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A Review of Liquidity Premium

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Abstract

This paper reviews studies of the liquidity issue in finance literatures. Liquidity imposes a premium on efficient asset returns in two different forms: liquidity costs and liquidity risks. The former is simply a transaction cost resulting from a bid-ask spread while the latter involves the volatility of liquidity levels that inflicts systematic and unsystematic risks on asset returns. Even with varying proposed proxies of unobservable liquidity levels, liquidity premiums on asset returns is evidenced by most studies. Empirically, a more critical issue besides measuring liquidity level is the estimating error of the market price of risk resulting from applying CAPM-type models that needs further attentions. While recent theoretical advancements on the liquidity issue give weight to developing liquidity (risk)-adjusted asset pricing models to address this issue, the increasing applications for risk management demand sophisticated dynamic modeling of liquidity risk, the area which is still well undeveloped that should emerge as a new active research area.

บทคัดย่อ

บทความนี้ทบทวนงานศึกษาด้านการเงินในประเด็นเรื่องสภาพคล่อง ซึ่งกำหนดค่าชดเชยสำหรับผลตอบแทนหลักทรัพย์ที่เหมาะสมในสองลักษณะคือต้นทุนสภาพคล่อง และความเสี่ยงด้านสภาพคล่อง ต้นทุนสภาพคล่องเป็นผลมาจากช่องว่างระหว่างราคาเสนอซื้อ-ขาย ในขณะที่ความเสี่ยงด้านสภาพคล่องเกิดจากความผันผวนของระดับสภาพคล่อง เนื่องจากสภาพคล่องไม่สามารถสังเกตได้โดยตรง งานศึกษาส่วนใหญ่ได้สร้างตัวชี้วัดที่หลากหลาย ซึ่งต่างก็ให้ผลยืนยันถึงค่าชดเชยสภาพคล่องที่สะท้อนในผลตอบแทนหลักทรัพย์ นอกเหนือจากประเด็นในเรื่องการวัดระดับสภาพคล่องในงานศึกษาเชิงประจักษ์แล้ว ความผิดพลาดจากการประมาณการราคา

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ตลาดขาดความเสี่ยง ซึ่งเกิดจากการประยุกต์ใช้แบบจำลองที่พัฒนาจาก CAPM เป็นประเด็นที่ต้องให้ความสนใจ การศึกษาในเชิงทฤษฎีขาดเรื่องสภาพคล่องในระยะหลังให้ความสำคัญกับการพัฒนาแบบจำลองผลตอบแทนหลักทรัพย์ที่คำนึงถึงปัจจัยด้านความเสี่ยงสภาพคล่องในแบบจำลองโดยตรงเพื่อลดความผิดพลาดดังกล่าว นอกจากนี้การประยุกต์ใช้ในเรื่องการบริหารความเสี่ยงที่มีความสำคัญมากในปัจจุบัน ทำให้เกิดความจำเป็นในการพัฒนาแบบจำลองเชิงพลวัตรขาดความเสี่ยงสภาพคล่องซึ่งยังค่อนข้างใหม่ และมีแนวโน้มที่จะเป็นหัวข้อวิจัยที่ได้รับความสนใจในอนาคต

Most asset pricing models are idealistically built on the assumptions of perfect market that ignore trading and transaction factors which predominate in the real world. Both factors project both liquidity costs and risks that influence asset prices. In addition, financial crises, transmissions of monetary policy, flight-to-quality among assets, size of stock floatations, market maker activities, etc. are among familiar episodes of liquidity shocks that most models fail to capture explicitly. Liquidity shocks that are common in the financial market impose significant influence on asset prices at two levels: macro liquidity (or marketwide liquidity) that systematically affects every asset, and micro liquidity (or transactions liquidity) that characterizes each individual asset's liquidity.

Definition

The first economic investigation of the liquidity issue dating back to 1968 in the area of market microstructure, is by Demsetz (1968) who points out the costs associated with transacting shares besides explicit (direct) costs such as brokerage or commission fees, an indirect cost associated with getting to trade whenever we want. Since buyers and sellers do not necessarily need to trade at the same time, and, as the result, if buyers/sellers need to trade immediately they need to pay additional costs (a higher price for the buyer and a lower for the seller) to motivate their counterparts to engage in transacting simultaneously. That additional cost is represented by a spread between bid and ask prices, called bid-ask spread, a major topic in market microstructure theory that founds the liquidity feature on asset pricing theory.

Liquidity at the utmost degree is simply defined as the ability to perform transactions instantaneously and costlessly without affecting prices. As there are perfect liquid assets hence trading them imposes costs. Every asset possesses some level of illiquidity that must be priced by the market. Kyle (1985) characterizes liquidity by three components. Market or individual assets said to be highly liquid, can be described by the following aspects.

Tightness – the divergence of transaction prices from efficient prices. Transacting illiquid assets typically involves wider bid-ask spread than that of more liquid assets. Absolute liquid asset implies zero bid-ask spread (infinite tightness), i.e., no indirect transaction cost.

Depth – the volume which can be traded at the current price. For an illiquid stock, the quoted prices are generally backed by small volumes of demand and supply that cannot absorb a large order without influencing prices. Prices of assets with deep trading activity will hardly be influenced by any particular trader, rather they are determined mainly by the efficient value of the asset itself, i.e., the investor has no market power.

Resiliency – the speed of adjustment of the return to the efficient price after a random deviation. A large order can easily affect the prices of a thinly-traded asset, leaving the asset prices to adjust slowly back to the efficient level, thus widening the bid-ask spread.

Early researches on the liquidity issue primarily focused on the static effect of liquidity on transaction costs entailed in the expected asset returns. Hence the liquidity (cost) premium is required to compensate for transaction costs. An initial issue is the measurement of the unobservable liquidity level so that it can be tied to the liquidity cost and the premium on asset returns.

Liquidity cost and asset return

A pioneer theme of research is on incorporating liquidity-induced transaction costs, i.e., liquidity costs, on asset returns. Accounting for this issue is tantamount to relaxing frictionless market assumptions from asset pricing models, the resulting efficient price of the asset must discount for liquidity cost, thus higher expected return. Among earlier studies the common main thesis was to verify the relationship between liquidity costs and liquidity premiums on asset returns. Since liquidity is unobservable directly from the market it is essential to find a proxy for liquidity measure. Amihud and Mendelson (1986) are among the first who studied theoretically and empirically the relationship between stock returns and liquidity costs using bid-ask spread as a liquidity measure. Their findings postulate a relationship of the expected return as an increasing concave function of relative spread[1]. Their proposition is that investors of different investment horizons construct their portfolios accordingly. Illiquid stocks described by large spreads are less preferred by short-term investors who are willing to pay to get rid of them. While the long-term investors will hold more illiquid stocks only when they are compensated by higher expected returns from a wider spread. In equilibrium this results in an increasing relationship between returns and spreads. Moreover stocks with higher spread (less liquid) in equilibrium are allocated to portfolios with longer expected holding periods so that the transaction costs will be amortized for a longer period. For this reason investors will demand a higher liquidity premium for a given change in the spread, for the more active stock. Thus spread-adjusted returns on a portfolio increase at a diminishing rate (concave) with the expected holding period. This result is called the *clientele effect*.

The Amihud and Mendelson methodology employs the CAPM (Capital Asset Pricing Model) framework by regressing the selected stock returns, market risk (beta), and spreads so that the effects of market risk are excluded (i.e., market risk premiums are excluded from returns). The liquidity level of individual stocks is then estimated. Several other studies investigate the relationship between returns and liquidity levels using various liquidity measures derived from spreads, which differ slightly from the Amihud and Mendelson methodology, and generally document that less liquid stocks have higher average returns. Nevertheless the methodology of using spread as a liquidity measure may suffer from errors in measuring returns that are not correctly adjusted for risk since spreads are derived from prices that are in turn correlated with market risks.

Brenan and Subrahmanyam (1996) estimate trading costs and decompose them into fixed and variable components and applying the Fama-French three-factor model. They find a concave relationship between return premiums

[1] *Relative spread is defined as the difference between the highest bid price and the lowest ask price, divided by the average of these two prices.*

and variable costs which is consistent with Amihud and Mendelson's clientele effect. However they also find a convex relationship between fixed costs and return premiums where fixed costs are highly correlated with the relative spreads. The last result is later referred to by Jacoby, Fowler, and Gottesman (2000) as the *level effect* where the expected return is convex in the expected spread for high spread levels.

Other recent studies, for instance, Datar, Naik, and Radcliffe (1998), Brennan, Chordia, and Subrahmanyam (1998), etc. using other common measures of liquidity levels besides spreads, including turnover ratio (number of shares traded divided by number of outstanding shares) and trading volume (number or value of stock traded), and applying either the Fama-French three-factor model or CAPM, generally report supporting evidence for Amihud and Mendelson (1986).

The idea of liquidity costs inducing liquidity premiums on asset returns is straightforward but not realistic enough. Since liquidity is time-varying and unpredictable, investors therefore expect compensation for this risk. The liquidity factor becomes a dynamic issue of liquidity risk where investors form expectations regarding the future volatility of liquidity and require liquidity (risk) premiums for compensation. Liquidity risk is examined in greater detail and found to be composed of marketwide and individual-asset liquidity.

Liquidity risk: Systematic and firm-specific

Another theme of research is to investigate the relationship between stock returns and liquidity risk (defined as volatility of liquidity level) as opposed to the level of liquidity per se. This viewpoint is that liquidity does not only affect individual stock but also the market as a whole. Furthermore market liquidity varies with time and affects the liquidity of individual stocks differently. The variability of liquidity postulates a market-related risk for which investors demand compensation (risk premium). Liquidity risk is then classified into two groups: the systematic (or marketwide) and firm-specific liquidity risks. Systematic liquidity varies with macro-factors that change over time, and the returns of individual firms differ in their correlation with systematic liquidity risks.

Chordia, Roll, and Subrahmanyam (2000) have pioneered the analysis of common determinants of individual liquidity and have documented commonality in liquidity. Amihud (2002) measures market illiquidity as the average daily absolute return over trading volume (in $) on the same day and finds support for the presence of market liquidity and expected market returns. Chordia, Subrahmanyam, and Anshuman (2001) study firm-specific liquidity using firm's volatility in trading volume and find the unexpectedly contradictory result that stocks with more volatile liquidity have lower expected returns. Pastor and Stambaugh (2003) investigate marketwide liquidity (systematic liquidity risk) as a state variable that affects expected stock returns across the market. They hypothesize and find support that the systematic liquidity risk is priced by the market. More specifically, stocks whose returns are closely correlated with the volatility of market liquidity will have greater expected returns than stocks whose returns are less correlated.

Other studies either explore the liquidity effects in other financial markets including derivatives markets, or develop new consistent measures of liquidity. Chaordia, Sarkar, and Subrahmanyam (2003) examine stock and bond market liquidity using bid-ask spreads and order imbalances[2] and report significant correlation of liquidity and volatility between both markets which implies the common factor driving liquidity and volatility of both markets. Roll, Schwartz, and Subrahmanyam (2006) analyze the relationship between futures-cash basis and liquidity using the Granger causality test and document a significant relationship which implies that the liquidity factor does improve market efficiency. Chacko, Mahanti, Mallik, and Subrahmanyam (2007) propose latent liquidity as a new measure of liquidity in the bond market and prove it to be a more consistent measure than traditional trade-based measures. Latent liquidity uses the information about ownership of corporate bonds (instead of transactional information) to measure the accessibility of securities by a dealer as liquidity proxy[3]. This allows

[2] *Order imbalances is defined as the dollar value of buys less the dollar value of sells each day, divided by the total dollar value of buys and sells.*

[3] *Latent liquidity is defined as the weighted average turnover of funds holding the bond where the weights are their fractional holdings of the bond.*

them to be able to assess liquidity for markets with extremely low trading activity.

Asset pricing model with liquidity premium

Asset pricing models are basically developed for determining the asset efficient value by decomposing risks and their effects on the asset value. This class of model is called the factor-based asset pricing model. The first and most well-known is the CAPM, a one-factor model, developed by Sharpe (1964). It offers powerful and intuitive predictions about how to measure risk and its relationship with asset return. Despite a poor empirical record that reflects the problem of oversimplified assumptions, while no alternative class of models has so far been proved to be more theoretically justified, the appealing simplicity and intuition of the CAPM still make it the main model to work with. Early liquidity researches (see Amihud and Mendelson (1986)) extend CAPM to include the liquidity factor. The major drawback of this approach involves errors in estimating the market price of risks that may outweigh all liquidity effects.

Brennan and Subrahmanyam (1996) apply the three-factor model proposed by French and Fama (1993) instead of CAPM in order to improve the estimation of the market price of risks, a key drawback in using CAPM. Empirical studies of the Fama-French model record the ability in explaining asset returns much better than CAPM. The model takes a form similar to the Market Model[4] (empirical version of CAPM) with two correction terms. The rate of return of asset *i* over period *t*, $r_{i,t}$ follows

$$r_{i,t} = \gamma_{i,t} + \beta_m r_{m,t} + \beta_{smb} r_{smb,t} + \beta_{hml} r_{hml,t} + \varepsilon_{i,t}$$

where γ_i represents constant return earned in each period for asset ***i***, ***m*** (market) represents the market portfolio calculated from a broad-based index, *smb* (small minus big) portfolio represents a zero-investment

4 *The market model is a more convenient version of CAPM widely used in estimating β value simply from the (stock and market) returns instead of excess returns. It is given by*

$$r_{i,t} = \gamma_i + \beta_i r_{m,t} + \varepsilon_{i,t} \qquad \text{where} \quad \gamma_i = \alpha_i + (1-\beta_i)r_f$$

portfolio that is long in "small cap" (cap is a short term for 'market capitalization') stocks and short in "big cap" stocks, *hml* (high minus low) portfolio represents zero-investment portfolio that is long in high book-to-market stock (so-called "value" stocks) and short in low book-to-market stocks (so-called "growth" stocks), and β 's represent the associated risk coefficients.

The rationale behind including SMB and HML portfolios in the Fama-French model is that they serve as correction factors for a broad-based index, used as a market portfolio like a market capitalization-weighted index[5]. Since this index puts more weight on "big cap" and "growth" stocks than in "small-cap" and "value" stocks, respectively, this adjustment might help reduce estimating errors of market returns caused by bias from a broad-based index. The Fama-French model is in essence based on empirical observation rather than on a theoretical ground, therefore it only helps improving the estimation of the market price of risk, but not correcting the estimating errors.

Nevertheless both traditional CAPM and the Fama-French model are among the standard approaches to studying liquidity effects that suffer from errors in estimating the market price of risk. The later researches emphasize on modifications of CAPM to measure liquidity factor separately from the market risk.

Liquidity-adjusted CAPM

A modification of CAPM to integrate liquidity effects comes in two forms, namely liquidity cost and liquidity risk. Instead of using gross (or market) return as in the standard CAPM approach, Jacoby, Fowler, and Gottesman (2000) use the net asset return that is adjusted by bid-ask spread and net market return that is adjusted by market liquidity cost. They derive a one-period CAPM with liquidity costs following a standard derivation of CAPM. Their variation of liquidity cost-adjusted CAPM in traditional CAPM form is given by

$$E[r_i^*] = r_f + \beta_i^*[E[r_m^*] - r_f]$$

[5] *Most stock market indices are market capitalization-weighted, except for Dow Jones Industrial Average, is price-weighted index.*

The superscript (*) denotes net (or spread-adjusted) returns and liquidity (cost)-adjusted beta and the superscript (~) symbolizes random variables as follows

$$\tilde{r}_i^* = \tilde{r}_i \frac{(1 - \tilde{s}_i)}{(1 + s_i)} \qquad \tilde{r}_m^* = \frac{(\tilde{r}_m - \tilde{c}_m)}{(1 + s_m)} \qquad \text{and}$$

$$\beta_i^* = Cov\left[\frac{(\tilde{r}_m - \tilde{c}_m)}{(1 + s_m)}, \tilde{r}_i \frac{(1 - \tilde{s}_i)}{(1 + s_i)}\right] \Big/ Var\left[\frac{\tilde{r}_m - \tilde{c}_m}{1 + s_m}\right]$$

where s_i and $\tilde{s}_i$ represent the current liquidity costs of transacting assets i and liquidity costs at the end of a period (random variable), respectively while $\boldsymbol{s_m}$ and $\tilde{c}_m$ denote, respectively, market liquidity cost (market capitalization-weighted liquidity cost) and total liquidity cost at the end of a period, relative to the market portfolio value today.

The Jacoby et al.' liquidity-adjusted CAPM suggests that risk premium per unit of systematic risk (net market excess return) is lower than that suggested by the traditional CAPM since $E[\tilde{r}_m] > E[\tilde{r}_m^*]$. The resulting β that differs nonlinearly from traditional β stresses a need to account for liquidity cost in measuring market systematic risk. According to Jacoby et al., their model yields a convex rather than a concave relationship as presented by Amihud and Mendelson (1986). However, their finding is consistent with the empirical result of Brennan and Subrahmanyam (1996) of the convex relationship between return premiums and relative spreads (the level effect).

Archarya and Pedersen (2005) develop a liquidity-adjusted CAPM that classifies liquidity risk into three forms. These liquidity risks are associated with (i) commonality in liquidity with the market liquidity, $Cov[c_i, c_m]$, as documented by Chrodia et al. (2000) that stocks' illiquidities are positively related with market illiquidity, (ii) return sensitivity to market liquidity, $Cov[r_i, c_m]$, as reported by Pastor and Stambaugh (2003) that stocks with high sensitivities to market liquidity yield higher returns than stocks with less sensitivities, and (iii) liquidity sensitivity to market returns, $Cov[c_i, r_m]$, liquidity risk that is significant, especially in a poor market situation. The "net beta" of expected asset returns then can be decomposed into the standard market beta and three additional betas representing different forms of liquidity risk. Following the notations of the previous model with subscript (t) which indicates the ending period, the model is given by

$$E[r_{i,t} - r_{f,t}] = E[c_{i,t}] + \lambda\beta_{1i} + \lambda\beta_{2i} - \lambda\beta_{3i} - \lambda\beta_{4i}$$

where $\lambda = E[r_{m,t} - c_{m,t} - r_f]$ and

$$\beta_{1i} = \frac{Cov[\tilde{r}_{i,t}, \tilde{r}_{m,t} - E_{t-1}[\tilde{r}_{m,t}]]}{Var[\tilde{r}_{m,t} - E_{t-1}[\tilde{r}_{m,t}] - (\tilde{c}_{m,t} - E_{t-1}[\tilde{c}_{m,t}])]}$$

$$\beta_{2i} = \frac{Cov[\tilde{c}_{i,t} - E_{t-1}[\tilde{c}_{i,t}], \tilde{c}_{m,t} - E_{t-1}[\tilde{c}_{m,t}]]}{Var[\tilde{r}_{m,t} - E_{t-1}[\tilde{r}_{m,t}] - (\tilde{c}_{m,t} - E_{t-1}[\tilde{c}_{m,t}])]}$$

$$\beta_{3i} = \frac{Cov[\tilde{r}_{i,t}, \tilde{c}_{m,t} - E_{t-1}[\tilde{c}_{m,t}]]}{Var[\tilde{r}_{m,t} - E_{t-1}[\tilde{r}_{m,t}] - (\tilde{c}_{m,t} - E_{t-1}[\tilde{c}_{m,t}])]}$$

$$\beta_{4i} = \frac{Cov[\tilde{c}_{i,t} - E_{t-1}[\tilde{c}_{i,t}], \tilde{r}_{m,t} - E_{t-1}[\tilde{r}_{m,t}]]}{Var[\tilde{r}_{m,t} - E_{t-1}[\tilde{r}_{m,t}] - (\tilde{c}_{m,t} - E_{t-1}[\tilde{c}_{m,t}])]}$$

Archarya and Pedersen explore all three kinds of liquidity premiums in their study with supporting empirical results. Their liquidity-adjusted CAPM can explain comprehensively key liquidity risks documented by earlier studies and the model is proved to be a significant improvement over the traditional CAPM.

Liquidity premiums on asset returns as the result of liquidity risks extend naturally to the theory of derivative pricing originally developed on a perfect market assumption. With no arbitrage opportunity allowed any asset either in the complete or incomplete market can be priced by constructing a portfolio with optimal trading strategy to replicate its dynamic payoff, i.e., hedging portfolio. While the portfolio in the complete market yields a risk-free rate of return, in the incomplete market it bears an additional risk premium (for adding a surrogate asset(s) to complete the market) consistent with intertemporal CAPM.

Lo and Wang (2001) derive an equilibrium intertemporal CAPM where assets contain two types of risks: market risk and risk of changing in market conditions. The equilibrium model then determines risk factors from economic fundamentals rather than the statistical mean. They construct the hedging portfolio that has forecasting power in predicting future market returns, and the ability to explain cross-sectional variations in expected returns that is comparable to other popular factor models.

Standard dynamic asset pricing theory is built on no arbitrage pricing and completeness of the market conditions (known as first and second fundamental theorems) with the stochastic process(s) of the underlying factor(s). However modeling a dynamic of liquidity factor is not as full-fledged as modeling volatility risk. Recent financial crises such as the Long-Term Capital Management, the Asian financial crisis, etc. have provoked great attention on the issue of liquidity risk in risk management. This urges the needs for modeling dynamic liquidity risk and capturing its effects by incorporating liquidity risk factor in modern asset pricing models.

Modeling Liquidity Risk

Modeling liquidity risk for the purpose of risk management and derivative pricing is so occasional. There are only a few stochastic treatments of liquidity risk documented so far. The basic idea is to study liquidity effects on optimal trading strategy for replicating asset returns, and eventually on derivative prices. Rogers and Zanes (1998) model liquidity risk in the form of the ability to switch between asset and money market (adjusting portfolio) only at the time of Poisson process. Their approach is to straightforwardly capture the effects of liquidity on trading strategy. Although it has no closed-form solution it can still be deduced that the liquidity cost is inversely proportional to Poisson intensity. Another approach is by taking liquidity risk as another underlying factor that affects asset prices directly. Cetin, Jarrow, and Protter (2004) give a rigorous theoretical treatment on liquidity risk by modeling supply curve for security prices as a function of trade size and theorizing in an arbitrage pricing framework. They derive the conditions on no arbitrage opportunity and completeness of the market in the presence of liquidity risk. The extensions yield derivative price and approximate hedging strategy. Though they do not provide explicit specification of a liquidity dynamic the result essentially establishes guidance on the model construction. Modeling asset prices as a function of trade size is in fact comparable to adding another underlying factor as a function of the other factor (in this case asset price). The result is classed as a multi-factor model.

Summary

The topic of liquidity risk has recently drawn more attention from financial researchers. Prior studies reveal two primary issues. First, liquidity measurement, for which there is still no unanimous agreement on the efficacy of each proxy. Many researches differ in their results simply because of using different measures. This advocates a need for both theoretical and empirical evaluation of various liquidity measures that have been proposed so far. Second, liquidity-adjusted asset pricing models, for which most prior studies rely either on CAPM modifications or the Fama-French model. Even if there have been recent developments of intertemporal liquidity-adjusted CAPM, the fundamental flaw of estimating error of market risk has yet been solved. On the other hand, the Fama-French model is indeed another empirical extension of CAPM, which adjusts for ‘size’ and ‘value’ effects. It proves to be more accurate than traditional CAPM, but when liquidity risk is concerned the model inevitably suffers from the same shortcomings as the CAPM.

A growing concern of liquidity risk management since the recent financial crisis incidents, suggests a promising area of research for the issue of modeling liquidity risk in dynamic asset pricing theory. This is a theoretical challenge and needs a lot further studies. Lastly, it is an empirical shortcoming that accessing the data for the study of liquidity is somewhat cumbersome and costly since it involves high-frequency microstructure-level data which in general is publicly inaccessible. This limitation may restrain many researchers from participating actively in this area.

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