influence price clustering?

In the previous sections, we have identified a robust relationship between economic freedom and price clustering in ADRs. However, finding this association is not tantamount to identifying a causal link. We note that it is difficult to think of way where causation might flow from ADR clustering to economic freedom instead of the other way around. However, it is still possible. Therefore, before making stronger causal inferences, we attempt to find a more appropriate identification strategy. On 31st March 2007, BASEL II was implemented in Japan which is an increased regulation on banking and credit/money markets in Japan, hence this implementation affects both the Regulation and the SoundMoney component of the Economic Freedom. We argue that this arguably exogenous event decreased the level of economic freedom in Japan and provides an appropriate natural experiment where we can examine the price clustering of Japanese ADRs both before and after the regulatory change. To the extent that causation flows from economic freedom to price clustering – as we suggest in our previous tests, we would expect to observe an increase in price clustering during the period after the BASEL II implementation. Table 7 provides the difference-in-difference tests. We use the following PROBIT regression around the BASEL II implementation in Japan, which occurred on the 31 st of March 2007. We note that our sample time period runs for the six-month period surrounding the BASEL II implementation (January 1st 2007 to June 30th 2007).

$$Cluster_{i,t} = \beta_0 + \beta_1 BASEL_t + \beta_2 JAPAN_i + \beta_3 BASEL_t \times JAPAN_i + \beta_5 NYSE_i + \beta_6 Ln(Price_{i,t}) + \beta_7 Ln(Size_{i,t}) + \beta_8 Ln(Turnover_{i,t}) + \beta_9 Spread_{i,t} + \beta_{10} Garch(1,1)_{i,t} + \varepsilon_{i,t} \quad (3)$$

The dependent variable is Cluster, which is equal to one if the daily closing ADR prices clustered on \$0.05, and zero otherwise. The independent variable includes BASEL which equals one on 31st March 2007 and onwards corresponding to

the implementation of BASEL II in Japan. JAPAN is an indicator variable which assigns a value of one to the ADRs belonging to JAPAN. BASEL × JAPAN is an interaction term which equals one after BASEL implementation for ADRs that belong to JAPAN. Ln (Price) denotes the natural log of the closing price for each ADR at the end of each day. Similarly, Ln(Size) is the natural log of market capitalization for each ADR each day. Ln(Turnover) is the natural log of average ratio of daily trading volume scaled by the shares outstanding. Spread refers to the relative (percent) bid-ask spread and is calculated as the difference between the ask price and the bid price scaled by the spread midpoint. Garch(1,1) represents daily estimates of volatility calculated by estimating Garch(1,1) model.[1]

The coefficients on both the indicator variables of BASEL and JAPAN in Columns [1] and [2] show a dramatic decline in cluster days surrounding the reform in Japan. The interaction term in column [4] i.e. BASEL × JAPAN which takes a value of one at the implementation of BASEL II in JAPAN, has a positive and significant coefficient (coefficient = 0.1045, p-value = 0.0370).[2] The inclusion of control variables helps identify that the previously noted increase in cluster days is not simply due to the control variables. These tests provide some support for the idea that an exogenous reduction in economic freedom is associated with a meaningful increase in price clustering and suggest that causation flows from economic freedom to clustering instead of the other way around.

4. Conclusion

This paper develops and tests the hypothesis that economic freedom influences the level of price clustering. The hypothesis is based on the idea that in countries with less economic freedom, policy uncertainty is high, which results in a tendency for prices to cluster on round increments. The existing literature seems to suggest that price clustering is explained by price resolution. Said differently, the costs associated with negotiating finer, more granular prices, motivate counter parties to settle on round prices. We argue that, when economic freedom is lacking, policy uncertainty will contribute to the magnitude of the negotiation costs since uncertainty makes it difficult to know true, or actual equilibrium prices.

Using a research design that allows for the cross-sectional variation of economic freedom across countries but holds constant the structure of financial markets, we conduct a series of multivariate tests using a sample of ADRs. Results show that economic freedom in the ADR home country meaningfully reduces the level of price clustering in the ADR on U.S. exchanges. These results are robust to alternative econometric specifications and controls for both ADR-specific and country-specific characteristics. Our general results seem to indicate that a one standard deviation increase in economic freedom is associated with a 60 basis point decrease in the level of price clustering. In a set of other tests, we attempt to determine which component of economic freedom explains our initial results. Here, we find that lighter regulatory burdens and more stable monetary policy contribute to the lower levels of price clustering.

Although low, we recognize the possibility that price clustering in ADRs may somehow endogenously determine the level of economic freedom in the home country. We conduct difference-in-difference tests using the implementation of Basel II regulations in Japan as a natural experiment. This exogenous shock to the level of regulation in credit/money markets in Japan provides a nice framework to begin to tease out causation. Results show that, relative to non-Japanese ADRs, ADRs from Japan tend to cluster more on round prices during the post-implementation period suggesting that causation flows from economic freedom to price clustering instead of the other way around.

The results from our study contribute to the literature that attempts to identify determinants of the level of price clustering. Instead of focusing on firm-specific factors, or exchange-specific characteristics, our tests seem to indicate that broader, macroeconomic factors can influence the level of price clustering. Our study also has important practical implications. Hayek (1945) argues that prices, generally, play an important role and act as an aggregator of disperse information from all market participants. The discreteness of prices – or the level of price clustering in equity markets – is troubling and suggests that prices are not as informative as they might otherwise be. Our findings seem to suggest that policies that weaken the level of economic freedom may contribute to the presence of price clustering and, therefore, make prices less informative

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[1] We note that the inclusion of Garch(1,1) is based on the need to have a daily estimate of volatility. The volatility estimates in previous specifications are annual observations obtained from daily returns. Garch(1,1) allows us to conditionally forecast daily volatility.

[2] Generally speaking, we are only interested in the sign of the interaction estimate. The positive interaction coefficient suggests that increased (financial) regulation in Japan results in higher levels of price clustering. We further note the difficulty interpreting the economic significance of the estimate since the marginal effects estimation of interaction terms have well known problems. We did estimate the marginal effect of the coefficient (evaluated at the mean) and found a substantial effect of .03 indicating that the likelihood of price clustering is about 3% higher in Japanese stocks after the implementation of BASELII. However, we raise caution when making strong inferences about this estimated marginal effect.

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