PART V
Price Impact

Introduction

In this part, we jump into the core topic of this book: understanding price dynamics. More specifically, we will consider the important question of how order flows interact to form a price. In particular, how can the *predictable* order flow elicited in the previous chapter produce *unpredictable* prices? This question will be our core motivation throughout the remainder of the book.

As ever, we start with two fundamentals: concepts and data. We begin by zooming out and asking questions about how market participants' actions impact prices, and, more broadly, the state of the market. We are immediately faced with a difficulty: since history cannot be replayed, how can we know how an action *really* affected the market? Put another way, how can we know that what we observed was not going to happen anyway? This conundrum leads us to the necessity of decomposing impact into two components: the *reaction impact,* which describes how an action directly affects future prices, and the *prediction impact,* which describes what would have happened anyway, even in the absence of the action. The sum of reaction impact and prediction impact will correspond to the *observed impact,* as measurable by an outside observer.

Because it does not require any information about the circumstances in which trades occurred, observed impact often seems to be a natural quantity of study for an outside observer who only has access to public data. However, upon deeper reflection, observed impact reveals itself to be rather non-trivial. On the one hand, some aspects behave as we would expect. For example, buy market orders push the price up on average, sell market orders push the price down on average, and observed impact first increases rapidly before reaching a stable plateau. On the other hand, other aspects are much more surprising. One prominent example is that impact scales as a concave function of order size, such that the seemingly natural idea that this relationship should be linear actually breaks down.

In the quest for reliable measurements of impact, private data is a prerequisite. By allowing a deconvolution of the prediction impact at the scale of the metaorder – and thus getting rid of most spurious conditioning effects – private data offers a reliable way to estimate how order flow dynamically affects the market. As we will discuss, this understanding provides a solid starting point for price-formation models, which indicate that prices move with the *square root* of metaorder volumes.

This widely reported empirical phenomenon is extremely surprising, and holds the key to unlocking several mysteries surrounding order flow and price formation. Does such impact remain forever imprinted on the market and the price? What does it mean for investors' trading strategies? And how does it relate to the idea of market efficiency? This part opens these and many other questions, which the remainder of this book will seek to address.