It is fundamental for financial institutions to monitor Liquidity Risk in an effective way, particularly in a period of volatile markets. Despite that many quantitative methods flourish in the modern finance literature, one can note that (i) it is challenging to unambiguously define what Liquidity Risk is, and (ii) it can be cumbersome to apply modern monitoring techniques, notably because of the data sample available and the assumptions made [e.g. correlations, distribution of returns, etc.].

1. Introduction

Monitoring Liquidity Risk is an area of concern for most financial institutions and competent authorities; if many modern techniques can be applied; it is of common knowledge that it is not easy to assess Liquidity Risk.

Within this paper, we focus on defining and understanding what Liquidity Risk is, and on the main criteria that can be used to identify a Liquidity stress. Being a broad topic, another paper will be dedicated to the common pitfalls of applying modern techniques, particularly in the context of illiquid assets and investment restrictions [*i.e.* gates, lock-up, *etc.*].

This paper is organised as follows: the first Section is dedicated to defining what Liquidity Risk is, this implies discussing the main features of Liquid markets, and understanding what is an endogenous and exogenous Liquidity effect. The second Section is committed to focus on what you are expected to assess through your quantitative model, for instance, do you want to measure the liquidation timing or the liquidation cost? The last Section is devoted to a brief conclusion.

2. Understanding Liquidity Risk

As stated by Baker (1996), there "*is no single unambiguous, theoretically correct or universally definition of Liquidity*".

Massimb and Phelps (1994) define Liquidity as "*market ability to provide immediate execution for an incoming market order and the ability to execute small market orders without large changes in the market price.*

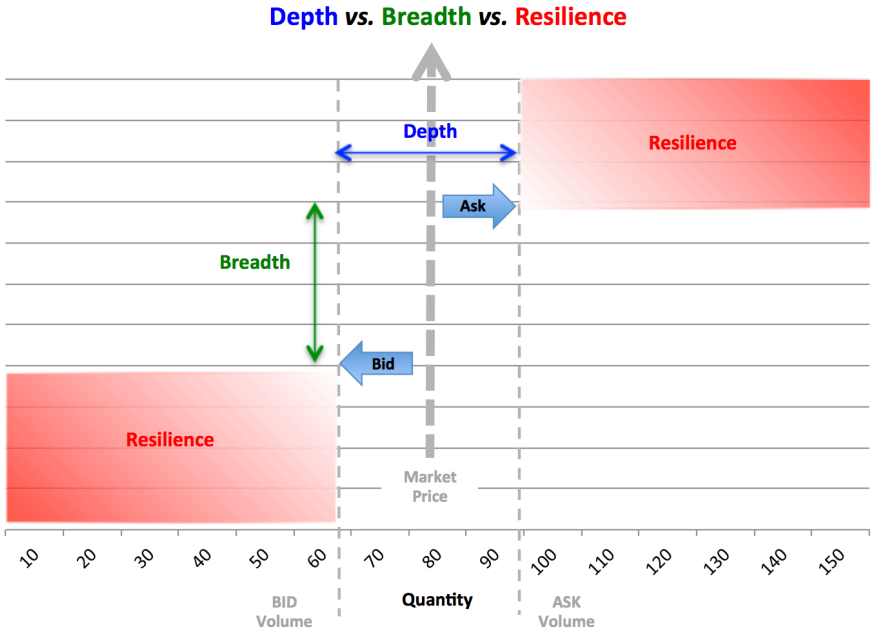
Several factors regularly are used in the modern literature to define Liquid markets; those criteria are defined here below.

2.1. *The Main Features of Liquid Markets?*

According to Baker (1996), Liquid markets exhibit five main characteristics:

1. **Tightness**: Refers to low transaction costs, typically bid-ask spreads ;
2. **Immediacy**: Reflects the speed at which trades can be executed and settled ;
3. **Depth**: Abundant orders, both above and below the equilibrium trading price ;
4. **Breadth**: There is a large volume of buying and selling orders; *i.e.* there are many market participants ;
5. **Resilience**: Price impacts caused by trading are small because the order flow quickly adjust in response to price swings.

The below table illustrates the relationship between the Depth, the Breadth and the Resilience

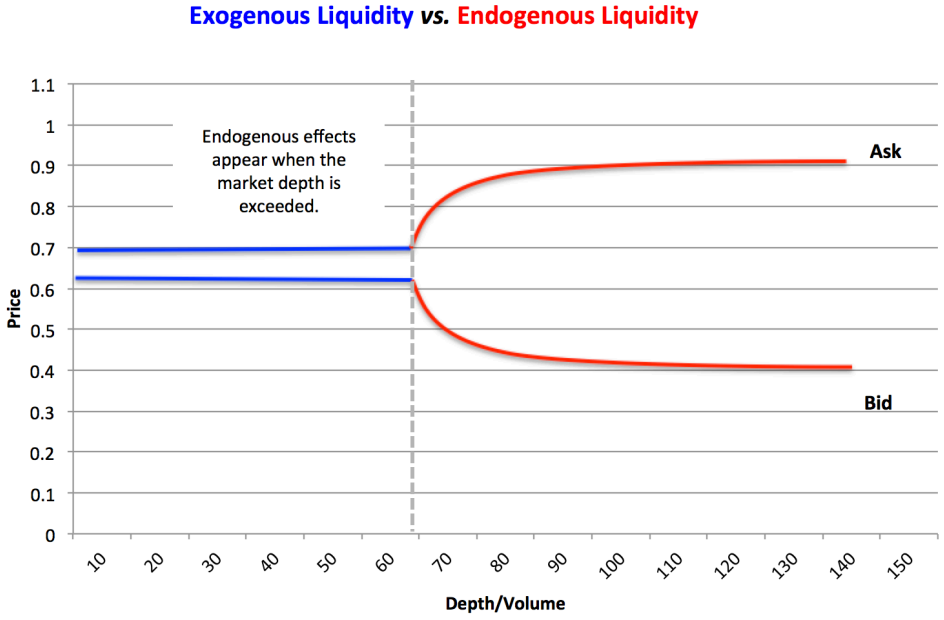


2.2. *Endogenous Effects versus Exogenous Effects*

In a period of volatile markets, a particular attention is drawn to resiliency, the adjustment to a new equilibrium; within stable prices period; assessing liquidation cost can be the priority. Those two aspects are not mutually exclusive, but it can be challenging to assess the liquidation cost during a stress period (resiliency phase).

Endogenous liquidity occurs when the market depth is outstripped (*i.e.* trading orders are not sufficient to satisfy the current demand/offer equilibrium, and bid-ask widen), this is typically a resiliency phase.

The graph below illustrates how bid-ask spreads widen when the depth is exceeded.



Because empirical methods can fail to observe a Liquidity pattern and assess the effective liquidation cost during stress periods, it is important to segregate endogenous effects from exogenous ones. It can indeed be more robust to build a Liquidity monitoring model under normal market conditions and perform in depth qualitative assessments in case of extraordinary market conditions, this implies looking through the portfolio.

3. Measuring Liquidity Risk

Once Liquidity Risk is defined, it must be decided what the model is expected to assess; for instance do you want to measure liquidity timing or liquidation cost, exogenous or endogenous effects.

3.1. Liquidation Cost versus Liquidation Timing

The liquidation cost represents the cost to liquidate your entire portfolio within a given time bucket (*e.g.* the cost to liquidate my full portfolio within 1 week is 10% of my AUM, independently from market effects). For its part, the liquidation timing represents the time required to liquidate your portfolio (*e.g.* I can liquidate 20% of my portfolio in 1 day, 40% in 1 week, and 100% within one month).

My personal opinion is that the liquidation cost is a much more relevant metric than the liquidation timing one; practically speaking you can liquidate everything you want and whenever you want, as long as the discount is sufficient to find a counterparty. If you get a property valued at USD 1mios, do you really think that if you place an offer at USD 100k, you will not find anyone ready to buy it straight away? Then you should rather wondering about the cost of liquidating your house in one day (discount of USD 900k), than about the time required to sell it at about the current market price. In addition to that, it can be challenging to assess from a quantitative or qualitative way the time required to liquidate very illiquid assets.

3.1. Choosing which Liquidity Effect to Evaluate.

We defined the main differences between the endogenous and the exogenous liquidity within the Section 2 of this paper; it must now be decided which effect will be considered within the modeling process, the endogenous one, the exogenous one or both. If you want to focus on exogenous effects, you need to take out the endogenous effects as follows:

$$Liquidity\ Risk = Exogenous\ Effect\ (Depth + Breadth) + Endogenous\ Effect\ (Resiliency)$$

$$Exogenous\ Liquidity\ Risk = \frac{Exogenous\ Effect\ (Depth + Breadth)}{Endogenous\ Effect\ (Resiliency)} + 1$$

Assuming that bid-ask spreads are representative of the breadth and the depth, and that the volatility of price returns represents the resiliency (how quick prices tend toward ordinary bid-ask spread level), you then reach a model - in the end - similar to the LVaR model:

$$Exogenous\ Liquidity\ Risk = \frac{Bid - Ask\ Spreads}{Standard\ Deviation\ Price\ Returns} + 1$$

Amid two bonds with the same bid-ask but with different price returns volatility, the less liquid bond would be the one with the lowest price volatility, then the one which would tend the most slowly towards a new equilibrium.

A word of cautious when applying this approach, if not applied to securities with comparable profiles, this technique may require several adjustments (*e.g.* a sovereign bond could get a similar ratio than a non investment grade bond because low spreads over low price returns volatility can give the same output as high spreads over high price returns volatility).

4. Conclusion

We expected to demonstrate within this paper that there is no single way to monitor Liquidity Risk, and that just focusing on a single criterion is not enough to build a robust approach. When building a Liquidity Risk quantitative model, it is crucial to specify at the beginning of the process the type of Risk you want to measure and the effects you want to consider.

We will focus within a next paper on the common pitfalls of several models regularly used by financial institutions, particularly in the context of illiquid assets and investment restrictions.

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