Asset Markets and Endogenous Liquidity

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April 2000

Abstract

In financial markets characterized by imperfect depth, speculative trading will have transitory effects on the market price as market makers must be compensated for the risk of holding the asset. The number of people providing liquidity to a market will generally be endogenously determined by the quantity of liquidity demanded. This paper looks for evidence of endogenous liquidity provision in several international stock and bond markets. Evidence shows strong evidence of these speculative dynamics in the stock markets. The evidence for these dynamics is less striking with fixed-income prices, consistent with the less speculative nature of these markets.

JEL Classifications: G12, F31, G15

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1 Introduction

Theory and experience suggest that financial markets price assets according to the present value of the cash streams they represent. However, short-term fluctuations in net demand for the asset can result in short-term fluctuations in the price of the asset away from this fundamental value.

This phenomenon has created substantial theoretical and empirical interest in the interactions between non-informational traders (who are often called "noise traders" as they are trading for reasons of liquidity or uninformed speculation) and people who provide liquidity to the market. These liquidity providers can be described as "market makers" – people who are willing to assume the opposite side of others' trades in exchange for a positive expected return. A paper by Faruqee and Redding [4] explores a model of endogenous liquidity provision. The prediction of this model is that a strong deviation from fundamentals will cause an influx of market makers attracted by the increased profitability of trading in the temporarily distorted market. This increase in the number of market makers will accelerate the return to fundamentals. This generates the time-series prediction that when a price is far from its fundamental value, the return to fundamentals will be greater both in absolute and relative terms.

Faruqee and Redding found empirical support for endogenous entry of market makers in the G7 currency markets. The present paper shifts attention from currency markets to domestic debt and equity markets for this sample of industrial countries. One might expect that certain types of speculative trading are more common in the markets for corporate equity than in the markets for government debt. For example, although many debtholders intend to hold their bonds to maturity, most equity holders plan ultimately to sell their shares in the open market. In a world where prices may deviate from fundamental values, this requires shareholders to consider the future market price of their shares and not simply the claim on cash flow represented by the asset.

If speculative activity ("noise trading") is present to a different extent in different markets, it is natural to expect that evidence of the sort of endogenous liquidity provision just described will also be present to a different extent in different markets. By comparing evidence from stock and bond markets, this paper presents the opportunity to better test and understand the importance of liquidity issues for asset pricing.

The paper proceeds as follows. Section two provides the theoretical framework of endogenous liquidity provision, and section three describes methods to empirically test the model. Section four then presents the empirical results, and the fifth section concludes.

2 A Model of Endogenous Liquidity

2.1 Model Outline

This section presents a three period model based on Faruqee and Redding [4] in which transitory traders affect the short-run price of the asset. This demand for liquidity is met by risk-averse market makers, who are willing to take a long or short position in the asset if it offers a positive expected return.

The asset will be liquidated in the third period at a price P_3. Information about the liquidation price arrives in such a manner that in the first two periods $t = 1, 2$ the market makers take the distribution of P_3 to be normal with mean $E_t P_3$ and variance σ_t^2. It is natural but not necessary to assume that $\sigma_2^2 < \sigma_1^2$.

Non-informational noise traders have an inelastic net demand of η_t, which is positively serially correlated across each of the first two periods. For simplicity, η will be taken to be the same in each of the two periods, and normally distributed with mean 0 and variance σ_η^2.

There are M_t distinct market makers in each period, who hold their asset positions until period 3. They will choose the optimal level of the asset to hold given a utility function with a constant coefficient γ of absolute risk aversion in terminal wealth.[1]

[1] As is well known, given the normal distribution of the asset, agents with constant absolute risk aversion act to maximize a linear function of the mean and variance of wealth: $U(W) = E(W) - \frac{\gamma}{2} Var(W)$.

The timing of the model in each of the first two periods is as follows:

- The number M_t of market makers is determined.
- The net demand η of the noise traders is revealed (in the first period)
- The estimate $E_t P_3$ is revealed
- Trading occurs which results in a market price P_t.

The third period consists solely of liquidation of the asset at price P_3.

2.2 Asset Prices

Since the traders will act as if to maximize a mean-variance function of wealth, each market maker will choose their holdings H_t to maximize

$$U_t(W_o, H_t) = [W_o + H_t[E_t P_3 - P_t]] - \frac{\gamma}{2} H_t^2 \sigma_t^2 \tag{1}$$

where the first term is the expected value of period 3 wealth and the second term is a penalty on the variance $H_t^2 \sigma_t^2$ of wealth.

The optimal asset holdings of each market maker can then be found as the value of H_t which maximizes (1):

$$H_t = \frac{E_t P_3 - P_t}{\gamma \sigma_t^2} \tag{2}$$

In equilibrium, the demand η of the noise traders must be offset by the aggregate demand of the M_t market makers, or $M_t H_t + \eta = 0$. This can be solved for the equilibrium market price in each period:

$$P_t = E_t P_3 + \frac{\eta \gamma \sigma_t^2}{M_t} \tag{3}$$

2.3 Endogenous Liquidity Provision

Market makers derive profits from servicing the liquidity needs of noise traders. Market makers will earn a higher expected profit and enjoy a higher expected utility when there is a large (absolute) amount of liquidity demand.

If (as in the present model) there is some persistence to the level of liquidity demand, market makers will be attracted to markets where the level of noise trader activity is high. This will result in the amount of noise trading revealed in period 1 influencing the equilibrium number of market makers in period 2.[2] If the reservation utility of the marginal market maker is given by $R(M_2)$, we can solve explicitly for the number of market makers. For simplicity, take this reservation utility to be linear in the number of market makers:

$$R(M_2) = \phi M_2 \tag{4}$$

The utility from being a market maker in period 2 is the excess of the utility found in equation (1) with the optimal holdings (2) over the initial wealth W_o:

$$\begin{aligned} U_2(W_o, H_2) - W_o &= \left[W_o + \frac{E_2P_3 - P_2}{\gamma\sigma_2^2}(E_2P_3 - P_2)\right] - \frac{\gamma}{2}\left(\frac{E_2P_3 - P_2}{\gamma\sigma_2^2}\right)^2 \sigma_2^2 - W_o & (5) \\ U_2 - W_o &= \frac{(E_2P_3 - P_2)^2}{2\gamma\sigma_2^2} & (6) \end{aligned}$$

Equation (3) can be rearranged to give

$$(E_2P_3 - P_2)^2 = \left(\frac{\eta\gamma\sigma_2^2}{M_2}\right)^2 \tag{7}$$

which can be inserted into equation (6) to give

$$U_2 - W_o = \frac{\eta^2\gamma\sigma_2^2}{2M_2^2} \tag{8}$$

[2] Clearly, given the timing of this model, the number of market makers in period 1 must be exogenous.

Market maker entry will occur to the point where the reservation cost (4) of the marginal market maker equals this surplus from market making:

$$\phi M_2 = R(M_2) = \frac{\eta^2 \gamma \sigma_2^2}{2M_2^2} \tag{9}$$

which reveals the equilibrium number of market makers:

$$M_2 = \sqrt[3]{\frac{\eta^2 \gamma \sigma_2^2}{2\phi}} \tag{10}$$

Now that the number of market makers has been determined in equation (10), the price of the asset can be determined as a function of the level η of transitory demand using equation (3):

$$P_2 = E_2 P_3 + \eta \gamma \sigma_2^2 \sqrt[3]{\frac{2\phi}{\eta^2 \gamma \sigma_2^2}} \tag{11}$$

$$P_2 = E_2 P_3 + \sqrt[3]{2\phi \eta \gamma^2 \left(\sigma_2^2\right)^2} \tag{12}$$

2.4 Error Correction

Transitory traders have transitory effects on the market price P_t. Market makers, along with the arrival of new information, tend to bring the market price closer to fundamental value over time. An error correction metric ω can be defined as the proportion of the first period error eliminated in the second period:

$$\omega = 1 - \frac{|E_2(P_2 - P_3)|}{|E_1(P_1 - P_3)|} \tag{13}$$

ω will generally vary between zero (no expected movement towards fundamentals in period 2) and unity (complete movement to expected fundamental value in period 2).

If there was no endogenous liquidity provision, so that M_2 was fixed, equation (3) can be used to show that the error correction is independent of the level η of transitory demand:

$$\omega = 1 - \frac{\sigma_2^2}{\sigma_1^2}\frac{M_1}{M_2} \tag{14}$$

However, if endogenous liquidity is present, equation (3) must be used together with equation (12) to derive the metric ω:

$$\omega = 1 - \frac{\sqrt[3]{2\phi\eta\gamma^2\left(\sigma_2^2\right)^2}}{\eta\gamma\sigma_1^2/M_1} \tag{15}$$

$$\omega = 1 - \sqrt[3]{\frac{2\phi}{\gamma\eta^2\sigma_2^2}}\frac{\sigma_2^2}{\sigma_1^2}M_1 \tag{16}$$

Equation (16) shows that the error correction metric ω is increasing in the absolute value of η. Intuitively, this means that a large noise trading element in one period creates a greater return towards fundamentals in the next period, both on an absolute and a proportional basis.

2.5 The Degree of Speculative Activity

This paper offers a model of endogenous liquidity provision, in which market makers enter a market in response to the demand from noise traders.

Of course, empirical tests of this model are likely to be more successful when there is a large amount of non-informational trading being met by market makers. In terms of the model, this means that the variance of η is large. To see this analytically, the variance of P_2 can be found from equation (12):

$$VarP_2 = VarE_2P_3 + \left(2\phi\gamma^2\left(\sigma_2^2\right)^2\right)^{\frac{2}{3}} Var\sqrt[3]{\eta} \tag{17}$$

The first term represents the uncertainty as to the fundamental value of the asset, and the second term represents price risk resulting from noise trading. This second term has also been affected by the endogenous liquidity provision which dampens the price effect of noise trading. Empirical tests of endogenous liquidity provision, which focus on this dampening effect, should therefore be more striking in markets where speculative activity is strong.

3 Empirical Strategy

In order to test the theory of endogenous liquidity provision, a means must be found to test equation (16), which predicts that the expected return towards fundamentals (the "error correction") should be greater, both in absolute terms and in relative terms, when the initial deviation from fundamentals is large.

This requires an interpretation of fundamental price. Rather than impose a particular economic view on the fundamental values of financial assets, this article uses statistical techniques to decompose the market price. a transitory component and a permanent (fundamental) component. Specifically, a Hodrick-Prescott [9] filter has been used with the smoothing parameter λ set to 57600. To ensure robustness, the results were also computed using values of λ equal to 14400 and 230400. The results are qualitatively very similar to those reported here.[3] A statistical filter will decompose each period's price into a transitory and fundamental component:

$$P_t = P_t^n + P_t^f \tag{18}$$

The idea that prices return toward fundamentals could be tested by regressing the change in price on lagged deviations from fundamentals:

$$\Delta P_t = \alpha P_t^n + \epsilon_t \tag{19}$$

A return to fundamentals would be represented by $\alpha < 0$. However, the prediction of endogenous liquidity provision is greater than this, suggesting that this relationship is more than

[3] In the interests of space, the results for $\lambda = 14400$ and $\lambda = 230400$ are not reported in this paper, but are available from the authors on request.

proportional. This can be tested by inserting a higher-order term[4] into the equation:

$$\Delta P_t = \alpha P_t^n + \beta (P_t^n)^3 + \epsilon_t \tag{20}$$

The theory of endogenous liquidity provision has the empirical implication that the effect of P_t^t is more than proportional, that is, in addition to the expectation of $\alpha < 0$ resulting from linear return to fundamentals, results should also show $\beta < 0$.

As a dynamic measure of central tendency, it is well known that filters such as the Hodrick-Prescott generate spurious cycles. (see for example Harvey and Jaeger [8]) Spurious cycles will result in specifications such as (19) and (20) as spurious returns to fundamentals, and a resulting estimated coefficient of a relatively large $\alpha < 0$ with the possibility of $\beta < 0$ as well. To control for this effect, Monte Carlo experiments with 10,000 iterations have been run for each specification shown in the data, and the β coefficient from the Monte Carlo runs compared with the β coefficient from the actual data.

Each Monte Carlo specification has been calibrated to the sample properties of the currency it is being used to analyze. However, as Table 1 shows, the distributions of the first differences of the asset series are not normal, but instead exhibit the excess kurtosis commonly found in financial data series. Since the endogenous liquidity predictions of equation (20) operate especially on the large deviations from fundamentals, the Monte Carlos have been calibrated to have normal distributions with the same mean and *fourth* moment as the actual data in each case.

In the results reported here, a constant was not included in the estimation of equation (20) and the Monte Carlo simulations were given a zero sample mean. Further estimation was performed including a constant in equation (20) and including the sample mean from Table 1

[4]Since P_t^t can be negative or positive, using $(P_t^t)^2$ would be problematic. Hence the cubic term is used. Estimates were also carried out using a sign-preserving square $P_t^t|P_t^t|$ on the data – these produced results qualitatively very similar to those reported here for $(P_t^t)^3$.

	Stock Market Data						
	USA	Japan	Britain	Germany	France	Italy	Canada
N	990	990	990	990	990	990	990
Mean	0.00247	0.00105	0.00253	0.00208	0.00243	0.00308	0.00131
Variance	0.000468	0.000619	0.000543	0.000601	0.000717	0.001131	0.000513
Kurtosis	2.9603	2.5394	12.6832	4.0740	6.7050	3.6064	3.7311
K.E.V.	0.000660	0.000841	0.001242	0.000923	0.001290	0.001678	0.000768

	Bond Market Data					
	USA	Japan	Britain	Germany	Italy	Canada
N	729	723	468	468	364	468
Mean	-0.00122	-0.00179	-0.00186	-0.00140	-0.00320	-0.001429
Variance	0.000472	0.001645	0.000410	0.000274	0.001540	0.000467
Kurtosis	3.3122	10.9190	4.0141	5.2120	73.7538	0.7303
K.E.V.	0.000685	0.003543	0.000627	0.000453	0.007790	0.000521

Notes: Shown are the moments from the logged differenced series. The kurtosis test statistic is from Kendall and Stuart [11] and is zero for normal distributions. Excess kurtosis is found at the 1% level of significance in all cases. Kurtosis-equivalent variance (K.E.V.) is the variance of a normal distribution which would generate the observed fourth moment, and is used to calibrate Monte Carlo simulations.

Table 1: Sample Moments of the Data

in the Monte Carlo simulations. The results were qualitatively and quantitatively very similar to the results presented in the following tables.

4 Empirical Results

4.1 Stock Markets

It is widely accepted that stock markets are characterized by a substantial amount of transitory or non-informational trading, so stock markets represent a reasonable place to look for evidence of endogenous liquidity provision in response to the hypothesized noise traders.

Stock market data has been collected for each of the G7 countries at a weekly frequency for the period 1980-1998.[5] The data is the Morgan Stanley Capital Markets Index for each country, converted to local currencies. Logarithms are taken of the data and the data is then

[5] Since the Hodrick-Prescott filter may be sensitive to the choice of endpoints, the main results have been recomputed for the sample 1981-1997. The results do not qualitatively change.

first differenced. As is shown in Table 1, the sample period was one of rising prices overall for each of the seven markets. Each of the markets is also characterized by excess kurtosis.

The results of testing equation (20) on this stock market data are shown in Table 2. Due to serial correlation concerns in several of the markets, results with robust standard errors are reported in addition to the standard OLS results. The results show that not only is the linear return to fundamentals evident ($\alpha < 0$) but also that the added endogenous liquidity term is consistently present ($\beta < 0$). Due to some large standard errors, the coefficient β on the cubic term is not always significant. However, in the seven countries studied, it is significantly less than zero in five countries (whether the OLS or robust standard errors are used). In addition, the point estimate of the term is always negative, as endogenous liquidity theory predicts.

In order to control for spurious dynamics generated by the statistical filter, calibrated Monte Carlo simulations with 10,000 iterations have been conducted for each of the seven countries. The results on the β coefficient are shown in Table 2 as β_{MC}. These point estimates are consistently negative as well, suggesting that some nonlinear reversion is simply a property of the statistical filter. However, in each of the seven cases the nonlinear term estimated using the data is greater (in absolute value) than the Monte Carlo term, showing that the estimated β terms reflect evidence of endogenous liquidity as well. Conducting a simple t-test, we find that the difference between the β found in the sample and the β from random walk Monte Carlos is often significant at the 5% level of confidence. In addition, the fact that in all seven independent cases the endogenous liquidity term is present to a greater degree than in the associated Monte Carlo estimates provides strong support for endogenous liquidity as a general property of G7 stock markets.

In order to further address the serial correlation evident in Table 2, in addition to the well-known positive short-run autocorrelation in stock market data, the regressions have been reestimated including lagged values of the dependent variable. These results are shown in Table 3. The values of the Durbin-Watson, adjusted R^2, and Box-Ljung Q statistics have

	USA		Japan		Britain	
	OLS	Robust	OLS	Robust	OLS	Robust
α	-0.0958**	-0.0958**	-0.0535**	-0.0535**	-0.0999**	-0.0999**
	(0.0226)	(0.0286)	(0.0207)	(0.0163)	(0.0216)	(0.0243)
β	-4.4907*	-4.4907	-5.7794**	-5.7794**	-1.6840	-1.6840*
	(1.8530)	(2.9691)	(1.5272)	(1.5857)	(1.4377)	(0.7887)
β_{MC}	-0.899	-0.899	-0.640	-0.640	-0.461	-0.461
p_β	0.0526	0.2264	0.0008	0.0012	0.3950	0.1210
D-W	1.993	1.993	1.855	1.855	1.863	1.863
$\bar{R}^2$	0.057	0.057	0.064	0.064	0.047	0.047
Q	41.49	41.49	67.31**	67.31**	76.55**	76.55**

	Germany		France	
	OLS	Robust	OLS	Robust
α	-0.0641**	-0.0641**	-0.0693**	-0.0693**
	(0.0199)	(0.0244)	(0.0198)	(0.0229)
β	-1.7232	-1.7232	-1.4803	-1.4803
	(0.9397)	(1.0235)	(0.8876)	(0.9089)
β_{MC}	-0.639	-0.639	-0.422	-0.422
p_β	0.2486	0.2895	0.2331	0.2443
D-W	1.769	1.769	1.777	1.777
$\bar{R}^2$	0.039	0.039	0.039	0.039
Q	66.57	66.57	87.36**	87.36**

	Italy		Canada	
	OLS	Robust	OLS	Robust
α	-0.0547*	-0.0547*	-0.0706**	-0.0706**
	(0.0203)	(0.0254)	(0.0219)	(0.0194)
β	-2.2642**	-2.2642**	-4.6122**	-4.6122**
	(0.6970)	(0.8561)	(1.6801)	(1.0493)
β_{MC}	-0.345	-0.345	-0.734	-0.734
p_β	0.0059	0.0250	0.0210	0.0002
D-W	1.693	1.693	1.855	1.855
$\bar{R}^2$	0.050	0.050	0.059	0.059
Q	87.77**	87.77**	43.83	43.83

Notes: Standard errors in parentheses. For each country, "OLS" denotes ordinary least squares results, and "Robust" has standard errors corrected for autocorrelations up to 18 lags. Q is the Box-Ljung Q-statistic against serial correlations up to 36 lags. A single asterisk for a coefficient estimate or the Q-statistic denotes significance at the 5% level, a double asterisk denotes significance at the 1% level. β_{MC} is the β coefficient from a calibrated Monte Carlo with 10,000 iterations, and p_β is the p-value from a t-test that the β coefficient equals β_{MC}.

Table 2: Stock Market Data Without Lagged Dependent Variables

	USA		Japan		Britain	
	OLS	Robust	OLS	Robust	OLS	Robust
α	-0.2142**	-0.2142**	-0.1452**	-0.1452**	-0.2127**	-0.2127**
	(0.0267)	(0.0287)	(0.0225)	(0.0111)	(0.0251)	(0.0270)
β	-3.4095	-3.4095	-7.4305**	-7.4305**	-1.3237	-1.3237
	(1.8483)	(2.3176)	(1.5156)	(1.5839)	(1.4046)	(1.4006)
β_{MC}	-0.970	-0.970	-0.749	-0.749	-0.516	-0.516
p_β	0.1869	0.2925	0.0000	0.0000	0.5653	0.5642
D-W	2.001	2.001	1.998	1.998	2.008	2.008
$\bar{R}^2$	0.117	0.117	0.140	0.140	0.122	0.122
Q	14.46	14.46	32.36	32.36	27.12	27.12

	Germany		France	
	OLS	Robust	OLS	Robust
α	-0.1714**	-0.1714**	-0.1545**	-0.1545**
	(0.0224)	(0.0179)	(0.0213)	(0.0223)
β	-1.9026*	-1.9026	-2.5335**	-2.5335**
	(0.9106)	(1.4905)	(0.8607)	(0.9544)
β_{MC}	-0.695	-0.695	-0.474	-0.474
p_β	0.2486	0.4178	0.0167	0.0309
D-W	2.005	2.005	2.012	2.012
$\bar{R}^2$	0.134	0.134	0.134	0.134
Q	24.03	24.03	28.60	28.60

	Italy		Canada	
	OLS	Robust	OLS	Robust
α	-0.1457**	-0.1457**	-0.1819**	-0.1819**
	(0.0214)	(0.0215)	(0.0248)	(0.0223)
β	-3.1599**	-3.1599**	-3.8265*	-3.8265*
	(0.6731)	(0.5899)	(1.6103)	(1.8196)
β_{MC}	-0.360	-0.360	-0.789	-0.789
p_β	0.0000	0.0000	0.0593	0.0951
D-W	2.004	2.004	1.987	1.987
$\bar{R}^2$	0.163	0.163	0.119	0.119
Q	22.75	22.75	18.67	18.67

Notes: Coefficients from eighteen periods of the lagged dependent variable not shown. Also see the notes to Table 2.

Table 3: Stock Market Data With Lagged Dependent Variables

	USA		Japan		Britain	
	OLS	Robust	OLS	Robust	OLS	Robust
α	-0.0227	-0.0227	-0.0359	-0.0359	-0.1355**	-0.1355**
	(0.0261)	(0.0233)	(0.0219)	(0.0279)	(0.0333)	(0.0241)
β	-18.7157**	-18.7157**	-0.5896	-0.5896**	-0.3245	-0.3245
	(3.5509)	(3.9407)	(0.3316)	(0.1939)	(3.2906)	(4.6085)
β_{MC}	-1.142	-1.142	-0.208	-0.208	-1.783	-1.783
p_β	0.0000	0.0000	0.2498	0.0491	*0.6576*	*0.7516*
D-W	2.026	2.026	1.635	1.635	2.020	2.020
$\bar{R}^2$	0.090	0.090	0.020	0.020	0.061	0.061
Q	65.49**	65.49**	88.30**	88.30**	33.73	33.73

	Germany		Italy		Canada	
	OLS	Robust	OLS	Robust	OLS	Robust
α	-0.0801*	-0.0801*	-0.0652	-0.0652	-0.0971**	-0.0971**
	(0.0261)	(0.0233)	(0.0219)	(0.0279)	(0.0333)	(0.0241)
β	-13.1972	-13.1972	-2.9763**	-2.9763**	-3.5525	-3.5525
	(7.4488)	(13.9582)	(0.2910)	(0.2911)	(4.0757)	(3.7276)
β_{MC}	-2.446	-2.446	-0.194	-0.194	-2.094	-2.094
p_β	0.1489	0.4412	0.0000	0.0000	0.7205	0.6956
D-W	1.890	1.890	2.029	2.029	2.025	2.025
$\bar{R}^2$	0.063	0.063	0.328	0.328	0.056	0.056
Q	39.21	39.21	48.51	48.51	39.07	39.07

Notes: See the notes to Table 2.

Table 4: Bond Market Data Without Lagged Dependent Variables

all improved, suggesting that the serial correlation problem has indeed been alleviated. The results for endogenous liquidity provision are qualitatively similar to the results in Table 2. In each case, the estimated coefficients of β relative to their Monte Carlos provides evidence suggesting rejection of a random walk model in favor of the hypothesis of a fundamental reverting component that is more than proportional. The results are still often individually statistically significant, and when considered jointly once again argue strongly for the existence of the endogenous liquidity phenomenon.

4.2 Bond Market Data

Bond markets in G7 countries offer an opportunity to examine a highly liquid market but one in which several types of uncertainty present in equity markets do not occur. For example, the (nominal) cash flow is known and fixed, there is a fixed maturity date, and in the case of

G7 government debt, uncertainty (due to default) of the cash flow is minimal. These properties suggest that speculative dynamics in bond markets may not be as important as they are in the stock market. If the transitory impact of noise traders on price is less important in the bond market, then the effect of market makers in alleviating that effect must be similarly smaller.

Data has been collected on 10-year government bonds at a weekly frequency. The data collected is the prevailing interest rate rather than the price of any particular bond. The data series ends in 1998, and begins at varying points between 1985 and 1992, depending on the availability of data.[6] Data was collected for the G7 countries. However, since the available series for French interest rates did not constitute a sufficiently long series, no analysis was carried out for France. Series length and information about the moments of the series are contained in Table 1.

As Table 4 shows, there is generally evidence of endogenous liquidity provision for bond market activity, but this evidence is less consistent than in the stock markets. This is compatible with the idea that bond market activity is characterized by some speculative activity, but that the activity is less important in this market than in the equity market. In Table 4, two of the six countries provide statistically significant evidence for endogenous liquidity provision when compared to the β coefficient from the random walk Monte Carlo simulations. However, three other countries provide statistically insignificant support, and for the first time, one country (Britain) actually fails to provide a β coefficient greater (in absolute value) than its Monte Carlo counterpart.

Evidence of serial correlation is still present for some countries, so the analysis was once again conducted using lagged dependent variables. These results are shown in Table 5. Again, while on balance the evidence supports endogenous liquidity provision, there are two countries (Britain and Canada) where the bond markets offer no evidence for endogenous liquidity provision

[6] Again to address concerns of robustness to endpoint choice, the main results were recomputed eliminating the first and last six months of each sample. The results were qualitatively unchanged with the exception of Germany, where the estimated coefficients become positive. These results are consistent with the general conclusions drawn below.

	USA		Japan		Britain	
	OLS	Robust	OLS	Robust	OLS	Robust
α	-0.1175**	-0.1175**	-0.1216**	-0.1216**	-0.2550**	-0.2550**
	(0.0287)	(0.0260)	(0.0268)	(0.0376)	(0.0398)	(0.0281)
β	-20.3850**	-20.3850**	-1.2032**	-1.2032**	3.5614	3.5614
	(3.4887)	(3.9407)	(0.3328)	(0.4540)	(3.2921)	(4.4077)
β_{MC}	-1.142	-1.142	-0.238	-0.238	-2.028	-2.028
p_β	0.0000	0.0001	0.0037	0.0335	*0.0895*	*0.2048*
D-W	1.986	1.986	1.914	1.914	2.005	2.005
$\bar{R}^2$	0.166	0.166	0.123	0.123	0.108	0.108
Q	29.49	29.49	29.72	29.72	17.62	17.62

	Germany		Italy		Canada	
	OLS	Robust	OLS	Robust	OLS	Robust
α	-0.1698**	-0.1698**	-0.1563**	-0.1563**	-0.2320**	-0.2320**
	(0.0375)	(0.0394)	(0.0462)	(0.0759)	(0.0415)	(0.0248)
β	-12.6696	-12.6696	-2.7758**	-2.7758**	-0.8490	-0.8490
	(7.3167)	(19.0224)	(0.3392)	(0.3697)	(4.0853)	(5.7452)
β_{MC}	-2.757	-2.757	-0.202	-0.202	-2.371	-2.371
p_β	0.1755	0.6023	0.0000	0.0000	*0.7095*	*0.7911*
D-W	1.962	1.962	2.049	2.049	2.000	2.000
$\bar{R}^2$	0.133	0.133	0.368	0.368	0.110	0.110
Q	11.52	11.52	23.69	23.69	14.78	14.78

Notes: Coefficients from eighteen periods of the lagged dependent variable not shown. Also see the notes to Table 2.

Table 5: Bond Market Data With Lagged Dependent Variables

when compared to their Monte Carlo simulations. This is particularly noticeable in the British case. At the same time, the only statistically significant evidence is from the three countries supporting the idea of nonlinear reversion towards fundamentals.

5 Conclusions

This paper has explored the empirical implications of endogenous liquidity theory. If the entry of liquidity providers ("market makers") to a market is endogenously driven by the profit opportunities created by the liquidity needs of noise traders, then the return to fundamentals should be absolutely and proportionally greater when a large number of noise traders have driven prices quite far from fundamentals. This phenomenon should be more evident empirically in markets where speculative activity is important.

This theory has been tested on G7 equity and bond markets. Comparing these two types of markets is useful since noise trading would be expected to be more important in the equity markets than in the bond markets. The empirical implications of the model are verified. While the data on balance support the hypothesis of nonlinear reversion in the bond markets, the results are more uniform in the equity markets, where evidence of endogenous liquidity provision is strong.

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