Maverick Firms and Merger Policy

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Thesis Summary

A “maverick firm” is one that behaves in a manner that differs from the industry norm. As a result they are perceived to present a barrier to tacit collusion and for that reason competition authorities can seek to prevent mergers that might result in their removal from a market. However, the existing literature on mavericks is limited. No formal theory exists and there is no established empirical method for identifying such firms.

This thesis seeks to address these gaps. First, we begin to formulate a formal theory of mavericks via a repeated games model in which firms have contrasting preferences and asymmetric capacities. Then we analyse the use of the concept in European Commission merger cases during 2000-2013. Finally, we explore three strategies for empirical maverick identification. The first consists of a replication of the only previous attempt, which used simple regressions and a ranking system. The second utilises cointegration and error correction techniques. The third explores asymmetric error correction, applying the nonlinear autoregressive distributed lag (NARDL) approach. These methods are used to identify the maverick in the market for bank and building society deposit accounts in the United Kingdom during 2000-2009.

The theoretical model formally illustrates how a maverick can adversely impact non-mavericks’ payoffs. However, we also highlight scenarios where collusion could occur despite the presence of a maverick. The analysis of EC merger cases highlights the fact that application of the concept has been inconsistent with merger guidelines. In particular, the term was regularly used in conjunction with unilateral effects whereas guidelines only relate the concept to tacit coordination. Finally, each of the identification strategies produces contrasting results. Ultimately, the NARDL approach allows the identification of favourable behaviours (from a consumer perspective). As a result we are able to identify the most likely candidate mavericks in our market.

Key words: maverick firms, merger policy, tacit collusion, asymmetric error correction, NARDL

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Chapter 1: Introduction

Competition policy[1] can broadly be described as the set of laws and policies that are designed to ensure that firms do not act in ways that are detrimental to economic welfare. European competition policy can be more specifically subdivided into the regulation of horizontal and vertical agreements between firms ("Article 101" under European competition law), abuse of dominance ("Article 102"), and merger regulation. Competition authorities, such as the Competition and Markets Authority (CMA) in the UK and the European Commission (EC) in wider Europe, are there to enforce competition policy[2]. Their fundamental goal is to uphold economic efficiency. They wish to ensure that competition is effective and to deter and punish actions that have a detrimental effect on welfare (Motta, 2004). It is within this sphere that the work presented in this thesis resides.

The focus of the thesis is merger policy. Competition authorities have the power to intervene in proposed mergers that are perceived to harm economic efficiency. To assess this they consider a wide array of factors. These include structural characteristics such as industry concentration, barriers to entry, symmetry and transparency, as well as factors such as market growth, the stage of the business cycle, and industry life cycles (Pepall, Richards and Norman, 2008). The sum of these factors captures the state of the market, or markets, that a given merger will impact. By considering how each of these factors would change following a given transaction, a competition authority is able to assess whether the merger is detrimental, acceptable, or requires some concessions ("remedies" or "commitments") in order to be permissible.

One factor that authorities consider is the possible impact of a "maverick firm". A maverick is a firm that, for one reason or another, behaves in a manner that is different from the industry norm. A maverick may be particularly price aggressive, highly innovative, or produce a product of favourable quality. In terms of the former, they may offer consistently lower prices than their rivals, engage in favourable price-cutting, or show a reluctance to raise prices in line with their competitors (Baker, 2002). Irrespective of how their behaviour manifests itself, the crucial point is that some aspect of their behaviour differs from other firms in the market. Broadly, in terms of *why* mavericks behave differently, this could be due to differences in costs, for example, or simply

[1] Otherwise known as "antitrust" in the United States.
[2] The Competition and Markets Authority was formerly known as the Competition Commission (CC).

managerial preference (Langenfeld, 1996)[3]. Proctor (2014) offers further specific explanations, including the desire to expand, the desire to improve the competitiveness of downstream operations, or to facilitate the growth of some new innovative product. Whatever the cause, mavericks are regarded as pro-competitive and are seen to impose a constraint on the actions of their rivals. Moreover, they are typically viewed as smaller players whose influence over rivals far exceeds their market share (Scheffman and Coleman, 2003; Breunig and Menezes, 2008).

How, exactly, do mavericks constrain their rivals? In the literature the maverick concept is commonly related to coordination, otherwise known as tacit collusion. Collusion is where firms set prices cooperatively. Under collusion, rather than engaging in individual profit-maximisation, firms effectively joint profit-maximise and set a price that is higher than the competitive level (Tirole, 1988). Collusion can be overt (explicit) or tacit. Overt collusion is where firms communicate with one another in order to cooperatively set prices and divide a market. Tacit collusion is where firms achieve this without directly communicating. Instead, market signals lead firms to the simultaneous realisation that a particular outcome is beneficial to them (De La Mano, 2008). Whilst overt collusion is illegal, tacit is not; however, merger policy can be used to prevent the emergence of conditions that are conducive with coordination. Tacit collusion requires two conditions in order to be sustained. First, firms must be able to detect when a rival has deviated from a collusive arrangement – hence, greater transparency is advantageous. Second, they must be able to credibly retaliate or "punish" any deviation in order to encourage ongoing cooperation on the part of their rivals (Slade, 1987; Vasconcelos, 2005). Where these conditions are met it is possible for tacit collusion to arise.

Tacit collusion is more likely to be achieved where a market is more symmetrical. Such markets have firms of similar sizes, with similar cost structures, and so on. As a result, firms' incentives are better aligned and they are more likely to be able to reach a mutually-beneficial collusive arrangement (Ivaldi et al, 2003). Maverick firms act as a barrier to successful collusion because they represent a source of asymmetry. We have stated that a maverick is a (typically smaller) firm that behaves in a way that is different from its rivals. Such a firm might be disinclined to go along with tacit collusion because the conditions under which collusion would appeal to its rivals would not necessarily appeal to the maverick. Consequently, having such a firm in a market reduces the likelihood of tacit collusion (Kovacic et al, 2007; Sabbatini, 2014).

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[3] Carlton (2010) argued that authorities should distinguish between those firms that are maverick because of differences in economic conditions (costs, etc.) and those that are maverick due to managerial preference – and that only the former should be given special treatment under merger policy.

It follows that the loss of a maverick from a market is seen to *increase* the likelihood of collusion. Consequently, merger guidelines allow authorities to intervene in transactions that might result in their removal from a market or impinge upon their ability to fulfil the role of constraint. “The Agencies consider whether a merger may lessen competition by eliminating a ‘maverick’ firm, i.e., a firm that plays a disruptive role in the market to the benefit of customers” (DoJ and FTC, 2010, p.3)[4]. In merger guidelines, the removal of a maverick has long been perceived to increase the likelihood of “coordinated effects” arising from a merger[5]. Indeed, the maverick concept is present in most regions’ merger regulations, having first appeared in the United States merger guidelines in 1992[6]. However, despite this, existing literature on the subject is relatively scant and only a handful of academic papers have been devoted to the topic. Moreover, it should be noted that despite its presence “…there is no direct and unambiguous definition, empirical or otherwise, for a ‘maverick’ firm in the Merger Guidelines” (Kovacic et al, 2009, p.401).

Most existing maverick papers discuss the concept from a legal perspective (e.g. Baker, 2002; Kolasky, 2002; Owings, 2013). Of these, Baker (2002) is by far the most detailed and widely-referenced paper to date, discussing the concept in terms of US antitrust. Baker outlined a number of avenues through which the maverick concept should be relevant in merger analysis, and discussed possible approaches to maverick identification, amongst other contributions[7]. There have been some attempts to relate the concept to economic theory (e.g. Kwoka, 1989; Ivaldi et al, 2003), though these studies have stopped short of producing a formal theory of mavericks. The issue of how to identify mavericks is particularly important to policymakers, and there have been a few attempts at empirical identification (Kovacic et al, 2007; Breunig and Menezes, 2008; Ivaldi, Mitraille and Muller, 2012). Finally, the maverick concept has arisen in some discussions of wider issues, for example Carlton (2010) considered the concept as part of a wider discussion of horizontal merger guidelines. We will elaborate on this literature throughout the thesis, as and when it becomes appropriate to do so. For now we simply emphasise that the literature on maverick firms is far from extensive.

The lack of a formal theory of mavericks is a key gap in the literature. This gap is surprising given that the concept has been applied to merger cases of multi-million

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[4] Authorities assume that if a maverick merges with another firm, its behaviour will change post-merger since it “must take into consideration the interests of the group which it [then] belongs to.” (Sabbatini, 2014, p.3). Thus, authorities seek to prevent mergers where one of the notifying parties is believed to be a maverick. We will elaborate on this in due course.

[5] “Coordinated effects” is synonymous with tacit collusion.

[6] We will further discuss the wording of the term in merger guidelines in Chapter 3.

[7] We will discuss Baker (2002) in detail at various points throughout this thesis.

pound value[8]. One would like to believe that where a concept is used by authorities as part of their argument for preventing a significant transaction that the concept would be comprehensively researched and fully understood. However, the dearth of studies on the topic would seem to suggest otherwise. Thus, the absence of a formal theory is the first gap that this thesis hopes to address. Almost all papers agree that the presence of a maverick affects the likelihood of collusion, yet no studies have formally outlined how and why this is the case. The closest thing to a formal theory can be found in Ivaldi et al (2003), who provided an illustrative example of a maverick as part of a wider discussion of tacit collusion[9]. However, Ivaldi et al do not generalise or expand upon their model beyond their illustrative example. Thus, the first objective of this thesis is to contribute toward the development of a formal theory of maverick firms by expanding upon their work.

A second gap in the literature is that whilst the maverick concept has been considered with respect to individual cases (such as *Heineken/Scottish & Newcastle* and *Statoil/Topaz* in Massey, 2010) no published academic work has analysed the practical use of the concept at an aggregate level. Lyons (2008) provides some analysis of the use of the term in cases, but this is far from comprehensive. The second objective of this thesis is therefore to analyse past use of the concept by the EC competition authority. We hope to establish the frequency with which the term is applied and whether its application is consistent with both theory and the wording of guidelines. We have reason to believe that authorities may apply the concept in ways that are inconsistent with guidelines. For example, Owings (2013) criticised US policymakers' understanding of the concept, with reference to the cases of *AT&T/T-Mobile* and *H&R Block/TaxACT*. We are therefore interested in exploring the way the concept has been applied, so that we might better understand how it is perceived and whether its use in theory and practice can be reconciled.

Finally, an issue which has been underexplored in the literature is the identification of maverick firms. Presently, their identification is usually achieved through qualitative reasoning[10]. Authorities apply their understanding of markets, combined with the views of market participants, in order to reason why a particular firm might be maverick. Following this, authorities sometimes apply econometric techniques to prove the "maverickness" of particular firms - though this is rarely done. Similarly, a couple of

[8] Such as *StatoilHydro/ConocoPhillips* (2008), *T-Mobile/Orange* (2010) and a host of other cases we will discuss throughout the thesis.
[9] This example is outlined in Chapter 2.
[10] This is something we confirm in Chapter 3.

academic papers have qualitatively identified potential mavericks and then tested their "maverickness" empirically (Kovacic et al, 2007; Ivaldi, Mitraille and Muller, 2012). However, to date only one paper has attempted to empirically identify a maverick without existing preconceptions regarding the likely identity of the party (Breunig and Menezes, 2008). It would be desirable to develop such a method since this would remove subjectivity from maverick identification[11]. This is the third objective of this thesis.

The thesis is structured as follows. Chapter 2 chronicles an attempt to develop a formal theory of maverick firms. We build upon Ivaldi et al (2003) via a repeated games model with asymmetric capacities. Chapter 3 analyses the use of the concept in European merger cases during the period 2000-2013. We produce some overall statistics on the population of cases and discuss three particularly interesting cases in more detail. Chapters 4-7 are then devoted to maverick identification. Chapter 4 outlines the dataset used; the market we consider is UK instant access deposit accounts, and the dataset is composed of individual banks' interest rates. Chapter 5 consists of a replication of the methods used in the only objective empirical identification paper to date, that of Breunig and Menezes (2008). We begin with a replication in order to appreciate the sentiments behind the only previous attempt, and to observe precisely the reasons why that attempt was unsuccessful. In Chapter 6 we develop our first original attempt, using error correction models and cointegration analysis. This is inspired by the methods commonly used to analyse markets such as ours. Chapter 7 then improves upon this by considering asymmetric cointegration; we propose and test an approach to maverick identification using the nonlinear autoregressive distributed lag (NARDL) approach. This is inspired by the apparent significance of asymmetry in the maverick literature. Finally, Chapter 8 concludes by discussing the implications of findings and outlines areas for further work.

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[11] The present mode of identification is open to abuse. For instance, a merging party may wish to portray itself as non-maverick to ensure a merger would be allowed, or an outside third party may wish to portray a merging party as maverick so it would not.

Chapter 2: A Repeated Games Model of Maverick Firms

2.1 Introduction

As we outlined in the introduction to this thesis, the existing literature on mavericks is limited. Papers tend to be discursive in nature and focus on the legal position of competition authorities (e.g. Kolasky, 2002; Owings, 2013) or refer to the concept in conjunction with particular merger cases (e.g. Kovacic et al, 2007; Massey, 2010). However, crucially, the literature has not yet produced a formal theory depicting maverick behaviour. This chapter seeks to at least begin to address this gap through the development of a repeated games model of maverick firms. Our objectives are to show formally how the presence of a maverick impacts the chances of tacit collusion arising in a market, to highlight scenarios where mavericks genuinely constrain their rivals, and to consider the impact to non-mavericks' profits in such scenarios. Overall, we aim to consider the appropriateness of preventing mergers that might remove a maverick from a market. Can we show, clearly, how and under what circumstances the removal of a maverick would have a significant impact on competition and when it would not?

In order to produce a formal theory it is first appropriate to consider what makes a firm behave in a maverick way. We have stated that maverick firms behave in a manner that is contrary to the industry norm by either charging a lower price, innovating to a greater extent, or producing a product of higher quality than their rivals (Baker, 2002). In terms of what *causes* this behaviour, we take the view that maverick behaviour is a rational response to some difference in the underlying conditions faced by a firm[12]. To this end, the literature suggests a few different explanations. Firstly, it could be due to the firm having a drastically different production capacity or cost structure to its rivals (Scheffman and Coleman, 2003; Proctor, 2014)[13]. Alternatively a firm may use (and be influenced by the price of) some input that its rivals do not, or may utilise common inputs to different extents, resulting in changes in input prices having a different effect on the maverick firm. Finally, it may be that a firm simply has a stronger preference for short-term payoffs than its rivals, due to its stage of development or individual circumstances (Ivaldi et al, 2003). Each of these represents a possible explanation for why a maverick firm might

[12] We conform to the view that "A maverick is not a wild firm that is out of control but one whose economic incentives make it an aggressive competitor" (Carlton, 2010, p.622). This is as opposed to Langenfeld (1996), for example, who discussed maverick behaviour possibly being attributable to managerial preference or whim.

[13] Proctor (2014) stresses that mavericks usually have low variable or (occasionally) fixed costs.

adopt a different strategy to its competitors. Therefore, each and any of these could potentially provide the basis for our model.

In the literature the closest thing to a formal theory of mavericks comes from Ivaldi et al (2003), who provided a simple mathematical example of a maverick firm. Ivaldi et al distinguished between mavericks and non-mavericks on the basis of their preferences over current and future payoffs. This was achieved using discount factors. Discount factors are effectively a measure of firm patience; they capture firms' preferences over current and future income streams, and range from zero to one. A discount factor of one represents the case where a firm values current and future income equally. For instance, a firm with a discount of one would be indifferent between receiving £1000 today or £1000 tomorrow. As a firm's discount factor tends to zero they become less and less patient. The closer it is to zero, the more they prefer receiving income in the present.

Ivaldi et al (2003) portrayed the maverick as having a lower discount factor than its rivals[14]. The result of this is that the maverick is less inclined to collude. Collusion involves cooperating to charge higher-than-competitive prices and sustain higher payoffs over time. The alternative (deviation from a collusive arrangement by charging a lower price) is typically modelled as one large payoff in the present followed by lower payoffs over time. This is because by "cheating" and deviating from a collusive arrangement the deviator is able to enjoy one period in which they "steal the market" and receive a boost in custom, after which rival firms respond and lower their own prices ("retaliation" or "punishment"). Hence, in subsequent periods the deviator loses custom and payoffs decrease (De La Mano, 2008a; Harrington, 2015). The more patient a firm is, the more likely it will favour collusion. The less patient a firm is, the more likely the one-off payoff from deviation would be appealing. Thus, by assigning a lower discount factor to the maverick, Ivaldi et al model that party as being less inclined to collude than its rivals.

Ivaldi et al (2003) give a simple example of a triopoly. Suppose that two firms have the same discount factor, whilst the third (the maverick) has a lower discount. Ivaldi et al denote non-maverick firms' discount factors as δ and that of the maverick as δ', such that $\delta > 2/3$ and $\delta' < 2/3$. It is assumed that if they were to collude then the three firms would share collusive market profits equally in each period. If any one firm decided to deviate away from the collusive arrangement then that firm would capture the entire

[14] This portrayal is both intuitive and consistent with merger guidelines. For example, take new entrants. New entrants to a market are often perceived as likely mavericks (Tucker and Sayyed, 2006; Proctor, 2014). Such firms might favour short-term profits since their long-term survival may be uncertain. As a result, they would naturally be less patient.

market profit for one period, after which a lower payoff would be received by all[15]. Firms cannot trust one another following deviation and the breakdown of collusion. Ivaldi et al assume that following deviation payoffs would equal zero forever[16]. They assume a "grim strategy" (Harrington, 2015).

In order for collusion to occur, the payoff to cooperation must exceed the payoff to deviation for all firms. Let π^c denote collusive market profit and α denote market share, such that $\sum\alpha_i = 1$, where i=1,2,3. If a firm deviates they receive π^c in the first instance followed by zero forever, whereas if collusion is achieved π^c is shared according to α. Thus, for an individual firm to wish to collude then the following condition must be satisfied: $\alpha(\pi^c/1-\delta) \geq \pi^c+\delta(0)$, or $\alpha(\pi^c/1-\delta) \geq \pi^c$. This term includes the discounting of future payoffs through the discount factor.

If the three firms were symmetrical then a collusive outcome with equal market shares ($\alpha = 1/3$) would arise. However, because of the maverick's lower discount factor this outcome is unsustainable. Specifically, Ivaldi et al (2003) demonstrate that in order for the non-mavericks to be willing to collude given their imposed discount factor ($\delta > 2/3$) they must be allocated a collusive market share of at least 1- δ[17]. Then, supposing that non-mavericks received this market share, Ivaldi et al calculated the share left over for the maverick and showed that the firm would not be willing to collude at that level. If non-mavericks had market shares equal to 1- δ, the maverick would be left with $\alpha' = 1-2\alpha = 1-[2(1-\delta)]$. For the maverick to favour collusion with this market share, its discount factor would have to be at least 2/3. Yet by construction its discount is below this level ($\delta' < 2/3$). Thus, Ivaldi et al show that collusion is unsustainable where there is a firm with a significantly lower discount rate than its rivals[18]. Effectively, the presence of a maverick constrains the ability of firms to achieve coordination.

Ivaldi et al's (2003) model is consistent with Baker (2002). Baker outlined four conditions under which a maverick would be able to constrain coordination. These are (i) where there is a diminished capacity for rivals to punish deviation by any one firm, (ii) where rents cannot be allocated satisfactorily amongst firms, (iii) where uncertainty over rivals' strategies makes deviation hard to detect, and (iv) where the joint profit-maximising

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15 This lower payoff could be a result of reverting to competition or due to punishment levied on the deviating firm.

16 This is in line with, for example, the competitive equilibrium where firms compete according to Bertrand competition. In a Bertrand setting, if a firm were to deviate from a collusive arrangement then they would revert to competition, which is where price equals cost and profit is zero, i.e. the Bertrand paradox (Tirole, 1988).

17 Note that this is derived from solving the inequality $\alpha(\pi^c/1-\delta) \geq \pi^c$ for α.

18 Their illustrative example is grounded in reality. For instance, Fershtman and Pakes (2000) give real-world examples of situations where one firm in a market would prefer to deviate whilst their rivals would prefer to collude.

outcome is hard to identify[19]. Whilst the four conditions are not insurmountable they "make it likely that incomplete coordination will be constrained by a maverick firm" (Baker, 2002, p.166). Collusion can only be sustained where the long-term gain from cooperating exceeds any short-term gain from deviating combined with whatever punishment rivals may levy. If we accept Ivaldi et al's idea of assigning a lower discount to the maverick, this would mean that they value the long-term gains from cooperation lower, and short-term gains from deviation higher, than their rivals. Therefore in order for them to collude they must be allocated a larger portion of the market than their rivals, making condition (ii) an issue. Moreover, they would be less concerned with the prospect of punishment than would a regular firm, making it harder for rivals to retaliate (i). Finally, their unusual strategy makes rivals uncertain over both what the joint-profit-maximising outcome might be (iv) and, should it be established and implemented, whether the maverick has deviated from it (iii). Thus, Ivaldi et al's simple model is consistent with the conditions Baker (2002) outlines in his key maverick paper.

As the closest thing to a formal theory and a seemingly accurate example of a maverick firm from a theoretical point of view, it makes sense for us to develop our model using Ivaldi et al (2003) as a basis. Hence, this chapter builds upon the idea that discount factors can be used to distinguish between mavericks and non-mavericks. One adaptation we make is to incorporate size into our model. Mavericks are typically viewed as smaller firms whose influence is greater than their market share would suggest (Scheffman and Coleman, 2003). In order to allow for this we allow capacities to differ across firms. We are then able to model the maverick as a firm with a smaller capacity than its rivals. Specifically, we build a repeated games model in which firms differ in the extent to which they are capacity constrained. This is in the spirit of Compte, Jenny and Rey (2002).

Compte et al (2002) presented a repeated games model in which firms each had different production capacities but common discount factors (δ). They sought to explore for which values of the common discount factor tacit collusion could be achieved. In general, as we have stated, collusion is sustainable where the value of coordination exceeds the value of deviation for all firms[20]. Thus Compte et al sought to establish how high this common discount needed to be in order for collusion to be sustainable. What they found was that larger firms required higher discount factors. Therefore, given that they stipulated the discount be common across firms, this meant that the level required for

[19] Broadly, (ii) and (iv) correspond to difficulties in reaching consensus over a collusive arrangement whilst (i) and (iii) relate to the deterrence of cheating.

[20] We assume at all times that firms are rational and that they would only choose Action A over Action B if the payoff to Action A were greater.

collusion depended on the capacity of the largest firm (k_L). Specifically, they found that this critical discount factor (δ^*) was equal to the ratio of the largest firm's capacity to the overall capacity in the market (k_L/K). For actual discount factors above this level all firms favour the discounted stream of profits from colluding to the one-off gain from deviating (followed by punishment).

The chapter proceeds as follows. Section 2.2 presents our basic model. Section 2.3 outlines a specific example, and identifies cases in which collusion could be sustained despite the presence of a maverick. Section 2.4 then considers partial collusion – the case where non-mavericks omit the maverick from their collusive activities. We consider whether it is ever optimal for firms to do so. Moreover, if full collusion with the maverick is impossible we consider the impact this has on firm profits. Finally, Section 2.5 summarises the findings of the chapter, outlines areas for further extension, and motivates the subsequent chapters.

2.2 Model

In order to explore the implications of the presence of a maverick, here we use a Compte et al (2002) style framework to extend the ideas of Ivaldi et al (2003). As in Compte et al we assume that firms have asymmetric capacities. By doing so, we are able to model the maverick as a smaller firm, just as the party is depicted in the literature. As in Compte et al we also assume for simplicity that costs are zero and the product is homogenous. However, unlike that paper, we allow discount factors to vary across firms in the spirit of Harrington (1989). By doing so, we are able to incorporate the maverick concept into the model. Ivaldi et al (2003) portrayed the maverick as a firm with a much lower discount rate than its rivals. Along similar lines, we model the party as a firm that has *a lower discount rate than the critical level necessary for collusion*. We will explain this subtle difference in due course.

We derive our model as follows. Let k_i denote the capacity of firm i, K denote the capacity of all firms ($\sum k_i$) and K_{-i} denote the capacity of all firms $\sum k_j$ where $j \neq i$. Firms produce a homogenous product. With regard to demand, for simplicity we assume that there is a population of M buyers and that each buyer will purchase one unit of the good from the cheapest seller so long as the price is below their reservation value, which we denote by r. We assume that demand is perfectly inelastic; the amount that will be bought does not vary with price. Further assume that $K > M > K_{-i}$ for all i. The first part of this, $K > M$, ensures that competition is effective and firms do not just charge the monopoly price (r). The fact that $M > K_{-i}$ meanwhile ensures that no subset of firms can serve the whole market; all firms must be involved in order to fully satisfy market demand. Finally, with regard to discount factors, let δ_i denote the actual discount factor of firm i.

If firms collude they charge a price equal to the reservation price, r, and sell a portion of demand M. We assume that at equal prices demand is divided according to a proportional rule; that is, proportionate to capacity[21]. If a firm deviates from the collusive agreement, it is optimal for the deviator to undercut its rivals and charge a price equal to (r - ϵ), where ϵ is some infinitesimally small value. By charging just under the collusive price, firms maximise their gains in the case of deviation. When a firm undercuts they are able to sell their full capacity k_i for one period, after which their rivals will retaliate. We assume that retaliation takes the form of a grim punishment strategy in which firms revert to the static Bertrand-Nash equilibrium forever ("Bertrand-Nash Punishments")[22].

Bertrand-Nash punishments in this context are derived as follows. The largest firm, firm l, can guarantee itself a profit of $r(M - K_{-l})$ by charging the reservation price, since the maximum its rivals can produce is K_{-l}, their combined capacity. Therefore firm l would not charge a price that yields a payoff lower than this amount; the minimum price firm l would ever charge is $p_{min} = r(M - K_{-l}) / k_l$. Since $M > K_{-l}$, smaller firms (i < l) can then sell to full capacity by slightly undercutting p_{min}. It follows that the Bertrand-Nash equilibrium will be in mixed strategies[23], with each firm making a profit of $p_{min}k_i = [r(M - K_{-l}) / k_l]k_i$.

Based on the above, we can derive expressions for the payoffs to collusion, deviation and during punishment. Let Π^c denote the collusive profit, Π^d the one-period profit from deviating, and Π^p the profit during the punishment phase:

$$\Pi_i^c = r\frac{k_i}{K}\frac{M}{(1-\delta_i)} \qquad (2.1)$$

$$\Pi_i^d = (r-\epsilon)k_i \qquad (2.2)$$

$$\Pi_i^p = \frac{r(M-K_{-l})}{k_l}k_i \qquad (2.3)$$

[21] This is as in Compte et al (2002).

[22] This also constitutes the optimal punishment under the proportional rule for allocating demand amongst equal price firms (Compte et al, 2002).

[23] See Fonseca and Normann (2008) for further detail.

Firms will choose to collude if the discounted value of collusion (2.1) exceeds the payoff to deviation (2.2) plus the payoff during the subsequent retaliation (2.3). Firms will therefore be willing to collude if $\Pi^c \geq \Pi^d + \Pi^p$, i.e. where:

$$r\frac{k_i}{K}\frac{M}{(1-\delta_i)} \geq (r-\epsilon)k_i + \frac{\delta_i}{(1-\delta_i)}\frac{r(M-K_{-l})}{k_l}k_i \tag{2.4}$$

Normalising $r = 1$ and exploiting the fact that $(r - \epsilon) \simeq r$, we see that collusion is sustainable if:

$$\frac{k_i}{K}\frac{M}{(1-\delta_i)} \geq k_i + \frac{\delta_i}{(1-\delta_i)}\frac{(M-K_{-l})}{k_l}k_i \tag{2.5}$$

In order for collusion to be sustainable this inequality (2.5) must be satisfied for all i. Note that for the largest firm this simplifies to:

$$\frac{k_l}{K}\frac{M}{(1-\delta_l)} \geq k_l + \frac{\delta_l}{(1-\delta_l)}(M-K_{-l}) \tag{2.6}$$

Let δ^*_i denote the "critical discount factor" required for firm i to favour collusion over deviation. Given this setup, it can be shown that each firm's critical discount factor depends on the capacity of the largest firm. Specifically, we find that $\delta^* = k_l/K$[24]. In other words, we find that, as in Compte et al (2002), collusion may be sustained provided that each firm's discount factor is greater than or equal to the proportion of the largest firm's capacity relative to total capacity.

2.3 A Specific Example

We have outlined the parameters of our model. We will now employ a specific example in order to demonstrate the impact of the presence of a maverick firm. Consider a triopoly with firms whose capacities are $k_1 = 5$, $k_2 = 4$, and $k_3 = 3$ such that industry capacity, K, equals 12. Suppose there is a population of M consumers and that $M = 10$[25]. Each of these consumers buys one unit of the good, which they will buy from the lowest price firm given the assumption of product homogeneity. Note that the critical discount factor in this case is $\delta^* = k_l/K = 5/12$ (0.417) for all three firms. Collusion would be sustainable if all firms had an actual discount factor that exceeded this critical discount factor ($\delta_i \geq \delta^*$). In other words, collusion is possible where $\delta_i \geq 0.417$ for i = 1,2,3.

[24] This is derived in Appendix A.

[25] Importantly, by construction the numbers satisfy the condition $K > M > K_{-i}$ for all i.

However, suppose that Firm 3 is the maverick, having an actual discount factor that is below the critical level needed for collusion, $\delta_3 < \delta^*$. In other words, suppose Firm 3 prefers current profits over future profits (for whatever reason) and consequently this gives them an aversion to collusion. In such a case, by construction the value of deviation would exceed the value of collusion for Firm 3. Given the assumption that each firm satisfies an amount of total industry demand that is proportionate to their capacity, the firm would not be willing to collude and would instead choose to deviate. Based on this, we can immediately see how the presence of an impatient maverick would act as a barrier to successful collusion. So far, this is consistent with Ivaldi et al (2003).

Next, let us consider whether there are circumstances in which the maverick could be encouraged to collude. In order to incentivise cooperation from Firm 3, the firm would have to be assigned a greater portion of the collusive market. In other words, they would have to receive a more-than-proportionate share of the demand at the collusive price. Recall the condition for collusion (2.5):

$$\frac{k_i}{K}\frac{M}{(1-\delta_i)} \geq k_i + \frac{\delta_i}{(1-\delta_i)}\frac{(M-K_{-l})}{k_l}k_i \qquad (2.5)$$

The term k_i/K on the left hand side captures collusive market share; it is the portion of demand that firm i receives when it is divided according to the proportional rule. Let us redefine this as α_i. To incentivise Firm 3 to collude given their low discount factor, α_3 must increase to a level where the inequality tilts in favour of collusion. In other words, market share α_3 must no longer equal k_3/K; it must exceed this level in order for the maverick firm to favour collusion.

To see this more clearly, let us assign a value to Firm 3's discount factor. Initially, suppose the firm has an actual discount equal to $\delta_3 = 1/12$, or 0.083. This represents a case where the maverick is extremely averse to collusion since this value is considerably lower than the critical level[26]. With this level of impatience we can compute the market share the firm would have to receive in order for it to be willing to collude. By inputting the values of the specific example we find that for a discount factor of 0.083 Firm 3 must receive a collusive market share of 0.290. By contrast, under the proportional rule, Firm 3's market share would be 3/12, or 0.250. Let us term the proportionate example the "base case". From this we can see that in order to be incentivised to collude a maverick with a discount factor of 0.083 would require 0.04 of market share above what was required in the base case. Choosing to collude rather than deviate is analogous with

[26] Later, we consider lesser degrees of maverickness by imposing values of δ_3 that are higher than 1/12 but which are still below the critical level.

choosing long-run payoffs over short-term ones and so the additional market share is needed in order to overcome the firm's preference for short-term payoffs.

Clearly, if collusion is to occur this additional amount of market share (0.04) must be taken away from other firms in the market. Under what circumstances is this possible? For this to be possible, the other firms must be willing to collude with a market share lower than their proportional amount. Theoretically, this would then allow them to give additional market share to the maverick and still prefer to collude themselves.

Another way to look at it is that there needs to be "slack" in the incentive conditions of one or both of the non-mavericks; one or both of the non-mavericks needs to have an actual discount factor that is strictly greater than their critical value. If $\hat{\delta}_1 = \delta^*$ and $\hat{\delta}_2 = \delta^*$ while $\hat{\delta}_3 < \delta^*$ then collusion would not be sustainable. In such a case, Firm 1 and 2's respective discounts would be just high enough for them to be willing to collude with a proportional market share but they would not be willing to give up some of their custom and still favour collusion. In such a scenario there would therefore be no scope for mutually beneficial coordination and the maverick would indeed present an effective barrier to collusion, as is suggested in the literature.

However, within our triopolistic setup we can demonstrate three broad hypothetical scenarios in which collusion could occur. These are: (i) where Firm 1 has sufficient slack in its incentive condition to unilaterally provide the maverick the necessary additional market share, (ii) where Firm 2 has sufficient slack to do so, and (iii) where both have some slack and could jointly sacrifice the necessary market share in some configuration. In the next few subsections we consider each of these in turn, demonstrating each scenario in the context of our specific example.

2.3.1 Scenario One: where $\hat{\delta}_1 > \delta^*$ but $\hat{\delta}_2 = \delta^*$

First, consider the case where $\hat{\delta}_1 > \delta^*$ but $\hat{\delta}_2 = \delta^*$, i.e. where there is slack in Firm 1's incentive condition but where Firm 2's discount is only just high enough for them to be willing to collude with a proportionate market share. If collusion is to be achieved in this scenario, we can immediately state that any movement away from the proportionate arrangement will involve a transfer of market share from Firm 1 to Firm 3 with no change in Firm 2's share of the collusive market. This is because if Firm 2 received a lower share then they would rationally choose to deviate and so collusion would break down. We therefore turn our attention to considering how high Firm 1's discount rate needs to be in order for them to be able to give up the necessary 0.04 of market share to Firm 3.

Under the proportional rule Firm 1 would be assigned a collusive market share of 5/12, or 0.417. Therefore, in order for them to be willing to give up 0.04 of market share to the maverick they must be willing to collude with a lower market share (0.377). We are therefore interested in finding the minimum level of $\hat{\delta}_1$ for which they would be willing to settle for a market share of 0.377. Specifically, Firm 1, the largest firm, is willing to collude if:

$$\alpha_1 \frac{M}{(1-\hat{\delta}_1)} \geq k_1 + \frac{\hat{\delta}_1}{(1-\hat{\delta}_1)}(M - k_2 - k_3) \tag{2.7}$$

By imposing the market share $\alpha_1 = 0.377$ and the values of our specific example, we can compute how high $\hat{\delta}_1$ would need to be for successful collusion in this scenario. Doing so yields a value of 0.615[27]. Recall that the critical discount was 5/12, or 0.417. From this we can see that Firm 1 would have to be considerably more patient than this benchmark in order to accommodate Firm 3; their discount factor would have to be 0.198 greater than it would need to be in order to achieve collusion in the absence of the maverick[28].

2.3.2 Scenario Two: where $\hat{\delta}_1 = \delta^*$ but $\hat{\delta}_2 > \delta^*$

A similar approach can be applied to the case where $\hat{\delta}_1 = \delta^*$ but $\hat{\delta}_2 > \delta^*$, i.e. where Firm 2 is the only non-maverick with slack in its incentive condition. In this case, the non-maverick with slack is not the largest firm, and so the collusion-deviation inequality takes the form:

$$\alpha_2 \frac{M}{(1-\hat{\delta}_2)} \geq k_2 + \frac{\hat{\delta}_2}{(1-\hat{\delta}_2)} \frac{(M-k_2-k_3)}{k_1} k_2 \tag{2.8}$$

We are nonetheless similarly able to identify how high Firm 2's discount factor would need to be in order to unilaterally sacrifice the necessary market share required to encourage the maverick to collude. Under the proportional rule, Firm 2 would be assigned a collusive market share of 4/12 or 0.333. Therefore, in order to give up 0.04 to the maverick and still be willing to collude, Firm 2 must possess a discount factor under which collusion is preferred with a collusive market share is just 0.293.

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[27] Note that for higher values of $\hat{\delta}_1$ Firm 1 would be willing to collude with a lower share than 0.377.

[28] It is noteworthy that the degree to which the non-maverick's discount factor needs to be above the critical level is less than the degree to which the maverick's was below it. In this specific example we imposed a discount factor of 0.083 on Firm 3, a value which is 0.334 lower than the critical level of 0.417. Yet the non-maverick's discount factor only needs to be 0.198 greater that this level. Hence the necessary "aggregate level of patience" in the market is actually lower than the case where each firm has $\hat{\delta}_i = \delta^*$.

As in Scenario One, we can calculate how high $\tilde{\delta}_2$ would need to be by imposing α_2 = 0.293. Doing so yields a value of 0.669. Again, if we compare this to the critical discount factor of 0.417 we see that in this scenario Firm 2's discount would need to be 0.252 greater than this level. This figure is higher than in Scenario One. From this we note that whilst collusion is possible if any non-maverick is sufficiently patient, it is easier to achieve where it is the largest firm that has more patience.

2.3.3 Scenario Three: $\tilde{\delta}_1 > \delta^*$ and $\tilde{\delta}_2 > \delta^*$

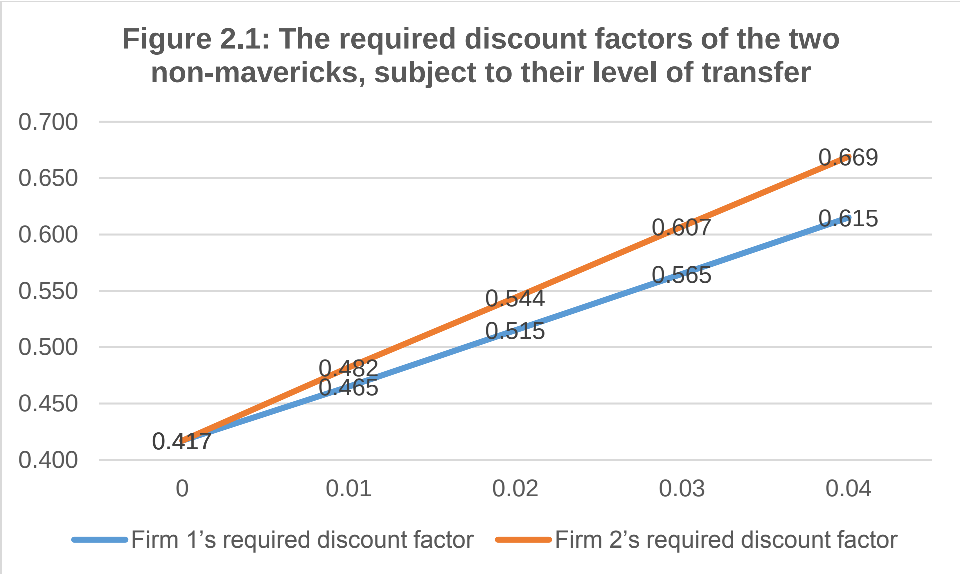
So far we have considered cases where only one of the non-mavericks has slack in their incentive condition. Next we consider the case where both have slack, i.e. where both $\tilde{\delta}_1 > \delta^*$ and $\tilde{\delta}_2 > \delta^*$. In such a scenario, both firms would be able to sacrifice some market share in order to achieve full collusion. As above, let the maverick third firm have an actual discount that is equal to $\tilde{\delta}_3 = 0.083$, requiring a market share transfer of 0.04 to encourage them to collude. In the base case, by the proportional rule, Firm 1 and 2's combined market share would be 0.75. Thus, in order for the maverick to receive an additional 0.04, Firm 1 and 2's respective discount factors must be such that they have a combined market share of 0.71 but still both favour collusion. Then, between them they can transfer the necessary market share required in order to encourage Firm 3 to collude.

Clearly, there are different ways in which the transfer of market share to the maverick could be divided between the non-mavericks. The two extreme options are portrayed in Scenarios One and Two. Between these two extremes, in principle we have a continuum of possibilities whereby the non-mavericks supply different proportions of the required transfer. However, if we restrict market share to units of 0.01, we can conceive of three possibilities in addition to the two extremes. These are where Firms 1 and 2 each provide half of the required transfer, where Firm 1 provides three quarters whilst Firm 2 provides a quarter, and where Firm 2 provides three quarters whilst Firm 1 provides a quarter. The level of actual discount factor required for each of the two firms in each of the five eventualities is summarised in Table 2.1. Figure 2.1 shows the difference in required discount factor for Firm 1 and Firm 2, according to the transfer they are required to make[29]. Figure 2.1 clearly demonstrates that the larger firm does not require as high a discount factor as its rival.

[29] Obviously, in any scenario the full transfer of 0.04 is being made, and so if Firm 1 is transferring 0 then Firm 2 must transfer 0.04 and so on.

Table 2.1: Required discount factors to facilitate collusion

Transfer given by Firm 1	Transfer given by Firm 2	Firm 1's required discount factor	Firm 2's required discount factor	Notes
0.04	0	0.615	0.417	"Scenario One"
0.03	0.01	0.565	0.482	
0.02	0.02	0.515	0.544	
0.01	0.03	0.465	0.607	
0	0.04	0.417	0.669	"Scenario Two"



It is clear that the presence of a maverick need not necessarily rule out collusion. Table 2.1 depicted several scenarios in which the maverick firm could theoretically be accommodated, provided that other firms in the market were sufficiently patient. However, in the event of both non-mavericks having slack in their incentive condition it is not immediately obvious which of these intermediate outcomes would arise. More generally, it is not obvious how market share would be transferred to the maverick; recall that we are operating in the realm of tacit collusion with no communication between firms. Thus, the presence of the maverick at least makes collusion more difficult to achieve. The need for reorganisations of market share makes the success of collusion less likely. We will further discuss these points in Section 2.4.

2.3.4 Degrees of Maverickness

In the three scenarios we outlined above we imposed a discount factor of 1/12, or 0.083, upon the maverick. This was an arbitrary value. In fact, we could capture maverick behaviour with any discount rate that satisfied the inequality $\delta_3 < \delta^*$. As a result, Table

2.2 below presents alternative results for hypothetical mavericks with different degrees of impatience. The table shows the discount factor Firms 1 and 2 would have to possess in order to unilaterally transfer market share to a maverick Firm 3 that has a discount rate of 2/12, 3/12 and 4/12, as well as the 1/12 case. Note that all of these possibilities are all under the critical discount level, 5/12.

Table 2.2: Required discount factors to facilitate collusion with mavericks of varying impatience

Maverick's discount factor (δ_3)	Required transfer	Firm 1's required discount factor (Scenario One)	Firm 2's required discount factor (Scenario Two)
0.083	0.04	0.615	0.669
0.167	0.03	0.565	0.606
0.250	0.02	0.515	0.545
0.333	0.01	0.465	0.481

We could similarly compute values for each of the three additional eventualities outlined in Scenario Three.

2.4 Partial Collusion

We have outlined scenarios in which collusion could hypothetically occur despite the presence of a maverick firm. However, as we have mentioned, successful collusion in these cases requires not only greater patience among non-mavericks but also the capacity to "transfer" market share amongst firms; in other words an ability to collude with market shares that differ from the proportionate distribution. Given that we are operating in the context of tacit collusion where there is no explicit communication between firms such a redistribution of market share may be difficult to achieve. A proportionate distribution may be intuitive because it is 'focal', however it is less clear how alternative arrangements would arise (Leahy and Pavelin, 2003). Whether such alternative allocations of market share are possible would vary from market to market. In some contexts other divisions of market share may be obvious to firms, but this would depend on the specific dynamics of a given market.

Rather than engage in full collusion (involving all firms), an alternative possibility is that non-mavericks engage in partial collusion (also known as "semicollusion") without the maverick. This would effectively involve "ignoring" the maverick firm, allowing it to produce to its full capacity and then colluding over the residual demand. Intuitively, non-mavericks may wish to consider this possibility where the maverick presented too great a barrier to coordination; in other words, in cases where the transfer of market share proved impossible to administer or where the maverick was insurmountably averse to collusion. Indeed, in the latter, omitting the party from collusive activities may be the only possibility available to would-be colluding non-mavericks.

Where full collusion is rendered impossible, it is interesting to analyse the impact of being limited to partial collusion on non-mavericks' payoffs. By doing so we are able to quantify the impact a maverick would have on its rivals. The greater the impact, the more likely a non-maverick would conceivably wish to acquire a maverick and remove them from the market, as merger guidelines suggest.

Engaging in partial collusion would clearly decrease the amount of demand faced by non-mavericks. In terms of the specific 3-firm example depicted earlier this would amount to colluding over $M - k_3$. In more general terms this would be M_{-m}, where subscript m denotes the maverick. The firms involved in partial collusion would have a total capacity of K_{-m}.

Importantly, firms' critical discount factors for partial collusion differ from those for full collusion. Recall that by "critical discount" we refer to the level of discount above which collusion gives a greater payoff than deviation. For full collusion the critical level was $\delta^* = k_l / K$. In the case of partial collusion, the critical discount factor is given by[30]:

$$\delta^*_{pc} = \frac{k_l}{K - k_m} \qquad (2.9)$$

Note that this again depends on the capacity of the largest firm, this time in relation to the total capacity of the semicolluding firms. Recall that in our specific example the three firms' capacities were $k_1 = 5$, $k_2 = 4$, and $k_3 = 3$. If we again assume that the maverick is the smaller firm, Firm 3, we find that the critical discount factor required for Firms 1 and 2 to engage in partial collusion is 5/9, or 0.556. This is in comparison to the full collusion critical discount of 0.417. It is immediately apparent that this difference in the critical level will be of significance, since there will be a number of discount factor combinations for which full collusion yields a higher payoff than deviation but where partial collusion does not. This is because it will always be true that $\delta^*_{pc} > \delta^*$.

Consider the following inequality:

[30] The derivation of this is shown in Appendix B.

$$\frac{k_l}{K-k_m} > \hat{\delta}_i \geq \frac{k_l}{K} \qquad (2.10)$$

For all actual discount factors that satisfy this inequality, we can immediately state that non-maverick i would favour full collusion over partial collusion, provided that transfers of market share could be made in order to incentivise the maverick to collude. Where such transfers proved impossible, partial collusion would not arise since in this example uncooperative behaviour (deviation) would provide a higher payoff to the partial option. Next, consider the inequality:

$$\hat{\delta}_i \geq \frac{k_l}{K-k_m} > \frac{k_l}{K} \qquad (2.11)$$

In cases where this inequality is satisfied, both forms of collusion would be preferred to deviation. In such cases, it is intuitive that full collusion would be preferred over partial. To appreciate why this is the case, note that one can essentially think of partial collusion as "full collusion with maximal transfers". By this it is meant that, under partial collusion, non-mavericks essentially surrender the maximum amount of market share to the maverick (up to its full capacity). In other words, ignoring the maverick and allowing it to produce to its full capacity is akin to making a transfer so large that the portion of the collusive market assigned to the maverick equates to their full capacity. Clearly, if it is possible for firms to achieve coordination whilst sacrificing a smaller amount of market share then they will of course regard this as preferable[31].

2.4.1 The "Transfer" of Market Share

Before considering which collusive alternative non-mavericks would prefer and under what circumstances, it is worthwhile defining more clearly the "transfer" of market share that needs to occur in order to encourage a maverick to participate in collusion. Let us denote this as T. Clearly, the amount of market share a non-maverick must sacrifice impacts upon the attractiveness of full collusion. The more they have to transfer to the maverick, the greater the decrease in their collusive payoff.

[31] Note that it is possible for some subset of non-mavericks to receive a higher payoff from partial collusion but that this can never be true for all non-mavericks. The relative attractiveness of the two collusive alternatives depends on how much market share a particular firm has to give up. In the case of partial collusion, firms would give up a proportional share of the maximal transfer. Accordingly, it is intuitive that a higher payoff would be received where full collusion could be achieved whilst giving less than a proportional share. However, if one non-maverick were transferring less than their proportional share then some other must be transferring more. It follows that partial collusion will never yield a higher aggregate payoff to non-mavericks than full collusion with transfers (though the two could be equal).

We can describe, in general terms, the size of T. It is simplest to consider this from the maverick's perspective. Given that they receive this transfer upon colluding, the *maverick* will collude if:

$$\left(\frac{k_m}{K}+T\right)\frac{M}{(1-\hat{\delta}_m)}\geq k_m+\frac{\hat{\delta}_m}{(1-\hat{\delta}_m)}\frac{(M-K_{-l})}{k_l}k_m \tag{2.12}$$

In other words, the maverick favours coordination if the extra amount of market share T tilts the inequality in favour of the left hand side term. We can solve (2.12) for T in order to derive the size of the transfer needed to sustain full collusion. Doing so yields[32]:

$$T\geq\frac{(K-M)k_m(k_l-\hat{\delta}_m K)}{KMk_l} \tag{2.13}$$

Where (2.13) holds with equality we have the minimum transfer of market share that could sustain collusion[33].

Recall that under Nash punishments the critical discount factor required for collusion is equal to the capacity of the largest firm relative to total capacity. From the expression for T given above, it follows that as $\hat{\delta}_m \to \delta^*$ we find that T = 0. In other words, when the maverick's actual discount factor is at the critical level no transfer is required. This is by construction. If $\hat{\delta}_m = \delta^*$ then firm m would not be a maverick in the sense that we have defined; they would not have an actual δ below the level needed for collusion and would therefore present no barrier to coordination. By definition, δ^* is the discount factor level at which collusion (absent any transfers) yields a higher payoff than the one-shot gain from deviation followed by punishment. Hence where the smallest firm's discount is equal to the critical level, we have a required transfer of zero and no maverick problem.

As $\hat{\delta}_m \to 0$, we find that:

$$T=\frac{(K-M)k_m}{KM} \tag{2.14}$$

A discount factor of $\hat{\delta}_m = 0$ would represent the extreme case where firm m places no value on future payoffs whatsoever. As a result, as the maverick's actual discount tends to zero the maximal transfer is required; their market share in the present period must equal their full capacity. When $\hat{\delta}_m = 0$, in order to achieve full collusion non-mavericks would have to give a transfer of a level such that the maverick again sells its full capacity;

32 The derivation of this is shown in Appendix C.

33 Importantly, T is the total transfer (i.e. the sum of the market shares that non-mavericks must collectively sacrifice), not the transfer that each firm would have to give.

this is what we earlier referred to as full collusion with maximal transfers. It is easy to see how this is comparable to partial collusion.

2.4.2 Full versus Partial Collusion

We have explained that partial collusion will never be preferable to full collusion for all non-mavericks. It is intuitive that non-mavericks would always prefer to achieve full collusion whilst giving up some amount of market share lower than the maximal transfer, as opposed to allowing the maverick to sell its capacity and colluding over the residual. However, here we seek to formalise this assertion. We wonder under what circumstances would a single non-maverick prefer partial collusion? Moreover, what would be the impact on firm payoffs of being restricted to partial collusion?

The share of the transfer fulfilled by each non-maverick affects the mode of collusion they would favour. Let β_i denote the share of T that is paid by non-maverick i. Moreover note that $\sum\beta_i = 1$. Rather than work with a specific example, here we present the analysis in general terms. From firm i's perspective partial collusion is profitable if:

$$\frac{k_i}{K-k_m}\frac{(M-k_m)}{(1-\hat{\delta}_i)} \geq \left(\frac{k_i}{K} - \beta_i T\right)\frac{M}{(1-\hat{\delta}_i)} \qquad (2.15)$$

In other words, partial collusion is profitable if the payoff to partial is greater than the payoff to full collusion with the required transfers. Here it is implicitly assumed that $\hat{\delta}_i \geq \delta^*_{pc}$. In other words, it is assumed that actual discount factors are sufficiently high so that partial collusion is a feasible option. If this were not the case then discussion of the partial alternative would be moot. It is straightforward to show that the inequality is never satisfied if $\beta_i = 0$[34]. If firm i does not have to make a transfer then they would always receive a higher payoff from full collusion.

What about when firm i does have to make a transfer to achieve full collusion? For positive values of β, consider first the case where $\hat{\delta}_m \rightarrow 0$. This is where the maverick is extremely averse to coordination and the "maximal" transfer is required. Firstly, if firm i makes the full transfer T, it can be shown that the payoff to partial collusion is greater so long as other non-mavericks possess positive capacities. That is, when $\hat{\delta}_m \rightarrow 0$ and $\beta_i = 1$, the payoff to partial collusion is strictly greater than that of full so long as $k_j > 0$ where $j \neq i \neq m$[35]. Therefore, if $\beta_i = 1$ firm i would prefer partial collusion. In line with the intuition

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[34] This is shown in Appendix D.
[35] This is shown in Appendix E.

given earlier, firm i prefers partial because the transfer they have to make under full is more than their proportional share. $\delta_m = 0$ implies that the maverick must be allowed to produce to their full capacity. Therefore, a non-maverick would clearly prefer for this to be given up proportionally by all firms rather than having to account for the whole amount themselves[36].

Note that $\beta_i = 1$ implies that all $\beta_j = 0$, i.e. that if one firm is making the full transfer then other firms do not have to give up any market share to achieve full collusion . In such a case, firm j would favour full collusion[37]. From this it is evident that non-mavericks have different preferences over collusive alternatives depending on whether they have to make the transfer or not. Where the full transfer T is singularly fulfilled by one non-maverick, rivals' incentives are misaligned with one another. What about when the transfer is divided amongst several firms? Where $\delta_m \to 0$ and $0 < \beta_i < 1$, we find that partial collusion is preferred where[38]:

$$\beta_i > \frac{k_i}{K - k_m} \qquad (2.16)$$

In other words, partial collusion yields a greater payoff than full where the proportion of the transfer given by firm i would exceed the market share they enjoy under partial[39]. These findings concerning firms' preferences over full and partial collusion are summarised in Table 2.3 below. Note that so far we have considered cases where the maverick has no interest in future payoffs and is extremely averse to collusion; in other words, where its discount factor is zero.

Table 2.3: Summary of non-mavericks' preferences over full and partial collusion when $\delta_m = 0$

Transfer required of non-maverick i (β_i)	Firm's preference	Notes
$\beta_i = 0$	Full collusion	Full collusion is preferred for any δ_m
$\beta_i = 1$	Partial collusion	Subject to some other non-maverick j having positive capacity
$0 < \beta_i < 1$	Partial collusion	Subject to firm i's transfer under full being greater than their market share under partial

36 Recall that in the case of partial collusion non-mavericks effectively give up a proportional amount of market share.
37 This follows from Appendix D.
38 This is shown in Appendix F.
39 Note that it is possible that this holds with equality for all firms, but it is impossible for all β's to be greater than this level.

Next, consider the case where the maverick has some interest in future payoffs. When $\delta_m > 0$ they no longer require the maximal transfer to collude, and we revert to the more general form seen earlier (Equation 2.13). It is still true that when $\beta_i = 0$ firm i finds full collusion to be unambiguously favourable. For positive β's, it can be shown that partial collusion is (strictly) preferable to full collusion when[40]:

$$\beta_i > \frac{k_i k_l}{(K - k_m)(k_l - \hat{\delta}_m K)} \qquad (2.17)$$

Again, in this context, we can show that partial collusion can never be strictly preferred by all non-mavericks[41]. *The aggregate payoff to partial collusion will always be lower for non-mavericks.*

To summarise our findings on the subject of full versus partial collusion, we have shown that firms that are not required to make a transfer would always prefer full collusion whilst firms that need to make the full transfer would always get a higher payoff from partial. For cases where T is divided amongst non-mavericks with each contributing some positive β, the relative profitability of collusive alternatives depends on the distribution of this transfer. Whilst it may be possible for some non-mavericks to possess a strict preference for partial collusion it is impossible for all to hold this preference. Moreover, where a single firm enjoys a strictly greater payoff from partial, some other firm must receive a strictly lower payoff. When full collusion is possible the only case in which all non-mavericks would find the partial option acceptable is where the maverick has a discount factor of zero and requires a maximal transfer. Then, they would be indifferent between the two collusive alternatives. Full collusion with the maximal transfer (divided proportionately) is effectively analogous to partial collusion. In all other cases, including all positive δ_m values, partial collusion would confer a lower (aggregate) payoff to the non-mavericks.

To reiterate the intuition, it makes sense that partial gives a lower combined payoff than full collusion. In the former the maverick is allowed to sell their entire capacity whereas in the latter non-mavericks can potentially sustain collusion whilst giving up a lesser amount of market share. Clearly the latter is preferable *if transfers are possible.* If collusion can be achieved with the maverick selling less than their full capacity then this will always be better for its rivals. *If transfers are not possible*, then the presence of a maverick creates an insurmountable barrier to full coordination. Colluding firms are then

[40] This is shown in Appendix G.
[41] See Appendix H.

restricted to the partial alternative (provided that $\delta_i \geq \delta^*_{pc}$). Consequently, the maverick's presence can be seen to decrease non-mavericks' collusive profits. Since one firm is averse to coordination, full collusion cannot be achieved and so the other firms are restricted to a lower collusive payoff. Moreover, from this it follows that it is plausible that rivals would seek to acquire or merge with the maverick to enable full collusion. Thus, the stance of competition authorities (to mergers that result in the removal of the maverick) may be at least conditionally supported by our findings.

2.5 Conclusion

In this chapter we have begun to develop a formal theory of mavericks by expanding upon the Ivaldi et al (2003) example. To model the maverick as a smaller firm we have incorporated asymmetric capacities into a repeated games model of the same type as Compte, Jenny and Rey (2002). We portrayed the firm as being averse to collusion, by having a lower discount factor than the level necessary for collusion to give a higher payoff than deviation. What we found was that collusion could still theoretically be achieved if two conditions were met. First, it is necessary for non-mavericks to be sufficiently patient to counteract the maverick's impatience. Second, "transfers" of market share must be possible between firms. By the latter, we refer to any movement away from a proportional distribution of collusive market share. As we have mentioned, it is not obvious that transfers of market share would be possible in a tacit collusion context given that firms do not communicate. Thus we can conceive of situations where an impatient maverick would indeed present a genuine barrier to collusion as existing papers and guidelines suggest.

Where full collusion proves to be impossible, partial collusion is an alternative option for non-maverick firms. We explored the implications of this in Section 2.4. What we found was that in the context of the repeated games model partial collusion was never preferred by all non-mavericks. Involving the maverick in collusive activities yielded a higher aggregate payoff to non-mavericks. Thus in situations where a maverick is insurmountably averse to collusion and rivals are forced to settle for the partial variant, profits are negatively impacted. This could be cited as a rationale for maverick mergers. Where a maverick presents an insurmountable barrier to collusive activity, it is conceivable that non-mavericks may wish to acquire it in order to achieve collusion. However, note that in the event of such a merger taking place, the acquirer would incur a cost whilst other non-mavericks would not; yet all non-mavericks would enjoy the benefits of such a merger via successful collusion. Hence, we can perceive of an incentive problem when it comes to the acquisition of mavericks for the purposes of facilitating collusion. Why would a non-maverick undertake such an acquisition if rivals could simply “free-ride” on the benefits? This is a question we will revisit in the overall conclusion to the thesis.

When it comes to competition authorities’ stance of preventing mergers that involve mavericks, our findings offer conflicting evidence. On the one hand, we have found evidence of situations where a maverick presents a barrier to collusion. On the other, we have outlined scenarios where collusion could occur in spite of their presence. Moreover, of importance is whether or not a merged firm ceases to be maverick. This is something which is debatable and has not been captured within our model as it stands. Consistent with Kwoka (1989), authorities typically assume that following a merger the maverick would be removed from the market. In other words, the merged firm does not adopt the maverick’s pre-merger behaviour[42]. Whether or not this is true would influence the conclusions we draw from our model.

Along these lines, a natural extension of the work presented here could be to explore hypothetical mergers within the model. In other words, if Firm 1 or Firm 2 merged with Firm 3, how would this impact their payoffs and the prospects of collusion? This could be considered in a context where the merged party takes on the discount factor of the maverick and where the merged party takes on the discount factor of the non-maverick, for example. In general, the model presented in this chapter can certainly be expanded. We will discuss this further in Chapter 8.

In this chapter we have discussed theory and hypothetical scenarios, but now it is appropriate to consider real-life applications of the maverick concept. To this end, we will turn our attention to past merger cases. In Chapter 3 we will examine the wording of the maverick concept in European merger guidelines and analyse its use in EC merger cases. In doing so, we can better-align the theory we have presented here with the way the notion is actually used by authorities. Are the two consistent? Should our model be adapted in any way as a result of the real-world use of the concept? These are questions we hope to address.

[42] This is a topic we will discuss further in Chapter 3.

Chapter 3: An Analysis of EC Merger Cases

3.1 Introduction

This chapter considers the use of the maverick concept in EC merger decisions during the period 2000 to 2013[43]. As we mentioned in the introduction to the thesis the concept has long been included in horizontal merger guidelines, yet despite this fact there has been little analysis of the extent to which it has been applied to cases (Lyons, 2008)[44]. Thus, this chapter provides some overall statistics on how the concept has been applied in Europe since 2000, accompanied by a discursive analysis of some of the key cases and themes that arise from our statistics. This work provides an indication of how the idea is perceived and understood by competition authorities. We are particularly interested in whether or not the EC's application of the concept is consistent with the theoretical depiction of mavericks in the literature; in other words, whether it is applied in the context of tacit collusion. Moreover, an understanding of how authorities view the concept is essential in order to achieve the objective of the final part of this thesis: to develop an empirical method of maverick identification.

The first mention of the maverick concept arose in the 1992 version of the US horizontal merger guidelines: "In some circumstances, coordinated interaction can be effectively prevented or limited by maverick firms - firms that have a greater economic incentive to deviate from the terms of coordination than do most of their rivals (e.g. firms that are unusually disruptive and competitive influences in the market). Consequently, acquisition of a maverick firm is one way in which a merger may make coordinated interaction more likely, more successful, or more complete." (DoJ and FTC, 1992). Unsurprisingly, this wording was entirely consistent with the treatment of maverick firms described in Kwoka (1989), the only maverick paper published prior to that date. Kwoka (1989) assumed that following a merger the merged entity would adopt the behaviour of the least rivalrous merging party[45]. It follows that where a transaction involves a maverick the end result would be the removal of the maverick from the market. The prospect of this happening is prevalent in merger guidelines.

[43] Parts of this chapter were written in conjunction with my supervisor, Matthew Olczak.

[44] One exception is Coate (2006), who looked at US horizontal merger cases spanning 1993 to 2003 and found that those which applied the maverick firm concept were more likely to result in enforcement.

[45] Though Kwoka (1989) was the first published academic paper to refer to mavericks, the notion of a maverick firm shares many similarities with the earlier "third firm hypothesis" (Kwoka, 1979; Mueller and Greer, 1984). The third firm hypothesis is where the presence of some smaller firm or group of firms imposes competition on larger rivals.

However, US guidelines also acknowledge a contrasting possibility, specifically that "…incremental cost reductions may make coordination less likely or effective by enhancing the incentive of a maverick to lower price or by creating a new maverick firm." (DoJ and FTC, 2010, p.30) This is a somewhat different perspective. The quote contains two ideas. The first is that the fact that one of the merging firms has maverick tendencies, combined with the larger size of the merged firm, may lead to a more effective maverick. The second is that a merger of two hitherto non-maverick firms may produce a party that has maverick tendencies post-merger[46]. These acknowledgements open up a wider array of applications for the concept. However, the common themes across the two quotes are that the maverick affects the likelihood of coordination and that they are either a party to, or created as a result of, a merger. It should also be noted that although US guidelines refer to possible positive efficiency effects stemming from maverick mergers, they do so whilst acknowledging that such mergers often have other anti-competitive effects.

The focus in this chapter is on European merger cases and so it is appropriate to consider the wording of the concept in EC regulation. EC merger guidelines define a maverick as a "firm that has a history of preventing or disrupting coordination, for example by failing to follow price increases by its competitors, or has characteristics that gives it an incentive to favour different strategic choices than its coordinating competitors would prefer" (EC, 2010, p.182). The emphasis is on the need for a firm to have a track record of hindering collusion in order to be identified as the party; as in the US guidelines, the focus is on coordination rather than unilateral effects. Moreover, as with the US version, the EC guidelines stress that "a merger may involve the elimination of a maverick in a market." (EC, 2013, p.207). They also go beyond a horizontal scope and consider a vertical possibility: "The vertical integration of the maverick may alter its incentives to such an extent that coordination will no longer be prevented." (EC, 2013, p.207). Again, the concern is that the merger will ultimately result in the removal of the maverick from the market.

Crucially, in the above quotes the maverick is assumed to be an insider to the merger in question. This is the traditional way in which such firms are considered and certainly the way the concept is allowed for in guidelines. However, Baker (2002) considered a scenario where the industry maverick was not one of the firms involved in a merger. Where the maverick was an *outsider* to a given merger, Baker argued that it may act as a shield against any harm a merger may have on competition. Broadly, the intuition is

[46] This is a largely unexplored notion. Only Jacobs (2001), Kolasky (2002) and Sabbatini (2014) mention it within the maverick literature.

that if there is a maverick that is external to the transaction then that firm will continue to constrain coordination post-merger just as it did pre-merger[47]. This view is supported by, for example, Kovacic et al (2007) and Billard, Ivaldi and Mitraille (2011), both of which emphasised that outsider mavericks made coordinated effects less likely. Indeed, it is somewhat surprising that this possibility is not explicitly recognised in merger guidelines. One of the objectives of this chapter is to establish whether or not the maverick concept has been applied in this alternative way.

In general, we are interested in exploring whether the concept has been applied in a manner that is consistent with guidelines. Within this objective, we are interested in both whether mavericks were identified as insiders or outsiders, and also whether the concept was applied to coordinated effects (as stipulated in guidelines) or to unilateral effects (for which guidelines make no allowance).

In order to address these objectives, we conduct a detailed search for the use of the maverick concept in all EC merger decisions in which there were competitive concerns during the period spanning the calendar years 2000 to 2013. Prior to 2000, the concept was not applied in Europe[48]. Furthermore, it should be noted that the period contains within it a time (2002-2004) during which EC merger regulation was reviewed and changed as a result of a number of merger decisions being overturned by the Court of First Instance (CFI). We will discuss this in due course, but the ultimate outcome was that EC regulation placed greater emphasis on unilateral effects after 2004. In our context, it is interesting to explore how the maverick concept was applied throughout this period of transition.

This chapter proceeds as follows. Section 3.2 provides analysis of the overall application of the maverick concept in EC cases spanning 2000-2013. The sample of cases is outlined and statistics are produced illustrating the use of the concept in these cases. As well as considering whether mavericks were insiders or outsiders and whether coordinated or unilateral effects were the concern, we examine elements such as the industries involved and the ultimate case decisions. Section 3.3 then provides a discursive account of three mergers where the EC's decision report included an interesting discussion of the concept. We consider these in detail since they reveal further information regarding the authority's interpretation of the idea. Section 3.4 provides a discussion of our findings and considers in more detail the 2004 change in merger regulation. Finally, Section 3.5 makes some conclusions about the use of the

[47] Baker (2002) also discussed the possibility that its degree of maverickness may be affected (positively or negatively) as a result of the merger and that it may even be excluded from the market.

[48] Lyons (2008) confirms that the term was not used in a single European case in the 1990s.

term to date, and motivates the rest of this thesis. Briefly, the ambiguous and at times inconsistent application of the concept in the past adds weight to the goal we hope to achieve in the remainder of the thesis; it supports the case for the development of an empirical method of maverick identification.

3.2 The Maverick Concept in EC Merger Cases

This section provides a comprehensive analysis of the nature of use of the maverick concept in European merger cases between January 2000 and December 2013. This analysis is done in a manifest style, with relevant cases being established by searches for keywords (initially and most importantly, the word "maverick"). During the time period under consideration there were over 4000 cases examined by the EC[49]. Of these, over 90% were cleared at the "Phase I" stage, meaning they were allowed in their proposed state. It is important at this point to outline the EC system of merger analysis and in particular to explain what is meant by "Phase I" and "Phase II".

The EC examines merger transactions that involve significant operations within the European Community. EC analysis consists of two phases. Phase I is an initial short investigation during which the authority gathers information from the notifying parties and their customers/competitors via questionnaires. After this the authority can make one of three broad decisions: to allow the merger in its proposed form, to allow the merger subject to commitments offered by the notifying parties, or to refer the merger to Phase II for further investigation. When a case is referred to Phase II, the authority conducts a more detailed assessment of the case. This involves considering companies' internal documents, the analysis of economic data, and more detailed questionnaires to customers/competitors. Again, at this stage the EC has three broad decisions it can make: approval, approval subject to remedies, or prohibition (ec.europa.eu/competition/mergers/procedures_en.html)[50]. Remedies are typically proposed by the notifying parties rather than by the authority and can be either behavioural or based upon the divestiture of particular assets (EC, 2010).

Each of the decision types are assigned an "Article" under EC merger regulation. Those that are allowed in Phase I come under Article 6.1(b). Since cases under Article 6.1(b) were quickly cleared with no competitive concerns it is highly unlikely that authorities

[49] See http://ec.europa.eu/competition/mergers/statistics.pdf for detailed statistics. The exact number depends on what date one uses. The date we use in this thesis is the decision date – i.e. the date on which the EC published its ultimate decision regarding a given case.

[50] Following this, there remains the possibility that the decision could be reviewed by the European Court of First Instance, and ultimately the European Court of Justice, should parties choose to appeal the decision.

would regard the maverick concept as relevant during their investigation. Therefore, there is little value in exploring these cases for their use of the maverick term. Moreover, in those cases that did refer to the notion, it was evidently dismissed very quickly. As a result these cases are omitted from our in-depth analysis; we focus our attention on instances in which the authorities felt the need for detailed investigation[51]. In addition, we further omit the handful of cases for which no English report was available. The sample we are left with comprises of 274 cases. These are summarised in Table 3.1, broken down by decision type. The table also indicates the relevant article numbers for the other case types[52].

Table 3.1: Total cases by decision type

Decision Type	No. of cases
Phase I remedies (Art 6.1 (b) compatible with commitments)	163
Phase II clearance (Art 8.1 compatible)	24
Phase II remedies (Art 8.2 compatible with commitments)	75
Prohibition (Phase II) (Art 8.3)	12
TOTAL	**274**

We are interested in whether the maverick concept was applied in our sample of cases. To investigate this, each case report was searched for reference to a maverick. This revealed that there was reference to the existence (or possible existence) of a maverick firm in only 22 (8%) of the 274 merger cases. Having identified 22 cases where the concept was mentioned in the EC's case report, we then conducted an in-depth reading of the decision in each case. The findings make up the analysis in this section[53].

Figure 3.1 below shows how often the concept was applied, by year of the case decision.

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[51] We conducted a search on a random sample of 5% of the 6.1(b) cases and found that the maverick term only appeared in 1.5% of cases (3 out of 196). In these cases, the maverick term was used only fleetingly and the prospect was immediately dismissed.

[52] In addition to those present in the table, cases where a transaction is deemed to be outside the scope of EC regulation come under Article 6.1(a) and cases that are referred to Phase II are initially classed under 6.1(c) but this is ultimately superseded by the subsequent Phase II designation.

[53] The content analysis was conducted as follows. Initially, relevant cases were identified by searching each of the 274 cases for the word "maverick". This established the 22 "maverick cases". These were then read comprehensively to ascertain the markets involved, the context with which the term was used, the identity of the maverick, and so on – these subsequent findings are documented throughout this chapter. The approach follows Posner (1970).

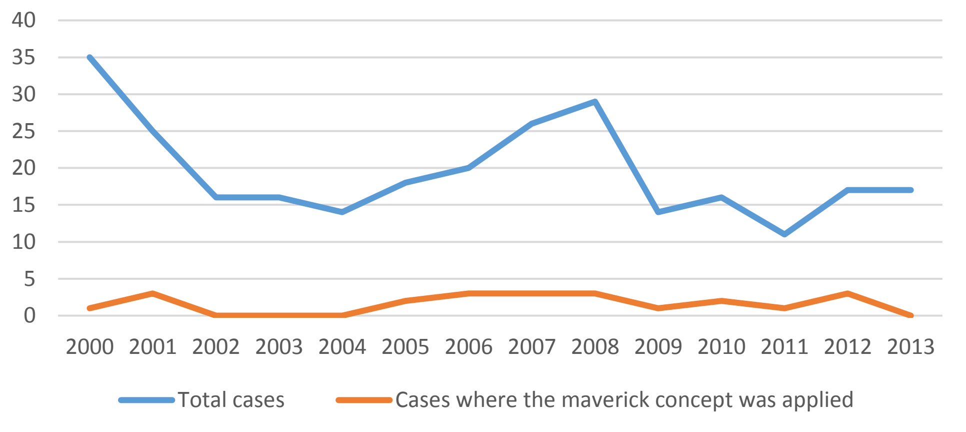

Figure 3.1: Application of the maverick concept by year

Over the period 2000-2013 the frequency of maverick cases was relatively consistent at between 1-3% (of total cases) per year[54]. The notable exception is 2002-2004, where the concept was not used at all. One explanation for this is that it was a time when EC merger regulation came under review[55]. The absence of reference to the maverick concept during this period may therefore be explained by the uncertainty surrounding the impending changes in policy. In other words, we may speculate that the EC was exercising caution during this time. We will further discuss the 2002-2004 review in Section 3.4 of this chapter.

3.2.1 Sectors

Next, let us consider the industries involved in maverick cases. Appendix I provides information on the prevalence of maverick cases across different sectors[56]. Obviously, some sectors experienced a lot less mergers than others, and so the column showing the *percentage* of cases that referred to mavericks is somewhat deceptive. It is therefore appropriate to consider both the *number* and *proportion* of such cases in order to get a more accurate picture. The sectors that had more than a single maverick case and also accounted for a significant portion of all cases in the sector were "Information and

[54] As a percentage of the 274 cases that warranted further investigation this percentage was more variable but this is a consequence of the small sample size.

[55] The outcome of this review was that in 2004 the previous dominance test was replaced by a significant impediment to effective competition test, in order to correct a perceived gap in merger legislation. See, for example, Röller and De La Mano (2006) or Monti (2008).

[56] The table in the appendix is constructed using the NACE codes attached to each case. Often, cases have NACE codes in multiple categories. In such instances, we count each category only once. For example, a case with a single K code and two C codes would count once under K and once under C.

Communication", "Electricity, Gas, Steam and Air Conditioning" and "Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles".

With regard to Information and Communication, there were five maverick cases. Specifically, these related to the mobile telecommunications industry (two cases)[57], portable navigation devices[58], databases[59], and contact line engineering (for railway lines)[60]. In the Electricity and Gas category there were three maverick cases, all related to gas supply or gas products[61]. Finally, there were four cases within the Wholesale and Retail Trade category which covered a broad range of markets with no clear common features[62]. Overall, we note that the concept was applied to a diverse range of industries, including both retail products supplied to final customers and upstream wholesale markets.

3.2.2 Cases Where the Concept Was Applied

We now focus on the 22 cases in which the maverick concept was applied. Table 3.2 provides an outline of the type of decision in these cases.

Table 3.2: Application of the maverick concept by decision type

Decision Type	No. of cases
Phase I remedies	8
Phase II clearance	4
Phase II remedies	10
Prohibition	0
TOTAL	**22**

The table shows that over one third of instances corresponded to cases where remedies were imposed in Phase I. However, as a proportion of total decisions the maverick concept was more likely to be applied in the more detailed Phase II enquiries (13% compared to 5%). This is what we would expect. Intuitively, cases where there was a potential maverick are more likely to require closer investigation and thus pass through

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[57] *M.3916 T-Mobile Austria/tele.ring* (2006) and *M.5650 T-Mobile/Orange* (2010).

[58] *M.4854 TomTom/TeleAtlas* (2008).

[59] *M.5529 Oracle/Sun Microsystems* (2010).

[60] *M.3653 Siemens/VA Tech* (2005).

[61] *M.3868 DONG/Elsam/Energie E2* (2006), *M.4141 Linde/BOC* (2006) and *M.5467 RWE/Essent* (2009). Moreover, in two other cases (*M.2389 Shell/DEA* and *M.2533 BP/E.ON*, both 2001) the product in the market of concern was ethylene, a gas, although these classified under manufacturing.

[62] The cases here cover wholesale of electrical products, household appliances and construction materials and sanitary equipment (*M.4963 Rexel/Hagemeyer*, 2008), wholesale of computer equipment (*M.4854 TomTom/TeleAtlas*, 2008), retail of fuel (*M.4919 StatoilHydro/ConocoPhillips*, 2008), and wholesale of sugar (*M.6286 Südzucker/ED&F Man*, 2012).

to the second phase. Other factors notwithstanding, the maverick issue itself usually requires further examination; if a maverick is suspected then the authority should closely examine whether the firm in question does indeed fulfil the role, in line with the wording of guidelines. Additionally, from Table 3.2 we note that the concept has been applied more frequently in cases where remedies were imposed but not, to date, in cases where the merger was prohibited outright[63]. This seems to indicate that whilst the involvement of a maverick may present an issue, this is not insurmountable; it is a concern that can seemingly be addressed via remedies.

Though remedies were clearly more common in maverick cases, as a proportion of total cases the maverick concept was applied in more clearance decisions than intervention decisions (17% compared to 7%). However, the “decisions” we refer to here are decisions *in the case overall*. Typically, multiple markets are analysed in any given merger case. Thus, for these cases, the maverick concept was usually applied in just one of the markets under consideration, and this was often a market that was peripheral to the main operations involved in the concentration. Given the multi-market nature of many merger cases examined by the EC, for the intervention cases it is the decision in the particular market in which a maverick was identified that is of interest to us. Further evidence on this is provided below.

There are a number of explanations regarding why the concept may be frequently applied in cases where the merger is eventually cleared. First, as we outlined in the introduction to this chapter, whilst guidelines discuss the concept in terms of a maverick being an insider to a merger, another possibility is that the party is an outsider. In the case of the latter, this should make it *less* likely that intervention would be deemed necessary. We will distinguish between cases of insider and outsider mavericks in due course. Second, the cases we have identified so far are those in which the possibility of a maverick was explicitly considered by the authority. That is, we are basing our analysis on references to the concept that appear in official correspondence. However, it may be that the maverick concept was briefly considered but dismissed and not deemed significant enough to include in the report. In cases where the maverick is an insider, in particular, this should decrease the likelihood of intervention. Finally, there is also the possibility that whilst the concept may be considered by the EC, it is not in fact determinative of their decision. This would be consistent with Baker (2002) who

[63] According to http://chillingcompetition.com/2013/04/05/thoughts-on-the-commissions-decision-in-upstnt/, the maverick concept was applied in *M.6570 UPS/TNT* (2013) and this merger was prohibited by the EC. However, this case is not included in our sample because the final report was not in the public domain. Note that this indicates that the concept may have been used even more widely than our statistics imply, which only serves to reinforce the motivations behind this thesis: that the concept is important and worthy of further study.

concludes that mavericks have been treated as a special case and something of an afterthought in contemporary anti-trust practice. It would also be consistent with the fact that we have observed that those cases in which there was concern resulted in remedies but not prohibition.

3.2.3 Cases Where a Maverick Was Established

Not every case that discussed the concept resulted in a maverick being conclusively established. We have stated that the concept was mentioned in 22 cases, yet the identity of the maverick was only ultimately established in 5 of these cases[64]. These were *T-Mobile Austria/tele.ring* (2006), *Linde/BOC* (2006), *StatoilHydro/ConocoPhillips* (2008), *Oracle/Sun Microsystems* (2010) and *T-Mobile/Orange* (2010). In the other 17 cases, the EC typically either suggested that a particular firm could be such a party and then ruled this out[65] or more broadly discussed the potential for mavericks in the industry[66]. In the remainder of the cases, there are instances where notifying parties suggested a maverick outside of the merger or a third party suggested that one of the merging parties was a maverick; the EC then ruled these out. This implies that the maverick concept may, in some cases, be used spuriously by involved parties in order to aid the chances of a decision in their favour[67]. Finally, in two cases the merging parties suggested that an insider was not a maverick and the EC agreed with their assertions[68]. Overall, note that whilst it is rare that the concept was considered in cases, it was even rarer that the EC was able to establish a clear maverick[69].

Focusing on the 5 cases with established mavericks, we can make observations about the nature and size of the party in each case. First, the EC often portrays maverick

[64] We impose strict criteria for the EC establishing the existence of maverick. To illustrate, take for example *M.3333 Sony/BMG* (2007). In response to third parties' claims that there would be collusion post-merger, the EC stated that EMI and Warner were "…significant 'mavericks' and would still have the power to jeopardy any attempt of collusion" (page 119). However, we do not include this as a case in which the EC established the existence of a maverick because it is not discussed further by the EC, with other arguments instead used to rule out coordinated effects.

[65] See for example *M.3653 Siemens/VA Tech*, para 174, where the EC considers VA Tech as a possible maverick but that there is insufficient evidence to label them as such.

[66] For example, in *M.2420 Mitsui/CVRD/Caemi* (2001), the EC claimed the potential for a maverick but did not explicitly name the party. They simply concluded that the conditions of the market were such that if collusion were to arise then several parties would have an incentive to deviate and behave in a 'maverick' manner. By contrast, in *M.1939 Rexam/ANC* (2000), the EC decided that there could not be a maverick due to the nature of the market; it was very symmetrical and characterised by substantial overcapacity. They suggested that any maverick could therefore be retaliated against and would not present a credible barrier to collusion.

[67] In this respect it is noteworthy that the eventual decision by the EC was almost always contrary to what would have been more likely had the maverick argument been convincing. For example, where the merging parties tried unsuccessfully to persuade the EC that there was a maverick outside the merger, the EC eventually intervened.

[68] *M.6214 Seagate Technology/Samsung* (2011) and *M.6455 SCA/Georgia-Pacific Group* (2012). Agreement was implicit, by not responding to parties' arguments.

[69] It is interesting to note that all five of these cases were post-2004. This suggests that despite the evidence in Figure 3.1, the maverick concept may be becoming a more established phenomenon.

players as aggressive competitors. For example, in the case of *Linde/BOC*: “The removal of Linde as an aggressive ‘maverick’ increases the risk of tacit collusion in this market and thereby raises serious doubts as to the compatibility of the merger with the common market.”[70] In addition, the firms identified as maverick were typically small; in the case of Linde with a market share of less that 5%. In general, the average market share of the maverick in these in these 5 cases was around 9%[71]. Alternatively, in cases where the maverick was largest (10-20%), the EC argued that this still underestimated their importance in the market. For example, in *StatoilHydro/ConocoPhillips*: “The Commission has considered whether JET Sweden has played a particular role as a low-price competitor putting downward pressure on prices in Sweden. If JET Sweden has acted as a "pricing maverick" in the Swedish market, the company has played a role in the market which is greater than its market share would imply at first glance.”[72]

Generally, in the 5 cases identification of a maverick usually centred on whether they had been increasing their market share in the recent past. This is taken as evidence that they are an aggressive rival and capable of taking custom from the larger firms. For example, in *T-Mobile Austria/tele.ring*: "The analysis of market shares alone shows not only that tele.ring has played an active role in the market in the last three years but also that it has been the only company to play such an active role, in terms of increased market share."[73] This is consistent with the wording of EC guidelines, which we outlined in the introduction to this chapter – it is evidence that the firms have displayed a tendency for (a “history” of) competing aggressively. Moreover, in the *Linde/BOC* case, Air Liquide, another rival, was also referred to as an aggressive competitor, but the Commission doubted its ability to expand due to issues relating to acquiring inputs. The distinguishing factor between the two firms, which led the Commission to assert that Linde was the maverick, was that Linde had larger future quantities that Air Liquide. Thus there was emphasis not only on aggressive pricing but also the potential to expand market share.

3.2.4 Insiders and Outsiders

We stated in the introduction to this chapter that guidelines are typically phrased in terms of the maverick being an “insider” to a merger; i.e. one of the merging parties. We now

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[70] *M.4141 Linde/BOC* (2006), page 35. In this case the maverick was an insider to the merger and the quote makes clear that the concept was clearly linked to collusive behaviour. For all of the cases, below we further examine whether the context was as a merger insider or outsider, and applied to collusion or unilateral effects.

[71] Market shares are typically reported as a range in case reports. For the purposes of reporting statistics, we take the midpoint of the range as a firm’s market share. When it is reported as less than 5% we record this as 5%.

[72] *M.4919 StatoilHydro/ConocoPhillips* (2008), page 20.

[73] *M.3916 T-Mobile Austria/tele.ring* (2006), page 10.

return to consider whether the maverick in each case was indeed an insider or rather an outsider, external to the merger transaction. Table 3.3 summarises whether the maverick was an insider or an outsider for each case in which the concept was applied. As we have stated, though there were 22 cases in which the concept was discussed, a maverick was only ultimately established in 5 of these. The insider/outsider status of the 5 is highlighted in the third column of the table.

Table 3.3: Established mavericks - insider and outsider distinction

	Total	Maverick established
Insider	13	4
Outsider	9	1

Table 3.3 suggests that the EC was more confident in applying the maverick concept in its more standard setting where the firm was an insider to the merger. Moreover, it is in exactly these cases where we expect the concept to contribute to a decision to intervene. In all of the cases where an insider was established as the maverick, remedies were required in that particular market[74]. These were typically structural divestments[75]. However, the EC did not go as far as to state that the remedy would restore the pre-merger level of competition by creating a new maverick.

Arguably the closest they came to this was in *T-Mobile Austria/tele.ring* where remedies were geared towards boosting Hutchison 3G ("H3G", a smaller rival). The implication was that this was with a view to H3G assuming a maverick-like role of competitive constraint: "Given the similar incentives and very similar communications profile of H3G and tele.ring customers, there is strong evidence that H3G will in future pursue an aggressive price strategy similar to that pursued by tele.ring in the past."[76] "H3G will probably come to play a bigger role in this market, offering an alternative to the other network operators once 3G-capable mobile telephones become more widespread and once it has built up a nationwide network, something which the commitments given makes possible."[77] In *Linde/BOC*, divestments were designed to promote ongoing competitive pressures to offset those lost when BOC was acquired. The divestments were intended to remove the additional risk of tacit coordination. In none of these cases

[74] This is in contrast to the other 9 cases (in which no maverick was established). The EC only intervened in 2 of these.
[75] The one exception is *M.5529 Oracle/Sun Microsystems* (2010), in which commitments were offered by the parties at the time of the notification.
[76] *M.3916 T-Mobile Austria/tele.ring* (2006), page 38.
[77] Ibid. page 39.

was it explicitly stated that the aim was to encourage a new maverick to replace one that was being eliminated.

T-Mobile/Orange was the single case in which the EC concluded that there was a maverick that was an outsider to the merger. Theoretically, in such cases the presence of this type of firm should go some way toward alleviating authorities' concerns. However, despite this, the EC still identified a problem in the market and required a divestment remedy. This is somewhat surprising[78]. We will further consider aspects of the *T-Mobile/Orange* case in greater depth in Section 3.3.

3.2.5 Theories of Harm

As outlined in the introduction, both the theoretical foundations and wording of guidelines relate the maverick concept to coordinated effects. There is no allowance in guidelines for the concept to bear any significance in cases of unilateral effects concerns. In the *Linde/BOC* merger it was clear that the EC applied the concept to coordinated effects. "The removal of Linde… increases the risk of tacit collusion."[79] However, the examination of the theories of harm used in the other four established maverick cases provides a much less clear picture and it is apparent that the EC does not stick rigidly to its guidelines.

In *StatoilHydro/ConocoPhillips* the EC applied the concept to unilateral effects analysis and this was the only theory of harm considered. Likewise, in *Oracle/Sun Microsystems* it appears that the EC also used the concept in a unilateral effects context, whilst still referring to merger guidelines to justify their arguments. As a result, Oracle were highly critical of the theory of harm adopted, arguing that the EC had neither established that the merger would create or strengthen a dominant position (as required) nor that the merging parties were close competitors. Interestingly, the Commission countered this by making clear that the 2004 change in merger regulation meant that the creation or strengthening of a dominant position was no longer required and by arguing that closeness of competition is only one relevant factor for unilateral effects. We will discuss both the impact of the 2004 change in regulation and the role of the maverick concept within unilateral effects analysis in the discussion section of this chapter.

In *T-Mobile/tele.ring*, the maverick concept was first applied in relation to the EC's main unilateral effects theory of harm. The EC then made clear that it also could not rule out

[78] Interventions followed in 7 of the 8 cases where mavericks outside the merger were considered but not established.
[79] *M.4141 Linde/BOC* (2008), page 35.

the possibility of coordinated effects and the maverick concept was again referred to. However, given the commitment offered by the merging parties, they did not need to come to a final decision on this. The EC's stance in this case is consistent with more general evidence that unilateral and coordinated effects analysis have been used somewhat simultaneously since 2004 (see for example Baxter and Dethmers, 2005 or Dethmers, 2005). However, it also runs contrary to economic theory which suggests that market factors such as symmetry that facilitate collusion also lessen competitive concerns when coordination is not possible, and vice versa (see for example Kuhn, 2001, or Frontier Economics, 2004). Commenting on the *T-Mobile/tele.ring* case, Charles River Associates (2006) made clear that running both theories of harm simultaneously at the very least requires careful consistency checks.

Finally, in *T-Mobile/Orange* the EC moved away from the traditional horizontal theories of harm through unilateral and coordinated effects and instead was concerned about the possibility of foreclosure via future monopolisation of the mobile phone network. Prior to the merger there were agreements between the industry maverick (3UK) and the notifying parties concerning the sharing of mobile network spectrums. The EC's primary concern was that post-merger these agreements would be terminated or quality would be compromised. Thus, the key theory of harm in this instance was the foreclosure of the maverick. "3UK is considered by several market players as an important competitive force in the UK market... The possible disappearance of 3UK or the degradation of its competitive position could consequently have a serious impact on the UK retail mobile communication market"[80] We will consider the *T-Mobile/Orange* case in greater detail in the following section. However, the case provides an example where the impact to an outsider maverick increases concern about a merger.

Overall, we therefore note that in only one of the 5 cases was discussion of the maverick firm concept confined to coordinated effects. More often the maverick firm concept was applied either solely or predominantly to unilateral effects, despite the fact that there is no allowance for this in merger guidelines[81].

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[80] *M.5650 T-Mobile/Orange* (2010), page 20.

[81] It is interesting to note that by 2010 the EC guidelines arguably became less clear on whether the maverick firm concept applied to unilateral or coordinated effects as it was also included in a general section on evidence of adverse effects to competition (EC, 2010). It is also interesting to note that in all of the pre-2004 cases in our sample the maverick firm concept was considered (but not established) only in the context of coordinated effects.

3.3 Interesting Cases

In this section, we will consider in more detail three cases in which the discussion and/or eventual application of the maverick firm idea revealed interesting information about the EC's attitudes toward the concept. The three cases comprise of one in which no firm was ultimately established as maverick, *Travelport/Worldspan* (2007), and two of our five maverick cases, *StatoilHydro/ConocoPhillips* (2008) and *T-Mobile/Orange* (2010). For each, we briefly outline its features before discussing the interesting aspects of the case report.

3.3.1 Travelport/Worldspan (2007)

Case M.4523 involved the acquisition of Worldspan by Travelport. Worldspan Technologies Inc. ("Worldspan") was a company that provided travel distribution services, as well as IT services to airlines. Travelport LLC ("Travelport") aggregated content from airlines and other holiday service providers for final consumers. The parties' operations primarily overlapped in global distribution systems (GDS) – via the "Worldspan GDS' and Travelport's 'Galileo'.

Travelport/Worldspan was not one of the cases in which a maverick was ultimately established yet the case warrants our attention since it provides a relatively lengthy discussion of the subject. The case is one of the instances where a potential maverick was mooted and ultimately dismissed by the EC. In most such cases the prospect is dismissed briefly with little elaboration, and so we are unable to glean much insight into the EC's viewpoint. However, in *Travelport/Worldspan* the view of the Commission was explained thoroughly. Moreover, the possibility that one of the notifying parties (Worldspan) was maverick and might be eliminated as a result of the transaction was one of the key theories of harm on which the case was based. Accordingly, the EC's rationale for dismissing this prospect was one of the key reasons for allowing the merger without remedies.

In assessing the compatibility of the merger with the common market, the EC considered several theories of harm spanning both coordinated and unilateral effects. One of these concerned whether the merger would eliminate a "pricing maverick', which it suggested was Worldspan. The report states that "During the market investigation, concerns were expressed that, following the loss of competition between the merging undertakings, Worldspan's prices would be increased and aligned with those charged by Galileo."[82] The report did not state who held these concerns. Nonetheless, in ruling out Worldspan, the EC documented the criteria by which it identified a pricing maverick: they stated that they would need to show that Worldspan's prices were significantly lower than those of its competitors prior to the merger[83]. Furthermore, they also outlined the criteria under which the concept would be relevant to merger prevention: they stated that they would have to establish that the merging parties had the incentive and ability to increase Worldspan's prices post-merger.

The EC asserted that Worldspan was not charging lower prices. In reaching this decision, they considered pricing data and the opinions of travel service providers ("TSPs"). The GDS market was not one with a clear price; pricing was complex since the product was not straightforward and firms had unique agreements with different parties. However, the EC suggested that the most appropriate proxies for price were "net average price per booking" and "net price (list price less discounts) for active segments"[84]. The notifying parties submitted a comparison of the prices charged by Galileo and Worldspan for both of these proxies, which suggested that Worldspan's prices were not consistently lower than Galileo's. Moreover, most respondent TSPs did not think Worldspan had charged consistently lower prices over the last few years and major European and US airlines stated that they thought Worldspan's prices were comparable to those of its rivals. Furthermore, the analysis implicated another party as the cheapest alternative on the market, though this third party was not named in the report.

The notifying parties went a step further by suggesting that Worldspan actually behaved as a price taker, thus precluding the possibility of it being maverick. This suggestion was reinforced by British Airways, a customer, who indicated that it was the market leader (Amadeus) that had been instrumental in guiding price changes, citing an example of a change implemented by Amadeus in 2005 and adopted by Worldspan in 2006. The report also identified Lufthansa as another customer who regarded Worldspan as a price follower.

Relatedly, data provided from notifying parties suggested that Worldspan had lost market share over recent years. Worldspan had been the smallest GDS provider in the EEA for the past 5 years and had shown little signs of growing. The report suggested

[82] *M.4523 Travelport/Worldspan* (2007), page 22.

[83] They explicitly named Galileo, Travelport's GDS provider, as a firm that Worldspan would have to be shown to price lower than.

[84] The latter refers to a monthly charge imposed by a GDS on an airline based on the net number of bookings (bookings minus cancellations) made in relation to that airline's inventory in each month.

that in the upstream market their share had decreased by [0-5%] between 2003 and 2006 whilst in the downstream market their share had fluctuated around a stable point in every country except Hungary (where they had experienced some growth). Moreover, in 2007, Worldspan had lost two of its main customers in the EEA. The report stated that "Therefore, contrary to what one would expect from a company which is alleged to be a maverick, Worldspan's markets share does not show general signs of growth." (EC 2007a, p.26). Indeed, charging lower prices than rivals and demonstrating a propensity to capture rivals' market shares are two characteristics outlined in guidelines as descriptors for a maverick firm. Thus, in showing that Worldspan displayed neither of these behaviours, the EC was consistent with guidelines in this regard[85].

As to whether Worldspan's prices might increase post-merger, the EC concluded that this would be unlikely. This was again based on the evidence of the notifying parties and the perceptions of TSPs. The EC's market investigation indicated that Galileo was perceived to be stronger for corporate travel whilst Worldspan was stronger in leisure travel and online travel agencies, suggesting that they were not close competitors. The opinions of customers (travel agents) further confirmed that Galileo and Worldspan were not one another's closest competitors. This and the fact that margins were decreasing pre-merger were cited as reasons to doubt the scope for post-merger price rises. Moreover, the EC pointed out that upstream price rises would likely cause TSPs to withdraw content from Worldspan's GDS, which would have a knock-on effect on their success in the downstream market.

3.3.2 StatoilHydro/ConocoPhillips (2008)

A second notable case, M.4919, involved StatoilHydro ASA ("SH") acquiring the Scandinavian petroleum business of the ConocoPhillips Company (JET Scandinavia, "JET"). SH's operations encompassed the exploration and production of both crude oil and natural gas, as well as the refinery and sale of fuels and their derivatives. They predominantly operated in Norway. ConocoPhillips was a US company whose subsidiary JET operated fuel stations in Scandinavia. JET Sweden also possessed petroleum storage facilities. SH was an integrated company, meaning that the fuel sold in their stations predominantly came from their own refining operations. By contrast, JET was a non-integrated company, obtaining its fuel on an "ex-refinery, ex-cargo or ex-terminal (ex-rack) basis, through a mix of short and long-term agreements and 'spot' deliveries."

[85] It was not however consistent with guidelines in the sense that the maverick concept was applied to non-coordinated effects.

(EC 2008, p.6). Interestingly, Conoco had previously been regarded as a maverick by competition authorities in an earlier case (Massey, 2010).

In defining the market, the EC settled upon the broad definition of “the market for retail sales of motor fuels”, citing the fact that JET did not possess niche outlets such as motorway stations. In terms of geographic scope the EC argued that this was national. The relevant nations were Denmark, Sweden and Norway, and the EC analysed the impact of the transaction on competition in the retail motor fuel markets of each of the three countries. In the case of Denmark, the EC’s market investigation confirmed that there were no competition concerns. The fact that none of the main suppliers of motor fuel had a market share greater than 25%, as well as the strong presence of Shell to mitigate unilateral effects, were cited as justifications for this stance. However, this was not the case in Sweden and Norway, where concerns were expressed.

In Sweden, SH was the largest supplier as a result of the merger of Statoil and Hydro in 2007. JET was a smaller player (the sixth-largest), with a market share of [10-20%]. The EC estimated that the merger of SH and JET would have resulted in the merged company holding a [40-50%] market share in Sweden. SH disputed this, pointing out that following the Statoil/Hydro merger they had closed a considerable number of fuel stations, something they would repeat following the proposed merger. Thus they suggested a post-merger share of around [30-40%]. Nonetheless, the EC reiterated the fact that SH was already the largest supplier and the transaction would make them larger. Moreover, SH’s market share would become more than twice that of OKQ8, the next largest competitor. Thus the EC had concerns over unilateral effects in the Swedish market.

The Commission investigated whether the removal of JET as an independent player would impede effective competition in Sweden through strengthening SH’s market position. In so doing, the EC explicitly referred to JET as the maverick. “If JET Sweden has acted as a ‘pricing maverick’ in the Swedish market, the company has played a role in the market which is greater than its market share would imply at first glance.”[86]

SH argued that JET was not a maverick but a price follower. They stated that JET gave the impression of being a low-cost supplier but that this was not accurate. The Commission disagreed, stating that “Contrary to SH's claims, a number of circumstances indicate that JET Sweden plays a unique role in the Swedish market for retail sales of motor fuels and that the removal of JET as an independent player would hamper

[86] *M.4919 StatoilHydro/ConocoPhillips* (2008), page 20.

competition."[87] In refuting the claim that the firm was a price follower the EC cited various factors. They stated that JET had repeatedly shown a tendency to undercut its rivals whereas a price follower would accept the price of its competitors. Moreover, JET had exhibited a willingness to increase its price differential in response to competitors' price rises – i.e. it had refused to follow price increases. In addition, due to its superior efficiency, JET was able to credibly engage in these behaviours; they were well placed to defend their price differential. The Commission therefore considered JET to exert a strong constraint over its rivals' behaviour. This viewpoint was furthermore supported by internal SH documents, which actually described JET as their most important competitive constraint.

The Commission used econometric analysis to establish the maverick in this case. Specifically, they conducted daily cross-sectional OLS analysis of the effect of certain factors on Statoil's prices over the period January 2004 to December 2007. The dependent variables were logs of Statoil's prices for petrol and diesel. The explanatory variables were a series of competition and control factors (such as number of fuel stations and population density). The primary competition variable, and the key variable of interest, was a binary indicator of JET's presence amongst nearby rivals. The results found that the presence of JET constrained the prices of Statoil – they were significantly lower when a JET station was in the local 'cluster'[88]. They found this to be true for both petrol and diesel. SH contested that this was not unique to JET and that the presence of other smaller competitors had the same effect. The EC tested this claim by including dummies for another firm as well; they produced a second set of analysis with a dummy for when JET alone, the other firm alone, and where both were in the local cluster. The results showed that the presence of the other firm had a lesser effect on Statoil's prices[89].

The Commission justified the special significance of JET by citing various factors. Since its creation JET had continuously expanded its network, predominantly opening stations in prime locations and densely populated regions. They consistently charged net prices with no rebate schemes (which were otherwise common in the market). They had a history of being innovative, for instance being the first company in Sweden to have fully automated petrol pumps. Moreover, JET was incredibly efficient, with a much higher throughput per station than its competitors. The EC reinforced its belief that JET was the

[87] Ibid. page 20.

[88] Similar analysis was conducted by Kovacic et al (2007) with respect to the US vitamins industry. They used econometric analysis to consider whether a potential maverick firm (Rhone-Poulenc) constrained industry prices.

[89] SH raised further queries related to the analysis, which the EC addressed. Overall, the analysis stood up to critique. Moreover, SH put forward descriptive analyses refuting the findings of the EC regression analysis, but the EC argued that their regression approach was more appropriate.

maverick via a survey of consumer perceptions. The survey findings suggested that the firm was perceived as a low-cost supplier and a strong brand. Moreover, most customers believed that the acquisition would result in the disappearance of JET and a decrease in competition. Overall, with regard to JET (as opposed to other smaller parties) fulfilling the maverick role, "[In terms of new entrants] there is no example of any other service-station chain being close to JET in terms of number of stations, throughput and profitability."[90] Thus in the context of Sweden, the EC doubted the compatibility of the merger with the common market on the basis of the removal of an important competitive constraint.

In Norway, the EC was similarly concerned about the loss of JET as an independent player. In the Norwegian market, the four main retailers (SH, Shell, Esso and YX Energi) all had a number of fuel depots in the country and the retailers all had agreements in place to access each other's depots. However, JET Norway (the fifth-largest competitor with a market share of only [0-5%]) had been unable to conclude agreements with the four. JET had no depots despite entering the market many years earlier (1992). Rather, JET Norway got its fuel from a JET Sweden depot near the border between the two countries. SH argued that JET's small presence in Norway meant that the increase in market share SH would enjoy upon completing the merger was limited. They further argued against the idea of JET representing a strong competitive constraint pre-merger, given that their fuel supplies came from their depot in Sweden. Moreover, just as they did in the Swedish market, SH claimed that JET was a price follower. Contrary to these claims, the EC ruled that JET did exert a significant competitive constraint over its rivals. Whilst they did not refer to the maverick term, their arguments were well-aligned with the maverick concept and similar to those made in the case of Sweden, where the concept was explicitly referred to.

Firstly, the EC argued that JET's incentives were different to those of the four major retailers – a notion that is central to much maverick theory. JET was the only player with purely automated fuel stations. Since automated stations have lower costs, this enabled JET to price aggressively in comparison to full-service stations. Additionally, just as in Sweden, JET offered simple net prices whereas their rivals commonly offered rebates and loyalty schemes. Moreover, the lack of agreements with rivals over depots affected JET's incentive structure.

Secondly, the EC argued that JET constrained the behaviour of its rivals, which was of particular importance since the market was characterised by high barriers to entry. As in

90 *M.4919 StatoilHydro/ConocoPhillips* (2008), page 17.

the Swedish case, they highlighted the efficiency and profitability of the company, as well as the fact that JET systematically undercut its rivals. The firm's ability to respond to its competitors was apparent in SH's internal documents and consumer perceptions revealed that JET was viewed as a low-cost supplier. Furthermore, the EC conducted econometric analysis and found that the presence of a JET station had constrained Statoil's prices. This followed the same format as the analysis of Sweden and was subject to the same robustness checks in response to SH's critique. Moreover, in the case of Norway the results of the EC's pricing analysis were consistent with an independent study by PFC Energy, which found JET to be the main driver of petrol prices in southeast Norway.

Thus, in both Sweden and Norway, the EC's concerns over the merger were oriented around the maverick concept, despite the fact that the maverick terminology was not used in the latter. In both markets the EC established that JET represented a significant constraint over its rivals and expressed concern over its potential elimination from the market. By contrast, in the case of Denmark, "econometric analysis of pricing data carried out by the Commission did not show that JET Denmark had any significant impact on Statoil's prices."[91], and so the EC had no competitive concerns in the Danish market. Overall, the EC's portrayal and treatment of JET in the case is consistent with the depiction of the maverick concept in guidelines. However, the fact that in both markets concerns were related to unilateral effects deviates from the wording of guidelines.

3.3.3 T-Mobile/Orange (2010)

Case M.5650 involved the creation of a new company via a joint venture (JV) between T-Mobile UK (wholly-owned by Deutsche Telekom) and Orange UK (wholly-owned by France Télécom). The JV was to encompass the mobile businesses of both T-Mobile and Orange as well as the broadband business of the latter. Each of the parent companies would hold a 50% stake in the venture. The EC investigated the case following a referral request from the UK's Office of Fair Trading (OFT). The OFT had two primary concerns. First, they were concerned that the transaction would affect the ability of another company (3UK), to compete in the UK mobile market. Second, they expressed concern over the 1800MHz band of the radio spectrum, which was important for the emerging fourth generation (4G) mobile network. They felt that transaction might result in the JV holding a monopoly over the 4G network.

[91] Ibid. page 12.

The EC considered four markets in their analysis of the case: "Mobile Telecommunication Services to End Customers", "Wholesale Access and Call Origination on Public Mobile Telephone Networks", the "Wholesale Market for International Roaming" and the "Wholesale Market for Mobile and Fixed Call Termination". The EC ultimately concluded that each market would remain competitive post-merger. However, they decided that their rulings in the first two markets ("Mobile Telecommunication Services to End Customers" and "Wholesale Access and Call Origination on Public Mobile Telephone Networks") could not be disconnected from the concerns expressed by the OFT. The EC's report stated that decisions regarding the first two markets were "…subject to the analysis of 3UK's RAN sharing agreement with T-Mobile and the spectrum concentration"[92] The EC ultimately found issues in both of these dimensions. Of particular relevance to our subject is the former since 3UK was identified as the maverick.

Prior to the proposed transaction, 3UK had a radio access network (RAN) sharing agreement with T-Mobile. The agreement was a JV to integrate the RANs of the two companies, with the objective of creating a single 3G network. In addition to this 3UK had a 2G national roaming agreement with Orange. The Mobile Network Operator (MNO) side of 3UK exclusively consisted of a 3G network and so the company relied on the 2G agreement to ensure it had the necessary coverage to satisfy its customers[93]. 3UK expressed concern that following the transaction these existing agreements might be in jeopardy since Orange would have an incentive to refuse to renew the roaming agreement, or impose higher roaming charges, and T-Mobile might terminate the RAN sharing arrangement. Thus, they argued that the merger potentially threatened their status as a maverick competitor.

The EC focused its analysis on the RAN agreement, since 3UK's business plan was oriented around the 3G network. Upon analysis, the EC concluded that post-merger the notifying parties "might have the ability to terminate or, at least, compromise the functioning of the existing 3G RAN sharing agreement to the detriment of 3UK"[94] Moreover, the EC accepted that without the agreement 3UK would struggle to remain profitable; it would be extremely difficult to create a separate nationwide network in a timely and cost effective manner and so they would likely lose custom and potentially

[92] *M.5650 T-Mobile/Orange* (2010), pages 13-14.

[93] MNOs were the owners of mobile networks, as opposed to Mobile Virtual Network Operators (MVNOs) who offered services to customers. Some companies were integrated (encompassing both), whilst some companies were MVNOs with agreements with MNOs (who acted as 'hosts'). In the case of 3UK, they had their own network for 3G services but relied on Orange as the host MNO in the case of 2G.

[94] Ibid. page 18.

exit the market. As a result the EC stated that it had doubts over the transaction's compatibility with the common market on the basis that the notifying parties had the ability and incentive to eliminate 3UK.

The Commission used market shares and switching data to establish the maverick in this case. The concept arose in the EC's preliminary analysis of the structure and characteristics of the market for the provision of "Mobile Telecommunication Services to End Customers". In considering the parties as important competitive forces the Commission first ruled out the notifying parties as potential mavericks. Neither Orange nor T-Mobile were considered a maverick because both had lost market share in recent years. By contrast, the EC stated that 3UK had increased its number of customers. Moreover, 3UK had captured a disproportionate amount of the custom lost by Orange and T-Mobile. "3UK could be considered more as a 'maverick' in the market since it captures more customers from Orange and T-Mobile than its market share would suggest."[95] Moreover, with regard to pricing, neither of the notifying parties was the cheapest provider. 3UK was cheapest in two key sub-markets (the "business segment" and "long-term post pay contracts", whilst O2 charged the lowest prices in the "prepay segment"). Based on this evidence, the Commission identified 3UK as a more likely maverick and "an important driving force for competition on the UK mobile market"[96]

In its referral request, the OFT hinted at the potential maverick status of 3UK. The request explicitly expressed concern over the impact of the merger on 3UK[97]. "The OFT was concerned that the parties might have the incentive and ability to foreclose or marginalise 3UK. This would result in a risk that 3UK could be significantly weakened as a competitor or exit the UK mobile market. This would effectively reduce the vertically integrated competitors from five to three and could cause significant detriment to competition in mobile retail communication."[98] The OFT clearly felt that 3UK imposed competitive constraint on the notifying parties, and that if the merger was allowed this constraining role would be compromised.

Moreover, there was agreement amongst market participants that 3UK was something of a maverick. The firm was "considered by several market players as an important competitive force… driving innovation… and lower prices for consumers"[99]. These descriptors are consistent with the portrayal of maverick behaviour given in horizontal

[95] Ibid. page 13.
[96] Ibid. page 13.
[97] It should be noted however, that the OFT did not explicitly describe 3UK as a maverick. It was the Commission that labelled the firm in this way.
[98] Ibid. page 3.
[99] Ibid. page 20.

merger guidelines, thus the EC was consistent in this regard. Furthermore, the report highlighted the fact that 3UK had a relatively low market share [5-10%] but played a more significant role than this market share would suggest. This is consistent with the application of the concept in the maverick literature. However, the EC's classification of 3UK as the maverick was not consistent in other regards. Recall that in EC guidelines the maverick is only mentioned as an insider to the merger, and yet 3UK was external to the transaction. However, as we have shown, the concept is often applied to outsiders – this case is not alone in this regard.

In most cases where a third party maverick was considered, such as *DONG/Elsam/Energie E2* and *Südzucker/EDFM* the EC ultimately decided that the firm was not fulfilling the role[100]. This was typically due to a lack of evidence of aggressive pricing, a lack of evidence that a firm could capture market share from its rivals, or an overall assessment that market conditions were not compatible with the concept. Thus, *T-Mobile/Orange* was unusual in the sense that an outsider maverick was actually established. In general, evidence suggests that on balance the EC prefers to avoid false positive/Type I errors when it comes to mavericks. In *T-Mobile/Orange*, the OFT's concern over 3UK likely reinforced and guided the EC's decision to label the firm as a maverick. This is one explanation. Another can be derived from earlier EC cases into the mobile communications industry. Recall that in *T-Mobile Austria/tele.ring* the maverick concept was also applied and so the EC had a precedent for relating the concept to the market. Moreover, though it corresponded to a different national market, the *T-Mobile Austria/tele.ring* case culminated with a set of remedies geared towards marking Hutchison 3G (the same company as 3UK) the new maverick in the Austrian mobile telecommunications market.

3.3.4 Concluding Remarks on These Cases

From considering the wording of *Travelport/Worldspan* we observed that in order to identify a firm as maverick the EC required evidence that its prices were significantly lower than those of its rivals, as well as evidence of a tendency to increase market share. Indeed, in *T-Mobile/Orange* the EC ruled out the merging parties as candidate mavericks because they had no track record of market share growth. By contrast, the maverick (3UK) had a history of increasing its market share, and in particular taking custom from the two notifying parties (T-Mobile and Orange). This latter fact underscored the

[100] *M.3868 DONG/Elsam/Energie E2* (2006) and *M.6286 Südzucker/EDFM* (2012).

authority's decision in the case. Moreover, in *Travelport/Worldspan* we noted that in order for the concept to raise concerns the EC needed to establish that the merged firm would have reason to raise prices post-merger. This is consistent with existing theory, for example Baker and Shapiro (2007)[101].

In both *Travelport/Worldspan* and *StatoilHydro/ConocoPhillips* the notifying parties' counter-arguments to the suggestion that a particular firm was maverick revolved around arguing that the proposed party was in fact a price follower rather than an instigator of price decreases. The success of arguments generally depended on the available evidence. In the *StatoilHydro/ConocoPhillips* case, the EC established a maverick since they had evidence from customer opinions[102], internal documents, and their own econometric analysis – a strong body of evidence. By contrast, in the *Travelport* case, the opinions of market participants refuted the idea of Worldspan being the maverick and ultimately the EC had insufficient evidence to establish the firm as such.

In the first two cases we discussed, the concern was clearly the removal of a maverick (i.e. concern over a firm no longer fulfilling the maverick role post-merger). This is consistent with guidelines. Yet the concept was related to unilateral effects in these cases, which is contrary to guidelines[103]. Moreover, recall that in Section 3.2 our own statistics on the population of cases showed that applying the maverick concept to unilateral effects was not uncommon. We will discuss this further in Section 3.4. In the final case, *T-Mobile/Orange*, the concern was somewhat different, relating to the foreclosure of an external third party (3UK). However, 3UK was regarded as the maverick and so the issue was still based on the transaction affecting the maverick's ability to fulfil a role of constraint.

3.4 Discussion

In Section 3.2 we presented our analysis of the use of the maverick concept in EC merger cases during the period 2000-2013. In Section 3.3 we discussed three interesting cases in which the concept was discussed at some length. Here, we consider in greater

[101] Baker and Shapiro (2007) outlined two approaches for establishing harm to competition through coordinated effects. Under the first, the authority must identify the likely maverick, discuss how a given merger would alter that firm's incentives, and explain how this would make collusion more likely. Under the second, the maverick need not be explicitly identified but the authority must show that it is highly probable that a maverick would favour collusion post-merger.

[102] Customers may be privy to certain information that implicates a firm as maverick. Customers have direct, first-hand knowledge of the prices and quantities that suppliers offer, as well as insightful information regarding the reputation of firms (Tucker, Reiter and Yingling, 2007).

[103] However, it is worth noting that Sabbatini (2014) took the view that the *StatoilHydro/ConocoPhillips* merger "clearly involved a maverick firm and should probably [have been] forbidden because of its coordinated effect" (Sabbatini, 2014, p.3).

detail two important issues that have arisen as a result of this work. Note that these issues are related to one another. First, we have noted an increase in the use of the maverick concept following the 2004 change in merger regulation. Thus, it is appropriate to consider the nature and consequences of this change in further detail. Second, we have noted inconsistencies when it comes to applying the concept to coordinated or unilateral effects. Thus, it is appropriate to consider whether we can reconcile the maverick concept with unilateral effects analysis. These two issues are related to one another because the 2004 policy change resulted in greater emphasis on the prospect of unilateral effects arising from a merger, and prompted the suggestion that coordinated and unilateral effects be considered alongside one another (Baxter and Dethmers, 2005).

3.4.1 Change in Merger Regulation

European supra-national competition law has been in place since the mid-20th Century (Motta, 2004). However, the implementation of the original regulations was not consistent (Neven et al, 1993). In particular, there was ambiguity over the interpretation of the ‘substantive test’ in merger control. One interpretation was that a merger should be prohibited if it created or strengthened a dominant position *and also* impeded effective competition. Another was that mergers that created or strengthened a dominant position *automatically resulted* in the impediment of competition. This confusion broadly led to under-enforcement. Mergers that produced anti-competitive effects but which did not align precisely with the wording of regulation were permitted (Röller and De La Mano, 2006). Essentially, the problem was how to treat mergers that potentially impeded competition but did not create a dominant position.

Consequently, in 2004 the EC adopted new merger regulation following a two-year review process. We have noted that the review coincides with a period in which there were zero mentions of the maverick concept in EC merger case reports. This may suggest a hesitance on the part of the EC to apply niche concepts, such as that of the maverick, during this period of review. Moreover, in general, the number of decisions published during this time was lower, suggesting a broad reluctance to intervene during the period of uncertainty.

Following the review the new regulation rephrased the substantive test, placing greater emphasis on the impediment of effective competition. The change clarified existing ideas whilst broadening the parameters of merger analysis. Instead of considering whether a merged firm would have significant market power, emphasis shifted to considering whether *the degree of market power increased significantly as a result of the transaction* (Röller and De La Mano, 2006). What we note with respect to mavericks is that the change appears to have stimulated an increase in the use of the concept and also a widening of its application in merger cases. For instance, we observed that the maverick concept is now regularly applied to unilateral effects. In general, evidence suggests that the change in policy resulted in an increased reliance on unilateral effects analysis and limited application of coordinated effects (Dethmers, 2005; Davies et al, 2011). Indeed, in our data, we find that maverick cases earlier in the sample were related to coordinated effects whilst later ones tended to be concerned with unilateral effects, or both.

The five cases which established mavericks all came after 2004. In these cases we note that three related the concept to unilateral effects, one to coordinated effects and one concerned foreclosure. An explanation for this is that EC thinking on the subject of mavericks has evolved alongside the general changes to the substantive test. However, these changes clearly have not yet filtered through to the wording used to depict mavericks in guidelines, which still do not relate the concept to unilateral effects (EC, 2013). We may speculate that future editions of guidelines may link the maverick concept to both types of effects, given that this already appears to be the stance that the EC has adopted in practice.

However, existing theoretical literature has not yet explained exactly how the concept relates to unilateral effects[104]. Whereas mavericks have clearly been shown to influence successful collusion via asymmetry, it is less clear that the acquisition of a maverick would necessarily produce a unilateral increase in prices. For example, as we mentioned in the introduction to this chapter, merger guidelines themselves have suggested that efficiency savings and cost reductions could hypothetically enhance the effectiveness of a maverick post-merger (DoJ and FTC, 2010). Note that this was in the US version of guidelines. Nonetheless, if this were the case, one would not expect to observe higher prices but in fact the opposite.

3.4.2 Reconciling the Concept with Unilateral Effects Analysis

In our sample of cases we have observed that the maverick concept has often been applied within unilateral effects analysis, despite this being contrary to existing maverick theory. Indeed, it has attracted at least some criticism. For example, commenting on the *T-Mobile Austria/tele.ring* case, Charles River Associates (2006) describe the use of the

[104] Note that our attempt in the preceding chapter strictly related the concept to coordination.

maverick concept as misleading because “Any unilateral effects analysis must model accurately any firm which adopts a business strategy of low cost/low-price. The word “maverick” adds nothing to the analysis.” (Charles River Associates, 2006, p.1). It is therefore debatable whether the change in merger policy means it is now appropriate to apply the concept to unilateral effects (as we expounded in the previous subsection) or whether explicit identification of the maverick is just not necessary when it comes to unilateral effects analysis.

Use of the term “maverick” would certainly seem to be unnecessary when the concept is being applied to an outsider to a merger. Ceteris paribus, we would expect a maverick outsider to remain so post-merger, at least in the short term. It is not immediately apparent why a merger of two non-mavericks would cause a third party maverick to cease to fulfil this role. The notion of unilateral effects is based on the idea that the merging parties internalise an externality and that this results in higher prices. In other words, whereas before they were setting prices individually, post-merger they set them jointly. The size of this effect crucially depends on the degree of substitutability between insiders and outsiders to a merger. Hence, unilateral effects analysis should take into account the business models of outsiders, irrespective of whether those outsiders are labelled as maverick or not. The concept therefore adds little to unilateral effects analysis when the maverick in question is an outsider.

What about when the maverick is an insider? Unilateral effects analysis has been criticised for the fact that it assumes that both merging firms continue to operate post-merger (Froeb, Scheffman and Werden, 2004). It does not, therefore, take into account product repositioning or the possibility that one firm exits the market altogether. This, of course, is precisely the worry authorities have with the removal of a maverick firm. Hence, it is possible that by using the maverick concept alongside unilateral effects arguments the EC may be strengthening its case for one of the firms exiting the market. In other words, perhaps identifying one of the merging parties as a maverick helps the EC to establish that that firm will be closed down post-merger, as opposed to the traditional view that the outcome of the transaction is simply a change in ownership. This was certainly the case in *T-Mobile Austria/tele.ring*, where unilateral effects were the main concern and where the EC assumed that tele.ring would be removed from the market following the merger. Likewise, in *Oracle/Sun Microsystems*, the EC argued that the maverick (a subsidiary of Sun Microsystems) could be “downgraded” post-merger, and the remedies imposed in the case addressed this concern.

Based on our analysis it is difficult to conclusively state whether the increased use of the maverick concept in relation to unilateral effects is the result of an evolution in the understanding and interpretation of mavericks or an evolution in the understanding of unilateral effects. As unilateral effects have been given greater prominence since the 2004 policy change, it may simply be a case of maverick theory lagging behind broad changes in competition policy enforcement[105]. Alternatively, it may be that the maverick concept is being used to address a gap in unilateral effects analysis. This is a subject that requires further investigation in order to be fully understood. It is worth noting that Baker (2002), one of the most influential maverick papers to date, advocated a bigger role for mavericks in merger analysis in general. Baker's whole paper was geared towards championing the idea of giving the maverick concept a central role in merger analysis overall. Perhaps this is precisely what authorities have attempted to do in recent years.

3.5 Conclusion

In this chapter we have examined the use of the maverick concept in EC merger cases during the period 2000-2013. Section 3.2 detailed statistics demonstrating the extent and nature of its application during this time. What we found was that the concept was applied relatively sparingly. Of those cases where remedies and/or further analysis were required by the authority, the concept was referred to in just 8% of case reports. Moreover, of those cases that applied the concept, only just over one fifth resulted in the EC conclusively establishing a maverick firm.

In addition, we have observed that the manner in which the notion is typically used in practice is misaligned with the way it is currently depicted in merger regulation. In particular, the concept is often applied in the context of unilateral effects, something which at present is not allowed for in guidelines. Given the shift in EC merger policy toward more of a unilateral effects focus after 2004, we have speculated that this is a case of guidelines being slow to catch up with practice. However, in the previous section we proposed an alternative possibility, that the maverick concept may be being used (perhaps wrongly) to simply address a gap in unilateral effects analysis.

Via our analysis of specific cases, and the information this has revealed about the EC's attitudes towards mavericks, we can see that the identification of particular behaviours

[105] Though, in an ideal world, the direction of causality is wrong if this is true. Ideally, theory should inform competition policy enforcement and not the other way around.

is central to establishing a firm as maverick. As we outlined in Section 3.3, the EC clearly requires evidence of historically favourable behaviours (from a consumer point of view) in order to classify a firm as maverick. In the cases we surveyed this has included evidence of charging lower prices (or being proactive in lowering prices), evidence of constraining the prices of rivals, and evidence of expanding market share. The presence of one or all of these behaviours is seemingly needed to definitively establish a maverick.

This finding is of interest for our purposes given the objective of the remainder of this thesis. In the coming chapters, our aim is to develop an empirical means of identifying maverick firms. Thanks to our findings in this chapter we now know what kinds of behaviours we wish to identify. Moreover, the EC's strong desire for evidence of these behaviours underscores the fact that an empirical method of maverick identification would be desirable. No such method currently exists. As we have seen, the EC more commonly relies on qualitative evidence such as the opinions of market participants to "identify" a maverick. However, these are subjective and potentially open to abuse. Therefore, if we were able to develop an objective empirical test of maverickness this would be extremely valuable to authorities conducting merger analysis.

Chapter 4: Data

4.1 Introduction

An issue we have not yet addressed is the lack of an empirical means of maverick identification. As we have illustrated, mavericks are often classified by qualitative reasoning - using prior knowledge of an industry and the perceptions of rival firms and customers in order to argue the maverick status of a given firm. For example, in the case of *SCA/Georgia-Pacific Europe* the notifying parties argued that GPE was not a maverick and the EC agreed after their argument was corroborated by third party opinion[106]. Decisions of this type are common in EC cases. EC merger analysis has occasionally adopted empirical methods in order to prove the "maverickness" of a certain firm, yet in all such cases the party was initially implicated by qualitative means. For instance, in *StatoilHydro/ConocoPhillips* econometric techniques were used to show that the presence of JET fuel stations constrained the prices of Statoil, but this analysis came after the EC had reasoned that JET was a maverick that might pose a constraint to its rivals[107].

Thus, the EC have in the past relied on their perception of industry dynamics alongside somewhat anecdotal evidence in order to implicate potential mavericks. On the contrary, it would be preferable to have a clear and objective empirical approach to identification that does not rely on preconceptions or conjecture. "Although the analysis of unilateral effects relies a great deal on economics and econometric techniques developed over the last two decades, the analysis of coordinated effects is not approached with the same scientific rigor… Indeed, there are no known techniques to identify maverick firms" (Breunig and Menezes, 2008, pp.811-812)[108]. A quantitative test of maverickness would be desirable in order to remove any bias, improve the clarity of decisions and to minimise disagreement. Such a test could reduce the costs of the merger process for notifying parties and authorities alike.

The remaining chapters of the thesis are therefore devoted to developing and testing empirical strategies for maverick identification. As we mentioned in the introduction to the thesis, the only existing *objective* attempt at empirical identification was that of Breunig and Menezes (2008), who sought to identify the maverick in the Australian

[106] M.6455 *SCA/Georgia-Pacific Europe.*

[107] M.4919 *StatoilHydro/ConocoPhillips.*

[108] This quote is interesting given the findings of the preceding chapter. If it is believed that it is appropriate to relate mavericks to unilateral concerns then this quote could be taken as support for the need for an empirical method of maverick identification. Alternatively, considering it from another angle, we could argue that mavericks have begun to be related to unilateral effects as a consequence of the lack of "scientific rigour" in coordinated effects analysis.

mortgage market[109]. Our approach therefore begins with a replication of the BM method. However, as we shall see, the method has certain limitations. As a result, two alternative methods are proposed and tested. These alternatives utilise cointegration and asymmetric cointegration, respectively. The three attempts are chronicled in chapters 5, 6 and 7. However, before we begin it is first appropriate to give an account of the dataset upon which our analysis will be conducted. This is presented in the current chapter.

Our analysis is focused on the UK banking industry. More specifically, we will attempt to identify the maverick in the UK instant access bank and building society (deposit) account market. Our reasons for choosing this market are threefold. First, it is closely aligned with the market analysed by Breunig and Menezes (mortgages), meaning we can apply the BM method to our data with only minimal changes. This is valuable since we can more easily compare our findings with those of Breunig and Menezes (2008). Second, it is a market in which prices are relatively transparent and readily available, since rates are published by banks and compiled and disseminated by financial organisations[110]. The BM method attempts to identify mavericks on the basis of their pricing behaviour, and so the availability of price data is crucial to the method's successful implementation. Third and most importantly, the industry is one in which mergers are commonplace. UK banking has undergone considerable consolidation during recent years. There have been multiple building society mergers and some very large acquisitions, such as Halifax/Bank of Scotland in 2001, Lloyds TSB/HBOS in 2008, and the acquisitions of Abbey National, Bradford & Bingley and Alliance & Leicester by Banco Santander. Since the maverick concept is first and foremost a consideration of merger policy (maverick identification would be conducted by authorities as part of the analysis of a merger) it makes sense to choose a market in which mergers often occur.

4.2 The Dataset

The data have been constructed using historical figures from Moneyfacts PLC, who provide a rich source of data on interest rates (i.e. "banks' prices")[111]. Moneyfacts compile, report and analyse the interest rates offered by UK banks and building societies on various financial products such as savings accounts, loans and mortgages, and print

[109] Ivaldi, Mitraille and Mueller (2012) attempted to prove the maverickness of a particular firm by showing that said firm constrained the prices of its rivals – just as in the handful of EC cases mentioned above. Similarly, Kovacic et al (2005) used empirical means to show that a particular firm influenced industry prices. However, Breunig and Menezes (2008) is the only paper to date that attempts to identify a maverick with no preconceptions about the maverick's identity.

[110] Ultimately, we want to be able to generalise our methods to a wide range of industries, however it is sensible to start with a market in which prices are relatively transparent. If the methods are unsuitable for such an industry then this would naturally preclude their application to more complicated contexts.

[111] Appendix J contains a list of all of the banks in our sample, alongside the abbreviations they have been assigned.

these in a monthly magazine alongside other financial data and economic commentary. As a data source, Moneyfacts is comparable to Cannex, which was the source of data for the Breunig and Menezes (2008) study. It is an excellent source of product-level data, the like of which is not available in many other nations, and it has been used by UK competition authorities as well as the Bank of England and the Treasury[112]. Moreover, note that there is a precedent for using Moneyfacts data in academic work, with studies such as Costanzo and Ashton (2006), Fuertes and Heffernan (2009) and Elliott and Wei (2010) having utilised their data to explore a variety of topics – in the named studies: product innovation and consumer choice, interest rate transmission, and regulatory intervention, respectively.

Our dataset has been built retrospectively using figures on "Bank and Building Society Accounts" that were reported in 120 editions of Moneyfacts magazine during the calendar years 2000 to 2009[113]. The full dataset comprises 79674 observations of interest rates on 2402 different accounts (i.e. "products") offered by 168 different banks and building societies. Accounts differ in terms of notice periods, perquisites, penalties, terms and conditions. Moreover, rates for a given account usually varied according to deposit level, with higher deposit customers typically afforded better rates of interest. As a consequence, each observation includes the rate offered at nine different deposit levels ranging from £1 to £100,000, where applicable[114].

The most common notice terms were Instant Access, no notice ("None") and 30 Day[115]. Of the 79674 total observations, 28461 relate to instant access accounts, 15458 to no notice accounts and 7063 to those with a 30 day notice period. The remaining 28692 observations correspond to accounts of numerous other notice periods, varying from those with less than two weeks' notice to multi-year bonds or a fixed future notice date. The majority of accounts paid interest on an annual basis however some paid interest monthly, quarterly, and so on. As a result, in some cases the dataset includes different versions of the same account[116].

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112 See for example the Bank of England: www.bankofengland.co.uk/publications/Documents/fsr/2010/fsr10jun1.ppt or www.moneyfactsgroup.co.uk/publications/reports.

113 Banking regulation is very complex, particularly during the period that we analyse in this thesis. From April 2013 onwards the Financial Services Act 2012 implemented a new regulatory framework for financial services in the UK, however during the period under consideration UK banks were regulated by several different authorities including the Financial Services Authority, the Bank of England, and the Treasury, each of with had different remits (Competition and Markets Authority, 2015). Banks are also subject to the Basel Accords, an international regulatory framework that covers capital adequacy and market liquidity (www.bis.org).

114 Not all accounts were offered at all deposit levels.

115 In the case of both instant access and no notice, money can be withdrawn from an account without prior notice. Effectively, the difference between the two is that with the former the customer has a bank card with which to withdraw cash from automated teller machines, whereas in the latter they have to go into a branch to withdraw their money.

116 For instance, Woolwich's "Branch Saver" and "Branch Saver Monthly" appear separately in the raw data.

Direct comparisons between accounts are complicated by the slight differences brought about by the varying notice periods, terms and so on. For example, it would be inappropriate to compare an instant access account with a 30 day notice account since customers who require immediate access to their money are typically given a lower rate of interest. Similarly, it would be inappropriate to compare an account that pays interest annually with one that pays it monthly since the former usually give a higher rate in order to compensate for accruing interest less frequently. This poses problems for our analysis since, for example, a bank that offered a high number of instant access/monthly interest accounts would naturally appear to offer worse rates of interest than a bank that had a high number of long-term/annual interest products[117]. Thus, whilst we would obviously like to include in our analysis as much data as possible to get a more complete picture of bank pricing, it is necessary to narrow the product scope[118].

There are other non-price characteristics that differentiate the products in the sample. One source of such differentiation is via deposit insurance. In the UK, the Financial Services Compensation Scheme (FSCS) protects customers against bank insolvency, to some extent[119]. However, many banks and building societies operate under the umbrella of a larger banking group. Any customers with existing accounts that are looking to open subsequent ones may not regard two potential products as direct substitutes if one of them is offered by a bank in the same network as their existing accounts, since their level of protection would be a factor in their decision. Thus two accounts that appear near identical in our data might not be perceived as such by all customers.

Moreover, the fact that some banks in the sample are part of wider branch networks, and others are foreign banks, should be acknowledged. These features contribute to differentiation in the sample. Products that are offered by firms that are part of the same network may follow similar pricing trends, or may be subject to strategic pricing behaviour. Thus we may question whether there is genuine competition between products that are offered by entities within the same group. In terms of foreign banks, their operations in other markets may impact their behaviour as well as the way these products are perceived by customers. These factors contribute towards the fact that not all products in the sample are strictly like-for-like substitutes.

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[117] The rates offered on accounts would not be the only factor considered by prospective customers. Factors such as account fees and levels of staffing would also have an influence (Dick, 2008). Moreover, as we discuss in this chapter, there are many other non-price factors that distinguish between products.

[118] Narrowing the product scope allows us to be more confident that our results are valid, and increases the likelihood that our ultimate assertions over the identity of the maverick(s) will be accurate. Breunig and Menezes (2008) made a similar judgement call by limiting their analysis to “ordinary variable rate” mortgages – as we will explain in Chapter 5.

[119] The protection is currently £75000 per person per authorised bank or building society (FSCS.org.uk).

Finally, the age of accounts differentiates products in the sample. Often, new products come with promotional offers and perks that confer additional benefits for a limited time. More generally they are typically priced more competitively. For these reasons, 'newer' products may not be directly comparable with 'older' ones, and customers that have recently switched to a product may receive different terms to those that have held an account for some time. Indeed, Anderson, Ashton and Hudson (2014) found that the age of a product was negatively correlated with the interest rate on offer. This is something we will discuss further later in the thesis, alongside the prospect of inertia in customer switching, but at this point it should be noted as a complicating factor which contributes toward product differentiation in the sample[120].

In sum, the sources of slight differentiation in the sample emphasise the importance of market definition. We have stated that it is necessary to narrow the product scope in order to minimise the effect of the slight differences between accounts and for our eventual conclusions to be valid. Later, we will give consideration to the geographical dimension of market definition, since the UK is composed of different nations: England, Scotland, Wales and Northern Ireland. However, the vast majority of firms in our sample operate across the whole of the UK and so product characteristics are of more pressing concern. It is necessary to narrow the product scope, but it is most feasible to do so on the basis of broad characteristics (account type, interest payment intervals) rather than the complex array of non-price characteristics we have alluded to above. It was important to note and appreciate these other non-price characteristics, but from a practical perspective they will not be factored into our narrowing of the market.

With these considerations in mind, we focus our analysis on *instant access accounts that paid interest on an annual basis*, of which we have 24028 observations for 461 different accounts offered by a total of 112 banks and building societies[121]. The choice of this account type is driven by two factors. First, it is the most common type of account, allowing us to retain as large a sample as possible. Second, it is one of the least differentiated product types, since most firms offered at least one basic instant access account. Figure 4.1 below shows the evolution of the average rate offered on this type of account for each of the nine deposit levels in each month of our sample. It is clear that rates varied considerably during the period, until their well-documented decrease following the onset of the 2008 financial crisis. The rates offered at each deposit level

[120] It is also important to appreciate that customers are not homogenous either.
[121] We do not discard the rest of the sample. We ultimately run the analysis on the full dataset for the purposes of robustness.

followed broadly the same pattern, although there was considerable difference between the rates offered at the highest and lowest deposit levels, particularly prior to the crisis.

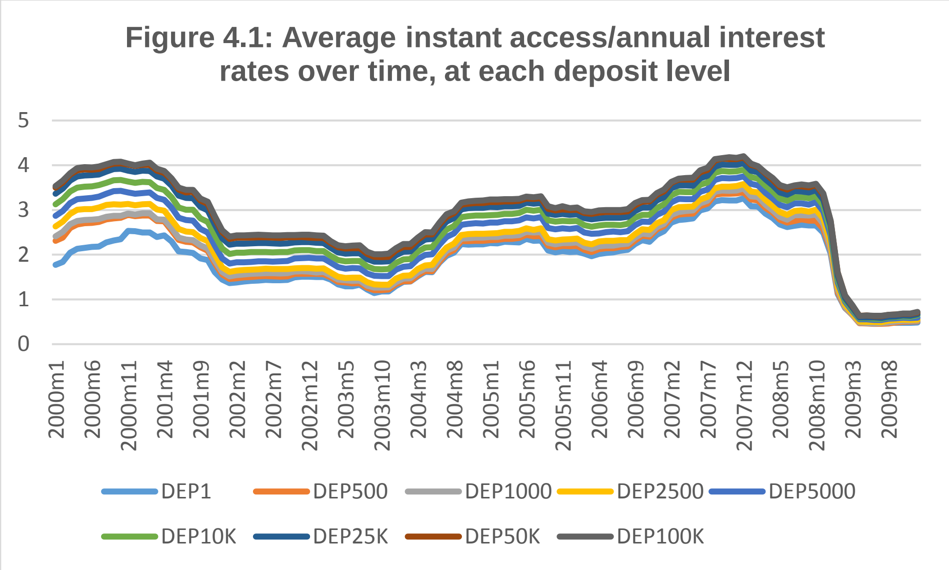
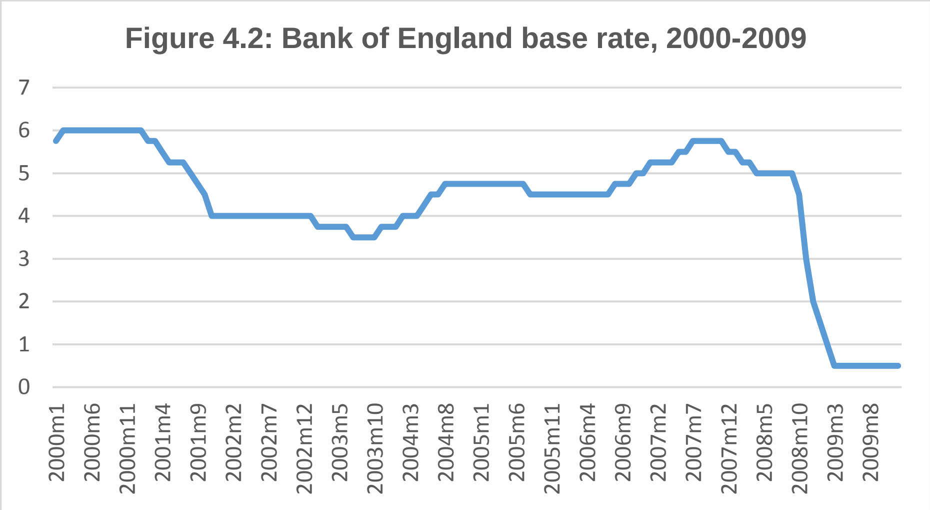


Table 4.1 below gives the average rate offered at each deposit level in each calendar year. As we would expect, on average banks offered higher rates of interest to customers with larger deposit amounts; in the table, rates increase as we move from left to right. From this we note that it may be necessary to conduct analysis at different deposit levels. If we were to average across deposit levels to produce a single "representative" interest rate for each bank, then any banks that did not offer their products at every deposit level would have a skewed representative rate. For example, Butterfield Private Bank ("BPB") only offered accounts to customers with deposits of £10,000 or more. Thus, if we were to produce a representative rate, BPB would naturally appear to offer higher rates than banks that served customers across the full deposit spectrum. This becomes a problem where we are interested in the levels of prices, as is the case in part of the BM approach.

Table 4.1: Yearly average interest rates by deposit level

YEAR	DEP1	DEP500	DEP1000	DEP2500	DEP5000	DEP10K	DEP25K	DEP50K	DEP100K
2000	2.92	3.39	3.57	3.88	4.23	4.53	4.75	4.92	5.03
2001	2.74	2.96	3.10	3.34	3.64	3.93	4.14	4.30	4.41
2002	1.90	1.96	2.06	2.23	2.47	2.71	2.90	3.04	3.14
2003	1.77	1.80	1.89	2.02	2.25	2.44	2.62	2.75	2.85
2004	2.45	2.46	2.55	2.65	2.86	3.05	3.22	3.34	3.45
2005	2.86	2.92	3.01	3.09	3.28	3.47	3.63	3.75	3.85
2006	2.85	2.92	2.98	3.05	3.21	3.38	3.54	3.67	3.76
2007	3.75	3.82	3.92	3.96	4.10	4.26	4.41	4.53	4.62
2008	3.56	3.63	3.74	3.78	3.89	4.03	4.18	4.29	4.37
2009	0.96	0.95	1.01	1.03	1.06	1.12	1.19	1.26	1.30

In addition to data on individual banks' interest rates, our dataset also includes the Bank of England base rate[122]. Figure 4.2 shows the evolution of the base rate during the period. Note that the base rate follows a similar pattern to the average bank rates shown in Figure 4.1. This is to be expected; in theory, commercial banks' rates should track the central bank rate, as we will explain.



The relationship between the central bank rate and banks' rates (known as the "interest rate channel of monetary policy") can be explained as follows. Briefly, the base rate represents a cost of funds for banks. Central banks typically ensure that there is a daily shortage of cash so that they are able to supply the shortage at whatever price they choose – the base rate, otherwise known as the "policy" or "official" rate (Hofmann and Mizen, 2004). Since banks are charged this rate it is assumed that it directly affects the rates they pass on to their customers[123]. At the simplest level, if a bank has to pay a higher price for funds then it will naturally charge more for lending those funds to customers, in the form of higher interest rates on loans and mortgages. With regard to interest rates on savings, these also tend to move in the same direction as the policy rate. One can think of customer deposits as an alternative source of funds for banks, and one that they favour. As the policy rate goes up banks are able to offer their deposit customers a better rate of interest because it is offset by the higher rates they charge on lending. Policy rate changes are ultimately intended to influence the performance of the economy (and consequently the level of inflation) via Aggregate Demand. Higher (lower) rates on savings accounts have the effect of decreasing (increasing) the levels of consumption and investment in the economy (see for example Mankiw, 2014).

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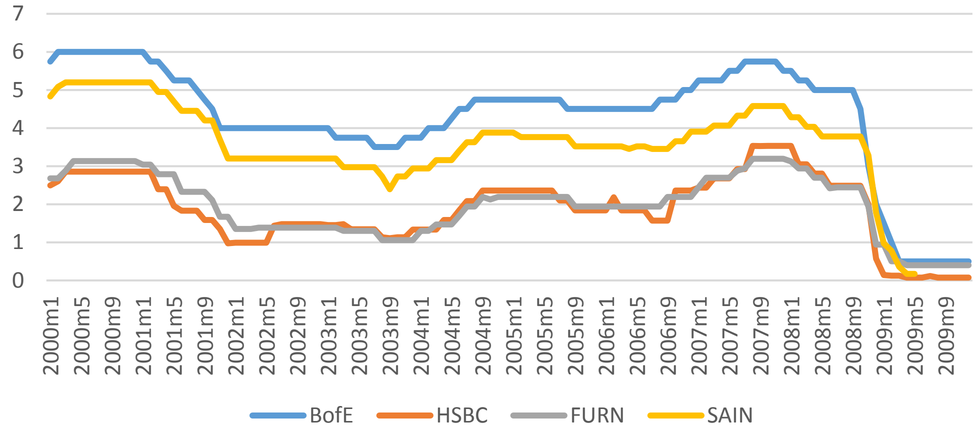
[122] As we will explain in the coming chapter, the central bank base rate has an important role to play in the BM method.
[123] See www.bankofengland.co.uk for example.

Despite a broad correlation between the average bank rate and the policy rate, at the firm level there were differences in the level and timing of rate changes. To illustrate these differences, Figure 4.3 shows the rates of one large bank (HSBC), one building society (Furness BS) and one "alternative provider" (Sainsbury's), alongside the base rate. Though these are the rates of specific firms, Figure 4.3 gives an indication of variations in the pricing practices of different types of provider.

Figure 4.3: The rates of HSBC, Furness BS and Sainsbury's



The levels of the rates offered by the three firms are distinctly different. Moreover, there are also noticeable differences in rate adjustments, particularly in the case of HSBC and Furness. Whilst the rate of Sainsbury's appears to broadly follow the base rate, those of HSBC and Furness display many more small deviations.

Chapter 5: The Breunig and Menezes Approach

5.1 Introduction

We have given an account of our dataset. We now turn to our first attempt at empirical maverick identification, a replication of the BM approach. Breunig and Menezes (2008) sought to identify the maverick firm in the Australian mortgage market. This chapter presents an attempt at applying their methods to an alternative market (UK instant access bank accounts), using the dataset we outlined in the preceding chapter. Such a replication provides a natural starting point in the exploration of empirical strategies for maverick identification. Testing the BM method allows us to fully appreciate the rationale behind the only previous identification attempt and helps clarify exactly what we hope to achieve when we state that we wish to "identify a maverick". Thus, replicating the BM method is a crucial step on the road to developing an objective empirical test of maverickness.

Breunig and Menezes (2008) adopted a "revealed preferences" approach to identification (Baker, 2002)[124]. They sought to detect the maverick party based on observable behaviour; they analysed mortgage providers' interest rates with a view to establishing pricing behaviours that would be considered favourable from a consumer point of view. To achieve this they proposed two measures. The first sought to identify firms that offered the most favourable rate of interest over the period (the "relative rate measure"). Since mortgages are a form of loan and interest is paid *by* the customer *to* the firm, a low rate of interest was better from a consumer perspective. In addition, Breunig and Menezes posited that the timing of rate changes could also be interpreted as favourable or unfavourable to consumers. They therefore suggested a second measure based on the responses of firms to changes in the central bank policy rate (the "responsiveness measure"). Again, since interest is paid *by* the customer *to* the firm, being quick to follow central bank decreases (or slow to follow central bank increases) was favourable to consumers.

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[124] Baker (2002) suggested three possible approaches to maverick identification. He termed these 'revealed preferences', 'natural experiments' and 'a priori factors'. The first two involve quantitative analysis. 'Revealed preferences' amounts to observing that one firm is clearly behaving differently to its rivals; for instance where a particular firm prices consistently lower than the norm. 'Natural experiments' searches for a link between a single firm's cost conditions and the prevailing industry price. The idea is based on the maverick's supposed ability to constrain its rivals; if market prices increase following a unilateral increase in one smaller firm's costs, then this may indicate that firm as the maverick. Finally, 'a priori factors' is qualitative and represents the typical approach of authorities; it is the identification of a maverick simply based on knowledge and understanding of the relevant market.

The composition of Breunig and Menezes' dataset was similar to our own. Their dataset comprised of weekly data on the interest rates offered by individual mortgage providers during the period January 2003 to October 2006. The source of their data was Cannex (now known as Canstar, a company that compiles and distributes information on financial products). They acquired data on a variety of mortgage products but focused their analysis on the "ordinary variable rate", a basic product offered by almost all providers. Not all products were offered by all firms. By focusing their attention on the "ordinary variable rate" they were able to consider a larger amount of firms in their analysis, giving the best chance of accurately identifying the maverick. They augmented their dataset with data on the policy rate. The policy rate should impact all banks in the same way and so they posited that contrasting responses to changes in this rate would be indicative of relative maverickness. The relevant policy rate was the Reserve Bank of Australia (RBA) cash rate.

The two BM measures were derived as follows. The relative rate measure was achieved by calculating the mean "ordinary variable rate" at each point in time and regressing the difference between this and each bank's rate against dummies for each provider. This produced a coefficient for each bank simply representing its position relative to the average over the period; i.e. the average difference from the mean rate after controlling for time. Accordingly, negative (positive) coefficients indicated that a provider charged a rate that was lower (higher) than the mean. Given the mortgage context, those with the lowest coefficients were interpreted as potential mavericks. Lower coefficients implied that they charged mortgage customers lower rates of interest on their repayments.

For the responsiveness measure, Breunig and Menezes devised a ranking system which incorporated banks' responses to RBA rate changes as well as "unprovoked" changes (those that were not associated with central bank action). For the former, for each provider they interacted the number of rate changes following a RBA change with the average number of weeks that bank took to react. Increases were assigned positive values whilst decreases were assigned negative ones. Greater positive values were apportioned to parties that were slower to increase their rate, whilst greater negative values were given to those who were slower to follow a decrease. Ignoring central bank increases gave firms a positive score whereas ignoring decreases impacted the score negatively. For unprovoked changes, a decrease (increase) was assigned a positive (negative) value[125]. The ultimate outcome of the ranking system was that providers that instantly responded to central bank changes but were otherwise inert got an overall

[125] We will formally state Breunig and Menezes' ranking metric in the next section, alongside our own interpretation.

score of zero. Firms with positive scores were regarded as behaving more favourably from a consumer point of view. Those with the highest scores were viewed as potential mavericks.

In terms of results, though there was broad correlation between the outcomes of their two measures, Breunig and Menezes regarded themselves as relatively unsuccessful in their attempts at identification. Although a particular provider ("ASHL") scored highest under both measures, the authors looked more closely at the most likely mavericks and noted that "ASHL ignore the two interest rate increases of the RBA in 2003, but then have a large one-off increase…After that point, ASHL appears to follow RBA changes as much as the large banks do." (Breunig and Menezes, 2008, p.826). They found similar evidence counting against their other candidate mavericks. Moreover, many firms that scored highly by one measure did not score highly by the other. Importantly, they concluded that timing played a crucial role in framing maverick behaviour. Though some firms appeared to be more maverick in the period overall, the extent to which their behaviour would be regarded as maverick varied during the period under consideration[126]. We will discuss these issues, and other problems with the approach, in the final section of this chapter.

The chapter proceeds as follows. Section 5.2 outlines the BM method as it is applied to our dataset. Some augmentations are made to their approach; this is primarily to account for the fact that our market of interest is deposit accounts rather than mortgages. Broadly, this means that higher rates, rather than lower rates, are regarded as favourable to customers. Section 5.3 presents the results for our market and highlights potential mavericks in our data. Section 5.4 provides further discussion of the results and problems with the method. Where possible, we attempt to address these problems. In general, the results of Breunig and Menezes (2008) were not particularly satisfying and by applying the method to our own data we are able to observe first-hand the issues they encountered. Moreover, we are able to appreciate the difficulties with attempting to classify "favourable behaviour" in general. Section 5.5 concludes by considering whether the analysis of interest rates (prices) is truly the best medium through which to achieve objective maverick identification.

[126] The time period is important. Firms may act in a seemingly maverick-like manner for some but not all of the period under consideration. The implication of this is that under the BM method the set of firms that appear relatively more maverick would depend on the time period chosen. Since Breunig and Menezes compute each provider's score for each of their measures *for their entire time period*, arbitrary changes in period would likely completely change the results. We will discuss this limitation in due course.

5.2 Methodology

Our method follows Breunig and Menezes (2008) with some slight alterations due to the difference in geographic location and product market. With regard to the former, the relevant policy rate for our purposes is the Bank of England base rate rather than the Reserve Bank of Australia cash rate. With regard to the latter, the interpretation of "favourable" (and consequently "maverick") behaviour differs for deposits in comparison to mortgages. As we have explained, in the context of *mortgages* a low rate of interest is favourable to consumers. This is because interest is paid *by* the customer *to* the financial institution. In contrast, in the case of *deposits*, interest payments flow in the opposite direction. As a result, behaviours that would be considered favourable or unfavourable are broadly inverted. This is important for our interpretation of which firms might be maverick.

As we have outlined, the BM method is composed of two parts: the "relative rate measure" and the "responsiveness measure". For the relative rate measure our approach is identical to that of Breunig and Menezes. We calculate the mean interest rate for instant access accounts at each point throughout our sample, compute the difference between this and each bank's rate, and regress this against a set of bank dummies. The only difference between our application and that of Breunig and Menezes is in the interpretation of the coefficients. Since a positive (negative) coefficient implies that a bank offered a higher (lower) rate of interest than the mean, banks that have higher values for this measure are perceived as more maverick in our case. A positive coefficient indicates that a given bank offered above-average interest rates to their deposit customers, which is clearly "favourable".

For the responsiveness measure, Breunig and Menezes' ranking took the form:

$$r_i = I^{+}_{RBA,i}*w_{I,i} - D^{+}_{RBA,i}*w_{D,i} + I^{-}_{RBA,i}*w^{(0.9)}_{I} - D^{-}_{RBA,i}*w^{(0.9)}_{D} + k_1 D^{i}_{i}*w^{(0.9)}_{D} - k_2 I^{i}_{i}*w^{(0.9)}_{I} \quad (5.1)$$

Where r_i denoted the responsiveness score of mortgage provider i, $I^{+}_{RBA,i}$ represented the number of increases by provider i in response to RBA rate increases, $w_{I,i}$ was the average number of weeks it took to react to an RBA increase, $I^{-}_{RBA,i}$ was the number of occasions where a provider ignored an RBA increase and I^{i}_{i} represented unprovoked increases. $D^{+}_{RBA,i}$, $w_{D,i}$, $D^{-}_{RBA,i}$, and D^{i}_{i} were defined similarly but corresponded to decreases. $w^{(0.9)}_{I}$ and $w^{(0.9)}_{D}$ were weightings that represented the 90^{th} percentile of the distribution of average time taken to respond to the RBA rate (across all firms). These were included in order to differentiate between instances where firms ignored RBA movements and instances of slow response. Unprovoked changes were similarly weighted. k_1 and k_2 were further weightings for the significance of unprovoked changes relative to RBA responses; in other words, $k_1 = k_2 = 1$ would relate to the case where equal weight was given to both types of change.

We adapt the BM ranking system in two ways. First, we reverse the sign of terms. The outcome of this is that, as in Breunig and Menezes (2008), a positive score is still indicative of favourable rate-setting. By doing so we ensure that relatively higher (positive) values are consistently indicative of maverickness, both in this chapter and in the subsequent chapters. Second, we omit the weighting k. Breunig and Menezes found that changing these weightings had no significant effect on the eventual results and so we omit them for simplicity. Thus our ranking takes the form:

$$r_i = D^+_{BofE,i}*w_{D,i} - I^+_{BofE,i}*w_{I,i} + D^-_{BofE,i}*w^{(0.9)}_D - I^-_{BofE,i}*w^{(0.9)}_I + I^i_i*w^{(0.9)}_I - D^i_i*w^{(0.9)}_D \quad (5.2)$$

The components of this expression are defined in a subtly different way to those in Equation (5.1). The reason for this is that in our sample we typically have multiple products (multiple accounts) for each bank. Thus, $I^+_{BofE,i}$ is the average number of increases by bank i in response to Bank of England policy rate increases, $w_{I,i}$ is the average number of months a bank took to react to central bank increases, $I^-_{BofE,i}$ is the average number of occasions where a bank ignored central bank increases and I^i_i are the average number of unprovoked increases. $D^+_{BofE,i}$, $w_{D,i}$, $D^-_{BofE,i}$, and D^i_i are defined analogously. By "average" in these definitions, we mean *the average across a bank's accounts*. Note that an implication of this is that a bank may have adjusted some of its accounts in line with policy rate changes whilst leaving others unchanged. Consequently, the ultimate values for the components of Equation (5.2) are generally on a much lower scale to those in Breunig and Menezes (2008)[127]. This does not matter per se because the comparison of firms is relative.

There is one other methodological difference between our responsiveness measure and that of Breunig and Menezes. In our sample, changes in the policy rate are higher in number and much more frequent than in the BM study, and occasionally occur in subsequent months. Resultantly, we cap the number of months it could conceivably take to respond to a central bank change at 3. If a bank changed its rates more than 3 months after a Bank of England adjustment this was treated as an unprovoked change. Moreover, where subsequent policy rate changes occurred we assume that individual banks' changes are in response to the last central bank change, since there is no

[127] To illustrate this, consider the following example. Take the component that represents increases following a central bank increase. In Breunig and Menezes' original paper each provider had a single product. So if a provider followed all five of the RBA increases in their sample, and took on average two periods to do so, they would score 5 x 2 = 10 for this component. Now suppose that the provider had two products, and that the rates of the second product did not change in line with policy rate changes. Then, the value for the component would be (10+0)/2 = 5.

discernable way of knowing for sure. We discuss this issue further in Section 5.4 of this chapter.

5.3 Results

As we outlined in the preceding chapter there is a tendency for banks to offer better rates to higher deposit customers. Moreover, not all banks offered products at each deposit level. For these reasons, rather than conducting analysis on a single "representative" rate for each bank, we apply the BM method to three different deposit levels representing "low", "medium" and "high" deposit customers. We use the deposit levels £500, £5000 and £50,000 to represent these three categories. These are the second, fifth and eighth of the nine deposit levels in the data; we avoid using the extreme deposit categories as these are most likely to produce unusual results. Applying the method to different deposit levels is particularly important for Measure 1 (the relative rate measure), but we conduct analysis on the three deposit levels for Measure 2 as well, for ease of comparison.

The full results of applying BM Measure 1 to our data are given in Appendix K. Banks are sorted by the average coefficient across deposit levels, but results for each deposit level can be seen separately. Recall that this coefficient effectively captures the relative interest rate a bank offered and that higher values are better for customers. Table 5.1 below displays the top ten scoring firms by this measure. Similarly, the full results of Measure 2 appear in Appendix L with the top ten in Table 5.2 below. Recall that for Measure 2 the value represents a bank's score according to the ranking metric for bank responsiveness, and that higher positive values are again better for customers.

Table 5.1: BM Measure 1

Bank	Low (£500)	Medium (£5000)	High (£50K)	Average
PO	2.28	2.00	1.66	1.98
NATC	1.60	1.52	1.40	1.51
TSCO	1.33	1.34	1.60	1.43
SBI	1.49	1.40	1.31	1.40
SUN	1.60	1.28	1.10	1.33
SAIN	1.25	1.00	0.92	1.06
TCHR	1.50	1.04	0.44	0.99
ABBE	0.93	1.00	0.77	0.90
OTB	1.42	0.87	0.25	0.85
NEWB	1.55	0.84	0.11	0.83

Table 5.2: BM Measure 2

Bank	Low (£500)	Medium (£5000)	High (£50k)	Average
NWDE	11.71	13.08	13.09	12.63
IPS	12.73	11.64	6.85	10.40
TSCO	10.00	8.59	10.02	9.54
CUMB	10.26	9.41	8.81	9.49
EARS	9.29	9.24	8.49	9.01
COD	8.08	8.96	8.90	8.64
LEEK	8.09	9.05	8.39	8.51
MANS	7.16	10.23	7.81	8.40
SCOT	9.16	7.31	7.91	8.13
TCHR	8.76	7.41	7.41	7.86

First let us consider overall trends in the results. With respect to Measure 1, the average coefficient was small and negative: -0.20, -0.17 and -0.12 for the respective low, medium and high deposit levels. The majority of banks had negative coefficients, which would be regarded as unfavourable for consumers. Only 39, 50 and 51 banks had non-negative values, increasing through the respective low, medium and high deposit levels.

In terms of Measure 2, most banks had a positive coefficient but this is difficult to meaningfully interpret. The coefficient is a product of the ranking metric shown in Equation (5.2) and the values mean little in isolation; the comparison is strictly relative. Since our sample period contains more policy rate decreases than increases and the 'D' terms are positive in Equation (5.2), it is unsurprising that most of the coefficients were positive. Indeed, strictly speaking, zero would not be an appropriate benchmark for comparing bank behaviour. Rather, the average coefficient (3.09) would provide a better point of comparison[128].

The Post Office ("PO") scored highest for Measure 1 but was ranked only 23rd in terms of Measure 2 with an average score of 3.80 – considerably lower than the top ten depicted in Table 5.2. Similarly, Nationwide BS ("NWDE") scored highest by Measure 2 but ranked only 35th in terms of Measure 1, averaging 0.22. In general, the banks that scored the highest tend to vary from one measure to the other. This is similar to the findings of the original paper. Breunig and Menezes noted that, "some [firms] are very aggressive on the price dimension but not as aggressive on the time dimension and vice

[128] Of note, recall that the outcome of the ranking system was that those banks that responded instantly to policy rate changes but were otherwise inert received a score of zero. In our sample, we can see from Appendix L that only 9 banks receive such a score for all three deposit levels. This may be an indication of the relative complexity of bank pricing; seemingly few banks operate a simple pricing rule based on the policy rate.

versa… A maverick may exert steady pressure to keep prices lower, as captured by [Measure 1]. Or, the maverick may engage in more frequent cost-cutting that is not long-lasting but nonetheless exerts downward price pressure on the market. This type of behaviour is picked up by [Measure 2]." (Breunig and Menezes, 2008, p.829). In our market (as in theirs) it is difficult to reconcile these two behaviours or to determine which is more favourable for consumers. As a result, it is difficult to conclusively assess maverickness using the BM method.

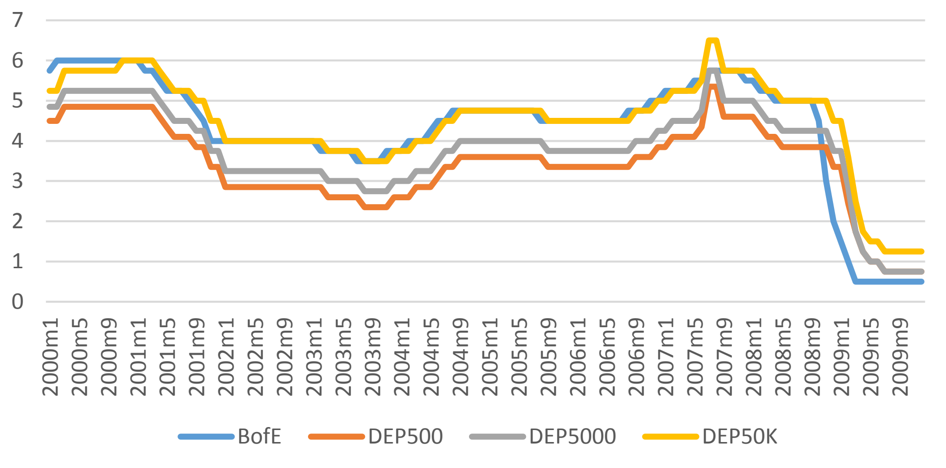
That said, Tesco ("TSCO") and Teacher's BS ("TCHR") appear in the top ten for both measures. TSCO in particular score very highly in both measures[129]. This is encouraging from the point of view of maverick identification since TSCO is a supermarket for whom banking operations represent a peripheral activity, distinct from its core area of business. Accordingly, the firm fits the profile of what we might expect a maverick to look like. In banking products, TSCO is not a large player. Moreover, as a supermarket, TSCO's cost and management structure would clearly differ from the majority of firms in our sample. It is clear from the results of Measure 1 that they chose to offer broadly higher interest rates than most firms, and as a relatively new entrant in the realm of financial services such higher rates would make sense in order to penetrate the market[130]. This could be facilitated by profits made in their core area of business; we may speculate that they could afford to make lower profits in their banking arm because of their success in other areas, and that they may have chosen to do so in order to acquire market share. Moreover, the fact that we find a relatively new entrant as a candidate maverick is consistent with the literature. For example, Tucker and Sayyed (2006) aligned the maverick concept with the idea of new entrants, whilst Motta, Polo and Vasconcelos (2007) stated that mavericks are rarely long-run competitors.

Can we glean any further insight by looking more closely at the behaviour of TSCO, our candidate maverick? Figure 5.1 below plots the Bank of England base rate against the representative rate of TSCO at the low, medium and high deposit levels.

[129] TCHR only appear very early on in the data, exiting the sample in October 2002. It is therefore unsurprising that they score highly by the BM measures. Rates were generally higher at that time and the period during which they appeared in the data coincided with far more policy rate decreases than increases.

[130] Similar practices are commonly employed by new entrants who often operate at a loss in the early stages in order to expand their customer base.

Figure 5.1: The rates of Tesco at the low, medium and high deposit levels



If we examine the rates of TSCO, we note that their high score for Measure 2 is driven by the timing with which they engaged in rate changes. They had few unprovoked changes in either direction – their only unprovoked increase was at the high deposit level in November 2000, whilst they engaged in unprovoked decreases at all deposit levels on two occasions, September 2007 and July 2009. Indeed, their high score in Measure 2 is not down to unprovoked changes but rather a product of the fact that they quickly followed rate increases whilst being slower to follow decreases. Such behaviour is favourable to consumers, however, ultimately, would we regard TSCO as the maverick? Whilst they offered relatively higher rates (Measure 1) and their responses were apparently broadly favourable (in Measure 2), the fact that they only instigated one unprovoked increase in rate is at odds with the theoretical depiction of a maverick. One would expect a true maverick to deviate from the policy rate and introduce additional, favourable rate changes. Furthermore, the fact that TSCO had a greater number of unprovoked decreases than increases counts against its identification as a maverick.

Moreover, recall that theory and guidelines emphasise the constraining effect of the maverick. Can we say that TSCO constrained the behaviour of its rivals? We cannot say for sure, but the answer is probably no. TSCO was a relatively minor player in the market, as evidenced by the fact that each only offered a single account whereas most banks and building societies had numerous products on offer. We can only speculate without market share and volume data, but it is unlikely that this firm had any great influence over other firms in the industry. The ability to constrain rivals is a crucial feature of mavericks in the theoretical literature. Indeed, in Chapter 2 we made it central to our theoretical discussion and in Chapter 3 we noted that it was important in the EC's interpretation of maverick firms. Thus, the probable lack of an ability to constrain is another reason to doubt TSCO's maverick status.

5.4 Discussion

With the initially intuitively pleasing finding of TSCO as a potential maverick, our use of the BM method appears somewhat more successful than in the original paper. However, on the basis of pricing data alone we cannot conclusively and convincingly confirm the identity of the maverick. We would need to consider elements such as market shares and the breadth of products on offer. In addition, we can note several criticisms of the approach - some of which were addressed by the authors in their original paper, whilst others have been mitigated in our replication. Yet, some remain an issue. Moreover, new problems have arisen as a consequence of the fact that our dataset is more complex than that of the original paper. These criticisms go some way to explaining why the BM method may be insufficient as a means of objective empirical maverick identification.

An issue that Breunig and Menezes (2008) acknowledged is the fact that under Measure 2 the responses of firms are right-censored. In other words, the response (or non-response) of firms to central bank changes are impacted by subsequent central bank action. Instances of non-response lasted until the next central bank change or the end of the sample period. Breunig and Menezes addressed this by weighting instances of non-response by the 90th percentile of the distribution of waiting times – something we maintain in our replication. However, our data contains many more central bank changes than Breunig and Menezes' sample. As a result, we also capped the possible time of response at 3 months. Yet, the greater number of central bank changes creates issues in the application of Measure 2. In particular, since policy rate changes often occur in subsequent periods there is ambiguity concerning how we should treat subsequent rate changes on the part of the firm[131]. Moreover, our interpretation of these subsequent changes impacts the interaction term with the timing of rate changes[132].

Another criticism of the original Breunig and Menezes dataset is that their sample period included only *increases* in the policy rate. A consequence of this is that it was impossible to factor in the reactions of firms to *decreases* in the central bank rate. It is of course

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[131] For example, suppose a bank increased its rates in subsequent periods during a time when the policy rate was also increasing in subsequent periods. There are several possible explanations for the bank's actions. Subsequent rate changes could be (i) additional responses to the original policy rate change, (ii) responses to subsequent policy rate changes, or (iii) pre-emptive changes based on expectations about the policy rate. Depending which of these we believed to be true, we could calculate the responsiveness measure differently.

[132] In the example given in the previous footnote, if we believed the second change by the firm was an additional response to the first policy rate change, then it would not count as a reaction to the second change in policy rate.

possible that firms in their market behaved in a consistently maverick way; in other words, those firms that were slow or resistant to follow central bank increases may also have been quick to follow central bank decreases. However, it is arguably more likely that firms that were slow to follow increases *would also be slow to follow decreases*. In other words, the "more maverick" firms in Breunig and Menezes (2008) might simply have been those that were broadly inert, and their apparent maverickness may simply have been driven by the fact that their sample happened to include only increases in the policy rate. Without analysing a dataset that contains both increases and decreases, it would be impossible to say for certain. Thus, our replication, using a sample that includes movements in both directions, is better suited to capture a more rounded picture of maverickness. However, we still have an issue in that the number and magnitude of increases and decreases is not equal in our sample – though this is not something that can be corrected without reducing the sample length.

A criticism which applies to both the original study and to our replication is that in narrowing the product scope we are unfortunately omitting much data. In the previous chapter we outlined our reasons for limiting analysis to instant access/annual interest accounts. However, a consequence of this is that we cannot hope to draw conclusions in terms of the identity of the overall "maverick bank" during the time period, but rather the maverick in the specific "market for instant access accounts that pay interest annually". This is not necessarily a problem. In practice, maverick identification would occur as part of the analysis of a proposed merger and authorities would first define the relevant market of concern. Thus, provided that the market was accurately defined, the methods could still be valid for identifying the maverick *in that market*[133].

A related issue with Breunig and Menezes' (2008) original paper is that by limiting their analysis to "ordinary variable rate" mortgages they omitted several mortgage providers altogether. Moreover, they omitted many of the smaller firms. Given that theory typically portrays mavericks as smaller parties, the maverick in Breunig and Menezes' market may have been absent from their analysis altogether. However, as we have explained, the actual narrowing of the product scope itself is not an issue per se.

Nonetheless, Appendices M and N give the results of applying the two BM measures to our entire dataset – i.e. data on all types of accounts, rather than just those that were

[133] When a competition authority analyses the acceptability of a merger, one of the first actions it takes is to define the relevant market in terms of product and geographical scope. This is done in order to establish the parameters of the market that the merger is perceived to impact, and plays an important role in the ultimate decision regarding whether a merger is acceptable or not (Motta, 2004). Since markets are routinely defined in merger cases our decision to narrow the market is not a problem in itself. The key point to note is that it is particularly important to define the market properly if an authority wishes to claim a given firm is acting as a maverick, since they could only ever conclusively establish a maverick in the specific market that was defined.

instant access with annual interest. This acts as a robustness check and a test of concerns about limiting analysis to a subset of our data. In terms of Measure 1, what we find is that all of the top banks from Table 5.1 slip significantly in the rankings when the whole dataset is taken into account. PO, the top ranked bank by the relative rate measure, slips to 19th when the full sample is used. TSCO is 43rd. In terms of Measure 2, some of the top banks from Table 5.2 retain this position in Appendix M. NWDE, the top ranked bank, only slips to 3rd and TSCO, which was 3rd in Table 5.2, only slips to 7th. However, IPS (the second placed bank in Table 5.2) falls all the way to 75th when the full dataset is used[134]. Overall, we observe that firms that offered favourable terms on instant access accounts were not necessarily those that offered favourable terms on all accounts. The fact that many firms' rankings change significantly when the full sample is used highlights the importance of product market definition. The products one chooses to include and exclude have a bearing on which bank(s) appear more or less maverick. This emphasises the need for authorities to carefully consider market definition before embarking on attempts at maverick identification.

One of the biggest issues with Breunig and Menezes' (2008) attempt is that the time period under consideration was arbitrary. The study looked at a period spanning January 2003 to October 2006 and sought to establish the maverick in the entirety of this period. This is also true in our replication (for the period January 2000 to December 2009). However, contrary to this, existing maverick theory suggests that the identity of the maverick changes over time; different firms may fulfil the role at different points. Therefore, attempting to identify a maverick within an arbitrary time period is likely misguided. Identification would be unsuccessful unless the parameters of the data happened to coincide with the duration of one maverick. Moreover, concerns over the arbitrary time period are increased by the fact that we found TSCO, a new entrant, to be a strong candidate maverick. New entrants may operate at a loss initially in order to expand their customer base, however in the long-run they would likely increase their prices. Thus, if we are to accept the coupling of the maverick concept with that of a new entrant we must take the view that mavericks only remain so in the short-term (Motta, Polo and Vasconcelos, 2007). If maverick status changes regularly it makes them more difficult to identify and the chosen time period is crucial.

We can go some way to addressing this issue by breaking down the time period into shorter blocks. If the market under consideration had some natural breaks, or we had

[134] To an extent, these results allow us to distinguish those banks that offered favourable rates across all their accounts from those that only behaved favourably when it came to their instant access accounts. However, it should be noted that some firms only offered instant access accounts.

some theoretical basis for believing that the identity of the maverick might change following a particular event, then we could divide the data accordingly. One possibility is consolidation in the market; we may theorise that the identity of the maverick would change after each merger. However, this would not be strictly consistent with theory. As we discussed in Chapter 3, mergers are only believed to change maverick status where a maverick is an insider to a merger. An outsider maverick is typically assumed to continue to fulfil the role (Baker, 2002; Baker and Shapiro, 2007).

Thus, in the absence of some natural break the best we can do is to subdivide our ten year period into smaller (albeit still arbitrary) time periods. The obvious subdivision is by individual calendar years. Note that there may be merit to doing so with Measure 1 (the relative rate measure) but there is less value to doing so with Measure 2 (the responsiveness measure). When we divide the time period the number of changes in the policy rate in each period becomes much smaller and so the responses of firms to these changes become more extreme; whereas Measure 2 gave us an indication of overall behaviour when applied to the whole period, applying it to short periods would give a much skewed depiction of bank behaviour. Therefore, Appendices O, P and Q present the results of applying BM Measure 1 to individual years in our sample at the respective low, medium and high deposit levels. Tables 5.3-5.5 below present the top-scoring firm in each calendar year for each deposit level.

Table 5.3: BM Measure 1 by year, low deposit level

Year	Bank	Measure 1	2000-2009 Rank
2000	EGG	2.81	14
2001	EGG	2.18	14
2002	NEWB	1.83	4
2003	CITI	2.62	20
2004	ABBE	1.79	16
2005	COV	1.79	12
2006	PO	2.61	1
2007	PO	2.62	1
2008	PO	2.74	1
2009	CITI	2.15	20

Table 5.4: BM Measure 1 by year, medium deposit level

Year	Bank	Measure 1	2000-2009 Rank
2000	EGG	2.25	22
2001	TSCO	1.76	4
2002	LAMB	1.65	16
2003	TSCO	1.27	4
2004	BOS	1.79	11
2005	BOS	1.71	11
2006	PO	2.27	1
2007	PO	2.29	1
2008	PO	2.38	1
2009	CITI	2.05	39

Table 5.5: BM Measure 1 by year, high deposit level

Year	Bank	Measure 1	2000-2009 Rank
2000	TSCO	1.83	2
2001	TSCO	1.89	2
2002	TSCO	1.62	2
2003	TSCO	1.58	2
2004	TSCO	1.59	2
2005	TSCO	1.52	2
2006	PO	1.82	1
2007	PO	1.86	1
2008	PO	1.99	1
2009	CITI	1.94	19

These tables emphasise the problem with analysing an arbitrary time period. We can see apparent periods in which a particular firm offered the best rates, with instances of the same firm scoring highest in subsequent years. For example, during 2006-2008 PO clearly offered the highest rates across all three deposit levels, and we can see a clear period (2000-2005) when TSCO offered the most favourable rates for high deposit customers. These patterns were not picked up when we analysed the ten year period as a whole. Thus, we can see why the choice of time period may have a significant impact on maverick identification[135].

Returning to criticisms of the BM method, and with regard to Measure 2 specifically, an additional comment is that whilst the responsiveness measure captures

[135] Moreover, these tables also validate our decision to separate analysis into different deposit levels, since different firms clearly offered the best rates to low, medium and high deposit customers.

increases/decreases in rates it does not take into account the magnitude of those changes. Magnitude is likely to be important. By Measure 2 in its present state a firm that made a series of small increases would be perceived as more maverick than a firm that made a single large increase of a greater amount. Whether they truly are more maverick may or may not be true – the answer relates to the debate over whether the level or timing of rates is most important for qualifying maverick behaviour[136]. However, regardless, it would be desirable to incorporate magnitude into our approach. This is something we strive to achieve in the upcoming chapters.

Finally, one last criticism is that we can question the simplicity of the BM measures. Whilst the relative rate measure is understandable given the broad intuition that a higher (lower) rate of interest is better for deposit (mortgage) customers, financial products are more complicated than this. In Chapter 4 we mentioned that there are an array of perks, penalties, terms and conditions that differ across products in our sample. Likewise, in the case of mortgages as in Breunig and Menezes (2008), these are not straightforward. Mortgages are bespoke in the sense that they differ in length, duration of fixed term, etc. and their rates depend on aspects such as creditworthiness and the amount of deposit a homebuyer has. Thus the relative rate measure, in particular, may be an overly simplistic method of capturing the prices of banks. In the context of deposit accounts, it is possible that rather than offering higher rates a maverick might offer better perks or more lenient penalties on its accounts[137]. If this were true then maverick behaviour would manifest itself in a way other than offering a favourable rate of interest. Thus, we can question whether other, less easily quantifiable factors in fact shape maverickness. We debate this point further in the conclusion to this chapter.

5.5 Conclusion

With the exception of TSCO, the firms implicated as maverick under one measure of the BM method differed from those implicated as maverick under the other. This largely parallels the results of Breunig and Menezes (2008). Moreover, as in the original paper, when we look more closely at the data we find reason to doubt the maverick status of TSCO. In particular, the firm made more unprovoked rate decreases than increases, with only one unprovoked increase in the entire ten-year period. Moreover, as we have discussed, it is difficult to reconcile the two measures or to establish which of these is

[136] In other words, whether greater emphasis should be placed on the relative rate measure or the responsiveness measure when identifying candidate mavericks.

[137] In the case of mortgages, we could speculate that a maverick might offer to supply mortgages to consumers with lower initial deposit amounts, for example.

the most appropriate in the context of our market. We further identified several criticisms of the method, some of which we attempted to address in the previous section. However, none of these amendments wholly solve the issues. In fact, in addition to problems stemming from the original paper, further problems arose due to the complexity of our dataset. For these reasons it is desirable to explore alternative methods of maverick identification.

A point of debate is whether price is the most appropriate dimension to assess maverick behaviour. Maverick behaviour could theoretically manifest itself in one of several different ways. In general, a maverick could offer a lower (or “more favourable”) price than its rivals, which in the context of savings accounts translates to offering higher rates of interest. However, alternatively, they could offer a product of superior quality. Moreover, in some contexts a maverick might innovate more than its rivals. In Breunig and Menezes (2008), and thus in our replication, the underlying assumption is that price is the dimension through which a firm would be maverick in the context of a banking product. This is based on the premise that when depositing one’s savings the rate of interest one receives is the key consideration[138]. However, in the preceding section we questioned whether qualitative dimensions such as the perks and penalties attached to accounts might provide a better indicator of true maverickness.

A key point to consider is that “quality” is not easily quantifiable and often subjective. This is an issue given that our aim is to develop an impartial and *objective* method of maverick identification. In the context of our market, there may be scope to catalogue the perks and penalties associated with different accounts in order to produce some proxy of quality. However, in other markets this may be much more difficult[139]. Given that we ultimately wish to generalise our methods so they could be used in any market, incorporating non-price characteristics could pose significant problems. Whilst it is true that in some industries pricing data may be less transparent than in banking, in general prices are more easily obtainable than measures of quality. Moreover, the non-price characteristics we mentioned earlier are specific to the particular market. Since non-price factors are often industry-specific it makes it difficult to devise a method of maverick identification based on them that could be applied to any market.

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[138] An issue that should be acknowledged is that of switching. In our discussions about how maverick behaviour manifests itself, we implicitly assume that banks are competing and that customers will choose the ‘best’ account for them; we hypothesise that price is the most important characteristic. However, studies have found that some subsets of consumers may be relatively inert when it comes to switching bank accounts (Kiser, 2002; Dick, 2008). Hence, competition may not be as intense as we are supposing, and price may not be as important as it initially seems. This should be acknowledged since it potentially limits the extent to which a ‘maverick’ bank could benefit from offering favourable rates.

[139] Similarly, innovativeness can be a difficult thing to quantify (see for example Swann, 2009).

In terms of our market, if we were to develop methods that draw upon the qualitative aspects of bank accounts we would introduce subjectivity into our analysis. How do we determine whether "Perk A" is more favourable than "Perk B", or to establish the effect of a building society being part of a particular branch network? It is important that we maintain objectivity since we wish to develop a means of identification that does not hold any preconceptions about the maverick's identity. Yet, if we were to rank perks and judge other qualitative aspects of products, we would be introducing preconceptions. Therefore, for these reasons, in the forthcoming attempts at identification we will continue to focus on prices as an indicator of maverickness, as opposed to non-price alternatives[140].

To conclude on the appropriateness of this method, the approach has several deficiencies when it comes to testing for mavericks as such firms are described in the theoretical literature. The BM approach has some value in identifying certain crude pricing behaviours, but as a method of maverick identification this is of limited value. In order for the BM approach to provide a suitable empirical test of maverickness, one would have to be certain about the nature of a maverick's behaviour in a given market, and this behaviour would have to be relatively one-dimensional and manifest itself solely through pricing. Unfortunately, the literature and our observations from earlier chapters imply that this is not the case; maverick behaviour is regarded as more complex. Therefore, the method is unsuccessful in testing the theory. Nonetheless, the replication proved a useful exercise since it draws attention to the ways in which subsequent attempts at identification can be improved.

In the next two chapters we propose and test alternative methods of maverick identification. In exploring other methods, an issue to overcome is the fact that the BM method involves two distinct measures which capture different aspects of behaviour. The relative rate measure considered the levels of interest rates whilst the responsiveness measure captured the timing of rate changes. On the contrary, it would be preferable to have a single measure incorporating both of these dimensions. This is something we will strive for in our subsequent attempts at identification.

[140] Moreover, in Chapter 3 we noted that in past cases the EC has stated that it requires evidence that a particular firm priced lower than its rivals when conclusively establishing a maverick. This reinforces our view that it is appropriate to focus on price.

Chapter 6: An Error Correction Approach

6.1 Introduction

Applying the BM method to our data was a natural starting point in exploring empirical strategies for maverick identification. Conducting the replication had certain benefits. It allowed us to gain an appreciation for the sentiments behind the only previous attempt, and to discover which banks offered the highest rates for instant access/annual interest deposit accounts, and which adjusted their rates most favourably according to the BM metric. These were the firms that appeared in Tables 5.1 and 5.2, respectively. However, as we outlined in the preceding chapter our results were subject to many of the same issues as Breunig and Menezes (2008). Most pertinently, the two BM measures largely implicated different firms as candidate mavericks. We also experienced additional issues due to the fact that our dataset was less straightforward than that of the original paper, given the greater number of policy rate changes and multiple accounts per bank. Moreover, the BM measures arguably over-simplify a mechanism (bank pricing) which is fundamentally complex. Thus we strive to explore alternative methods.

In considering other approaches, it is appropriate to contemplate the following. When we state that we wish to identify a maverick, what exactly are we trying to achieve? To reiterate, mavericks are often characterised as acting unlike the norm and, specifically, behaving more favourably from a consumer point of view. Thus, we are trying to detect firms that exhibit favourable behaviour in comparison to their rivals. What would be considered "favourable"? In general terms, charging a lower price or offering a superior product would be regarded as favourable to consumers. Thus, price and quality are the two main dimensions we could consider[141]. Breunig and Menezes (2008) opted for the former in the case of a financial product, an assumption we discussed and agreed with in the final section of the preceding chapter. However, favourable behaviour is a relative construct. In order to compare the behaviours of rival firms we must either compare firms' prices against the average or use some common factor(s) or cost(s) as a yardstick. Breunig and Menezes' responsiveness measure treated the policy rate as such a yardstick. However, is the policy rate the most appropriate choice in our market or should we use some other variable?

Given our market of interest (UK bank and building society accounts) it is appropriate to consider the existing literature on banking in order to answer this question. Banking has

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[141] We have also referred to greater innovativeness as a third possibility.

been the subject of countless empirical studies on a wide array of topics. These include the analysis of the relationship between market structure and competition (Bikker and Groeneveld, 1998; Bikker and Haaf, 2002), studies of efficiency (Aly et al, 1990; Berg and Kim, 1994; Sathye, 2001), ownership structure and performance (Iannotta, Nocera and Sironi, 2007), and the effect of horizontal mergers on interest rates (Prager and Hannan, 1998), in addition to broader studies of pricing behaviour (Hannan and Berger, 1991; Gambacorta, 2008). Our primary interest in reading this literature is to discover what factors affect bank pricing, and in particular which of those factors are firm-specific and which are common, since the latter provide possible yardsticks against which to compare bank behaviour.

For firm-specific factors, studies typically used balance sheet information. For example, Bikker and Haaf (2002) used ratios such as the ratio of annual interest expenses to total funds (as a proxy for the unit price of funds) and the ratio of personnel expenses to the total balance sheet (a proxy for the unit price of labour) to approximate marginal costs. Similarly, Iannotta, Nocera and Sironi (2007) used balance sheet items, such as the log of total assets and the ratio of retail deposits to total funding, as controls, and both papers also used total assets as a scaling factor. We could therefore use similar proxies to explain what drives differences in interest rates across banks – but this is not our goal. Rather, our interest lies in identifying *contrasting responses to common factors*.

In terms of common factors, Gambacorta (2008) suggested real GDP, inflation, and the policy rate as possibilities. The way each of these should affect banks' rates is as follows. First, commercial banks' deposit rates should depend negatively on real GDP. Higher output is synonymous with higher income, which naturally leads to higher savings, ceteris paribus. This therefore reduces the incentive for banks to offer a high rate of interest to savings customers since as incomes rise the level of deposits is higher anyway; banks need not offer a high rate to attract deposits[142]. Second, banks' rates should also relate negatively to the price level. One explanation for this is that as prices rise, so too do bank costs. The greater the level of inflation, the higher the number of transactions, and so banks incur additional labour and administrative costs (Hanson and Rocha, 1986; Demirgüç-Kunt and Huizinga, 1999). Finally, with regard to the policy rate, Gambacorta (2008) argued that the link between savings rates and money market rates (proxies for the monetary policy rate) should be positive. As the money market rate increases, risk-free securities become more attractive, thus reducing demand for savings

[142] Relatedly, studies have found that bank profitability is pro-cyclical (Athanasoglou, Brissimis and Delis, 2008; Albertazzi and Gambacorta, 2009). During downturns there is increased risk and so lending tends to decrease – banks hold more reserves and offer higher rates on deposits.

accounts. Subsequently, one would expect banks to increase their rates to offset any reduction in deposits. The link between the policy rate and banks' rates is also supported by the interest rate channel of monetary policy, which we outlined in Chapter 4.

Of these common factors we are particularly interested in the policy rate, not least because of its prominent role in Breunig and Menezes (2008), but also because there is a vast literature examining the relationship between policy rates and individual banks' rates – known as the interest rate pass-through (IRPT) literature. Such papers have analysed the dynamics of retail and/or corporate interest rates with respect to changes in policy rates. Some of the most prominent include Heffernan (1993, 1997, 2002), Hofmann and Mizen (2004), De Graeve et al (2007) and Fuertes and Heffernan (2009)[143]. The common aim of these papers was to assess the effectiveness of the interest rate channel of monetary policy: to what extent do the actions of monetary policymakers influence bank behaviour?

In order for monetary policy to be effective, changes in policy rates should be passed-through to commercial rates on a one-for-one basis. We can refer to this as the "completeness hypothesis" (De Graeve et al, 2007). Policymakers adjust the policy rate by an amount they believe will ultimately produce the desired change in Aggregate Demand (AD). For this to be successful financial institutions must pass on any changes to customers in full. Incomplete pass-through would weaken the influence of policy since AD would not be affected to the extent that policymakers intended. Moreover, rates should be passed-through relatively quickly (ideally immediately). If banks were slow or resistant to follow changes, or if there was heterogeneity in the speed and extent of banks' responses, then the effectiveness of monetary policy would be compromised. Thus, the proliferation of IRPT studies was borne out of the desire to examine the extent to which complete and timely pass-through was achieved, typically by assessing pass-through at the aggregate level[144].

We can immediately observe complementarities between the IRPT literature and the work of Breunig and Menezes (2008). The BM method suggests that maverick behaviour can be identified in financial institutions via contrasting reactions to policy rate changes, whilst the IRPT literature examines the nature of the relationship between banks' rates and policy rates. Thus, on this basis, we are given an indication that the methods

[143] With the exception of De Graeve et al, the named studies are focused on the UK and are therefore highly relevant to our context. We refer to some studies of other countries below, but we intentionally focus on the UK.

[144] By implication, policymakers must have faith in the completeness hypothesis, otherwise reviewing the policy rate with such regularity (e.g. once a month by the Bank of England Monetary Policy Committee) would be of questionable value.

prominent in the IRPT literature may inform and guide our approach to maverick identification.

This chapter proceeds as follows. Section 6.2 reviews the IRPT literature. Ultimately, we develop and test an empirical strategy that is based on the methods commonly used in the literature: cointegration and error correction. These methods underlie our subsequent approach to maverick identification and so Section 6.2 first introduces the well-established notion of cointegration. Section 6.3 describes the methodology, outlining our assumptions and formally depicting the error correction models we employ. We effectively capture the adjustment of each bank's rates to the policy rate and the other common factors identified above, with a view to identifying rate-setting behaviour that appears to be unlike the norm. Section 6.4 presents the results of applying the method to the same dataset used in the preceding chapter. Section 6.5 provides a discussion of the findings, including a comparison of the results with those of Chapter 5, and outlines problems with the approach. Section 6.6 then concludes and motivates the next chapter.

6.2 Cointegration, Error Correction and Interest Rate Pass-Through

In analysing the relationship between policy rates and bank rates, IRPT papers typically exploit the fact that the policy rate and bank rates are cointegrated in order to fit error correction models (ECMs). Before we proceed to review the IRPT literature it is therefore helpful to define cointegration and to explain what is meant by an ECM.

Conventional econometric techniques require weak stationarity in order to be valid. This is where neither the expected value, variance, nor covariance of successive values of a variable depend on time. By contrast, nonstationarity is where time affects the probability distribution of a variable, which poses problems for conventional analysis. We can categorise variables in terms of their order of integration. Stationary variables are known as integrated of order zero, or I(0). By contrast, many time series trend upward over time, making them nonstationary. However, we often find that the differenced series of such variables is in fact stationary; in other words, first-differencing may produce a stationary series. Such variables are known as integrated of order one, or I(1)[145]. In the presence of nonstationarity test statistics may converge to non-standard distributions, parameter estimates can be biased, and spurious relationships are likely (Granger, 1981). Whilst ordinary least squares regression analysis of I(0) variables can produce

[145] A variable's order of integration can be ascertained using unit root tests. We will elaborate on these in due course.

meaningful results, the inclusion of the levels of I(1) series would produce spurious regressions (Wooldridge, 2012).

Whilst this is true, regressions using I(1) variables can yield meaningful results thanks to the notion of cointegration. If two or more series are I(1) but a linear combination of them is stationary I(0) then the variables are said to be cointegrated[146]. In simple terms, this means that the series move together in the long-run; there is a tendency for them to gravitate towards one another over time. To illustrate this more formally, consider the following long-run specification:

$$X_{1t} = \alpha + \beta X_{2t} + \varepsilon_t \qquad (6.1)$$

Where X_1 and X_2 are two I(1) variables that are believed to be related, α is a constant and ε is an error term. Subscript t denotes the time period. Equation (6.1) depicts a linear long run relationship between X_1 and X_2[147]. If some nonzero parameter β exists such that the error term in Equation (6.1) is I(0), then we would describe X_1 and X_2 as cointegrated. The presence of a cointegrating relationship between series facilitates the use of cointegration techniques to estimate their relationship (Engle and Granger, 1987; Johansen, 1988). In particular, if variables are cointegrated, the Granger representation theorem states that their relationship can be expressed as an ECM (Koop, 2008). We can re-write (6.1) as:

$$\varepsilon_t = X_{1t} - \alpha - \beta X_{2t} \qquad (6.2)$$

ε effectively denotes the deviation in each period from the long-run relationship between X_1 and X_2. If there are deviations then ECMs can be used to study how quickly the variables adjust to the long-run equilibrium. The ECM(s) in this case are given by:

$$\Delta X_{1t} = \beta_1 \sum \Delta X_{1t-k} + \beta_2 \sum \Delta X_{2t-k} + \beta_3 \varepsilon_{t-1} + \gamma_{1t} \qquad (6.3)$$

$$\Delta X_{2t} = \beta_4 \sum \Delta X_{1t-k} + \beta_5 \sum \Delta X_{2t-k} + \beta_6 \varepsilon_{t-1} + \gamma_{2t} \qquad (6.4)$$

Showing, respectively, how X_1 adjusts to X_2 and X_2 adjusts to X_1. The γ_t term in each equation is an error term.

In the IRPT literature, policy rates and bank rates were found to be cointegrated and so ECMs were employed to study the dynamics of their relationship. Typically, IRPT papers

[146] More broadly, if two or more series are I(d) but a linear combination of the series is I(d-b), where b>0, then they are said to be cointegrated (Harris, 1995). An I(0) series cannot be cointegrated with an I(1) series since the former would have a constant mean whilst the latter would change over time; they cannot possibly follow a similar trend. Thus variables need to be integrated of the same order in order to be cointegrated.

[147] X_1 and X_2 could be, for example, the prices of two similar goods. Koop (2008) gives the example of oranges and organic oranges. Consumers may be willing to pay a different price for the organic variant, such that the prices of the two goods differ, but their prices should broadly follow a similar pattern.

estimate ECMs with the objective of analysing "long-run pass-through" and "short-run speed of adjustment". The former refers to the extent to which changes in the policy rate (or a proxy for this such as LIBOR) filter through to the rates that banks offer. The latter refers to the speed with which the gap between a product's rate and a (typically linear) function of the policy rate closes from period to period (the error correction term, ECT). In the example of cointegration given above, the coefficients β_3 and β_6 in Equations (6.3) and (6.4) capture the extent to which deviations from the long-run relationship in period t-1 are error-corrected in period t. In other words, they represent the respective ECTs of the two models.

Take Heffernan (1997) as an example of how error correction was applied to the topic of IRPT. Heffernan studied the dynamics of British retail deposit and loan rates over the period 1986-1993. The aims of the paper were typical of IRPT papers; under the umbrella of testing the effectiveness of monetary policy she sought to provide an insight into the speed of adjustment of retail rates to policy rate changes. Accordingly she posited that the long-run relationship between a given product's interest rate and the Bank of England base rate could be described by the expression:

$$INT_j = A_j + C_j(BASE) \qquad (6.5)$$

This is the posited long-run equilibrium relationship. The values A_j and C_j were estimated from the equation:

$$DINT_{jt} = \alpha_j + \beta_j INT_{j\text{-}k} + \delta_j BASE_{-k} + \varepsilon_{jk} DBASE_{-k} + \mu_{jt} \qquad (6.6)$$

Where INT denoted the retail rate and BASE denoted the central bank base rate. Subscript j denoted the product (deposit or loan), t is time and k is the lag length in months. $DINT_{jt}$ is equal to $INT_{jt} – INT_{j(t-k)}$, i.e. the change in interest rate offered on product j from time t-k to time t. $BASE_{-k}$ is a lag of the central bank base rate. Finally, $DBASE_{-k}$ is equal to $BASE_{-k} – BASE_{(k+l)}$, i.e. the change in the central bank rate. Equation (6.6) is the ECM in this case. Since in the long-run steady state $DINT_{jt} = DBASE_{-k} = 0$, Equation (6.6) can be rearranged as $-\beta_j INT_{j\text{-}k} = \alpha_j + \delta_j BASE_{-k}$. Parameters A_j and C_j are then given by $A_j = -\alpha_j / \beta_j$ and $C_j = -\delta_j / \beta_j$.

In terms of interpretation, A_j is essentially the "markup" – the amount by which product j was priced above (or below, if negative) the central bank rate in the long-run. C_j is long-run pass-through – the degree to which central bank rates influenced the price level of product j. The other point of interest, short-run speed of adjustment, is captured by β_j. This parameter is the ECT in this setup, capturing how much the difference between the rate of product j and the base rate was "error corrected" from period to period. A negative value on the ECT indicates that the rate of the given product converged to the long-run relationship with the base rate (Equation (6.5)) over time.

The work of Heffernan (1997), an early IRPT paper, is broadly indicative of the literature as a whole. Subsequent studies differed with regard to the banking products and regions they considered and whether they assumed a linear or nonlinear relationship between the rates. With regard to the latter, of those papers mentioned earlier, the many studies involving Heffernan adopted linear models, whereas Hofmann and Mizen (2004) argued that a nonlinear specification more accurately captured bank behaviour. Hofmann and Mizen was by no means the only study that adopted a nonlinear or asymmetric approach (see for example Sander and Kleimeier, 2004, or Payne and Waters, 2008, amongst others).

Within the literature, methods and their application evolved over time to become more sophisticated. For example, Fuertes and Heffernan (2009) adopted the Akaike Information Criterion in lag selection whereas the earlier Heffernan papers used arbitrary lag lengths. Later papers also shifted focus from studying pass-through on an overall level to considering the differences in adjustment speeds of different banking products. Moreover, IRPT was tested in a wide range of countries and regions, such as Belgium (De Graeve et al, 2007), Eastern Europe (Égert, Crespo-Cuaresma and Reininger, 2007) and New Zealand (Liu, Margaritis and Tourani-Rad, 2008), amongst many others. Studies also made comparisons, such as between countries within the euro area (Sørensen and Werner, 2006) or comparing the euro area with the US (Kwapil and Scharler, 2010; Karagiannis, Panagopoulos and Vlamis, 2010).

In terms of results, the majority of studies found pass-through to be broadly incomplete, raising questions about the effectiveness of monetary policy. One exception was Hofmann and Mizen (2004) who found complete pass-through in the case of deposit accounts[148]. However, the completeness or incompleteness of pass-through is not of direct interest for the purposes of this thesis. What is of interest are IRPT studies that considered heterogeneities (in other words, differences in rates of pass-through across different products or firms). Crucially, such studies found rates of adjustment to vary (De Graeve et al, 2007; Fuertes and Heffernan, 2009). The implication of this is that were we to apply IRPT methods to the individual banks in our sample we would likely find contrasting rates of adjustment for each bank. This has implications when it comes to maverick identification. In the introduction to this chapter we identified a number of

[148] Given that Hofmann and Mizen adopted a nonlinear specification, this suggests that the relationship between policy rates and bank rates is more complex than many IRPT studies assume. The prospect of nonlinearity or asymmetry is a subject we take up in Chapter 7.

common factors that should affect banks in the same way: real GDP, the level of prices, and the policy rate. However, IRPT studies such as De Graeve et al (2007) and Fuertes and Heffernan (2009) found heterogeneities in adjustment rates to the latter. This leads us to believe that by applying ECMs to each individual bank we will be able to distinguish between the responses of banks to the common factors. If we can do so, then we may be able to identify potentially maverick behaviour.

We are hopeful that individual-firm ECMs can provide a way of establishing firms that adjust differently to common factors, but a key question remains: what rates of adjustment would be considered more or less maverick? A simple answer is that we would expect to see banks' rates converge toward a long-run equilibrium with the common factors; at least, this is what we would expect to see from "normal" banks, given our understanding of the relationship between banks' rates, GDP, prices and the policy rate. In the ECM context a negative ECT implies convergence. Thus, we can argue that positive ECTs would constitute indicators of abnormal and potentially maverick behaviour[149].

6.3 Methodology

Here we outline an empirical strategy for maverick identification that builds on the premise and methodologies employed in the IRPT literature. IRPT studies have found bank rates to be cointegrated with policy rates. In addition, we have reason to believe that the level of prices and real GDP will also share long-run relationships with banks' rates (Gambacorta, 2008). Policy rates, prices and GDP are "common" to all banks. Since we expect a long-run relationship between each bank's rates and these common factors, our approach is as follows. We will fit an error correction model (ECM) consisting of these four variables for each individual bank in our sample. We will then interpret the respective ECTs as indicators of relative maverickness. We expect each bank's rates to converge to a long-run equilibrium relationship with the common factors. Therefore, formally, we posit the following long-run relationship:

$$Rate_t = \alpha_1 Base_t + \alpha_2 Prices_t + \alpha_3 Output_t + \varepsilon_t \qquad (6.7)$$

Where Rate is the interest rate a bank offered, Base is the monetary policy rate (the Bank of England base rate), Prices represents the price level, Output is real GDP

[149] Note that a similar interpretation was adopted by Nair and Filer (2002), for example. Nair and Filer utilised cointegration analysis to compare the behaviour of firms within strategic groups. In that study, the authors postulated a long-run relationship between the prices of firms and the prices of their rivals. They used error correction techniques to model the relationship, and interpreted the ECT as indicative of convergence toward, or divergence away from, the mean price in a given strategic group. Our suggested interpretation of the ECT is therefore consistent with past work.

(seasonally adjusted) and ε is an error term. All variables are in logs. Subject to Rate, Base, Prices and Output passing the necessary unit root tests, if there exist constants α_1 α_2 and α_3 ("cointegrating parameters") such that ε_t is I(0) then we are able to state that the variables are cointegrated. It is then appropriate for us to fit ECMs to the data. Our ECMs will take the form:

$$\Delta Rate_t = \beta_1 \sum \Delta Rate_{t-k} + \beta_2 \sum \Delta Base_{t-k} + \beta_3 \sum \Delta Prices_{t-k} + \beta_4 \sum \Delta Output_{t-k} + \rho(Rate_{t-1} - \alpha_1 Base_{t-1} - \alpha_2 Prices_{t-1} - \alpha_3 Output_{t-1}) + \gamma_t \qquad (6.8)$$

Where k denotes lag length. The coefficient of primary interest is ρ, the ECT. This captures the speed with which a bank adjusts towards the long-run cointegrating equilibrium (Equation (6.7)) when in disequilibrium. Given our expectations regarding a long-run relationship between the variables, we expect to see convergence toward the equilibrium. Convergence, as indicated by a negative value on the ECT, would be considered "normal" since bank rates are believed to respond to changes in the other three variables. Divergence, as indicated by a positive value for a bank's ECT, would be considered abnormal – and potentially maverick. Larger positive values would be considered more abnormal and therefore more likely maverick.

Recall that our dataset contains the interest rates that each bank offered on all of their accounts at nine different deposit levels (where applicable). In the previous chapter, we applied the BM method to three different deposit levels representing low, medium and high deposit customers. This was because not all banks offered rates at all deposit levels and averaging would have therefore biased BM Measure 1 (the "relative rate measure"), which considered the *levels* of rates. However, this is not an issue here. In applying error correction techniques, our focus is on the *adjustment* of rates rather than actual levels (though levels are incorporated via the extent of adjustment toward equilibrium). Moreover, for clarity, it is cleaner to have a single coefficient per bank. Consequently, in this chapter we conduct our analysis on a single "representative rate" for each bank. This rate is computed by averaging across the nine deposit levels for each account, and then averaging across accounts for each bank. In taking this approach we are left with a single value for each bank in each month, representing the average rate they offered on their instant access/annual interest accounts in that particular time period.

In order for cointegration analysis to be appropriate we must first establish that all variables are I(1). The results of unit root tests on the central bank rate, prices and output are given in Table 6.1 below. All of these variables are I(1) according to both the augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests. Lag lengths for these tests were determined using Stata's in-built lag selection function, which runs a series of unrestricted VARs with different lag lengths and reports the various information criteria for each. We imposed a maximum lag of 12 on our monthly data. The information criteria (SBIC, HQIC, AIC) were typically consistent in their lag choice. Where there was some discrepancy, ADF and PP tests were conducted using all suggested lag lengths. These are shown in the table but the choice of lag did not affect the result of the test. MacKinnon P values are given in parentheses under each test statistic.

Table 6.1: Unit root tests for the base rate, prices and output

Unit Root Tests				
	ADF		PP	
Log base rate*	2 lags$^{\varphi \psi}$	10 lags$^{\xi}$	2 lags$^{\varphi \psi}$	10 lags$^{\xi}$
Level	-0.781	-2.349	0.916	0.279
	(0.8246)	(0.1567)	(0.9933)	(0.9764)
	1 lag$^{\varphi \psi}$	5 lags$^{\xi}$	1 lag$^{\varphi \psi}$	5 lags$^{\xi}$
First difference	-4.193	-3.928	-5.074	-5.323
	(0.0007)	(0.0018)	(0.0000)	(0.0000)
Log prices**	1 lag$^{\varphi}$	2 lags$^{\psi \xi}$	1 lag$^{\varphi}$	2 lags$^{\psi \xi}$
Level	-1.213	-1.172	-1.123	-1.149
	(0.9077)	(0.9162)	(0.9251)	(0.9205)
	1 lag$^{\varphi \psi \xi}$		1 lag$^{\varphi \psi \xi}$	
First difference	-6.972		-9.541	
	(0.0000)		(0.0000)	
Log real output**	5 lags$^{\varphi}$	7 lags$^{\psi \xi}$	5 lags$^{\varphi}$	7 lags$^{\psi \xi}$
Level	0.325	-0.955	0.971	0.779
	(0.9964)	(0.9499)	(1.0000)	(1.0000)
	3 lags$^{\varphi}$	6 lags$^{\psi \xi}$	3 lags$^{\varphi}$	6 lags$^{\psi \xi}$
First difference	-3.769	-2.617	-11.72	-11.802
	(0.0182)	(0.2720)	(0.0000)	(0.0000)

* intercept only

** intercept and trend

ξ AIC

φ SBIC

ψ HQIC

It was appropriate to conduct cointegration analysis for 88 of the 112 banks and building societies that offered an instant access/annual interest account during the period. The other 24 providers either had gaps in their data and/or a sample that was too short for time series analysis. The reasons for omitting these firms are detailed in Table 6.2. For the remaining 88 firms, ADF and PP tests were conducted on each individual bank's series. As with the explanatory variables, these were also found to be I(1).

Table 6.2: Firms omitted from time series analysis

Bank	Obs	Notes
AALG	3	Exited after 2000m3
AIRD	13	Exited after 2001m1
BAW	69	Exited after 2005m9
BEV	26	Entered 2007m11
BMID	69	Exited after 2005m9
CATH	31	Gap
CLAY	45	Exited after 2003m9
COUT	81	Gap
DAOH	9	Entry and exit
EGG	67	Exited after 2005m7
HFC	12	Exited after 2000m12
MLB	2	Entered 2009m11
NATC	1	One observation: 2009m12
NOTI	1	One observation: 2000m1
OTB	8	Entry and exit
PO	45	Entered 2006m4
POP	6	Entry and exit
SBI	5	Entered 2009m8
STAF	48	Exited after 2003m12
SUN	33	Exited after 2002m9
TCHR	34	Exited after 2002m10
TRIO	2	Exited after 2000m2
TURK	5	Entered 2009m8
WLB	18	Entered 2008m7

Next, the Johansen test was used to test for the presence of a cointegrating relationship between each individual bank's rate, the base rate, prices and output. Lag lengths for the tests were determined as above, by comparing the AIC, SBIC and HQIC values for a series of unrestricted VARs with different lags. The Johansen test was conducted at each of the suggested lag lengths and where a cointegrating relationship was detected an ECM was fitted with the appropriate rank. Again, the information criteria were used to determine lag lengths for ECMs. Where multiple possible ECMs were fitted for a given bank the model with the smallest lag length was selected, subject to the residuals being white noise. Thus we conducted the Lagrange-Multiplier test for residual autocorrelation after each ECM, accepting the model where the resulting P-value was above 0.05. Where there were issues over the correlation of residuals in all possible models we selected the specification with the lowest lag length with the intention of preserving degrees of freedom[150].

6.4 Results

The ECT from the ECM for each bank is given in Appendix R. The lag length adopted for each model is indicated. Cases with possible autocorrelation issues are marked by (*). For cases where the ECM had a rank of two or three the first ECT is reported. This is consistent with the literature (see for example Binner et al, 2005). Cointegrating relationships with a rank of two (**) or three (***) are indicated in the appendix and in Table 6.3 below. Table 6.3 shows the ECT for all banks that had a positive value for this term. These are the firms that we regard as "abnormal" given that they do not converge to a long-run relationship with the common conditions over the period.

Table 6.3: Error correction terms for the "divergent" banks

Bank	Obs	Period	ECT
NBNK	120	2000m1 to 2009m12	0.977
ECO	112	2000m1 to 2009m4	0.254
CHGL (***)	120	2000m1 to 2009m12	0.110
PRIN	120	2000m1 to 2009m12	0.050
MANS (*)	120	2000m1 to 2009m12	0.045
CUMB	116	2000m5 to 2009m12	0.038
FURN (*)	120	2000m1 to 2009m12	0.031
YBNK	120	2000m1 to 2009m12	0.029
CLYD	120	2000m1 to 2009m12	0.028
LBRO	120	2000m1 to 2009m12	0.026
LTSB	120	2000m1 to 2009m12	0.022
JHB	120	2000m1 to 2009m12	0.017
HLFX	120	2000m1 to 2009m12	0.010
CHOR	120	2000m1 to 2009m12	0.009
ULSB	120	2000m1 to 2009m12	0.008
RBS	120	2000m1 to 2009m12	0.005
SAS (**)	120	2000m1 to 2009m12	0.003
NOTT	120	2000m1 to 2009m12	0.003
HANL	90	2002m7 to 2009m12	0.002
MONM	120	2000m1 to 2009m12	0.001
CHSM	120	2000m1 to 2009m12	0.001

[150] Models with potential autocorrelation issues are clearly indicated in the results.

The headline result is that 21 firms had a positive ECT over the period. In other words, 21 firms do not show evidence of convergence toward the postulated long-run relationship. However, many of these are close to zero; only four had an ECT greater than 0.05. The mean ECT was -0.178, the median was -0.061 and the values ranged from -1.311 to 0.977. Therefore, we note that firms typically converged to a long-run relationship with the common factors as we expected. Nonetheless, between firms there was a lot of variation in the speed of adjustment. This is broadly what we expected to find. We were unable to establish a cointegrating relationship for only 6 of the firms in our sample, which goes some way to reassuring us that most banks rates truly are influenced by the common factors we have identified[151].

6.5 Discussion

Of note, six of the top ten firms in Table 6.3 are building societies: Ecology BS ("ECO"), Principality BS ("PRIN"), Mansfield BS ("MANS"), Cumberland BS ("CUMB"), Furness BS ("FURN"), and Loughborough BS ("LBRO"). Moreover, a seventh (Cheltenham & Gloucester, "CHGL") is a former building society. Northern Bank ("NBNK"), which was by far the most "divergent" bank according to our analysis, operated solely in Northern Ireland, which likely had a strong bearing on the result. Also of interest is that for the early part of the sample (up until December 2004) NBNK was part of the National Australia Bank group, as were Yorkshire Bank ("YBNK") and Clydesdale Bank ("CLYD"), which appear 8th and 9th in the table, respectively. The latter two firms remained part of the group for the entire sample. Given this association it is unsurprising that their strategies were seemingly aligned. However, assuming that our interpretation of the ECT as an indicator of maverick behaviour is valid, this may suggest maverickness as a result of managerial decision-making (as alluded to by Langenfeld, 1996) as opposed to such behaviour being a reaction to differing economic conditions[152].

With regard to NBNK, the fact that the firm operated solely in Northern Ireland precludes their identification as the maverick in the UK on the whole. As we stressed earlier, market definition is important. Whenever a competition authority assesses a case they first

[151] These 6 firms were Derbyshire BS ("DERB"), National Savings ("NATS"), Portman BS ("PORT"), Shepshed BS ("SHEP"), Skipton BS ("SKIP") and Woolwich ("WOOL").

[152] To reiterate a point made earlier in the thesis, arguably authorities should distinguish between mavericks whose behaviour is a response to economic conditions and those whose behaviour is simply due to managerial preference (Carlton, 2010). It is possible that NBNK, YBNK and CLYD belong in the latter category, but we cannot say for sure. Our method allows us to identify abnormal behaviour but it stops short of explaining the origins of this behaviour.

define the relevant market, and that is what we must do here in order to give context to our findings. The UK market encompasses England, Wales, Scotland and Northern Ireland. Given that it only operated in Northern Ireland, NBNK's market was much narrower than those of the other firms in the sample. Hence, we cannot reasonably argue that NBNK is a candidate maverick for the whole of the UK. Many UK customers were not served by NBNK. Moreover, the bank could not reasonably be described as having a constraint over the other banks in the sample since they were not even a competitor in three of the national markets[153]. Therefore, for geographical reasons, NBNK cannot be regarded as the maverick given our decision to define the market as *UK* instant access accounts that paid interest annually. This highlights the importance of market definition on the part of a competition authority. It cannot be stressed enough that any attempt at maverick identification is limited to identifying the maverick in the particular market that has been parameterised.

Ecology BS ("ECO") was the second most divergent bank by some distance, and the most divergent of those that operated in the whole of the UK. ECO was originally set up by members of the Green Party (a political party) with a mission to specialise in activities of ecological benefit. According to their own website, their "lending is governed by the principles of sustainable development" (www.ecology.co.uk). Thus, they are especially concerned with how the funds that they lend are used and accordingly distinguish themselves from typical banks. It is therefore apparent that ECO would not be regarded as a "normal" bank. Hence, finding that ECO were potentially maverick by our measure is particularly promising. We sought to identify behaviours that were different from the norm via the proposed long-run relation between banks' rates, the policy rate, prices and output, and the presence of ECO near the top of the list serves to indicate that we may have achieved this. With a large positive ECT, in ECO we effectively find that a bank that strives to be different is identified as precisely that. This is in support of our approach as a method of maverick identification.

Counting against the approach is the fact that three of the firms with positive ECTs are large banks: Royal Bank of Scotland ("RBS"), Halifax ("HLFX") and Lloyds TSB ("LTSB"). Firms of their size and stature would never be considered maverick by the definition given in merger guidelines. However, we can offer alternative explanations for why these firms had positive ECTs. A positive ECT suggests that the bank in question did not converge to the posited long-run relationship during the period. One explanation for this is that these large banks appear in the list because of the difficulties they experienced

[153] To an extent these comments are also true of many of the building societies in our sample, whose operations are often concentrated in a particular region.

during the financial crisis; RBS and HLFX were the worst-affected large UK banks, and LTSB subsequently acquired HLFX during the crisis[154]. The crisis may therefore have influenced their pricing behaviour[155]. Another explanation is that large banks are subject to a more complex rate-setting mechanism and so their apparent divergence is due to their responding to some other factor(s). Ultimately, banks' rates are affected by a huge number of variables (many of which are firm-specific) and not just the three we have considered.

Although bank pricing is certainly influenced by a wide array of factors, choosing to include only few in our ECMs was an appropriate decision. By incorporating the policy rate, we have included the most important supply-side element influencing the rate-setting of banks (www.bankofengland.co.uk). By incorporating prices and GDP, we have included what the literature suggests are the most important demand-side elements influencing consumers' demand for deposit accounts (Gambacorta, 2008). Moreover, the policy rate, prices and GDP clearly impact all banks in a similar way. By contrast, it is less clear that this would be true of other variables that we could include.

In the preceding chapter we outlined several criticisms of the BM methods. Of these, a few issues persisted through our replication. These were the fact that the responses of individual banks were right-censored, that the magnitude of rate changes was not incorporated into the methods, and that we analysed an arbitrary time period. By adopting an error correction approach we have circumvented most of these issues. Right-censoring was an issue in the BM method because we were attempting to quantify specific reactions of banks to specific policy rate changes. Here, instead we are modelling the gradual adjustment of rates toward equilibrium and so we less concerned with which rate change is in response to which stimulus. Moreover, magnitude is incorporated into our error correction approach. We are focusing on adjustment as in BM Measure 2, however, unlike that measure, here the *extent* of adjustment is also captured. For instance, if a bank's rates were below (above) their long-run equilibrium level with respect to the common factors, then a greater rate increase (decrease) on the part of the bank would contribute toward a larger negative ECT, in absolute terms. This is in contrast to BM Measure 2 where only the *occurrence* of an adjustment was counted, with no allowance for the *size* of that adjustment.

[154] For comparison, note that the ECTs of HSBC and BARC (the other two "big" banks) were both negative. These were -0.412 and -0.172 respectively.

[155] Alternatively, perhaps the pricing behaviours identified in our analysis are one of the causes of their difficulties during the crisis.

Therefore the only issue that carries over from Chapter 5 is the use of an arbitrary time period. Indeed, this is something we can never eradicate unless some theoretical rationale were devised to explain why maverick status changes. Without such a rationale, we will always be restricted to analysing an arbitrary period of time; the best we can hope for is that when competition authorities conduct merger analysis they properly define the market and the relevant time period that should be analysed. In fact, our use of time series methods exacerbates the issue of an arbitrary time period. In order for these methods to be applicable the period under analysis needs to be sufficiently long; an ECM cannot be fitted to a sample that is too short. This was evidenced by the fact that we could not analyse all of the banks in our sample due to a lack of data - recall Table 6.2 above. Indeed, this is a key criticism of the approach and in using time series methods this issue cannot be overcome. Moreover, this is at odds with merger analysis, which typically takes a short-term perspective (Motta, 2004).

As a result, rather than achieving definitive maverick identification, in using time series methods the best we can realistically hope to achieve is to quantify firms' relative maverickness during a particular period. In terms of the analysis we have conducted, we can state that during the period January 2000 to December 2009 NBNK was the most divergent firm and therefore the "most maverick" of the firms in our sample. Of the firms that operated in the whole of the UK, ECO was the "most maverick". However, this is for the period in its entirety. Whether their unusual behaviour persisted for the whole ten years is not immediately clear and cannot be ascertained from the ECMs alone. Closer inspection of the data would be necessary in order to shed light on this.

In the preceding chapter we highlighted the fact that Tesco ("TSCO") was implicated as a candidate maverick by the BM measures. However, under the error correction method we find that TSCO was ranked only 39th, with an ECT of -0.032. The finding that TSCO converges is unsurprising. We saw from Figure 5.1 in the previous chapter than the firm seemed to follow policy rate changes and we noted that they initiated few unprovoked changes of their own; the high score by BM Measure 2 was simply a result of the fact that they took longer to follow policy rate decreases than increases. Hence, though they may have taken slightly longer to follow policy rate decreases they did ultimately converge toward the postulated long-run relationship, which we do not regard as particularly maverick.

However, as we have stated, the ECTs generated in this chapter quantify firm behaviour over the entirety of the time period 2000-2009. Yet, as we noted in the discussion section of Chapter 5, TSCO seemed to be especially maverick during the sub-period 2000-2005, with other firms offering more favourable rates towards the end of our sample. Thus, it is conceivable that TSCO might have been the maverick early in the sample but that their subsequent behaviours meant that they appeared to behave in a “normal” way for the sample overall.

Another key criticism of our approach is that whilst we can identify “abnormal” behaviour via our interpretation of the ECTs, we cannot say for certain whether this is abnormal in a positive or negative way. We have postulated that firms should converge toward a long-run relationship with the common factors, and methodologically we have explained that a positive ECT suggests that this is not so. However, from the ECTs alone we are unable to tell whether those firms that exhibit divergence are being maverick and (for example) resisting rate decreases, or being extremely un-maverick and resisting rate increases. Either of these actions would be a move contrary to convergence. Yet, the ECM approach is deficient in distinguishing between these behaviours. Recall that maverick behaviour is not simply abnormal; it is *favourable* from a consumer point of view. The ECM approach does not go as far as to establish the presence of favourable behaviour.

6.6 Conclusion

Where appropriate we have fitted an ECM for each bank in our sample. These models gauged the convergence or divergence of each bank’s rates toward or away from a long-run equilibrium with certain common factors (the policy rate, prices and output). We have found that just under a quarter of firms in our sample exhibited divergence, although many of the positive ECTs are very close to zero. It is conceivable that if we extended the sample, these firms would revert to convergence. Indeed, the overall the tendency is for banks to converge, which we regard as “normal”. Many of the most divergent firms are as we would expect – smaller building societies, and in the case of ECO, a firm that strives to be different. However, some of the firms identified as “divergent” are large banks that would not be considered maverick. We have speculated that these banks may be affected by a different array of variables, given their different structures, or that their unusual results were a consequence of the financial crisis.

In general, we note that the BM method and our error correction approach do not produce consistent results[156]. In the preceding section we discussed the fact that TSCO

[156] It should be noted that many of the firms that appeared more maverick by the BM measures did not appear in the sample for the full ten years, and so fitting an ECM was impossible for those banks.

(a promising candidate by the BM methods) does not appear to be particularly maverick by the ECM approach. Moreover, when we consider the performance of ECO (a promising candidate by the ECM approach) in the BM measures, we observe that it ranked only 41st in terms of BM Measure 1 and a very low 100th in terms of BM Measure 2. One explanation for this can be linked to our key criticism of the ECM approach. In the previous section we stated that whilst positive ECTs are indicative of unusual behaviour, they are not necessarily suggestive of favourable behaviour. Arguably, this would appear to be the case with ECO. Through analysing ECO by the BM measures, we have seen that the firm did not offer the highest relative rates and scored relatively poorly in terms of responsiveness to policy rates. Thus, it would appear that ECO provides an example of a firm whose divergence is likely “unfavourable divergence”. This brings into focus the fact that the ECM approach is insufficient to identify maverick behaviour on its own.

Ultimately, which do we believe is a better approach to maverick identification, the BM method or the ECM approach? The answer to this is that neither is perfect. The BM measures quantify specific behaviours that are favourable for consumers, but the methods are very simplistic and capture two distinct behaviours. By contrast, the ECM method produces a single measure capturing overall convergence toward or divergence away from long-run equilibrium with the common factors, but the nature of this convergence or divergence is not established. The ECMs allow us to identify firms that behaved unusually, but maverick behaviour is more specific than “unusual”. Rather, it is “favourable” from a consumer point of view. Divergence could be favourable if the positive ECT was a consequence of a bank declining to adjust to decreases in the policy rate, for example. However, should a bank decline to follow *increases* in the policy rate, this would also result in a positive ECT, yet in the latter case the behaviour would be *unfavourable*. Thus it is easy to see why a positive ECT in itself is not sufficient to identify maverick behaviour.

Overall, because of its ability to identify divergent behaviour, the ECM approach is more successful at testing the theory than the relatively simplistic BM methods. However, there is still scope for improvement. Whether a change in rate would be considered favourable or unfavourable broadly depends on the direction of change in the common factor(s). The ECM specification we have used in this chapter does not allow for this direction of change. In order to do so, we need to incorporate asymmetry into our analysis. This can be achieved by exploring the category of models known as asymmetric error correction models (AECMs), of which there are several variants. This is what we explore in the next chapter.

Chapter 7: An Asymmetric Error Correction Approach

7.1 Introduction

In the previous chapter we proposed an approach to maverick identification that was based on the principles of cointegration. We applied error correction techniques to fit an error correction model (ECM) for each individual firm in our sample, exploiting the fact that banks' interest rates were cointegrated with the Bank of England base rate, the level of prices, and real output ("common factors" that affect all banks in the same way). The error correction term (ECT) in each regression captured the speed of convergence of that bank's rates to its long-run relationship with the common factors. A positive ECT was indicative of divergence away from said relationship. Subsequently, we argued that the ECT could be interpreted as an indicator of relative maverickness. We expected normal banks' rates to converge and so divergence was regarded as evidence of behaving contrary to the norm.

The methods presented in the previous chapter assumed that the underlying long-run relationship between banks' rates and the common factors was linear and symmetric. This is a simplification adopted in the standard error correction approach. In reality, many cointegrated variables have a more complex, nonlinear or asymmetric relation to one another (Psaradakis et al, 2004). Examples where this has been found include the relationship between exchange rates and prices (Lo and Zivot, 2001), tax and government expenditure decisions (Ewing et al, 2006), and oil prices and GDP (Lardic and Mignon, 2008). Moreover, asymmetry has been found in the case of interest rate pass-through ("IRPT"; Hofmann and Mizen, 2004; Yu, Chun and Kim, 2013). This latter point is naturally of particular relevance to this thesis and we discussed IRPT in the previous chapter. In general, imposing linearity when a true relationship is nonlinear is a key problem for cointegration analysis (Granger and Terasvirta, 1993). In our context if there are asymmetries in the rate-setting behaviour of banks then fitting a linear ECM would represent a misspecification of the underlying relationship between the variables[157].

[157] In some of the literature, 'asymmetry' and 'nonlinearity' are used somewhat interchangeably. However, in this thesis we adopt the following definitions. By 'asymmetries' we refer to cases where the dependent variable exhibits contrasting behaviour when one or more of the independent variables is in a different state. An example would be where banks' rates respond differently when policy rates increase compared to when they decrease. By 'nonlinearities' we refer to the possibility that changes in the dependent variable are not linear transformations of changes in the independent variables. In our context an example could be if the change in a bank's rate was a quadratic function of the change in price level, for instance.

We have reason to suspect that we must allow for asymmetries when identifying mavericks. Breunig and Menezes noted that, "…it is unlikely that useful models to understand maverick-like behaviour will be symmetric." (Breunig and Menezes, 2008, p.829). Moreover, existing literature and merger guidelines both suggest asymmetries may be important with regard to the maverick because they emphasise "favourable behaviour". For example, Baker (2002) suggested that the behaviour of firms revealed their underlying type and that distinguishing between favourable and unfavourable behaviour could result in maverick identification. Moreover, recall that horizontal merger guidelines suggest that maverick behaviour can be characterised by relatively favourable pricing. As we discussed in the preceding chapter, linear ECMs allowed us to identify rate-setting that differed from what we expected to observe, but the method did not allow us to distinguish whether this was favourable or unfavourable from a consumer perspective. In order to do so, asymmetry must be incorporated into the model.

Why is asymmetry crucial for identifying the maverick? In general, whether a given behaviour is favourable or unfavourable depends on the nature of change in the common factor against which it is being measured. In the context of banking, "favourable pricing" depends on, for example, the direction of change in the policy rate. Banks are broadly bound to follow the policy rate but have some control over the speed with which they do so. In the case of savings, being quick (slow) to pass on base rate increases (decreases) would be considered more favourable to consumers. Thus, we may look for an asymmetric response when policy rates are increasing compared to when they are decreasing and use this to more accurately model maverick behaviour. Indeed, Breunig and Menezes (2008) made a similar argument in their attempt at identification; in their responsiveness measure they distinguished between positive and negative changes in the RBA cash rate. Thus, there is a precedent in previous maverick identification work for the expectation of asymmetry. Moreover, this precedent was set in a finance/banking context.

More generally, the "rockets and feathers" literature supports the likely presence of asymmetry (Bacon, 1991; Tappata, 2009). "Rockets and feathers" refers to the observation that firms often exhibit asymmetric price transmission; in other words, they are broadly quicker to increase their prices following cost rises and slower to decrease their prices following cost reductions. The phenomenon has often been examined in the context of the relationship between gasoline and oil prices (Bacon, 1991; Borenstein and Cameron, 1992), but the economic intuition holds for firms in a variety of contexts (for example, in agriculture - Meyer and Cramon-Taubadel, 2004). Indeed, asymmetric price transmission has been found in an array of contexts. If our market were one such context, then a linear ECM would inadequately capture the behaviour of our firms; “rockets and feathers” contradicts the notion of a single rate of adjustment. However, even if our particular market did not exhibit aymmetry, we ultimately wish to generalise our method of maverick identification to other markets. Thus, we should allow for the possibility of asymmetry[158].

As an aside, it is notable that ECMs have been commonly used in the “rockets and feathers” literature. Early asymmetric price transmission papers used simple regressions of downstream and upstream prices (Karrenbrock, 1991; Shin, 1992) but later papers adopted ECMs (Borenstein et al, 1997; Balke et al, 1998). Indeed, we could align the earlier papers with the Breunig and Menezes (2008) approach, whilst the latter studies are more aligned with our own attempts at identification. Moreover, it is also notable that whilst earlier papers typically found symmetric price transmission, the later papers are the ones that found evidence of asymmetry. Thus, we could argue that as our methods are more sophisticated than those of Breunig and Menezes, we are more likely to be able to identify maverick behaviours.

The linear ECMs of the preceding chapter allowed us to gauge the speed with which banks’ rates adjusted to changes in the common conditions, but this was a single measure irrespective of the direction of change. Contrary to this, what we expect to observe is a more complex form of cointegration with contrasting adjustments to different directional changes in the common conditions. In particular, we follow the precedent set in Breunig and Menezes (2008) in that we primarily expect contrasting changes with respect to positive and negative changes in the policy rate.

In order to capture asymmetry we turn to the class of asymmetric error correction models (AECMs). Whilst linear ECMs can indicate firms that may be acting unusually in an unspecified way, the use of AECMs can narrow this down and shed light on the nature of their unusual behaviour. Several different asymmetric error correction approaches have been proposed in the literature. Each augments conventional error correction by incorporating some form of asymmetry or nonlinearity, though they differ in their approach to doing so.

This chapter proceeds as follows. Section 7.2 briefly describes the most prominent AECM variants. The AECM we ultimately adopt in this chapter is the nonlinear autoregressive distributed lag (NARDL), because of its treatment of asymmetry and its

[158] Allowing for asymmetry is not the same as imposing asymmetry. We will be careful to retain the possibility of symmetry; we will ensure that if the relationship between the variables were ultimately symmetric our methods would not distort this.

wide applicability[159]. Section 7.2 explains in more detail why the NARDL is most appropriate for the purposes of maverick identification. Section 7.3 outlines our methodology. We place particular emphasis on positive and negative changes in the policy rate, but we also allow for asymmetric responses to changes in prices and output. Section 7.4 presents the results of fitting a NARDL to each firm in our sample, as well as the associated diagnostic tests. Section 7.5 provides a discussion, comparing the results to those of the previous chapters. Finally, Section 7.6 concludes.

7.2 Asymmetric ECMs

A number of techniques have been proposed to incorporate asymmetry into cointegration analysis. These include the asymmetric ECM of Granger and Lee (1989), the threshold autoregressive ECM (Hansen 1996, 1997, 2000), the ECM with threshold cointegration (Balke and Fomby, 1997; Enders and Granger, 1998), Markov-switching ECMs (Psaradakis et al, 2004), smooth transition ECMs (Michael et al, 1997; Kapetanios et al, 2006) and the nonlinear autoregressive distributed lag (NARDL) model of Shin, Yu and Greenwood-Nimmo (2009, 2014).

These methods typically capture asymmetry via some form of 'regime shift'. In other words, it is assumed that the relationship between variables is contingent on one or more of the variables being in a particular 'state' (or 'regime'), and that asymmetry stems from contrasting effects to the dependent variable under these different states. One example could be where an independent variable is increasing under Regime A and decreasing under Regime B, with the two regimes provoking different reactions in the dependent variable. Another example could be where variables are cointegrated under Regime A but there is no cointegrating relationship under Regime B. In these examples there would not be a single rate of adjustment, but rather a different rate under the two regimes. Asymmetric error correction approaches differ with regard to the way in which regimes are defined and determined, but this is the broad sentiment underlying AECM techniques.

Granger and Lee (1989) developed an AECM approach that is based on the idea of "multicointegration". Multicointegration is a deeper form of cointegration that has two levels; in addition to conventional cointegration, in certain contexts one might also expect series to be cointegrated with the accumulated ECTs from their long-run relationship.

[159] The NARDL would more appropriately be regarded as the "asymmetric ARDL", but we conform to the "nonlinear ARDL" naming convention.

Granger and Lee motivated this with an example of inventories. Sales and production are cointegrated with one another, but one could also expect them to be cointegrated with inventories (stock) since the level of stock would influence the amount of production needed to satisfy demand. Inventories are defined as production minus sales, and the difference between production and sales is effectively the accumulated residuals from their long-run relationship – in other words, the ECTs. Thus, multicointegration implies an inherent endogeneity in the cointegrating relationship, which necessitates an asymmetric ECM since the rate of adjustment depends on the state of the deeper form of cointegration. For instance, in the inventories example, when firms hold a *low* level of stock and sales suddenly increase, production needs to increase suddenly too. However, when firms hold a *high* level of stock, production would not follow the change in sales so rapidly. This is because inventories can be reduced to account for the additional sales. Thus, in the given example, the rate of adjustment depends upon the state of inventories.

The implication of Granger and Lee's assertions is that in the presence of multicointegration there is a need to allow for different speeds of adjustment based on the position of the variable of interest with respect to its long-run equilibrium relationship with the independent variable(s). The initial application of this was effectively to set a threshold (or 'attractor') at zero, allowing the speed of adjustment to be different where the long-run residuals were positive or negative. In general terms, by Granger and Lee's AECM the strength of attraction could be different on both sides of the attractor. The goal of their paper was then to test whether estimated coefficients were statistically different in order to establish, broadly, whether there was evidence of asymmetry (Manera and Grasso, 2005).

Were we to apply the method to our data, we would decompose our cointegration residuals into positive and negative values, allowing two coefficients to be estimated. We could then compare these values for different banks. Such an approach would have some merit in the context of maverick identification, but the Granger-Lee AECM fails to capture the exact form of asymmetry we have outlined above. One could make an argument for measuring maverickness in terms of the difference in convergence when a bank's rates were above and below their long-run relationship; in deposits, one would expect a maverick to adjust more quickly (slowly) when below (above) the long-run steady state, since this would be favourable to consumers. However, what we would ideally like to gauge is the difference in the adjustment of banks' rates when the independent variables themselves are increasing or decreasing (something which is actually simpler than the form of asymmetry captured by Granger and Lee). Thus, the Granger-Lee approach does not perfectly satisfy our requirements.

An alternative approach, the threshold autoregressive ECM (TAR-ECM) of Hansen (1997, 2000) incorporates asymmetry by adding a threshold autoregressive mechanism to the standard ECM. In Granger and Lee (1989) there was effectively a threshold set at zero; they had two regimes defined by positive and negative deviations from the long-run relationship. By contrast, with the TAR-ECM the threshold need not be zero nor predetermined; the appropriate threshold can be consistently estimated (Manera and Grasso, 2005). This is an econometrically desirable and appropriate feature in many situations. For example, suppose a series is constantly increasing but doing so at varying rates. In such a case a model with a threshold of zero would be inappropriate since there would never be negative changes. A suitable choice of threshold would instead be some positive value to allow for asymmetric responses dependent on whether increases were above or below a certain level. However, in the context of mavericks, our rationale for exploring asymmetry is centred on an expectation that firms will behave differently when the policy rate is increasing or decreasing, implying a zero threshold. A model that imposes a nonzero threshold would be difficult to interpret and we therefore rule out the TAR-ECM.

Both Granger and Lee's AECM and the TAR-ECM are based upon the Engle-Granger two-step procedure, in which the presence of cointegration is established by performing an augmented Dickey-Fuller (ADF) test on long-run residuals. However, Balke and Fomby (1997) showed that where the long-run equilibrium relationship is nonlinear this test for cointegration is misspecified. This observation led to the "ECM with threshold cointegration", in which the ADF regression is replaced by a TAR process with an indicator function based on the sign of the long-run residuals. However, treatment of the threshold in the model is similar to the TAR-ECM in that it is estimated and thus need not be zero. Again, this does not align with our rationale for exploring asymmetry and so we discount the approach as a possibility for maverick identification in this instance.

Psaradakis et al (2004) propose a two-regime 'Markov-switching' ECM, which they term the Markov error correction (MEC) model. They based their approach to asymmetry on observations of the dynamics of stock prices and dividends, which at times follow a similar path but also exhibit periods of persistent deviation, producing two distinct regimes. The MEC model is designed to allow for a different speed of adjustment in each state; the system is allowed to switch from one state to the other. This has some appeal for our purposes, since, for example, positive/negative changes in policy rate could be treated as the two regimes. However, the typical application of the MEC is in cases where cointegration breaks down during parts of a sample. In such cases traditional ECM techniques would simply find no cointegrating relationship in the sample overall, when in fact the true relationship would be one where there are periods of cointegration and periods of no cointegration. This is not the case in our context. We do not expect cointegration to break down; we expect it throughout, but with a different rate of adjustment under our alternative regimes. Thus the MEC is not ideal for our purposes[160].

Another approach is that of Kapetanios et al (2006). They proposed a procedure that detects the presence of a cointegrating relationship that follows a globally stationary smooth transition process. In other words, they modelled the process of error correction as adjusting more slowly when the cointegrating residual was close to zero, thereby depicting a gradual adjustment toward the long-run equilibrium. This and other smoothing approaches are somewhat different from the aforementioned AECMs in that asymmetry stems from the closeness of a series to its long-run equilibrium, rather than due to some threshold or state of the world. As a result, smooth transition ECMs model a more gradual form of adjustment, in contrast to the sharper adjustment of TAR models. In many contexts smooth adjustment may offer a more realistic depiction of reality. However, such models are deficient where adjustment is in response to a sudden shock (Psaradakis et al, 2004). This presents a problem for our analysis since shocks are common in banking; for instance, in our data we see the sudden and dramatic decrease in the base rate following the onset of the financial crisis. Therefore smooth-transition methods are inappropriate given our choice of market and the desire to ultimately generalise our methods.

Finally, the nonlinear autoregressive distributed lag (NARDL) approach of Shin, Yu and Greenwood-Nimmo (2014) builds upon the ARDL method of Pesaran, Shin and Smith (1999, 2001). The method incorporates asymmetry through positive and negative 'partial sum decompositions' of explanatory variables. In other words, variables are separated into two subsets representing their positive and negative changes, and the subsets are modelled as having separate effects on the variable of interest. Moreover, the positive and negative decompositions appear separately in the long-run equilibrium relationship. As a result it is possible to assess both short- and long-run asymmetry[161]. The approach

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[160] In the previous chapter there were a small sample of banks for which we did not find a cointegrating relationship using standard ECM techniques. Visual inspection of the plots for those banks seems to suggest that this was due to the breakdown of cointegration part way through the sample, and so the MEC approach may be of some value for analysing the rate-setting behaviour of those particular banks. However, there were only six such firms in our dataset, and so this avenue will not be explored in this thesis.

[161] However, the model can be easily constrained to impose either short- or long-run symmetry (see for instance Yu, Chun and Kim, 2013, or Atil, Lahiani and Nguyen, 2014).

also has the benefit that it can be consistently estimated by standard OLS (Shin, Yu and Greenwood-Nimmo, 2014) and that it is well-suited to deal with sudden shocks to the system (Hammoudeh et al, 2014). This latter point is appealing given our rationale for discounting the smooth-transition approaches.

The NARDL method has two further advantages which make it appealing from the perspective of maverick identification. Firstly, since both short- and long-run asymmetries are simultaneously modelled, the approach is appropriate where the nature of asymmetry is uncertain. In our context we have drawn upon economic reasoning to explain our expectation of asymmetry, yet in other contexts the source of asymmetry may be less clear. For instance, suppose we had a trivariate model and specifically expected a *long-run* asymmetric effect in *only one* of the explanatory variables. If, on the contrary, the true source of asymmetry were in the *short-run* or via the *other* or *both* explanatory variable(s), the NARDL would pick this up. Thus, prior understanding of the nature of asymmetry is not necessary, which makes the approach attractive from the perspective of generalisability.

Secondly, the method has been shown to be appropriate for the analysis of variables of different orders of integration (Shin, Yu and Greenwood-Nimmo, 2014). All the other AECMs we have surveyed rely on the fundamental principle of cointegration, i.e. that in order for methods to be valid all variables must be non-stationary I(1) whilst some combination of them is stationary I(0). By contrast, the NARDL approach is valid for a combination of I(1) and I(0) variables. This gives the method much wider applicability. Bank rates, the policy rate, prices and output were all found to be I(1) in the preceding chapter. However, in other markets this may not be the case, which would impact our ability to apply the method to other contexts. By adopting the NARDL as our AECM we ensure greater generalisability and fulfil one of the core criteria of this work – ensuring that the methods of identification we develop can be applied to other industries.

Though it is a relatively new technique, NARDL models have already been applied in a variety of contexts. These include exchange rate pass-through (Delatte and Lopez-Villavicencio, 2012), the analysis of house prices (Katrakilidis and Trachanas, 2012), crop production (Mitra, 2014), and the relation between gasoline and oil prices (Atil, Lahiani and Nguyen, 2014). Moreover the technique has been applied to interest rate pass-through, albeit at an aggregate level (Yu, Chun and Kim, 2013). Indeed, previous studies that have adopted the NARDL approach have typically modelled only a handful of series, using aggregated data. Our undertaking is on a much larger scale; we will fit a

NARDL to each of our 88 banks[162]. Moreover, previous studies set out with the objective of establishing asymmetry. In our case, asymmetry is expected (though not imposed) and it is the interpretation of individual banks' coefficients that is of interest. Thus our application of the method is novel and distinct from existing NARDL papers.

7.3 Methodology

In the first piece of analysis our approach was to fit a standard (linear and symmetric) ECM for each bank, interpreting a positive coefficient on the ECT as indicative of potential maverickness. This was based on the fact that we expected banks' rates to have a long-run relationship with the common factors (the base rate, prices and output):

$$Rate_t = \alpha_1 Base_t + \alpha_2 Prices_t + \alpha_3 Output_t + \varepsilon_t \qquad (6.7)$$

Where ε_t quantifies the deviation from the long-run relationship in period t. Our ECMs were of the form:

$$\Delta Rate_t = \beta_1 \sum \Delta Rate_{t-k} + \beta_2 \sum \Delta Base_{t-k} + \beta_3 \sum \Delta Prices_{t-k} + \beta_4 \sum \Delta Output_{t-k} + \rho(Rate_{t-1} - \alpha_1 Base_{t-1} - \alpha_2 Prices_{t-1} - \alpha_3 Output_{t-1}) + \gamma_t \qquad (6.8)$$

Where ρ represents the ECT. Since we postulated a long-run relationship between the variables (Equation (6.7)), we expected a bank's rate to converge toward this long-run equilibrium over time. Thus we expected a negative coefficient on the ECT; we expected any deviation from the long-run relationship in time t-1 to be corrected (reduced) to some extent in period t. Behaviour consistent with this hypothesis was regarded as "normal". On the other hand, a positive value of ρ implied that when out of equilibrium in t-1 a bank's rate deviated further from that equilibrium in t. Such behaviour was not regarded as normal. Therefore in our first piece of analysis we took a positive coefficient (evidence of divergence) to be indicative of relative maverickness.

However, as we have discussed, we have reason to believe that there is a more sophisticated relationship between banks' rates, the policy rate, prices and output. Consequently, we have outlined a rationale for identifying the maverick on the basis of banks' reactions to positive and negative changes in the policy rate[163]. To incorporate this into our model, consider the following alternative long-run relationship:

[162] As in the preceding chapter, there are a number of firms whose samples are too short to conduct time series analysis.

[163] Rate changes in response to increases/decreases in the other common conditions may also be important, and so we also include these in our model. It is easy to impose symmetry under the NARDL methodology, and so where prices and output do not produce asymmetric responses we have the ability to constrain these terms.

$$Rate_t = \alpha^+_1 Base^+_t + \alpha^-_1 Base^-_t + \alpha^+_2 Prices^+_t + \alpha^-_2 Prices^-_t + \alpha^+_3 Output^+_t + \alpha^-_3 Output^-_t + \varepsilon_t \quad (7.1)$$

Where $Base^+_t$ and $Base^-_t$ are partial sum processes of positive and negative changes in Base, such that $Base^+_t = \sum_{j=1}\Delta Base^+_j = \sum_{j=1}max(\Delta Base_j,0)$ and $Base^-_t = \sum_{j=1}\Delta Base^-_j = \sum_{j=1}min(\Delta Base_j,0)$. In other words, $Base^+_t$ and $Base^-_t$ represent sums of the positive and negative changes in the variable up to time t. Partial sum processes for prices/output are defined analogously as the sums of their positive/negative changes when they are increasing/decreasing. Whereas in the previous chapter each of the common conditions appeared in the long-run relationship as a single term, here positives and negatives appear separately, implying a more complex form of cointegration. The relationship between the variables is essentially allowed to differ according to the nature of change in each of the independent variables. Following Shin, Yu and Greenwood-Nimmo (2014) we are then able to formulate a NARDL(p,q) of the form:

$$\Delta Rate_t = \lambda Rate_{t-1} + \theta^+_1 Base^+_{t-1} + \theta^-_1 Base^-_{t-1} + \theta^+_2 Prices^+_{t-1} + \theta^-_2 Prices^-_{t-1} + \theta^+_3 Output^+_{t-1} + \theta^-_3 Output^-_{t-1} + \sum^{p-1}_{j=1}\varphi_j \Delta Rate_{t-j} + \sum^{q}_{j=0}(\omega_1{}^+_j \Delta Base^+_{t-j} + \omega_1{}^-_j \Delta Base^-_{t-j} + \omega_2{}^+_j \Delta Prices^+_{t-j} + \omega_2{}^-_j \Delta Prices^-_{t-j} + \omega_3{}^+_j \Delta Output^+_{t-j} + \omega_3{}^-_j \Delta Output^-_{t-j}) + u_t \quad (7.2)$$

Where p and q denote ARDL-style lag lengths for the respective dependent and independent variables (Pesaran and Shin, 1998). $Base^+_t$, $Base^-_t$ and the analogous price and output variables are defined above. Short-run adjustments to positive and negative changes in the common conditions are captured by the various ω^+_j and ω^-_j terms. Positive and negative long-run coefficients can be computed by $L_{Base^+} = - \theta_1{}^+/\lambda$ and $L_{Base^-} = - \theta_1{}^-/\lambda$, analogously for L_{Prices} and L_{Output}. Note that $L_{Base^+} = \alpha^+_1$ and $L_{Base^-} = \alpha^-_1$. In other words, the long-run coefficients correspond to the parameters of the long-run relationship depicted in Equation (7.1).

We can rewrite our NARDL as a conditional AECM to facilitate ease of comparison to the standard ECM. Doing so yields:

$$\Delta Rate_t = \rho(Rate_{t-1} - \alpha^+_1 Base^+_{t-1} - \alpha^-_1 Base^-_{t-1} - \alpha^+_2 Prices^+_{t-1} - \alpha^-_2 Prices^-_{t-1} - \alpha^+_3 Output^+_{t-1} - \alpha^-_3 Output^-_{t-1}) + \sum^{p-1}_{j=1}\varphi_j \Delta Rate_{t-j} + \sum^{q}_{j=0}(\omega_1{}^+_j \Delta Base^+_{t-j} + \omega_1{}^-_j \Delta Base^-_{t-j} + \omega_2{}^+_j \Delta Prices^+_{t-j} + \omega_2{}^-_j \Delta Prices^-_{t-j} + \omega_3{}^+_j \Delta Output^+_{t-j} + \omega_3{}^-_j \Delta Output^-_{t-j}) + u_t \quad (7.3)$$

Comparing Equation (7.3) to Equation (6.8), we can clearly see the how the NARDL augments the conventional ECM. First, the error in this AECM representation, ($Rate_{t-1} - \alpha^+_1 Base^+_{t-1} - \alpha^-_1 Base^-_{t-1} - \alpha^+_2 Prices^+_{t-1} - \alpha^-_2 Prices^-_{t-1} - \alpha^+_3 Output^+_{t-1} - \alpha^-_3 Output^-_{t-1}$), reflects the individual importance of positive and negative changes in the independent variables. Second, we allow for different lag lengths on the dependent and independent variables (p and q, per an ARDL model). Overall, adopting the NARDL approach should allow us to capture more precisely the relationship between the variables, allowing us to characterise the response of banks' rates to the common conditions more accurately.

Our ultimate goal is maverick identification. In addressing this objective, there are several elements of the NARDL output that we could examine. One is ρ, which is effectively the "ECT". This would be consistent with our analysis of the preceding chapter as it is the value that corresponds to speed of adjustment. However, as in the standard ECM we again produce only a single value for adjustment under the NARDL method (albeit adjustment is toward a hypothetically more accurate long-run relationship that allows for different effects from positive and negative decompositions of the variables). Thus the value does not bestow upon us any additional information about a bank's responses to positive or negative changes in the common factors; it does not make it any clearer whether banks were diverging favourably or unfavourably. At best, this value would give us a more precise rate of adjustment, i.e. a more accurate picture of which banks' rates diverged from the long-run relation. However, shedding light on the nature of the divergence was our primary goal in exploring asymmetry.

Our other options are the short-run coefficients (the various ω^{+}_{j} and ω^{-}_{j} terms), and the long-run coefficients (the L^{+}_{j} and L^{-}_{j} terms). With regard to the former, these are many in number (depending on the number of lags in a relevant model) and typically exhibit varying signs and significances across lags as a consequence of the method. It would therefore be difficult to compare these coefficients across banks and direct comparisons would not be possible in many cases. By contrast, the long-run coefficients produce a single value for each variable that appears on the right hand side of Equation (7.1) and these can therefore be more easily compared. These coefficients define the parameters of the long-run relationship; the interpretation of L_{Base}^{+} and L_{Base}^{-} is as the respective long-run effects of positive and negative changes in the base rate, and analogously for prices and output. As a result, these coefficients convey information about the nature of asymmetry evident within the behaviour of a given bank.

We will therefore focus our attention on the long-run coefficients, and specifically L_{Base}^{+} and L_{Base}^{-} given the widely-acknowledged influence of the policy rate in bank rate-setting. Broadly, we expect L_{Base}^{+} to be positive and L_{Base}^{-} to be negative; that is, we expect a positive (negative) change in base rate to have a positive (negative) long-run effect on a bank's rates[164]. However, of greater interest is the magnitude of coefficients.

[164] With regard to L_{Prices}^{+}, L_{Prices}^{-}, L_{Output}^{+} and L_{Output}^{-}, when inflation is higher individuals are more inclined to save rather than spend and so banks need not offer such a high interest rate on deposits (Gambacorta, 2008). Thus in a "normal" bank we expect L_{Prices}^{+} to be negative and L_{Prices}^{-} to be positive. With regard to real output, higher incomes naturally lead

Specifically, we are interested in observing the size of L_{Base}^{+} and L_{Base}^{-} for the "divergers"; the banks that were implicated as "abnormal" and potentially maverick in the preceding chapter because they exhibited positive ECTs. Divergence, as we have discussed, could be favourable or unfavourable from a consumer point of view, and could be caused by several things. By examining the long-run coefficients from the NARDL output for the divergent banks we should be able to clarify which of them diverged from the long-run relationship in a favourable way and which diverged in an unfavourable way. This in turn should allow us to produce a more convincing case for candidate mavericks.

We adopt a "general-to-specific" approach to lag length choice (Hendry 1995, 2000). In the context of the NARDL(p,q) this amounts to starting with the longest feasible lags of p and q before reducing these (where applicable) according to a sequential rule. Our chosen starting point is a NARDL(8,8); that is, a lag of 8 months on both the dependent and independent variables[165]. Starting with this maximum lag length, we apply the method to each bank and inspect the t-statistic for each of the final lags. We adopt a 10% sequential rule with regard to eliminating lags; if, for a given bank, the final lags are significant at the 10% level then we accept the NARDL(8,8)[166]. If they are not significant we repeat the process, iteratively reducing the respective lag lengths in a sequential manner until such point as the final lag demonstrates a significant effect on the dependent variable. This process is then repeated for our population of banks.

The adoption of a general-to-specific approach is borne out of the desire to include the maximum amount of relevant information, in order to accurately portray the behaviour of banks' rates. Such an approach is becoming reasonably standard in the NARDL literature (see for instance Yu, Chun and Kim, 2013). Alternative approaches to NARDL model selection include the comparison of information criteria (for example used in Mitra, 2014) or the adjusted R-squared, although there are issues with each[167]. A general-to-specific approach is preferred.

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to greater savings and so as output rises banks need not offer such a high rate of interest to attract deposits (Gambacorta, 2008). Thus, again, we expect L_{Output}^{+} to be negative and L_{Output}^{-} to be positive. However, we focus our assessment of maverickness on the base rate.

165 Our reason for starting at this length is twofold. Firstly, in the preceding chapter we allowed for a lag of up to 12 months but no individual bank warranted an ECM with a lag greater than 8. Secondly, in general longer lags are difficult to justify in economic terms; it is difficult to argue that the base rate from more than 8 months in the past has a bearing on a bank's rates today. For these reasons, a NARDL(8,8) is a reasonable starting point.

166 In terms of the 'q' lag, we focus our attention on significance of the base rate variable.

167 It is not strictly appropriate to compare information criteria across models with different lags because a change in the lag impacts the sample size which in turn affects the criteria. With regard to R-squared, by construction this will always decrease as the lag length decreases. Thus the sequential general-to-specific approach is favoured.

7.4 Results

Following the process of model selection, initial results are given in Appendix S. The table shows the chosen lag lengths as well as the corresponding long-run coefficients L_{Base}^{+} and L_{Base}^{-} for each bank[168]. In addition, we fit a NARDL to the aggregated sample to act as a benchmark. Note that direct comparisons of the coefficients of different banks are not entirely appropriate by virtue of the varying lag lengths (and in some cases slight differences in sample lengths) across banks. Overall, Appendix S can be regarded as the "fully asymmetric ARDL" in that the dependent and independent variables are unconstrained and allowed to be asymmetric in both the short run and the long run.

It is important to test whether the fully asymmetric model is appropriate for each individual bank. Although we have a rationale for identifying maverick behaviour based on asymmetric responses to changes in the policy rate, it would be inappropriate to impose an asymmetric model if the data suggested symmetry. Moreover, there are two possible sources of asymmetry: in the long-run relationship between the variables and in the short-run responses of a banks' rates to changes in the common factors. Under the NARDL approach, testing for symmetry is achieved through the use of long-run (LR) and short-run (SR) Wald tests. In essence we test the equality of the coefficients (on the positive and negative decompositions of each variable) in order to assess whether we can rule out the possibility that they are the same. Where we are unable to reject symmetry with regard to a particular variable we are then able to impose symmetry, producing a partially constrained model for that bank[169]. Thus we are able to produce a more accurate depiction of the relationship between each banks' rates and the common factors.

The LR Wald test tests the equality $L_{Base}^{+} = L_{Base}^{-}$ in the case of base rate, and analogously for prices and output. In other words, it tests whether positive and negative decompositions of the independent variables have the same long-run effect on the dependent variable. The null hypothesis is symmetry. If we are unable to reject the null then we are unable to say with certainty that a given bank's rates exhibit long-run asymmetry with respect to that particular variable. We would therefore conclude that a constrained model with symmetry imposed on the relevant parameters would be more

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[168] Recall that these values quantify the parameters of a given bank's long-run relationship with positive and negative changes in the base rate. For example, a larger value of L_{Base}^{+} indicates that positive changes in the base rate had a greater impact on that bank in the long-run.

[169] Though the focus of our attention is on the base rate, it is important that symmetry tests are conducted on each of the independent variables. This is because we wish to fit the most accurate model to each bank. If Wald tests suggest it is appropriate to impose symmetry on prices or output then we wish to do so in our model.

appropriate. We could refer to the resultant model as a “constrained NARDL” or “partly asymmetric ARDL with long run symmetry imposed”.

The SR Wald test has two variants, “pairwise” and “additive” (Shin, Yu and Greenwood-Nimmo, 2009). In our context, the pairwise SR Wald would amount to testing $\omega_1{}^{+}{}_{j}=\omega_1{}^{-}{}_{j}$, $\omega_2{}^{+}{}_{j}=\omega_2{}^{-}{}_{j}$ and $\omega_3{}^{+}{}_{j}=\omega_3{}^{-}{}_{j}$ for each lag j (up to q). In other words, testing whether positive changes in each of the independent variables have the same effect as negative changes with the same lag. By contrast, the additive SR Wald tests whether $\sum\omega^{+}{}_{j}=\sum\omega^{-}{}_{j}$, i.e. whether the sum of the short-run coefficients for positive changes is equal to the sum of the coefficients for their negative counterparts. Both forms of the test essentially strive to establish whether changes in the independent variables have the same effect on the dependent variable regardless of their direction of change. Again, the null hypothesis is symmetry. If we are unable to reject the null then we are unable to reject a symmetric effect and would conclude that a partly asymmetric ARDL (with short run symmetry imposed) would be appropriate for that bank. Greenwood-Nimmo et al (2012) note that the pairwise test involves a very strong restriction which is unlikely to be satisfied given a general-to-specific approach to lag selection. Accordingly, following their work and others (e.g. Atil, Lahiani and Nguyen, 2014), our SR Walds are of the additive variety.

The results of symmetry tests are given in Appendix T. The first value reported is the test statistic. The value in parentheses reflects our confidence in rejecting the null hypothesis – we reject only where we have 95% confidence. Where the value in parentheses is greater than 0.05 we are unable to reject the null hypothesis of symmetry.

In response to the results of the Wald tests, we then impose symmetry on the independent variables (where appropriate) in order to fit a more accurate model to our data. As an example, take the case of Yorkshire Building Society (“YORK”), which can be seen at the very bottom of Appendix T. For YORK, we cannot reject symmetry in the long-run coefficients for prices and output and we cannot reject symmetry in the short-run coefficients for the base rate and output. Thus a more appropriate model for YORK would be a partly asymmetric ARDL which allows only $L_{Base}{}^{+}$ and $L_{Base}{}^{-}$ to differ amongst the long-run coefficients and $\omega_2{}^{+}{}_{j}$ and $\omega_2{}^{-}{}_{j}$ to differ amongst the short-run coefficients. Given the previously-determined lag lengths of p=3 and q=2 for YORK, its constrained NARDL(3,2) therefore takes the form:

$$\Delta Rate_t = \lambda Rate_{t-1} + \theta^{+}{}_{1}Base^{+}{}_{t-1} + \theta^{-}{}_{1}Base^{-}{}_{t-1} + \theta_2 Prices_{t-1} + \theta_3 Output_{t-1} + \sum^{3-1}{}_{j=1}\varphi_j\Delta Rate_{t-j} + \sum^{2}{}_{j=0}(\omega_{1j}\Delta Base_{t-j} + \omega_2{}^{+}{}_{j}\Delta Prices^{+}{}_{t-j} + \omega_2{}^{-}{}_{j}\Delta Prices^{-}{}_{t-j} + \omega_{3j}\Delta Output_{t-j}) + u_t \qquad (7.4)$$

This should be compared with Equation (7.2) to appreciate the constraints that are imposed in response to the Wald tests.

In addition, roughly analogous with the Johansen tests in the previous chapter, we need to test for a long run relationship between the variables[170]. In the context of the NARDL, the appropriate test is the F_{PSS} "bounds test" of Pesaran, Shin and Smith (2001). The F_{PSS} test essentially tests the null hypothesis that all of the long-run coefficients are zero, by means of a straightforward F test. If they are zero then clearly there is no relationship between the variables. However, if we can reject the null then we are contented that there is some form of underlying relationship.

The F_{PSS} test is termed a bounds test because we compare the calculated statistic against *two* critical values representing upper and lower bounds. Asymptotic critical values for various situations (defined by trend, intercept, and number of parameters) were computed and tabulated by Pesaran, Shin and Smith (2001). The upper and lower bounds correspond to the two extreme cases where all regressors are I(0) and where all regressors are I(1). For calculated values above the upper bound, we reject the null of no long-run relationship. For values below the lower bound, we accept the null. For values between the bounds, we have an inconclusive result. Of course, if we are confident that all variables are either I(0) or I(1), then we can simply use the single relevant critical value and compare it against our calculated F_{PSS} value. This is true in our case; recall that in the preceding chapter we confirmed that all variables are I(1). However, Pesaran, Shin and Smith's bounds are valuable given that we hope to generalise the method to identify mavericks in other situations.

"Constrained" NARDL results (with appropriate forms of symmetry) and F_{PSS} test values are shown in Appendix U. With regard to the latter, our NARDLs have unrestricted intercepts and no trend, so with 4 variables the relevant critical values at the 95% confidence level are 2.86 and 4.01 (Pesaran, Shin and Smith, 2001). We can see from Appendix U that for the majority of our banks we can comfortably reject the null and conclude that there is a long-run levels relationship between the variables. However, we have a number that fall within the inconclusive range and a handful for which we reject a long-run relationship[171].

If we consider our NARDL results in isolation, we regard larger positive values for L_{Base}^{+} as indicative of relatively maverick behaviour. A larger value for this coefficient would imply that a bank's rates increased by a larger amount (in the long-run) in response to

[170] We are testing for a long run "levels" relationship, as opposed to the "cointegrating" relationship of the preceding chapter. Cointegration is the special case wherein all variables are I(1).

[171] A note on the F_{PSS} test for constrained models. As more symmetry constraints are imposed, the test becomes more stringent and difficult to pass. Therefore, note that we are unable to accept a long-run relationship for the banks for which we have had to impose greater constraints. For the purposes of maverick identification, firms exhibiting a symmetric response to the base rate would not be regarded as maverick anyway, and so this quirk is perceived to pose no great problems. However, it is important to acknowledge the issue.

central bank increases. In terms of L_{Base}^{-} we regard negative values that are closer to zero as more maverick, and positive values as especially maverick. A small negative value would imply that a bank only decreased its rates by a small amount (in the long-run) in response to central bank decreases. A positive value for this coefficient would imply that a bank actually increased its rates (in the long-run) in response to policy rate decreases. Tables 7.1 and 7.2 display the top ten banks when each of these coefficients are ranked.

Table 7.1: Banks with the largest positive coefficients for L_{Base}^{+}

BANK	p lag	q lag	L_{Base}^{+}
YBNK	6	5	8.656
CHSM	4	5	5.997
NATS	6	7	5.928
NBNK	5	3	5.926
CLYD	3	3	5.533
FIRD	4	2	5.502
LAIK	6	2	5.417
NATW	6	5	5.104
PRIN	4	2	4.727
EARS	5	2	4.512

Table 7.2: Banks with the largest positive coefficients for L_{Base}^{-}

BANK	p lag	q lag	L_{Base}^{-}
AAL	2	8	2.581
NBNK	5	3	2.071
TAC	5	6	0.83
NRCK	8	4	0.801
HLFX	5	5	0.785
MARH	2	6	0.461
CHGL	4	8	0.403
HOLM	5	5	0.39
SCAR	2	2	0.194
NATS	6	7	0.095

National Savings ("NATS"), which appears in both of these tables, might be considered a candidate maverick. However, it may be more insightful to consider the L_{Base}^{+} and L_{Base}^{-} coefficients for the firms that were identified as "divergers" when straightforward linear methods were applied in the previous chapter[172]. In Chapter 6, we found that 21 firms had a positive ECT and therefore displayed unusual behaviour (divergence from the postulated long-run relationship with the common factors). These were our candidate mavericks, yet we were unable to state whether their divergence was favourable or unfavourable from a consumer point of view. Indeed, our whole rationale for exploring asymmetric methods was based around shedding light on the nature of these firms' apparent abnormal behaviour. Thus, Table 7.3 below presents the L_{Base}^{+} and L_{Base}^{-} values from the constrained NARDLs of the 21 firms that had a positive ECT in Chapter 6. Also displayed is their ECT value, by which the firms are sorted. Interesting results are discussed below.

Table 7.3: Constrained NARDL results for the "divergent" banks

Bank	**Period**	**ECT**	L_{Base}^{+}	L_{Base}^{-}
NBNK	2000m1 to 2009m12	0.977	5.926	2.071
ECO	2000m1 to 2009m4	0.254	2.086	-0.829
CHGL	2000m1 to 2009m12	0.110	4.239	0.403
PRIN	2000m1 to 2009m12	0.050	4.727	-0.763
MANS	2000m1 to 2009m12	0.045	3.061	-0.919
CUMB	2000m5 to 2009m12	0.038	3.696	0.092
FURN	2000m1 to 2009m12	0.031	3.001	-0.571
YBNK	2000m1 to 2009m12	0.029	8.656	-0.764
CLYD	2000m1 to 2009m12	0.028	5.533	-0.433
LBRO	2000m1 to 2009m12	0.026	4.089	-0.484
LTSB	2000m1 to 2009m12	0.021	3.226	-0.440
JHB	2000m1 to 2009m12	0.017	2.254	-1.068
HLFX	2000m1 to 2009m12	0.010	3.443	0.785
CHOR	2000m1 to 2009m12	0.009	3.424	-0.916
ULSB	2000m1 to 2009m12	0.008	4.060	-1.089
RBS	2000m1 to 2009m12	0.005	1.041	-1.041
SAS	2000m1 to 2009m12	0.003	2.726	-0.606
NOTT	2000m1 to 2009m12	0.003	2.593	-0.027
HANL	2002m7 to 2009m12	0.002	3.034	-0.584
MONM	2000m1 to 2009m12	0.001	2.645	-0.865
CHSM	2000m1 to 2009m12	0.001	5.997	-0.230

The "benchmark" values of L_{Base}^{+} and L_{Base}^{-} were 2.821 and -0.903 respectively; these were the coefficients when a single NARDL model was fitted to the entire sample. Though these values provide a broad indication of banks' long-run responses to base

[172] It is interesting to note that NATS was one of the few firms for which we did not find a cointegrating relationship in the previous chapter. This may be evidence that the bank exhibits a more complex form of cointegration.

rate changes, it is not entirely appropriate to compare individual banks to this benchmark since lag lengths vary considerably from bank to bank.

As we have stated, hypothetically we would expect a maverick bank to have a relatively larger value for L_{Base}^{+}, implying a greater long-run effect of positive changes in the policy rate on their own rates. To this end, four of the “divergers” from Table 7.3 (YBNK, CHSM, NBNK and CLYD) are in the top five banks by the L_{Base}^{+} coefficient. This can be seen in Table 7.1. This implies that in the long-run these banks increased their rates by the greatest amount in response to policy rate increases. Such behaviour is favourable from a consumer point of view, and supports the case for YBNK, CHSM, NBNK and CLYD as candidate mavericks. At the other end of the spectrum, two of the banks from the table (RBS and ECO) appear in the thirty lowest when L_{Base}^{+} is sorted, making them unlikely mavericks.

With regard to L_{Base}^{-}, as we have stated, relatively higher values would be regarded as favourable, with positive values considered especially favourable. A positive coefficient implies that the long-run response of that bank to decreases in the policy rate was to *increase* its own rates. We consider this to be very unusual given the interest rate channel of monetary policy. We can see from Table 7.3 that four of the divergers have a positive value for L_{Base}^{-} (NBNK, HLFX, CHGL and CUMB), and the first three of these appear in the top ten in Table 7.2. This is evidence in support of these firms as candidate mavericks. A positive value for L_{Base}^{-} is not exclusive to the firms in Table 7.3; overall, eleven firms had such a positive value. However, of these, four were the result of imposing long-run symmetry on Base following the Wald tests. Thus, only seven firms exhibited a positive value for L_{Base}^{-} when the effect of the policy rate was asymmetric in the long run, and nearly two-thirds of these appear amongst our candidate mavericks from the preceding chapter. Two of the divergers (JHB and ULSB) from Table 7.3 appear in the thirty lowest banks by the L_{Base}^{-} coefficient. This is evidence against the notion that JHB or ULSB might be maverick.

The most promising candidate mavericks from the preceding two chapters were ECO and TSCO. We have already stated that ECO was in the bottom thirty banks for L_{Base}^{+}; suggesting a modest long-run response to increases in the policy rate. Moreover, it is the median bank when L_{Base}^{-} is ranked, indicating a relatively normal response to decreases in the policy rate. Both of these coefficients are close to our benchmark for the sample as a whole. Overall, this counts strongly against the notion that ECO was the maverick in our market. These facts are also consistent with our observation in conclusion of the previous chapter that ECO performed poorly by the Breunig and

Menezes (2008) responsiveness measure, indicating that whilst ECO may have behaved unusually this unusual behaviour was not favourable to consumers. It seems that the source of ECO's divergence was primarily in its reactions to prices and output, on which we place less emphasis when it comes to identifying maverick behaviour.

Moreover, TSCO, which seemed to be a strong candidate maverick by the BM measures in Chapter 5, had a coefficient of 1.482 for L_{Base}^{+} and -0.604 for L_{Base}^{-}. These coefficients place it in the bottom thirty when L_{Base}^{+} is ranked and a modest 29th overall when L_{Base}^{-} is ranked. Again, these findings count against the notion that TSCO might be the maverick in the market for instant access deposit accounts. The firm's long-run response to positive changes in the base rate, in particular, strongly suggests behaviour that is unfavourable from a consumer point of view. This serves to highlight deficiencies in the simple BM measures of maverickness.

In general, applying the NARDL approach to our sample has allowed deeper exploration of the nature of the "divergence" we established in the previous chapter. By looking at the long-run coefficients on Base we are able to get an indication of which of the "divergers" from Chapter 6 behaved favourably with regard to changes in the policy rate. Specifically, we have evidence supporting the cases of CHGL, CHSM, CLYD, CUMB, HLFX, NBNK and YBNK as candidate mavericks[173]. Of these, it is notable that CUMB also appeared in the top-scoring banks by BM Measure 2. This suggests that as well as having positive long-run responses to changes in the policy rate, the timing of their rate changes was also favourable to consumers. Thus, in the case of CUMB, we have a firm that appears to be favourable by the simple BM measure, diverges per our ECM approach, and *diverges in a favourable way* by the NARDL approach. Therefore, of the firms in our data during the period under consideration, we conclude that CUMB shows the greatest propensity to behave in a maverick way. TSCO and ECO, which were identified as candidate mavericks by the simpler measures, are revealed to have distinctly un-maverick tendencies when we modelled their specific responses to increases and decreases in the policy rate.

We cannot state that CUMB was the maverick at each and every point in the sample. It may even be the case that CUMB was not the maverick at any point in the sample; Tables 5.3-5.5 in Chapter 5 demonstrated that CUMB never offered the highest rates at either the low, medium or high deposit levels in any of the ten calendar years. However,

[173] As we have discussed, CLYD, NBNK and YBNK were all part of the same banking group, and so we repeat the point that it is intuitively pleasing that they are identified as having similar levels of relative maverickness.

we can state that during the entirety of the period 2000-2009 CUMB appeared to display the greatest level of relative maverickness[174].

7.5 Discussion

A point of discussion is whether the NARDL approach is appropriate for the purposes of maverick identification. As we mentioned in Section 7.2 of this chapter there are a couple of items counting in its favour. First, it successfully separates out the effects of positive and negative changes in the common factors. By using the approach we are able to model the rate-setting behaviours of firms when each of the common factors was in a different state (i.e. increasing or decreasing). Whilst we did not compare the short run effects of changes in the independent variables due to the different lag lengths from model to model, we were able to compare the long run effects. In doing so, we were able to capture firm behaviour in a more specific way than we could using the standard (linear and symmetric) time series methods deployed in Chapter 6. Assuming that price is indeed the medium through which maverick behaviour manifests itself in our market, the NARDL approach allows us to distinguish between favourable and unfavourable behaviours, whereas linear ECMs could only highlight "abnormal" behaviour.

Second, a key advantage is the fact that the NARDL approach can be applied in cases where variables are not all I(1). This is particularly appealing when it comes to applying it to other markets. Our ultimate objective was to develop a means of maverick identification that could be applied to any case. Whereas the error correction approach of the preceding chapter would only be applicable in markets where key variables happen to be I(1), the methods we deploy here are much more widely generalisable (Shin, Yu and Greenwood-Nimmo, 2014).

These points are positive and the asymmetric methods deployed in this chapter are certainly an improvement over those used the preceding one. However, there are some issues with the approach. One is that we are still analysing an arbitrary time period. Unfortunately, in order to apply a method such as the NARDL, this is unavoidable. As we discussed in the previous chapter, in order for time series methods to be applicable the sample needs to be sufficiently long[175]. Thus, in adopting a time series approach the

[174] Recall that in Chapter 5 we discounted NBNK as a possible maverick because the bank operated solely in Northern Ireland. Along similar lines, CUMB is a regional building society whose physical branches are located in the north west of England. However, crucially, CUMB did serve the entire UK market (for example via online banking). Thus, the concerns we had with respect to NBNK are lesser when it comes to CUMB.

[175] Indeed, in this chapter and the one preceding it we were unable to fit models to banks whose samples were too short. The result of this was that some firms could not be analysed, and it is possible that the true maverick may have been amongst that group.

best we can hope to achieve is to produce estimates for the *relative maverickness of firms during a pre-determined period*. We are not able to state conclusively which firm was the maverick at each and every point in time. Moreover, the required sample length poses particular problems as merger analysis typically takes a short-term outlook. The conditions in markets regularly change, and so to consider such a long period is questionable for our purposes.

From the point of view of merger analysis, being able to identify the maverick at each point in time would be more valuable than producing a broad overall measure of relative maverickness. We could theoretically capture the maverick at a given point in time using cross-sectional methods, at least in terms of the relative level of rates that firms offered; by taking an approach along the lines of BM Measure 1 we could state which firm offered the best rates at particular times. However, as we have seen, such simple measures do not appear to accurately identify the maverick. Moreover, we have emphasised that maverick behaviours are best identified via the reactions of firms (in our case to changes in the common factors). Indeed, the responses of firms are recognised as crucial to maverick identification in the existing literature (e.g. Baker, 2002). Such responses could not be picked up using simple cross-sectional methods.

Recall that we chose to explore time series methods as a consequence of our chosen market. As we outlined in the previous chapter, error correction techniques have been widely used in the analysis of banking. However, we may speculate that *panel time series* methods may prove more fruitful in the identification of mavericks (Deaton, 1985; Coakley, Fuertes and Smith, 2004). By using panel time series methods, we could still analyse the responses of banks to common factors but we could potentially investigate shorter time periods. If we were able to establish breaks in the data in order to subdivide the period into shorter segments, then this would theoretically give a more accurate account of the maverick(s) in the market. More generally, there are a number of other variables we could have included had we adopted panel methods. For instance, we could have considered characteristics of the firms and how these influence the prices they set; of relevance since mavericks are supposedly smaller players. We take up this discussion further in the overall conclusion to the thesis.

Another issue is that the analysis of maverickness using the NARDL approach makes no explicit allowance for strategic effects; we do not allow for the fact that firms' interest rates are likely to be influenced by one another. This is particularly pertinent given that mavericks supposedly constrain the behaviours of their rivals. Our attempt at maverick identification constitutes what Baker (2002) termed a "revealed preferences" approach[176]. Recall that this is where a maverick is identified on the basis of its observable behaviour, and we have argued that such an approach is preferable to the qualitative "a priori factors" approach that authorities currently typically employ. However, Baker also suggested a third approach to identification which he termed "natural experiments". This is where a firm is shown to have a significant influence over the prices of its rivals or the prevailing industry price. Arguably, maverick identification could be enhanced by incorporating strategic effects and attempting to identify firms whose actions constrained the actions of others[177]. For instance, what if the majority of firms in our sample chose to follow policy rates because a specific competitor had a history and reputation for doing so? By conducting individual time series analysis, we are unable to pick up any such effect. Again, we will return to this discussion in the conclusion to the thesis.

7.6 Conclusion

Using the NARDL approach was an improvement over the ECM approach of Chapter 6 since it incorporated asymmetries. Allowing for asymmetric reactions to the common factors is crucial in order to distinguish between favourable and unfavourable behaviours, and thus crucial in order to establish maverick behaviour as it is depicted in theory. Without some allowance for asymmetry, the best we can hope to achieve is the identification of "abnormal" behaviour, which in itself is not enough to establish maverickness. "Abnormal" behaviour could be good or bad for consumers. Mavericks must not only behave in an unusual way, but must behave in a manner that is positive for consumers; this notion underlies the entire rationale for giving such firms special treatment under merger policy.

More generally, the time series methods we adopted in this chapter and the one that preceded it are preferable to the methods of Breunig and Menezes (2008) because they encompass firm behaviour in a single measure. One of the key issues with the BM approach was that the relative rate and responsiveness measures captured two distinct behaviours and that there was no way to know which was the appropriate dimension to capture maverick behaviour. In the error correction approaches we have employed,

[176] This is also true of the methods used in the preceding two chapters.

[177] This would be consistent with the few pieces of econometric analysis that competition authorities have conducted, for example the econometric analysis of the presence of JET fuel stations in the *StatoilHydro/ConocoPhillips* case we discussed in Chapter 3. Moreover, Sabbatini (2014) argued that a maverick could only be identified where there was evidence that collusion had been constrained by a maverick in the past.

these two dimensions are combined into one measure. Crucially, the *magnitude* of rate adjustments is incorporated.

Our aim in exploring strategies for maverick identification was to develop an objective empirical test of maverickness, which we argued would be preferable to the subjective, qualitative approach that we have observed in past merger cases. This led us to explore asymmetric error correction, with the NARDL emerging as our chosen approach for the reasons we have documented: in addition to incorporating asymmetries, the fact that it is applicable to variables of different orders of integration is particularly advantageous from the perspective of generalisation. We have discussed at some length the need to allow for asymmetry, since the theoretical literature emphasises that maverick behaviour is *favourable* rather than just simply *different*. Therefore as an empirical exercise to test the theory the NARDL method is much more appropriate than those that have come before it.

However, it is clear that the approach does not represent a perfect method of maverick identification. In particular, it is difficult to reconcile the conflicting facts that time series methods require a long sample whilst merger analysis tends to be focused on the short-term[178]. Thus, this empirical approach is not completely perfect; it may be useful in some merger analyses, but in others where the relevant period under consideration is relatively short it may not be appropriate. In this regard, we have not been wholly successful in devising a generalisable empirical test of maverickness (but rather a test that provides a strong indicator of potential maverick behaviour). We have suggested that panel time series methods may be the solution to this problem, but this idea is in its infancy. Much like our survey of AECM variants earlier in this chapter, further work would require careful consideration regarding what would be the best approach. If alternative methods are pursued it is imperative that the asymmetric dimension is maintained.

[178] Time series methods are good at capturing dynamics; in our case, the reactions of firms to the policy rate and so on. However, as an empirical exercise to test the maverick theory such methods are not ideal since merger analyses tend to be conducted on relatively short time periods for which such dynamics might not be observable.

Chapter 8: Conclusion

This thesis sought to address perceived gaps in the literature on maverick firms. Specifically, the three core objectives of the thesis were to contribute toward the development of a formal theory of mavericks, to analyse and understand the way the European Commission has applied the maverick concept in merger cases, and to try to develop an empirical method of maverick identification. In terms of the latter, crucially, we sought to develop an approach that was objective in nature and did not rely on preconceptions regarding the likely identity of the maverick party. Prior to this thesis, no formal theory existed, no study had considered in detail the use of the concept across a population of cases, and there had been only one (relatively unsuccessful) attempt at objective empirical identification. This concluding chapter will summarise how the thesis contributes to the literature, discuss policy implications, and outline areas for possible further study.

In Chapter 2 we began to formulate a formal theory of mavericks. Building upon Ivaldi et al (2003), we constructed a repeated games model in the style of Compte, Jenny and Rey (2002). In other words, we produced a model in which the maverick had a lower discount factor than the level required in order for it to favour collusion over deviation, and where firms had different production capacities. By adopting this framework we were able to portray the maverick in a manner that was consistent with the way such firms are depicted in merger guidelines (i.e. as a smaller player that is averse to collusion). Moreover, we were able to use the model to explore the effect that such firms have on markets.

The repeated games model contributes to the maverick literature in several ways. First, we were able to formally demonstrate how and under what circumstances the maverick would genuinely constrain coordination. We have shown that the patience of non-mavericks is crucial in this regard. Where non-mavericks are sufficiently patient to offset the impatience of the maverick, we outlined scenarios where collusion could theoretically occur in spite of the presence of a maverick. This has significant policy implications since it implies that the presence of a maverick may not be enough to prevent collusion on its own. Rather, we have demonstrated that collusion would only be restricted where a maverick was present *and* other firms in the market were not patient enough to accommodate it (or alternatively where the redistribution of market share proved impossible). These findings suggest that the application of the maverick concept is not clear-cut. Our model implies that identifying a particular firm as maverick is not the same as identifying a constraint to collusion; it seemingly also depends on the status of non-mavericks and the nature of firm interaction in a given market.

In addition to this, our model also formally demonstrates that the presence of a maverick has a detrimental effect on the payoffs of non-mavericks. Where a maverick is insurmountably averse to collusion and rivals can only achieve partial collusion, we have shown that the collective payoff of the latter would be lower. To reiterate the findings of Chapter 2, depending on the makeup of firms within a market, it is possible for *some* non-mavericks to receive a greater payoff from partial collusion but it is not possible for *all* firms to do so. Thus, non-mavericks would generally favour full collusion; being restricted to partial collusion has an adverse effect on their collective profits. This is an important finding because it provides a motive for firms to instigate the removal of a maverick from a market, which is a key concern of competition authorities. Since we have shown that non-mavericks' payoffs are impacted by the presence of a maverick, we have formally provided an explanation for why non-mavericks might wish to actively acquire and remove mavericks. However, we also noted an incentive problem: why would a non-maverick incur a cost to acquire a maverick, when other non-mavericks could enjoy the benefits of this without incurring the cost?[179]

In Chapter 3 we analysed the use of the maverick concept in EC merger cases during the period 2000 to 2013. Having searched for the term in the population of merger case reports, we conducted an in-depth analysis of the nature and context of the concept's application. The work presented in Chapter 3 gave invaluable insights into the way the EC competition authority regards maverick firms. We noted that application of the concept was inconsistent with merger guidelines. In particular, the term was regularly used in conjunction with unilateral effects, whereas guidelines relate the concept only to coordination. Moreover, it was applied to outsider mavericks when EC guidelines only discuss the party as an insider to a merger. These observations highlight the need for authorities to clarify their position with regard to maverick firms. It is possible that this apparent misapplication of the concept is a consequence of the lack of a formal theory and a fundamental misunderstanding of the subject. Alternatively, we have speculated that the shift in thinking following the 2004 review of merger regulation may have caused a change in attitude with respect to mavericks, or that the term has been consciously used to add weight to unilateral arguments. In any case, our findings emphasise the fact

[179] The findings of Chapter 3 may help answer this question and so we provide an explanation in the discussion of further areas of study below.

that this issue requires clarification. Moreover, our findings align with similar criticisms of US authorities' application of the concept (Owings, 2013).

The analysis of EC merger cases also provided useful insights that informed our subsequent maverick identification work. From studying individual cases in detail it seemed to be apparent that those mergers in which the authority was able to conduct some form of econometric analysis were more likely to result in the maverick being ultimately established (recall, for example, the case of *StatoilHydro/ConocoPhillips*). This added emphasis to the third objective of this thesis, the desire to develop an objective empirical method of maverick identification. It is clear that the EC authority places emphasis on the value of quantitative analysis. Therefore, this reaffirmed our initial perception that an empirical test of maverickness would be preferable to the current approach, which typically involves identification based on qualitative reasoning and the perceptions of market participants. Furthermore, from our analysis in Chapter 3 we noted that in order for the authority to identify a firm as maverick they typically required evidence that the firm's prices were lower than those of its rivals. This focus on prices reinforced the notion that our attempts at empirical identification should be based around the prices of firms, as opposed to, for example, quality considerations.

Chapters 5-7 documented our attempts at empirical maverick identification. Having first replicated the methods involved in the only previous attempt by Breunig and Menezes (2008), we went on to explore alternative approaches based on cointegration and asymmetric cointegration, respectively. We were drawn to explore such methods as a consequence of investigating the techniques commonly used to analyse our market of interest, UK bank and building society deposit accounts. Our methods followed Breunig and Menezes in that they placed particular emphasis on the responses of firms to changes in the policy rate. Ultimately, in Chapter 7 we applied the nonlinear autoregressive distributed lag (NARDL) approach, which allowed us to distinguish between the effects of positive and negative changes in the "common factors" we had established (with emphasis on the policy rate). We then argued that we were able to identify favourable and unfavourable behaviours from the long-run coefficients in the NARDL output. This allowed us to judge relative maverickness.

Breunig and Menezes' (2008) attempt at empirical identification was not particularly successful. Moreover, as we have discussed, their methods were relatively simplistic and there were several problems with their approach. Our subsequent attempts, and particularly the NARDL approach, contribute to the literature since they provide more sophisticated and more accurate depictions of firm behaviour. Based on similar principles to that of Breunig and Menezes, our attempts overcome many of the issues with their study. For example, BM Measure 2 (the responsiveness measure) incorporated rate adjustments but did not allow for their magnitude. Our attempts, using both ECMs and the NARDL, implicitly incorporate the size of rate adjustment. Moreover, the sample we chose to analyse had an advantage over Breunig and Menezes' since it included both policy rate increases and decreases, whereas theirs included only increases. Therefore we were better able to accurately capture favourable, and potentially maverick, behaviours – thus, the NARDL approach developed in this thesis represents a more accurate test of maverick behaviour as it is defined in the literature[180].

However, as we outlined in the previous chapter, an issue that persists through all three attempts at identification is the fact that we were analysing an arbitrary time period. This was necessary given that we used time series methods; in order for these to be valid the sample needed to be sufficiently long. As we have discussed, a consequence of this is that our methods are only able to produce estimates of relative maverickness for the entirety of the period; we cannot state which firm was the maverick at each and every point in time. From a policy perspective this is not ideal. Nonetheless, our approach can provide useful indicators regarding firms' relative maverickness, which can inform and guide authorities with respect to the likely role of particular firms within a market. As a minimum our methods would allow authorities to rule out firms that were clearly not maverick, which is a significant contribution to the subject.

The empirical analysis of Chapters 5-7 was conducted on the market for UK instant access deposit accounts that paid interest on an annual basis. Whilst most of our discussion and conclusions here have been related to maverick firms in a more general sense, it is appropriate to consider the implications of this work for the market itself. Can we draw any insights into the functioning of the market on the basis of our analysis? Amongst other findings, Chapter 5 demonstrated that there are clear periods where one particular bank offered the most favourable rates, Chapter 6 identified a firm with a different business model (ECO) that was exhibiting very different pricing behaviour, and Chapter 7 showed that firms within the same branch network do indeed appear to follow similar rate-setting strategies. These are, in the most part, observations one would expect, but our analysis confirms them.

Moreover, our various empirical approaches have suggested different candidate mavericks in the instant access deposit market. One reason for this may be because, as

[180] From a methodological standpoint, our use of the NARDL method was in a context and on a scale that has never been done before. Typically, NARDL models have been fitted to single series, but never to a sample as large as 88 banks. Thus, this is another contribution, albeit to a different literature.

we have discussed at length, our methods were based around prices (interest rates) and rate-setting behaviour yet consumers may choose their account on the basis of non-price characteristics such as those we outlined in Chapter 4. Consumers have been found to be prone to inertia when it comes to switching between bank accounts (Kiser, 2002) and the age of a product has been found to be negatively correlated with the interest rate paid (Anderson, Ashton and Hudson, 2014). In terms of mavericks in the deposit market, these facts contribute to the difficulty in stating who the maverick might be. Is a maverick in this market a firm that offers the most favourable introductory rates, or a firm that continues to offer favourable rates to its long-standing customers? These are considerations that we are unable to allow for with the data at hand, but they allude to the fact that identifying the maverick firm in this particular market may not be as straightforward as it initially seemed. These would be important considerations for any merger analysis conducted on this market, or similar markets, in the future.

Let us now consider areas for further study. In terms of the repeated games model, there are several directions in which the work could go. An obvious natural step would be to model hypothetical mergers within our framework. Such an idea has tentatively been explored by Baker (2010). "In order for the market participants to coordinate more effectively… the maverick's incentives must change so that the constraint it imposes is relaxed. One way that could happen is through merger." (Baker, 2010, p.243). Assuming that market shares and capacities were simply added together upon merger, Baker presented a simple example showing how the constraint on coordination was relaxed following a merger involving the maverick. In the context of our model, mergers could be imposed and the resultant firms' payoffs could be calculated. We could then explore whether non-mavericks of different sizes and discount factors would find it profitable to merge with the maverick, from the perspective of facilitating collusion.

Alternatively, given our observation that the EC has increasingly applied the concept to unilateral effects, we have reason to believe that our theoretical model of mavericks should allow for this type of anti-competitive effect. It is not clear how unilateral effects could be explored within our existing model. However, alternative models could be produced that attempt to incorporate product repositioning and post-merger closures into models of unilateral effects. Doing so would help to reconcile our maverick theory with the current approach of competition authorities. Moreover, recall the incentive problem we highlighted with regard to maverick acquisitions. We have taken the detrimental impact on non-mavericks' payoffs as evidence supporting the notion that firms may wish to acquire and remove mavericks, yet we have questioned why a firm would do so when it also confers a "free-riding" benefit to its rivals. A solution to this may come in the form of unilateral effects. If the merged firm can unilaterally increase its prices following the acquisition of a maverick, then there would no longer be an incentive problem; it would be quite clear as to why a firm may wish to engage in such a merger.

With respect to the merger analysis of Chapter 3, areas for further work could involve analysing cases from other regions. We stated in the introduction that whilst individual cases are often studied, aggregate-level analysis had not been done. It would be interesting to consider the population of US cases to see if attitudes to mavericks follow similar patterns to those in Europe. This would then allow us to test the significance of the 2004 European merger review; if US authorities demonstrated similar trends to that of the EC, then we would place less emphasis on the effect of the review. In general, the greater prominence of unilateral effects requires further consideration. An area of possible further work could be to interview competition authorities and gather first-hand information regarding their attitudes to maverick merger enforcement. In this thesis we have inferred their attitudes based on the wording of case reports, but we could gain a better understanding by communicating with the authorities directly.

Along similar lines, note that our analysis was conducted on cases considered by the EC; i.e. those that had international dimensions and impacted the European Community. Thus, the sample of cases that we analysed did not include *every single maverick case in Europe* during 2000-2013, simply *those that warranted the EC's attention*. In addition to those analysed by the EC, national competition authorities also made reference to the maverick term in their own merger analysis. This was evidenced by, for example, Massey (2010) in the context of Irish merger cases and Billard, Ivaldi and Mitraille (2011) in the context of a French case. Thus, a possible extension could be to consider populations of merger cases on a national level. This would allow us to fully appreciate the extent to which the concept is used, and to assess the consistency of its application. It would be interesting to observe whether individual countries' approaches to the concept mirrored those of the EC and whether trends in the use of the concept (for example, the increasing emphasis on unilateral effects) also emerged at a national level.

Finally, as we mentioned in the concluding remarks to the preceding chapter, there are potential areas of further work with regard to maverick identification. First, it would be interesting incorporate strategic effects into identification attempts. The approaches used in Chapters 5-7 are all based on "revealed preferences". On the contrary, an avenue that could be explored is the alternative "natural experiments" approach suggested by Baker (2002). In other words, rather than attempting to identify mavericks based on some notion of overall favourable behaviour, we could attempt to identify them via the constraints they have over rivals. If we were able to establish links between the prices of a single firm and overall trends in industry prices, then this could be construed as maverick behaviour. This would be particularly true if the firm in question was a smaller party that would not be expected to influence overall market prices.

More generally, applying the NARDL approach to other markets would be a valuable contribution. This would serve to reinforce our arguments regarding the appropriateness of the method; we have suggested that it is applicable to other markets and contexts, but this is something that should be tested. Specifically, it would be interesting to apply the method in markets that are dissimilar to bank and building society deposit accounts. A traditional manufacturing context would provide a good example, whereby the "common factors" that firms' prices respond to would be the key inputs to the manufacture of that product. Alternatively, it would be insightful to apply the methods to industries in which the EC has applied the concept in cases. For instance, the concept has twice been applied to mergers in the mobile communications industry, so this would be a strong candidate market. In general, the method could be applied to any industry in which the EC established a maverick, and we could test whether the firm implicated by the method was consistent with the party identified by the authority via qualitative means.

Finally, in Chapter 7 we suggested that the approach developed in this thesis may exhaust the usefulness of time series methods with regard to maverick identification, and that panel time series methods could be explored next. In particular, such methods are appealing since they could still be based around the responses of firms to common factors but shorter periods of time could be analysed. This would be better-aligned with the short-term outlook of merger enforcement. Panel methods could also allow the inclusion of a wider range of variables. It would be interesting, for example, to incorporate firm characteristics into the econometric analysis of mavericks. This may facilitate the identification of particular characteristics that make firms more or less likely to be maverick.

To conclude, we have unearthed evidence that the maverick concept will continue to grow in importance within the sphere of merger policy; this was particularly evidenced by our findings in Chapter 3. Moreover, the literature suggests that this trend is appropriate; several studies have advocated a wider role for the maverick concept in merger analysis (for example Baker, 2002, and Owings, 2013). Therefore, we are hopeful that contributions like the formal theory (depicted in Chapter 2) and attempts at objective identification (chronicled in Chapters 5-7) prove valuable to authorities. However, it is also clear that there is plenty of scope for both the theory and identification techniques to be developed further. Moreover, these should be developed in conjunction with the use of the concept in merger case decisions in order to ensure consistency.

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Appendix A – Derivation of the critical discount factor (Chapter 2)

Here we derive the 'critical discount factor' - the level of discount factor that a firm must have in order to sustain collusion.

In Equation 2.6 we have stated that Firm i favours collusion over deviation if:

$$\frac{k_i}{K}\frac{M}{(1-\delta_i)} \geq k_i + \frac{\delta_i}{(1-\delta_i)}\frac{(M-K_{-l})}{k_l}k_i$$

In other words, if the payoff to collusion is greater than the one-shot payoff to deviation followed by Nash punishment forever more. If we set these things equal and solve for δ_i, this gives the level of discount factor above which collusion is strictly preferred.

Multiplying the equation by $(1 - \delta_i)$ gives:

$$\frac{k_i}{K}M \geq (1-\delta_i)k_i + \delta_i\frac{(M-K_{-l})}{k_l}k_i$$

Multiplying out the parentheses and dividing by k_i gives:

$$\frac{M}{K} \geq 1 - \delta_i + \frac{\delta_i M - \delta_i K_{-l}}{k_l}$$

Multiplying by k_l gives:

$$\frac{M}{K}k_l \geq k_l - \delta_i k_l + \delta_i M - \delta_i K_{-l}$$

We can then exploit the fact that $k_l + K_{-l} = K$. Substituting this into the expression simplifies the right hand side:

$$\frac{M}{K}k_l \geq k_l - \delta_i(K - M)$$

Rearranging the terms and multiplying by K gives:

$$\delta_i(K-M)K \geq k_l K - k_l M$$

Simplifying and dividing by (K – M) gives:

$$\delta_i K \geq k_l$$

Then dividing by K gives us the critical discount factor:

$$\delta^* = \frac{k_l}{K}$$

Above this level a firm prefers collusion. At this discount level, a firm is indifferent between collusion and deviation.

Appendix B – Derivation of the critical discount factor for partial collusion (Chapter 2)

Here we derive the level of discount factor that would be needed in order to sustain *partial collusion*.

Non-maverick i prefers partial collusion to deviation if:

$$\frac{k_i}{K-k_m}\frac{M-k_m}{(1-\delta_i)} \geq k_i + \frac{\delta_i}{(1-\delta_i)}\frac{(M-K_{-l})}{k_l}k_i$$

In other words, if the payoff to collusion when the maverick firm m is ignored is greater than the one-shot payoff to deviation followed by Nash punishment forever. If we set these things equal and solve for δ_i, this gives the level of discount factor above which partial collusion is sustainable.

Multiplying the equation by $(1 - \delta_i)$ gives:

$$\frac{k_i}{K-k_m}(M-k_m) \geq (1-\delta_i)k_i + \delta_i\frac{(M-K_{-l})}{k_l}k_i$$

Dividing by k_i and multiplying out the parentheses gives:

$$\frac{M-k_m}{K-k_m} \geq 1-\delta_i + \frac{\delta_i M-\delta_i K_{-l}}{k_l}$$

Multiplying by k_l gives:

$$\frac{M-k_m}{K-k_m}k_l \geq k_l - \delta_i k_l + \delta_i M - \delta_i K_{-l}$$

As in Appendix A, we can again exploit the fact that $k_l + K_{-l} = K$. Substituting this into the expression simplifies the right hand side:

$$\frac{M-k_m}{K-k_m}k_l \geq k_l - \delta_i(K-M)$$

Multiplying by $(K - k_m)$ gives:

$$k_l M - k_l k_m \geq k_l(K-k_m) - \delta_i(K-M)(K-k_m)$$

Multiplying out the first set of parentheses on the right hand side leaves us with a negative $k_l k_m$ term on either side of the inequality, which cancels out:

$$k_l M \geq k_l K - \delta_i(K-M)(K-k_m)$$

This rearranges to:

$$\delta_i(K-M)(K-k_m) \geq k_l K - k_l M$$

Dividing by $(K – M)$:

$$\delta_i(K - k_m) \geq k_l$$

Thus the critical discount factor for partial collusion is given by:

$$\delta^*_{pc} = \frac{k_l}{(K - k_m)}$$

Above this level partial collusion is sustainable. Exactly at this discount level, a firm is indifferent between partial collusion and deviation.

Appendix C – Derivation of the transfer, T (Chapter 2)

Here we derive the size of the total transfer of market share needed in order to encourage the maverick to participate in full collusion.

Equation 2.12 states that the maverick receives a higher payoff from collusion when:

$$(\frac{k_m}{K}+T)\frac{M}{(1-\hat{\delta}_m)}\geq k_m+\frac{\hat{\delta}_m}{(1-\hat{\delta}_m)}\frac{(M-K_{-l})}{k_l}k_m$$

In other words, where the maverick's payoff to collusion when it is afforded some additional amount of market share (T) is greater than its payoff to deviation.

Multiplying this by $(1 - \delta_m)$:

$$(\frac{k_m}{K}+T)M\geq k_m(1-\hat{\delta}_m)+\hat{\delta}_m\frac{(M-K_{-l})}{k_l}k_m$$

Multiplying out the parentheses, dividing by M, and subtracting k_m/K can give us an expression for T:

$$T\geq\frac{k_m-\hat{\delta}_m k_m}{M}+\frac{\hat{\delta}_m k_m M-\hat{\delta}_m k_m K_{-l}}{k_l M}-\frac{k_m}{K}$$

However, this can be simplified much further. Multiplying by M, k_lM and K gives:

$$TKMk_l\geq k_m k_l K-\hat{\delta}_m k_m k_l K+\hat{\delta}_m k_m MK-\hat{\delta}_m k_m K_{-l}K-k_m k_l M$$

Simplifying gives:

$$TKMk_l\geq k_m k_l(K-M)-\hat{\delta}_m k_m K(k_l-M+K_{-l})$$

Once again, we can again exploit the fact that $k_l + K_{-l} = K$ in order to simplify the right hand side:

$$TKMk_l\geq k_m k_l(K-M)-\hat{\delta}_m k_m K(K-M)$$

$$TKMk_l\geq(K-M)(k_m k_l-\hat{\delta}_m k_m K)$$

Dividing by KMk_l:

$$T\geq\frac{(K-M)k_m(k_l-\hat{\delta}_m K)}{KMk_l}$$

This is as far as we are able to simplify the expression.

Appendix D – Proof that partial collusion is never preferable when $\beta_i = 0$ (Chapter 2)

Here we are proving that, for a given non-maverick firm, the payoff to partial collusion is never greater than the payoff to full collusion, provided that firm is not required to give up market share to the maverick.

If firm i is not required to make a transfer then $\beta_i = 0$ and Equation 2.15 simplifies to:

$$\frac{k_i}{K-k_m}\frac{(M-k_m)}{(1-\hat{\delta}_i)} \geq \frac{k_i}{K}\frac{M}{(1-\hat{\delta}_i)}$$

We can show that it is not possible for the left hand side of this inequality to be larger than the right hand side.

Multiplying by $(1 - \delta_i)$:

$$\frac{k_i}{K-k_m}(M - k_m) \geq \frac{k_i}{K}M$$

Subsequently multiplying by $(K - k_m)$ and K:

$$Kk_i(M - k_m) \geq (K - k_m)k_iM$$

Multiplying out the parentheses:

$$Kk_iM - Kk_ik_m \geq Kk_iM - k_mk_iM$$

Cancelling out like terms:

$$K \leq M$$

Yet, recall that by construction we imposed that K > M. Therefore, the inequality is never satisfied when $\beta_i = 0$.

Appendix E – Proof that when $\hat{\delta}_m \rightarrow 0$ and $\beta_i = 1$, the payoff to partial collusion is strictly greater than that of full so long as $k_j > 0$ where $j \neq i \neq m$ (Chapter 2)

For a given firm i, partial collusion is preferred to full collusion if Equation 2.15 is satisfied:

$$\frac{k_i}{K-k_m}\frac{(M-k_m)}{(1-\hat{\delta}_i)} \geq \left(\frac{k_i}{K} - \beta_i T\right)\frac{M}{(1-\hat{\delta}_i)}$$

Multiplying this by $(1 - \delta_i)$:

$$\frac{k_i}{K-k_m}(M - k_m) \geq \left(\frac{k_i}{K} - \beta_i T\right)M$$

When $\hat{\delta}_m \rightarrow 0$, the maverick is extremely averse to collusion and the maximal transfer is required in order to incentivise its cooperation. The maximal transfer is given in Equation 2.14. Substituting in this value of T gives:

$$\frac{k_i}{K-k_m}(M - k_m) \geq \left(\frac{k_i}{K} - \beta_i \frac{(K-M)k_m}{KM}\right)M$$

Multiplying out the outer parentheses on the right hand side:

$$\frac{k_i}{K-k_m}(M - k_m) \geq \frac{Mk_i}{K} - \beta_i \frac{(K-M)k_m}{K}$$

Subsequently multiplying by $(K - k_m)$ and K:

$$k_i(M - k_m)K \geq (K - k_m)Mk_i - \beta_i(K - k_m)(K - M)k_m$$

Multiplying out the first two sets of parentheses:

$$KMk_i - Kk_ik_m \geq KMk_i - k_mMk_i - \beta_i(K - k_m)(K - M)k_m$$

Cancelling out like terms:

$$-Kk_ik_m \geq -k_mMk_i - \beta_i(K - k_m)(K - M)k_m$$

Rearranging and simplifying:

$$-k_mk_i(K - M) \geq -\beta_i(K - k_m)(K - M)k_m$$

Dividing by $(K – M)k_m$ and inverting the sign:

$$k_i \leq \beta_i(K - k_m)$$

Where $\beta_i = 1$, this becomes:

$$k_i \leq K - k_m$$

This is true so long as there are more than two firms in the market. Non-maverick i prefers partial collusion to full collusion so long as there is some other non-maverick j.

Appendix F - When $\delta_m \rightarrow 0$ and $0 < \beta_i < 1$, under what circumstances is partial collusion preferred? (Chapter 2)

Our proof is the same as in Appendix E - from Equation 2.15 we arrive at the point:

$$k_i \leq \beta_i (K - k_m)$$

However, this time, rather than imposing $\beta_i = 1$, we can solve for β_i to ascertain the levels of transfer for which a maverick would still favour partial collusion. Dividing by $(K - k_m)$ yields:

$$\frac{k_i}{(K - k_m)} \leq \beta_i$$

Therefore partial collusion is (strictly) preferred by non-maverick i where:

$$\beta_i > \frac{k_i}{K - k_m}$$

In other words, it is preferred where their share of the 'transfer' to the maverick in order to achieve full collusion exceeds their collusive market share under partial collusion.

Appendix G – When $\hat{\delta}_m > 0$ and $\beta_i > 0$, under what circumstances is partial collusion preferred?

Here we are deriving an expression for the proportion of transfer (β_i) that would result in non-maverick i preferring partial collusion to full collusion, in cases where the maverick is not completely averse to collusion; in other words, where the maverick has some positive discount factor ($\hat{\delta}_m > 0$).

When $\hat{\delta}_m > 0$, the level of transfer required in order to facilitate full collusion with the maverick is given by the expression we derived in Appendix C:

$$T \geq \frac{(K-M)k_m(k_l-\hat{\delta}_m K)}{KMk_l}$$

Substituting this value into Equation 2.15 and multiplying by $(1 - \delta_i)$ gives:

$$\frac{k_i}{K-k_m}(M-k_m) \geq \left(\frac{k_i}{K} - \beta_i \frac{(K-M)k_m(k_l-\hat{\delta}_m K)}{KMk_l}\right)M$$

We aim to simplify this as much as possible and to ultimately produce an expression for β_i. Multiplying out the outer parenthesis on the right hand side and then multiplying by $(K - k_m)$ gives:

$$k_i(M-k_m) \geq \frac{(K-k_m)Mk_i}{K} - \frac{\beta_i(K-k_m)(K-M)k_m(k_l-\hat{\delta}_m K)}{Kk_l}$$

Multiplying by Kk_l gives:

$$k_i(M-k_m)Kk_l \geq (K-k_m)Mk_ik_l - \beta_i(K-k_m)(K-M)k_m(k_l-\hat{\delta}_m K)$$

Multiplying out the first two sets of parentheses and cancelling out like terms gives:

$$-Kk_ik_mk_l \geq -k_mMk_ik_l - \beta_i(K-k_m)(K-M)k_m(k_l-\hat{\delta}_m K)$$

Adding $k_mMk_ik_l$ gives:

$$k_mMk_ik_l - Kk_ik_mk_l \geq -\beta_i(K-k_m)(K-M)k_m(k_l-\hat{\delta}_m K)$$

Simplifying the left hand side gives:

$$-k_mk_ik_l(K-M) \geq -\beta_i(K-k_m)(K-M)k_m(k_l-\hat{\delta}_m K)$$

Dividing by $(K - M)$ and inverting the sign gives:

$$k_ik_l \leq \beta_i(K-k_m)(k_l-\hat{\delta}_m K)$$

Dividing by $(K - k_m)(kl - \hat{\delta}_m K)$ gives:

$$\beta_i > \frac{k_ik_l}{(K-k_m)(k_l-\hat{\delta}_m K)}$$

Appendix H – Proof that partial collusion is never strictly preferred by all non-mavericks (Chapter 2)

This is a straightforward proof to show that partial collusion can never be strictly preferred by all non-mavericks.

In Appendix G we showed that in order for a non-maverick to prefer partial collusion their transfer under full collusion would have to satisfy:

$$\beta_i > \frac{k_i k_l}{(K-k_m)(k_l-\hat{\delta}_m K)}$$

In order for the maverick to be incentivised to collude, we know that βs sum to one. In addition, the market shares of non-mavericks in the case of partial collusion also sum to one:

$$\sum \frac{k_i}{K-k_m} = 1$$

Thus, in order for all non-mavericks to simultaneously favour partial collusion, it would have to be the case that:

$$\sum \beta_i > \sum \frac{k_i k_l}{(K-k_m)(k_l-\hat{\delta}_m K)})$$

In other words, it would have to be the case that:

$$\frac{k_l}{(k_l-\hat{\delta}_m K)} < 1$$

Yet when $\hat{\delta}_m > 0$ it is apparent that this will never be true.

Appendix I - Application of the maverick concept by industry sector (Chapter 3)

Sector	Number of total cases	Number of maverick cases	% of maverick cases
Agriculture, Forestry and Fishing	4	0	0
Mining and Quarrying	6	1	17
Manufacturing	169	9	5
Electricity, Gas, Steam and Air Conditioning	18	3	17
Water Supply, Sewerage, Waste Management and Remediation Activities	2	0	0
Construction	3	1	33
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	10	4	40
Transportation and Storage	26	1	4
Accommodation and Food Service Activities	1	0	0
Information and Communication	31	5	16
Financial and Insurance Activities	7	0	0
Real Estate Activities	0	0	0
Professional, Scientific and Technical Activities	4	0	0
Administrative and Support Service Activities	6	1	17
Public Administration and Defence; Compulsory Social Security	0	0	0
Education	0	0	0
Human Health and Social Work Activities	1	0	0
Arts, Entertainment and Recreation	5	1	20
Other Service Activities	1	0	0
Activities of Households as Employers; Undifferentiated	0	0	0

Goods- and Services -Producing Activities of Households for Own Use			
Activities of Extraterritorial Organisations and Bodies	0	0	0
Not specified	5	0	0
Total	**299**	**26**	**9**

Appendix J – List of banks and their associated abbreviations

Bank/Building Society Name	Abbreviation
AA	AA
ABBEY	ABBE
AIRDRIE SAVINGS BANK	AIRD
ALDERMORE	ALDE
ALLIANCE & LEICESTER	AAL
ALLIANCE & LEICESTER GIRO	AALG
ALLIED IRISH BANK	AIB
AMP BANKING	AMP
ANGLO IRISH BANK	ANGL
ASDA	ASDA
AVIVA	AVIV
BANK OF CHINA (UK)	BOCH
BANK OF CYPRUS	BOCY
BANK OF IRELAND (GB)	BOIG
BANK OF IRELAND (NI)	BOIN
BANK OF SCOTLAND	BOS
BANK OF WALES	BOW
BARCLAYS	BARC
BARNSLEY BS	BARN
BATH BS	BATH
BEVERLEY BS	BEV
BIRMINGHAM MIDSHIRES	BMID
BIRMINGHAM MIDSHIRES INTERMEDIARY	BMII
BMW SAVINGS	BMW
BRADFORD & BINGLEY	BAB
BRISTOL & WEST	BAW
BRITANNIA BS	BRIT
BRITISH GAS	BGAS
BUCKINGHAMSHIRE BS	BUCK
BUTTERFIELD PRIVATE BANK	BPB
CAHOOT	CAH
CAMBRIDGE BS	CAMB
CAPITAL ONE	CAP
CATER ALLEN PRIVATE BANK	CATA
CATHOLIC BS	CATH
CHELSEA BS	CHEL
CHELTENHAM & GLOUCESTER	CHGL
CHESHAM BS	CHSM
CHESHIRE BS	CHSE
CHORLEY & DIST BS	CHOR
CITIBANK	CITI
CITY OF DERRY BS	COD

CLAY CROSS BS	CLAY
CLOSE BROTHERS	CLOB
CLYDESDALE BANK	CLYD
CO-OPERATIVE BANK	COOP
COUTTS & CO	COUT
COVENTRY BS	COV
CUMBERLAND BS	CUMB
DAO HENG BANK	DAOH
DARLINGTON BS	DARL
DERBYSHIRE BS	DERB
DIRECT LINE	DIRL
DUDLEY BS	DUD
DUNFERMLINE BS	DUNF
EARL SHILTON BS	EARS
ECOLOGY BS	ECO
EGG	EGG
FIRST ACTIVE	FIRA
FIRST DIRECT	FIRD
FIRST TRUST BANK (NI)	FTB
FIRST-E	FIRE
FIRSTSAVE	FIRS
FLEMING PREMIER BANK	FLEM
FRIZZELL BANK	FRIZ
FURNESS BS	FURN
GOLDFISH	GOLD
HALIFAX	HLFX
HANLEY ECONOMIC BS	HANL
HARPENDEN BS	HARP
HERITABLE BANK	HERI
HFC BANK	HFC
HINCKLEY & RUGBY BS	HAR
HOARE & CO	HOAR
HOLMESDALE BS	HOLM
HSBC	HSBC
ICESAVE	ICE
ICICI BANK UK	ICIC
ING DIRECT (UK)	ING
INTELLIGENT FINANCE	IF
INVESTEC BANK	INVC
IPSWICH BS	IPS
JULIAN HODGE BANK	JHB
KAUPTHING EDGE	KAUE
KAUPTHING SINGER & FRIEDLANDER	KAUS
KENT RELIANCE BS	KENT
LAIKI BANK	LAIK

LAMBETH BS	LAMB
LEEDS BS	LEED
LEEK UNITED BS	LEEK
LEGAL & GENERAL	LAG
LEOPOLD JOSEPH	LEOJ
LIVERPOOL VICTORIA	LV
LIVERPOOL VICTORIA BANKING SERVICES	LVBS
LLOYDS TSB	LTSB
LOMBARD DIRECT	LMBD
LOMBARD NORTH CENTRAL	LNC
LOUGHBOROUGH BS	LBRO
MANCHESTER BS	MANC
MANSFIELD BS	MANS
MARFIN LAIKI BANK	MLB
MARKET HARBOROUGH BS	MARH
MARKS & SPENCER	MAS
MARSDEN BS	MARS
MBNA EUROPE BANK LTD	MBNA
MBNA INTERNATIONAL	MBNI
MELTON MOWBRAY BS	MELM
MERCANTILE BS	MERC
MONEYWAY	MYWY
MONMOUTHSHIRE BS	MONM
NATIONAL COUNTIES BS	NATC
NATIONAL SAVINGS	NATS
NATIONWIDE BS	NWDE
NATWEST	NATW
NEWBURY BS	NEWB
NEWCASTLE BS	NEWC
NORTHERN BANK (NI)	NBNK
NORTHERN ROCK	NRCK
NORWICH & PETERBOROUGH BS	NAP
NORWICH UNION	NORU
NOTTINGHAM BS	NOTT
NOTTINGHAM IMPERIAL BS	NOTI
OPEN + DIRECT	OPEN
OVERSEAS TRUST BANK	OTB
POPULAR BANK	POP
PORTMAN BS	PORT
POST OFFICE	PO
PRINCIPALITY BS	PRIN
PROGRESSIVE BS	PROG
PRUDENTIAL BANKING	PRU
ROYAL BANK OF SCOTLAND	RBS
RUFFLER BANK	RUFF

SAFEWAY	SFWY
SAFFRON BS	SAFF
SAGA	SAGA
SAINSBURY'S	SAIN
SCARBOROUGH BS	SCAR
SCARBOROUGH INVESTMENTS DIRECT	SCID
SCOTTISH BS	SCOT
SCOTTISH WIDOWS BANK	SWB
SECURE TRUST BANK	STB
SHEPSHED BS	SHEP
SKIPTON BS	SKIP
SMILE	SMLE
STAFFORD RAILWAY BS	STRY
STAFFORDSHIRE BS	STAF
STANDARD LIFE BANK	SLB
STATE BANK OF INDIA	SBI
STROUD & SWINDON BS	SAS
SUN BANK	SUN
TEACHERS' BS	TCHR
TESCO	TSCO
TIPTON & COSELEY BS	TAC
TRIODOS BANK	TRIO
TURKISH BANK (UK)	TURK
ULSTER BANK	ULSB
UNITED NATIONAL BANK	UNB
UNITED TRUST BANK	UTB
UNIVERSAL BS	UNIV
VERNON BS	VERN
VIRGIN	VIRG
WEATHERBYS BANK LTD	WBYS
WESLEYAN SAVINGS BANK	WESL
WEST BROMWICH BS	WEST
WHITEAWAY LAIDLAW BANK	WLB
WOOLWICH	WOOL
YORKSHIRE BANK	YBNK
YORKSHIRE BS	YORK

Appendix K – Full results of Breunig and Menezes measure 1 (Chapter 5)

Rank	Bank	Low (£500)	Medium (£5000)	High (£50K)	Average
1	PO	2.28	2.00	1.66	1.98
2	NATC	1.60	1.52	1.40	1.51
3	TSCO	1.33	1.34	1.60	1.43
4	SBI	1.49	1.40	1.31	1.40
5	SUN	1.60	1.28	1.10	1.33
6	SAIN	1.25	1.00	0.92	1.06
7	TCHR	1.50	1.04	0.44	0.99
8	ABBE	0.93	1.00	0.77	0.90
9	OTB	1.42	0.87	0.25	0.85
10	NEWB	1.55	0.84	0.11	0.83
11	BRIT	0.68	0.98	0.73	0.80
12	COV	1.10	0.76	0.40	0.75
13	BOS	0.37	0.93	0.92	0.74
14	SMLE	1.07	0.72	0.27	0.69
15	NOTI	0.95	0.70	0.39	0.68
16	WESL	0.24	1.05	0.68	0.66
17	LEED	0.47	0.83	0.67	0.66
18	WEST	0.61	0.81	0.52	0.65
19	DAOH	1.14	0.67	0.05	0.62
20	EGG	1.07	0.65	0.13	0.62
21	CHEL	1.18	0.42	0.19	0.59
22	WOOL	0.75	0.57	0.46	0.59
23	BAW	0.85	0.61	0.13	0.53
24	YORK	0.75	0.61	0.23	0.53
25	LTSB	0.53	0.31	0.47	0.44
26	CITI	0.70	0.10	0.50	0.43
27	JHB	n/a	0.23	0.64	0.43
28	STRY	0.39	0.03	0.77	0.40
29	PORT	-0.04	0.69	0.53	0.40
30	HARP	0.25	0.46	0.37	0.36
31	BOIG	0.66	0.35	-0.01	0.33
32	LAMB	-0.05	0.79	0.23	0.32
33	BARN	0.65	0.33	-0.07	0.30
34	CHSE	0.19	0.30	0.28	0.25
35	NWDE	0.40	0.07	0.19	0.22
36	BUCK	-0.16	-0.19	0.98	0.21
37	MARS	0.28	0.23	0.08	0.20
38	HOLM	0.01	0.14	0.34	0.16
39	BARC	0.04	0.15	0.26	0.15
40	SKIP	-0.02	0.07	0.37	0.14
41	ECO	0.30	0.16	-0.07	0.13

42	MANC	-0.86	0.59	0.58	0.10
43	MELM	-0.04	0.09	0.12	0.06
44	SCAR	0.51	-0.09	-0.25	0.06
45	SAS	0.18	0.07	-0.16	0.03
46	PROG	-0.20	-0.01	0.25	0.01
47	NATS	-0.75	-0.24	0.96	-0.01
48	HLFX	0.11	0.08	-0.25	-0.02
49	DUNF	-0.71	0.07	0.41	-0.07
50	CUMB	-0.15	-0.29	0.16	-0.09
51	NAP	-0.35	-0.12	0.07	-0.13
52	TAC	-0.75	0.09	0.22	-0.15
53	COOP	-0.30	-0.21	0.02	-0.16
54	WLB	n/a	-0.26	-0.10	-0.18
55	FIRD	-0.16	0.06	-0.44	-0.18
56	SCOT	-0.13	-0.30	-0.18	-0.20
57	MARH	-0.71	0.31	-0.26	-0.22
58	NBNK	-0.39	-0.23	-0.06	-0.23
59	COD	-0.48	-0.37	0.15	-0.23
60	BATH	-1.05	0.06	0.10	-0.30
61	SHEP	-0.70	-0.10	-0.19	-0.33
62	HFC	n/a	-0.28	-0.41	-0.35
63	CHGL	-0.21	-0.35	-0.51	-0.36
64	CHOR	-0.46	-0.43	-0.19	-0.36
65	MONM	-0.40	-0.49	-0.33	-0.40
66	SAFF	-0.35	-0.55	-0.43	-0.44
67	FURN	-0.49	-0.61	-0.27	-0.46
68	LBRO	-0.25	-0.47	-0.65	-0.46
69	DERB	-0.38	-0.51	-0.52	-0.47
70	STAF	-1.02	-0.51	0.12	-0.47
71	IPS	-0.53	-0.59	-0.31	-0.47
72	TURK	-0.44	-0.47	-0.51	-0.48
73	HSBC	-0.37	-0.69	-0.62	-0.56
74	CAMB	-0.51	-0.76	-0.41	-0.56
75	BAB	-1.30	-0.04	-0.40	-0.58
76	DUD	-1.06	-0.90	0.21	-0.59
77	NOTT	-0.69	-0.70	-0.40	-0.59
78	MLB	-0.51	-0.59	-0.69	-0.60
79	AAL	-0.43	-0.57	-0.79	-0.60
80	MANS	-0.92	-0.72	-0.25	-0.63
81	RBS	-0.63	-0.73	-0.54	-0.63
82	COUT	-0.65	-0.90	-0.36	-0.64
83	HAR	-0.96	-0.90	-0.23	-0.70
84	BOCY	-0.98	-0.94	-0.27	-0.73
85	TRIO	-1.84	0.00	-0.38	-0.74
86	KENT	-0.73	-0.95	-0.62	-0.77

87	BOIN	-1.12	-0.92	-0.31	-0.78
88	NATW	-0.80	-0.79	-0.78	-0.79
89	LEEK	-0.71	-0.83	-0.85	-0.80
90	CLYD	-0.80	-0.99	-0.76	-0.85
91	ULSB	-1.37	-0.92	-0.28	-0.85
92	YBNK	-0.95	-0.84	-0.78	-0.86
93	BEV	-0.91	-0.93	-0.74	-0.86
94	BMID	-1.18	-0.93	-0.49	-0.87
95	NEWC	-1.05	-1.01	-0.58	-0.88
96	EARS	-0.71	-1.07	-0.92	-0.90
97	PRIN	-0.77	-1.01	-0.92	-0.90
98	CLAY	-0.90	-0.91	-0.91	-0.91
99	DARL	-1.17	-0.89	-0.77	-0.94
100	CATH	-1.13	-1.11	-0.65	-0.96
101	FTB	-1.46	-1.19	-0.25	-0.97
102	MERC	-1.18	-1.05	-0.83	-1.02
103	POP	-0.45	-1.01	-1.65	-1.04
104	HOAR	-1.00	-1.37	-0.83	-1.07
105	HANL	-0.87	-1.13	-1.36	-1.12
106	VERN	-1.11	-1.06	-1.19	-1.12
107	UNIV	-1.32	-1.25	-0.80	-1.13
108	NRCK	-1.56	-1.15	-1.06	-1.25
109	LAIK	-0.97	-1.32	-1.76	-1.35
110	AIRD	-1.71	-2.03	-1.18	-1.64
111	CHSM	-1.67	-1.75	-1.97	-1.80
112	AALG	-2.18	-2.75	-3.38	-2.77

Appendix L – Full results of Breunig and Menezes measure 2 (Chapter 5)

Rank	Bank	Low (£500)	Medium (£5000)	High (£50k)	Average
1	NWDE	11.71	13.08	13.09	12.63
2	IPS	12.73	11.64	6.85	10.40
3	TSCO	10.00	8.59	10.02	9.54
4	CUMB	10.26	9.41	8.81	9.49
5	EARS	9.29	9.24	8.49	9.01
6	COD	8.08	8.96	8.90	8.64
7	LEEK	8.09	9.05	8.39	8.51
8	MANS	7.16	10.23	7.81	8.40
9	SCOT	9.16	7.31	7.91	8.13
10	TCHR	8.76	7.41	7.41	7.86
11	NEWC	7.88	7.56	7.57	7.67
12	STAF	6.86	8.18	7.79	7.61
13	EGG	7.61	7.59	7.61	7.60
14	BEV	7.39	7.00	8.41	7.60
15	CHGL	7.83	5.77	7.42	7.01
16	HOAR	6.75	6.82	6.85	6.81
17	SHEP	3.43	8.45	8.42	6.77
18	DAOH	6.39	6.41	6.39	6.40
19	BOIG	6.64	5.99	5.98	6.20
20	KENT	6.95	5.47	5.71	6.04
21	MON	5.99	6.00	6.02	6.00
22	VERN	5.01	6.41	6.44	5.95
23	PO	5.75	5.82	5.83	5.80
24	BOIN	5.72	5.65	5.81	5.73
25	CLAY	5.61	5.59	5.61	5.60
26	BOS	4.68	5.64	5.94	5.42
27	HLFX	5.60	5.18	5.35	5.38
28	CHSM	5.28	6.29	4.52	5.37
29	LAIK	5.78	5.83	4.39	5.33
30	MARS	6.33	5.66	3.42	5.13
31	YBNK	5.55	6.50	3.31	5.12
32	ABBE	4.46	5.27	5.49	5.07
33	BRIT	6.14	4.07	4.81	5.00
34	HAR	3.77	5.30	5.94	5.00
35	PRIN	4.58	5.06	4.53	4.73
36	WLB	2.78	5.41	5.00	4.40
37	COV	3.14	4.87	5.16	4.39
38	HOLM	3.54	4.16	4.57	4.09
39	DUD	1.85	4.07	5.67	3.86
40	PROG	4.04	3.96	3.57	3.86
41	DERB	3.89	3.77	3.91	3.86

42	DUNF	4.04	3.46	3.92	3.81
43	RBS	2.35	4.04	5.02	3.80
44	FURN	2.59	4.39	4.38	3.79
45	MONM	2.93	2.55	5.29	3.59
46	NEWB	2.81	5.77	2.18	3.59
47	SKIP	3.77	4.34	2.34	3.48
48	TAC	0.06	4.45	5.68	3.39
49	COUT	2.92	3.87	3.28	3.36
50	JHB	9.73	1.00	-0.78	3.31
51	MELM	6.47	1.87	1.56	3.30
52	BAW	3.49	3.34	2.99	3.27
53	CAMB	3.40	3.00	2.98	3.13
54	WOOL	1.87	2.56	4.33	2.92
55	NATS	4.16	3.37	1.09	2.87
56	NATW	4.92	2.67	0.69	2.76
57	LBRO	2.17	2.67	3.23	2.69
58	SAIN	2.60	2.58	2.63	2.60
59	CHOR	2.00	1.63	4.06	2.57
60	BATH	3.29	2.11	2.22	2.54
61	CHEL	1.31	2.95	3.27	2.51
62	MERC	4.30	1.53	1.53	2.45
63	BARN	2.24	2.09	2.54	2.29
64	FTB	1.78	2.00	3.00	2.26
65	SAS	2.58	1.98	2.16	2.24
66	CLYD	2.63	1.86	2.15	2.21
67	HARP	3.99	1.70	0.69	2.13
68	LAMB	2.99	2.34	1.05	2.13
69	BAB	3.46	1.52	1.38	2.12
70	DARL	1.14	2.29	2.77	2.07
71	MARH	1.08	3.59	1.21	1.96
72	HANL	1.21	2.74	1.69	1.88
73	AAL	1.17	0.26	3.36	1.59
74	WEST	1.58	1.64	1.44	1.55
75	LTSB	1.62	1.59	1.41	1.54
76	BOCY	1.78	2.45	0.03	1.42
77	WESL	1.79	1.00	0.98	1.26
78	ULSB	4.45	-0.94	-0.09	1.14
79	STRY	2.19	1.07	-0.07	1.06
80	CHSE	0.66	1.40	1.10	1.05
81	NBNK	1.04	1.05	0.95	1.01
82	TRIO	0.00	1.41	1.41	0.94
83	AIRD	0.69	1.41	0.21	0.77
84	BARC	0.41	0.43	1.12	0.65
85	FIRD	-0.12	1.21	0.53	0.54
86	NAP	0.99	0.29	0.22	0.50

87	CITI	1.38	-0.37	0.13	0.38
88	SAFF	-0.67	0.54	1.20	0.36
89	LEED	-0.46	0.37	0.46	0.12
90	BUCK	0.65	0.21	-0.84	0.01
91	AALG	0.00	0.00	0.00	0.00
92	HFC	0.00	0.00	0.00	0.00
93	MLB	0.00	0.00	0.00	0.00
94	NATC	0.00	0.00	0.00	0.00
95	NOTI	0.00	0.00	0.00	0.00
96	OTB	0.00	0.00	0.00	0.00
97	POP	0.00	0.00	0.00	0.00
98	SBI	0.00	0.00	0.00	0.00
99	TURK	0.00	0.00	0.00	0.00
100	ECO	3.00	-1.41	-1.83	-0.08
101	BMID	-0.54	0.30	-0.39	-0.21
102	YORK	-0.94	-0.29	0.03	-0.40
103	NOTT	-3.54	2.16	0.02	-0.46
104	NRCK	0.25	-0.72	-1.11	-0.52
105	MANC	2.47	-0.85	-3.24	-0.54
106	SCAR	1.23	-2.31	-1.81	-0.96
107	HSBC	-1.60	-0.81	-0.87	-1.09
108	COOP	-0.99	-1.82	-0.77	-1.20
109	SMLE	-3.67	-3.74	-3.75	-3.72
110	UNIV	-3.75	-4.90	-4.32	-4.32
111	PORT	-4.78	-4.83	-4.37	-4.66
112	CATH	-5.41	-6.21	-6.20	-5.94

Appendix M – BM measure 1 applied to the full dataset (Chapter 5)

Rank	Bank	Low (£500)	Medium (£5000)	High (£50K)	Average
1	KAUE	2.71	2.40	2.00	2.37
2	UNB	2.47	2.36	2.19	2.34
3	ICE	2.20	1.93	1.51	1.88
4	HERI	2.72	1.67	1.23	1.87
5	FIRE	2.32	1.87	1.21	1.80
6	OPEN	2.58	1.72	1.03	1.78
7	SCID	n/a	1.83	1.66	1.74
8	ICIC	1.93	1.73	1.42	1.69
9	ANGL	1.99	1.73	1.31	1.68
10	SWB	2.03	1.63	1.31	1.66
11	AA	1.85	1.58	1.19	1.54
12	BMW	2.15	1.40	1.01	1.52
13	INVC	n/a	1.96	1.07	1.52
14	FIRS	1.74	1.52	1.24	1.50
15	RUFF	n/a	n/a	1.47	1.47
16	BGAS	1.78	1.48	1.03	1.43
17	MBNA	n/a	1.65	1.12	1.39
18	CAP	1.50	1.50	1.09	1.37
19	PO	1.64	1.40	1.04	1.36
20	GOLD	1.59	1.27	1.19	1.35
21	SUN	1.83	1.23	0.83	1.30
22	ASDA	1.52	1.32	1.00	1.28
23	ING	1.62	1.32	0.89	1.28
24	LMBD	1.60	1.16	0.97	1.24
25	IF	1.62	1.26	0.83	1.24
26	CAH	1.56	1.25	0.87	1.23
27	LAG	1.67	1.19	0.70	1.19
28	FRIZ	1.71	1.13	0.57	1.14
29	MBNI	n/a	1.42	0.78	1.10
30	SLB	1.29	1.05	0.76	1.04
31	FIRA	1.10	1.14	0.83	1.02
32	KAUS	n/a	n/a	1.01	1.01
33	SBI	1.14	1.02	0.86	1.01
34	LV	1.41	1.04	0.55	1.00
35	UTB	1.18	1.03	0.78	1.00
36	EGG	1.43	1.02	0.51	0.99
37	ALDE	n/a	1.05	0.88	0.97
38	BMII	n/a	0.92	0.98	0.95
39	WLB	n/a	1.00	0.86	0.93
40	NATC	0.83	0.99	0.96	0.92
41	SFWY	1.12	0.98	0.67	0.92

42	LEOJ	n/a	n/a	0.89	0.89
43	TSCO	0.85	0.77	0.95	0.86
44	TCHR	0.74	0.82	0.86	0.81
45	CHEL	1.41	0.64	0.28	0.78
46	BOW	0.05	1.46	0.77	0.76
47	DIRL	1.00	0.68	0.55	0.74
48	BPB	n/a	n/a	0.74	0.74
49	VIRG	1.13	0.69	0.22	0.68
50	SAIN	0.85	0.68	0.52	0.68
51	WESL	0.73	0.87	0.42	0.67
52	NWDE	0.99	0.57	0.23	0.60
53	MAS	0.72	0.62	0.45	0.60
54	NORU	n/a	0.76	0.35	0.55
55	SAGA	-0.34	1.21	0.74	0.54
56	STB	-0.58	1.24	0.94	0.53
57	FLEM	n/a	0.54	0.49	0.52
58	CLOB	0.54	0.71	0.27	0.51
59	NEWB	0.95	0.29	0.25	0.49
60	AMP	0.25	0.62	0.55	0.47
61	LVBS	0.73	0.47	0.09	0.43
62	BOS	-0.06	0.76	0.49	0.40
63	SKIP	0.02	0.37	0.68	0.36
64	BUCK	0.28	0.24	0.42	0.32
65	BMID	0.04	0.46	0.39	0.29
66	PORT	-0.15	0.54	0.45	0.28
67	JHB	n/a	0.08	0.47	0.27
68	MYWY	-0.59	0.64	0.70	0.25
69	NRCK	0.57	0.25	-0.09	0.24
70	CATA	n/a	0.03	0.42	0.23
71	YORK	0.52	0.26	-0.14	0.21
72	SCAR	0.72	0.13	-0.23	0.21
73	NATS	0.11	0.01	0.48	0.20
74	WEST	0.27	0.29	0.04	0.20
75	ABBE	0.18	0.19	0.18	0.18
76	LNC	n/a	n/a	0.13	0.13
77	COV	0.38	0.18	-0.18	0.12
78	HARP	-0.57	0.60	0.25	0.09
79	BAW	0.31	0.19	-0.25	0.08
80	LEED	-0.17	0.31	0.07	0.07
81	SMLE	0.50	0.08	-0.40	0.06
82	AAL	0.18	0.16	-0.17	0.05
83	BAB	-0.76	0.62	0.28	0.05
84	BRIT	0.06	0.08	-0.05	0.03
85	CITI	0.15	-0.16	0.07	0.02
86	NAP	0.06	0.03	-0.09	0.00

87	SAFF	0.21	-0.06	-0.16	0.00
88	OTB	0.74	-0.06	-0.75	-0.02
89	STAF	-1.24	0.52	0.65	-0.03
90	LAMB	-0.31	-0.01	0.23	-0.03
91	WOOL	0.11	-0.06	-0.20	-0.05
92	HOLM	-0.08	-0.41	0.29	-0.07
93	STRY	0.16	-0.25	-0.15	-0.08
94	LBRO	0.00	-0.14	-0.19	-0.11
95	PROG	-0.41	-0.08	0.14	-0.12
96	LEEK	-1.32	0.57	0.39	-0.12
97	MLB	-0.07	-0.11	-0.18	-0.12
98	MANS	-0.69	0.01	0.31	-0.12
99	LTSB	0.00	-0.22	-0.18	-0.13
100	DAOH	0.53	-0.14	-0.80	-0.14
101	HAR	-0.55	-0.06	0.12	-0.16
102	TAC	-0.85	0.07	0.27	-0.17
103	MARH	-0.65	-0.04	0.14	-0.18
104	IPS	-0.67	0.07	0.05	-0.18
105	CHGL	-0.35	-0.05	-0.16	-0.19
106	SAS	-0.34	-0.13	-0.12	-0.19
107	CHSE	-0.37	-0.03	-0.19	-0.20
108	BARN	0.06	-0.32	-0.34	-0.20
109	PRIN	-0.23	-0.30	-0.10	-0.21
110	HLFX	0.09	-0.25	-0.49	-0.22
111	FIRD	-0.17	-0.04	-0.46	-0.22
112	TURK	-0.79	0.11	-0.02	-0.23
113	ECO	-0.15	-0.23	-0.38	-0.25
114	CHOR	-0.77	-0.04	0.05	-0.26
115	DUNF	-0.71	-0.21	0.15	-0.26
116	NEWC	-0.16	-0.54	-0.07	-0.26
117	CUMB	-0.57	-0.25	0.02	-0.27
118	MELM	-0.45	-0.40	0.03	-0.27
119	BARC	-0.26	-0.31	-0.25	-0.27
120	COD	-1.07	-0.22	0.47	-0.27
121	NOTI	0.28	-0.37	-0.77	-0.29
122	UNIV	-1.16	0.17	0.12	-0.29
123	MARS	-0.31	-0.34	-0.24	-0.30
124	DERB	-0.40	-0.26	-0.23	-0.30
125	MANC	-1.63	0.41	0.32	-0.30
126	BOIG	-0.01	-0.32	-0.68	-0.33
127	SCOT	-0.62	-0.27	-0.19	-0.36
128	EARS	-0.43	-0.61	-0.09	-0.38
129	TRIO	-0.37	-0.26	-0.51	-0.38
130	POP	0.25	-0.57	-0.84	-0.38
131	CLYD	-0.60	-0.36	-0.38	-0.44

132	NATW	0.01	-0.78	-0.62	-0.46
133	RBS	-0.51	-0.68	-0.39	-0.53
134	NOTT	-1.20	-0.25	-0.13	-0.53
135	MONM	-1.04	-0.42	-0.14	-0.54
136	SHEP	-0.62	-0.56	-0.43	-0.54
137	BEV	-1.24	-0.24	-0.14	-0.54
138	DUD	-1.03	-0.85	0.03	-0.62
139	CAMB	-1.10	-0.41	-0.38	-0.63
140	BATH	-1.89	-0.16	0.10	-0.65
141	FURN	-0.98	-0.64	-0.34	-0.65
142	COOP	-0.71	-0.71	-0.57	-0.66
143	YBNK	-0.73	-0.67	-0.60	-0.67
144	KENT	-0.63	-0.97	-0.49	-0.70
145	CLAY	-1.45	-0.54	-0.18	-0.72
146	NBNK	-0.90	-0.67	-0.61	-0.73
147	HSBC	-0.49	-0.85	-0.86	-0.73
148	BOCY	-1.23	-0.69	-0.35	-0.75
149	LAIK	-0.45	-0.80	-1.04	-0.76
150	AVIV	n/a	-0.68	-0.85	-0.77
151	HANL	-1.09	-0.81	-0.42	-0.77
152	PRU	-0.44	-1.14	-0.85	-0.81
153	CATH	-1.19	-0.89	-0.47	-0.85
154	WBYS	-0.79	-0.89	-0.89	-0.86
155	VERN	-1.71	-0.58	-0.29	-0.86
156	BOCH	-0.82	-0.92	-1.09	-0.94
157	DARL	-1.38	-1.15	-0.41	-0.98
158	MERC	-1.74	-0.90	-0.54	-1.06
159	ULSB	-1.82	-0.96	-0.51	-1.10
160	BOIN	-1.72	-1.08	-0.52	-1.11
161	CHSM	-2.12	-1.01	-0.22	-1.12
162	COUT	-1.30	-1.58	-0.90	-1.26
163	HFC	n/a	-1.25	-1.44	-1.35
164	FTB	-2.06	-1.84	-0.94	-1.61
165	HOAR	-1.60	-2.02	-1.23	-1.62
166	AIRD	-2.40	-2.00	-1.54	-1.98
167	AIB	n/a	-2.73	-1.37	-2.05
168	AALG	-2.86	-3.75	-4.43	-3.68

Appendix N – BM measure 2 applied to the full dataset (Chapter 5)

Rank	Bank	Low (£500)	Medium (£5000)	High (£50K)	Average
1	ASDA	10.63	11.02	10.38	10.67
2	ICIC	9.44	9.14	10.05	9.54
3	NWDE	9.90	9.15	8.00	9.02
4	CUMB	6.63	10.37	9.90	8.97
5	ING	9.14	8.00	8.33	8.49
6	NATC	6.09	7.52	8.04	7.22
7	TSCO	7.24	6.43	7.92	7.20
8	LMBD	6.66	6.73	7.07	6.82
9	BEV	3.00	8.09	9.33	6.81
10	NATS	7.60	7.37	5.32	6.76
11	BOS	5.57	6.64	7.50	6.57
12	BMW	10.23	4.74	4.73	6.57
13	VIRG	5.00	7.23	6.00	6.08
14	LNC	5.63	4.03	8.34	6.00
15	BOIN	7.45	5.65	4.81	5.97
16	PRU	1.78	7.96	8.13	5.96
17	SUN	5.88	5.94	5.96	5.93
18	CLAY	4.02	6.66	6.88	5.86
19	LAIK	6.36	5.49	5.50	5.78
20	KENT	6.28	5.18	5.45	5.64
21	FLEM	1.25	7.63	7.72	5.53
22	EGG	4.73	6.06	5.58	5.46
23	PO	5.01	5.57	5.68	5.42
24	DAOH	6.13	5.00	5.00	5.38
25	FTB	6.88	4.63	4.34	5.28
26	SHEP	3.90	5.43	6.47	5.27
27	PRIN	4.78	4.83	6.14	5.25
28	IF	5.92	5.09	4.69	5.23
29	TCHR	2.12	6.57	6.94	5.21
30	BOIG	5.45	5.06	5.11	5.20
31	HAR	3.05	6.27	6.10	5.14
32	UTB	5.00	5.00	5.00	5.00
33	DUD	4.43	4.91	5.58	4.97
34	RBS	5.12	4.72	4.75	4.86
35	HOLM	3.94	5.33	5.27	4.84
36	LEEK	3.64	5.32	5.55	4.84
37	MBNA	4.50	5.00	5.00	4.83
38	FRIZ	4.92	5.17	4.16	4.75
39	STRY	4.79	4.37	4.21	4.46
40	HLFX	3.47	4.92	4.85	4.41
41	NATW	4.21	5.34	3.40	4.31

42	STAF	3.00	3.97	5.58	4.18
43	WESL	2.19	4.98	5.32	4.16
44	LAMB	4.04	4.32	3.89	4.08
45	CLOB	2.50	4.03	5.60	4.05
46	NEWB	2.07	5.84	4.22	4.04
47	CHSM	2.85	3.73	5.50	4.02
48	NEWC	3.52	3.82	4.46	3.93
49	BRIT	3.50	3.89	4.29	3.89
50	WLB	2.21	4.50	4.82	3.84
51	TAC	1.82	4.44	5.10	3.79
52	LVBS	2.91	4.42	4.02	3.78
53	COD	1.94	4.53	4.76	3.74
54	SCOT	3.55	3.75	3.59	3.63
55	CAH	2.95	3.26	4.49	3.57
56	FURN	2.92	3.90	3.82	3.55
57	EARS	4.08	3.21	3.19	3.49
58	BARC	2.20	4.19	4.04	3.48
59	DIRL	2.95	3.85	3.37	3.39
60	FIRS	2.50	3.95	3.65	3.37
61	ANGL	5.79	2.10	2.15	3.35
62	COV	2.77	3.45	3.70	3.30
63	SKIP	3.46	2.51	3.65	3.21
64	CHGL	3.48	2.89	3.22	3.20
65	FIRA	3.28	3.28	3.02	3.20
66	HOAR	3.52	3.03	2.63	3.06
67	MARS	2.35	3.96	2.85	3.05
68	MARH	1.95	4.05	3.11	3.04
69	FIRE	2.88	2.94	2.96	2.93
70	ECO	3.70	2.39	2.64	2.91
71	MANS	2.00	3.72	2.98	2.90
72	MELM	2.71	2.42	3.28	2.81
73	AA	2.77	2.53	2.54	2.61
74	ABBE	2.81	2.18	2.80	2.60
75	IPS	1.40	2.94	3.14	2.49
76	CAMB	2.95	1.03	3.18	2.39
77	YBNK	2.74	2.40	1.75	2.30
78	COUT	1.69	1.98	2.99	2.22
79	CLYD	1.66	2.49	2.48	2.21
80	PROG	1.60	2.02	2.96	2.19
81	BARN	1.90	1.77	2.81	2.16
82	RUFF	1.13	0.00	5.33	2.15
83	FIRD	3.76	1.09	1.18	2.01
84	MONM	2.18	1.49	2.22	1.97
85	LEED	1.57	1.65	2.62	1.95
86	BAW	1.59	2.00	2.17	1.92

87	SWB	0.93	1.41	3.28	1.88
88	LAG	0.93	2.24	2.35	1.84
89	WOOL	1.21	1.25	2.75	1.74
90	ULSB	2.50	1.09	1.50	1.70
91	INVC	0.50	-0.04	4.63	1.70
92	DARL	0.61	1.10	3.26	1.66
93	HARP	1.58	1.75	1.44	1.59
94	GOLD	1.45	1.51	1.52	1.49
95	DERB	1.46	1.68	1.31	1.48
96	WEST	1.54	1.45	1.22	1.40
97	NBNK	1.21	1.32	1.66	1.39
98	LBRO	1.27	1.15	1.75	1.39
99	SAGA	1.90	1.12	0.99	1.34
100	SAFF	1.99	0.88	1.03	1.30
101	SAS	1.14	1.84	0.89	1.29
102	NAP	1.73	1.21	0.86	1.27
103	KAUE	1.00	1.29	1.34	1.21
104	AAL	0.81	1.17	1.62	1.20
105	BOCY	0.25	1.92	0.83	1.00
106	SAIN	1.12	0.39	1.36	0.96
107	BAB	0.26	1.42	1.17	0.95
108	CAP	1.05	0.66	1.10	0.94
109	HANL	1.72	0.54	0.51	0.92
110	CHSE	0.44	1.30	0.95	0.90
111	MERC	1.69	0.32	0.63	0.88
112	CHEL	0.56	1.09	0.93	0.86
113	LTSB	1.07	0.75	0.68	0.83
114	LEOJ	0.81	0.55	1.06	0.81
115	NORU	0.47	1.12	0.74	0.77
116	DUNF	1.17	0.02	1.05	0.75
117	BMID	0.07	0.85	1.24	0.72
118	AIRD	0.00	1.29	0.67	0.65
119	SFWY	0.80	-0.66	1.75	0.63
120	BATH	0.44	0.57	0.20	0.40
121	CITI	0.55	-0.19	0.79	0.38
122	BOW	0.00	0.29	0.34	0.21
123	OPEN	0.00	0.29	0.34	0.21
124	TURK	0.00	0.26	0.27	0.18
125	MBNI	0.12	0.06	0.04	0.07
126	VERN	1.20	-0.34	-0.66	0.07
127	BPB	0.31	-0.27	0.14	0.06
128	ALDE	0.00	0.00	0.00	0.00
129	AALG	0.00	0.00	0.00	0.00
130	AMP	0.00	0.00	0.00	0.00
131	AVIV	0.00	0.00	0.00	0.00

132	BOCH	0.00	0.00	0.00	0.00
133	BMII	0.00	0.00	0.00	0.00
134	MLB	0.00	0.00	0.00	0.00
135	MAS	0.00	0.00	0.00	0.00
136	MYWY	0.00	0.00	0.00	0.00
137	NOTI	0.00	0.00	0.00	0.00
138	OTB	0.00	0.00	0.00	0.00
139	POP	0.00	0.00	0.00	0.00
140	SCID	0.00	0.00	0.00	0.00
141	SBI	0.00	0.00	0.00	0.00
142	WBYS	0.00	0.00	0.00	0.00
143	HERI	-0.70	0.51	0.16	-0.01
144	MANC	0.62	-0.25	-0.61	-0.08
145	AIB	-0.50	-0.36	0.34	-0.17
146	HFC	-1.00	0.00	0.00	-0.33
147	YORK	-0.58	-0.40	-0.16	-0.38
148	COOP	0.12	-1.09	-0.22	-0.40
149	CHOR	1.17	-1.47	-1.24	-0.51
150	TRIO	-1.06	-0.11	-0.42	-0.53
151	SCAR	-0.15	-1.12	-0.88	-0.71
152	NRCK	-0.25	-0.88	-1.03	-0.72
153	CATA	-0.64	-3.69	1.96	-0.79
154	HSBC	-0.69	-0.92	-1.15	-0.92
155	JHB	4.11	-3.41	-3.53	-0.95
156	CATH	0.70	-1.67	-2.25	-1.07
157	SMLE	-2.82	-0.97	0.35	-1.15
158	ICE	-1.43	-1.04	-0.97	-1.15
159	UNB	-1.13	-1.34	-1.38	-1.28
160	BUCK	-0.19	-2.05	-2.10	-1.45
161	STB	-1.61	-2.53	-1.14	-1.76
162	SLB	-3.04	-1.85	-2.91	-2.60
163	UNIV	0.05	-4.39	-4.16	-2.83
164	KAUS	-3.78	-1.14	-4.11	-3.01
165	NOTT	-0.20	-4.93	-5.42	-3.52
166	BGAS	-6.13	-3.71	-3.66	-4.50
167	PORT	-0.95	-7.10	-5.81	-4.62
168	LV	-7.13	-7.34	-7.38	-7.28

Appendix O – BM Measure 1, individual calendar years (£500 deposit level)

Bank	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AAL	-0.29	-0.43	-0.26	0.44	0.34	-0.50	-0.79	-1.12	-1.39	-0.46
AALG	-2.18	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ABBE	-1.95	0.26	1.15	1.08	1.79	1.71	1.65	1.42	1.68	0.57
AIRD	-1.70	-1.87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BAB	-0.68	-1.14	-1.22	-1.06	-1.19	-1.30	-1.34	-1.69	-1.96	-0.50
BARC	-0.38	-0.72	-0.87	-0.55	-0.16	-0.20	0.83	0.92	1.22	0.48
BARN	1.18	1.35	0.96	0.82	0.74	0.63	0.21	-0.24	-0.18	-0.04
BATH	-0.83	n/a	n/a	n/a	-1.31	-1.40	-1.55	-1.81	-1.91	0.26
BAW	0.76	0.88	0.81	0.96	0.92	0.80	n/a	n/a	n/a	n/a
BEV	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-1.28	-1.28	-0.48
BMID	-0.96	-1.16	-1.27	-1.11	-1.19	-1.42	n/a	n/a	n/a	n/a
BOCY	-1.19	-0.92	-0.77	-0.93	-1.09	-1.15	-1.13	-1.13	-1.18	-0.33
BOIG	-1.55	0.58	0.98	0.80	0.91	0.85	0.87	0.87	0.74	-0.49
BOIN	-1.33	-0.98	-1.27	-1.16	-1.11	-1.21	-1.23	-1.23	-1.30	-0.48
BOS	0.15	-0.19	-0.08	-0.16	-0.34	-0.40	0.01	2.27	2.40	0.51
BRIT	0.48	1.01	1.17	0.67	0.65	0.69	0.54	0.82	0.68	0.49
BUCK	-1.26	-1.48	-1.02	-0.86	-0.69	-0.53	0.41	1.73	1.70	0.45
CAMB	0.26	0.02	-0.52	-0.62	-0.58	-0.60	-0.80	-0.85	-0.88	-0.51
CATH	0.06	n/a	n/a	n/a	n/a	n/a	-1.05	-1.16	-1.18	n/a
CHEL	n/a	n/a	n/a	n/a	n/a	n/a	1.89	1.50	1.19	0.77
CHGL	-1.48	-1.57	-1.02	-0.86	-0.64	-0.78	-0.10	0.62	0.46	0.08
CHOR	0.09	-0.35	-0.67	-0.79	-0.78	-0.80	-0.48	-0.47	-0.27	-0.39
CHSE	-0.24	0.61	0.56	0.53	0.42	0.11	-0.03	-0.36	-0.53	-0.42
CHSM	-2.09	-2.15	-1.42	-1.26	-1.47	-1.54	-1.62	-2.00	-2.10	-0.54
CITI	-2.40	n/a	n/a	2.62	1.01	0.38	0.30	0.14	1.50	2.15
CLAY	-0.45	-1.04	-1.12	-1.03	n/a	n/a	n/a	n/a	n/a	n/a
CLYD	0.06	-0.65	-0.84	-1.00	-0.80	-1.05	-1.19	-1.38	-1.47	-0.45
COD	0.25	-0.05	-0.52	-0.63	-0.63	-0.70	-0.68	-0.72	-0.66	-0.44
COOP	-0.34	-0.34	-0.52	-0.86	-1.24	-0.51	-0.01	0.97	1.41	0.28
COUT	-1.65	n/a	n/a	n/a	n/a	-0.40	-0.38	-0.46	-0.96	-0.19
COV	0.94	0.55	0.59	0.87	1.22	1.79	1.65	1.46	1.34	0.15
CUMB	0.16	0.02	-0.69	-0.63	-0.45	-0.13	-0.01	-0.07	0.07	-0.10
DAOH	n/a	1.14	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
DARL	-1.06	-1.15	-1.02	-0.93	-1.02	-1.20	-1.26	-1.55	-1.74	-0.52
DERB	-1.29	-1.41	-0.57	-0.46	-0.34	-0.38	-0.16	0.06	0.04	-0.32
DUD	-0.54	-0.90	-1.12	-1.02	-1.03	-1.16	-1.34	-1.49	-1.52	-0.50
DUNF	-0.29	-0.66	-1.02	-0.97	-0.85	-0.93	-1.02	-1.06	-0.43	-0.48
EARS	0.38	-0.22	-0.66	-0.85	-0.84	-0.86	-0.90	-1.12	-1.34	-0.47
ECO	0.95	0.66	0.33	0.22	0.16	0.15	0.12	-0.08	0.18	0.23
EGG	2.81	2.18	0.90	0.57	-0.15	-0.62	n/a	n/a	n/a	n/a
FIRD	0.69	0.26	-0.15	-0.51	-0.67	-0.70	-0.77	-0.82	-1.00	-0.77
FTB	-1.68	-1.86	-1.42	-1.27	-1.34	-1.46	-1.43	-1.73	-1.91	-0.53

FURN	-0.02	-0.59	-0.52	-0.47	-0.58	-0.70	-0.70	-0.68	-0.86	-0.13
HANL	-2.19	-1.99	-0.54	-0.46	-0.56	-0.70	-0.70	-0.73	-0.78	-0.45
HAR	-0.80	-1.08	-0.83	-0.80	-0.94	-1.09	-1.15	-1.18	-1.33	-0.48
HARP	-0.02	-0.46	-0.52	-0.36	-0.83	-0.84	0.89	0.70	0.83	0.83
HLFX	0.95	1.07	0.46	0.38	0.30	0.18	-0.09	-0.43	-0.58	-0.37
HOAR	-0.52	-0.86	-1.22	-1.13	-1.09	-1.15	-1.13	-1.13	-1.33	-0.49
HOLM	0.14	0.30	0.03	-0.04	0.09	-0.05	-0.05	-0.17	-0.17	-0.19
HSBC	0.01	-0.57	-0.49	-0.29	-0.20	-0.34	-0.47	-0.33	-0.55	-0.49
IPS	0.27	0.32	-0.52	-0.59	-0.72	-0.86	-0.94	-1.33	-0.96	-0.21
KENT	0.52	0.18	-0.26	-0.77	-1.04	-1.20	-1.17	-1.38	-0.76	-0.39
LAIK	-0.60	-0.42	-0.77	-0.93	-1.16	-1.25	-1.23	-1.23	-1.26	-0.55
LAMB	n/a	1.70	0.94	0.26	-0.91	-1.19	-1.27	n/a	n/a	n/a
LBRO	0.55	0.17	-0.23	-0.56	-0.64	-0.79	-0.49	-0.25	-0.34	0.05
LEED	0.57	0.07	0.83	0.71	0.60	0.50	0.35	0.29	0.43	0.27
LEEK	-0.16	-0.50	-0.77	-0.80	-0.84	-0.90	-0.88	-0.88	-1.10	-0.44
LTSB	0.11	0.34	0.58	0.41	0.37	0.53	0.48	0.48	0.78	0.82
MANC	-1.52	-0.32	-1.27	-1.11	-1.29	n/a	n/a	n/a	n/a	n/a
MANS	-0.36	-0.48	-1.23	-1.11	-0.88	-0.91	-0.99	-1.38	-1.51	-0.36
MARH	0.03	-0.44	-0.94	-0.86	-0.90	-1.05	-1.09	-1.25	-1.31	-0.21
MARS	0.83	0.43	0.23	0.17	0.12	0.37	0.02	0.02	0.46	0.12
MELM	0.41	-0.03	-0.32	-0.18	0.20	0.12	0.13	0.12	-0.01	-0.43
MERC	-0.51	-1.05	-1.27	-1.19	-1.32	-1.48	-1.54	n/a	n/a	n/a
MLB	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.51
MONM	0.22	-0.19	-0.52	-0.58	-0.48	-0.71	-0.74	-0.70	-0.65	-0.13
NAP	-0.29	-0.32	-0.52	-0.31	-0.41	-0.68	-0.71	-0.55	0.07	-0.04
NATC	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.60
NATS	-1.00	-1.23	-1.02	-1.07	-0.40	-0.40	-0.48	-0.78	-0.92	-0.17
NATW	-0.29	-0.89	-0.87	-0.87	-0.91	-0.95	-0.88	-0.93	-1.10	-0.41
NBNK	-0.61	-1.28	-1.42	-1.26	-1.25	-0.41	0.76	1.33	-0.25	-0.48
NEWB	1.66	1.38	1.83	1.63	1.56	1.54	1.70	1.67	1.56	0.86
NEWC	-1.07	-1.35	-1.26	-1.13	-1.20	-0.23	-1.24	-1.68	-1.83	-0.55
NOTI	0.95	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOTT	-1.54	-1.47	-0.67	-0.58	-0.72	-0.87	-0.60	-0.80	-0.89	0.68
NRCK	-1.05	-2.17	-1.37	-1.21	-1.54	-1.90	-1.90	-2.15	-2.18	0.58
NWDE	1.49	1.13	0.63	0.56	0.54	0.43	0.37	0.11	-0.10	-0.38
OTB	1.43	1.38	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PO	n/a	n/a	n/a	n/a	n/a	n/a	2.61	2.62	2.74	1.23
POP	-0.45	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PORT	1.43	1.37	1.31	0.34	-0.99	-1.16	-1.43	-1.70	n/a	n/a
PRIN	-0.30	-0.76	-1.02	-0.95	-0.77	-0.81	-0.70	-0.81	-1.12	-0.47
PROG	0.32	0.48	0.16	0.14	0.21	0.04	-0.64	-0.93	-1.14	-0.54
RBS	-1.22	-1.40	-1.04	-0.63	-0.26	-0.41	-0.49	-0.57	-0.49	-0.30
SAFF	0.39	0.02	-0.47	-0.35	-0.39	-0.50	-0.61	-0.85	-1.10	-0.52
SAIN	2.12	1.76	1.33	1.24	1.36	1.21	1.16	1.02	0.66	-0.33
SAS	0.65	0.34	-0.04	-0.06	-0.06	-0.01	0.33	0.18	0.03	0.24

SBI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.49
SCAR	-1.69	-2.03	-0.95	0.44	0.62	1.13	1.54	1.51	1.27	1.56
SCOT	0.23	0.27	-0.17	-0.28	-0.21	0.14	-0.39	-0.73	-0.73	-0.41
SHEP	0.25	0.01	-0.57	-0.77	-0.73	-0.73	-0.80	-1.16	-1.20	-0.47
SKIP	n/a	n/a	n/a	n/a	-0.69	0.22	-0.63	-0.09	-0.08	0.16
SMLE	2.25	1.89	1.48	1.12	1.12	1.10	1.05	0.71	0.64	-0.40
STAF	-0.92	-1.14	-1.02	-0.96	n/a	n/a	n/a	n/a	n/a	n/a
STRY	0.75	0.35	0.48	0.39	0.46	0.40	0.41	0.37	0.49	-0.17
SUN	2.05	1.56	1.05	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TAC	-2.19	-1.86	-1.27	-1.09	-0.84	-0.93	-0.37	-0.30	-0.50	-0.48
TCHR	1.91	1.48	1.04	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TRIO	-1.84	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TSCO	2.10	1.82	1.33	1.19	1.26	1.20	1.22	1.37	1.15	0.70
TURK	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.44
ULSB	-2.19	-2.05	-1.42	-1.26	-1.56	-1.39	-1.34	-1.16	-1.39	-0.53
UNIV	-1.27	-1.55	-1.08	-1.11	-1.14	-1.42	-1.57	n/a	n/a	n/a
VERN	-0.80	-0.97	-1.02	-0.86	-1.27	-1.46	-1.38	-1.49	-1.54	-0.38
WESL	n/a	n/a	n/a	n/a	0.67	0.62	0.51	0.13	-0.01	-0.37
WEST	1.21	0.85	0.57	0.67	0.39	0.18	0.81	0.97	0.79	0.00
WOOL	0.75	0.59	1.07	0.56	0.87	0.83	0.67	0.44	n/a	n/a
YBNK	-0.51	-0.95	-0.96	-1.08	-1.19	-0.95	-1.09	-1.28	-1.29	-0.45
YORK	0.92	0.66	0.91	0.80	0.98	0.99	0.81	0.74	0.73	0.01

Appendix P - BM Measure 1, individual calendar years (£5000 deposit level)

Bank	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AAL	-0.45	-0.50	-0.48	0.19	0.05	-0.74	-1.00	-1.30	-1.63	-0.08
AALG	-2.75	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ABBE	-0.23	0.81	0.81	0.75	1.46	1.35	1.34	1.12	1.61	1.01
AIRD	-2.02	-2.13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BAB	-0.94	-0.06	-0.05	-0.06	-0.20	-0.43	-0.30	0.01	1.34	-0.31
BARC	-0.83	-0.87	-0.29	0.03	0.41	0.34	0.09	0.47	0.83	0.36
BARN	0.83	0.98	0.70	0.54	0.38	0.24	-0.14	-0.55	-0.52	-0.13
BATH	0.17	0.05	0.10	0.06	-0.12	-0.14	-0.24	-0.40	0.10	0.39
BAW	0.29	0.67	0.66	0.80	0.72	0.57	n/a	n/a	n/a	n/a
BEV	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-1.23	-1.25	-0.57
BMID	-1.30	-1.32	-0.62	-0.64	-0.76	-1.03	n/a	n/a	n/a	n/a
BOCY	-0.34	-0.57	-0.86	-1.00	-1.21	-1.29	-1.24	-1.21	-1.29	-0.43
BOIG	-1.36	0.30	0.64	0.52	0.54	0.46	0.51	0.54	0.38	-0.60
BOIN	-1.15	-0.79	-1.11	-1.20	-1.21	-1.29	-1.24	-1.21	-1.15	0.33
BOS	0.09	-0.22	0.52	0.44	1.79	1.71	1.81	2.06	2.30	0.83
BRIT	0.94	1.15	1.49	1.09	1.09	1.02	0.90	0.93	0.73	0.42
BUCK	-1.17	-1.46	-1.36	-1.19	-0.56	0.09	0.05	1.40	1.34	0.35
CAMB	-0.10	-0.28	-0.76	-0.84	-0.85	-0.90	-1.06	-1.08	-1.14	-0.60
CATH	0.14	n/a	n/a	n/a	n/a	n/a	-1.06	-1.14	-1.26	n/a
CHEL	-1.94	-0.43	0.60	0.57	0.54	0.41	0.39	0.30	0.55	0.82
CHGL	-2.04	-2.04	-1.36	-1.19	-1.01	-1.17	-0.46	0.35	0.78	0.20
CHOR	0.13	-0.22	-0.71	-0.81	-0.85	-0.89	-0.40	-0.35	-0.18	-0.40
CHSE	0.07	0.69	0.80	0.67	0.45	0.16	0.07	-0.21	-0.42	-0.49
CHSM	-1.79	-2.05	-1.61	-1.44	-1.70	-1.78	-1.83	-2.19	-2.33	-0.64
CITI	-0.57	-1.30	-1.36	-1.28	-0.93	-0.58	0.10	0.10	1.33	2.05
CLAY	-0.52	-0.97	-1.11	-1.05	n/a	n/a	n/a	n/a	n/a	n/a
CLYD	-0.31	-0.78	-0.99	-1.23	-0.97	-1.24	-1.35	-1.51	-1.64	-0.56
COD	0.18	-0.02	-0.36	-0.46	-0.50	-0.54	-0.49	-0.50	-0.52	-0.46
COOP	0.50	-0.05	-0.39	-0.80	-1.10	-0.37	-0.27	0.65	1.06	0.17
COUT	-1.04	-1.35	n/a	n/a	n/a	-0.80	-0.74	-0.80	-1.32	-0.30
COV	-0.04	0.44	0.59	0.74	1.00	1.28	1.21	1.04	0.91	-0.06
CUMB	-0.20	-0.31	-0.85	-0.74	-0.60	-0.35	-0.20	-0.17	-0.08	-0.04
DAOH	n/a	0.67	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
DARL	-0.64	-0.76	-0.96	-0.68	-0.73	-0.91	-0.93	-1.18	-1.40	-0.63
DERB	-1.15	-1.36	-0.90	-0.80	-0.61	-0.68	-0.40	0.05	0.02	-0.28
DUD	-0.30	-0.34	-0.86	-0.85	-0.85	-0.95	-1.46	-1.63	-1.49	-0.47
DUNF	1.08	0.68	0.38	0.06	0.03	-0.06	-0.06	-0.14	-0.05	-0.50
EARS	-0.18	-0.69	-1.00	-1.17	-1.21	-1.28	-1.26	-1.46	-1.70	-0.57
ECO	0.64	0.45	0.24	0.14	0.04	0.01	0.02	-0.12	0.07	0.09
EGG	2.25	1.72	0.56	0.25	-0.52	-1.01	n/a	n/a	n/a	n/a
FIRD	1.12	1.08	0.18	-0.69	-0.89	-0.95	-0.98	-1.01	-1.22	-0.92
FTB	-0.63	-0.80	-1.11	-1.25	-1.39	-1.54	-1.49	-1.46	-1.62	-0.63

FURN	-0.29	-0.42	-0.76	-0.78	-0.71	-0.79	-0.76	-0.71	-0.89	-0.24
HANL	-2.75	-2.48	-0.54	-0.69	-0.93	-1.09	-1.06	-1.06	-1.14	-0.29
HAR	-0.73	-1.08	-0.64	-0.71	-0.86	-1.04	-1.06	-1.06	-1.22	-0.56
HARP	0.41	0.03	-0.41	-0.33	-0.39	-0.32	1.03	0.87	1.00	0.76
HFC	-0.28	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HLFX	0.42	0.66	0.16	0.10	-0.04	-0.18	-0.12	-0.12	-0.08	0.05
HOAR	-1.09	-1.33	-1.56	-1.45	-1.46	-1.54	-1.49	-1.46	-1.68	-0.60
HOLM	1.08	0.22	-0.04	0.08	0.22	0.06	0.09	-0.01	-0.03	-0.13
HSBC	-0.50	-0.97	-0.75	-0.53	-0.51	-0.71	-0.83	-0.66	-0.90	-0.59
IPS	-0.10	-0.14	-0.65	-0.70	-0.84	-0.99	-0.99	-1.36	-0.82	0.01
JHB	1.64	1.05	0.29	0.03	0.02	-0.04	0.01	0.04	-0.24	-0.54
KENT	0.46	0.14	-0.39	-0.88	-1.18	-1.42	-1.48	-1.72	-1.11	-0.50
LAIK	-1.15	-0.89	-1.11	-1.25	-1.53	-1.64	-1.59	-1.56	-1.62	-0.66
LAMB	n/a	1.52	1.65	0.99	-0.40	-0.77	0.51	n/a	n/a	n/a
LBRO	0.21	-0.08	-0.40	-0.72	-0.82	-0.99	-0.64	-0.48	-0.69	-0.05
LEED	1.39	1.11	1.20	1.00	0.88	0.78	0.70	0.54	0.38	0.41
LEEK	-0.42	-0.72	-0.86	-0.88	-0.96	-1.04	-0.99	-0.96	-1.20	-0.51
LTSB	0.47	0.12	0.21	0.01	-0.05	0.33	0.33	0.36	0.53	0.72
MANC	-1.10	0.96	0.47	0.75	0.81	0.51	0.27	0.33	-0.21	-0.31
MANS	0.08	0.05	-0.58	-0.79	-0.90	-0.96	-0.99	-1.20	-1.45	-0.42
MARH	1.31	1.06	0.66	0.56	0.42	0.26	-1.19	-1.44	-1.49	-0.07
MARS	0.57	0.24	0.14	0.09	0.20	0.32	0.16	0.14	0.41	0.03
MELM	0.15	-0.22	-0.56	-0.36	0.48	0.38	0.44	0.49	0.38	-0.59
MERC	-0.57	-1.09	-1.11	-1.01	-1.18	-1.38	-1.17	n/a	n/a	n/a
MLB	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.59
MONM	0.01	-0.31	-0.66	-0.69	-0.55	-0.76	-0.75	-0.68	-0.71	-0.23
NAP	-0.23	-0.24	-0.39	0.03	0.12	-0.17	-0.20	-0.10	0.03	-0.24
NATC	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.52
NATS	-1.57	-1.70	-1.36	-1.40	0.88	1.01	0.97	0.69	0.37	-0.27
NATW	-0.84	-1.46	-1.34	-1.28	-0.78	-0.70	-0.66	-0.65	-0.84	-0.20
NBNK	-0.05	-0.44	-0.89	-0.80	-0.89	-0.46	0.46	0.99	-0.63	-0.58
NEWB	1.12	0.91	0.56	0.51	0.65	0.60	1.06	1.34	1.21	0.76
NEWC	-0.63	-0.82	-0.97	-1.13	-1.32	-0.45	-1.30	-1.70	-1.94	-0.64
NOTI	0.70	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOTT	-1.23	-0.81	-0.60	-0.65	-0.95	-1.18	-0.80	-1.05	-0.89	0.72
NRCK	-0.98	-2.49	-1.71	-1.54	-1.91	-2.29	-2.26	-1.04	-0.07	0.81
NWDE	1.02	0.73	0.34	0.26	0.17	0.03	0.02	-0.22	-0.46	-0.48
OTB	0.87	0.86	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PO	n/a	n/a	n/a	n/a	n/a	n/a	2.27	2.29	2.38	1.12
POP	-1.01	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PORT	1.34	1.07	0.96	0.76	0.62	0.36	0.20	0.03	n/a	n/a
PRIN	-0.56	-0.95	-1.16	-1.19	-1.05	-1.13	-1.06	-1.14	-1.47	-0.57
PROG	0.78	0.39	0.19	0.19	0.21	0.04	-0.38	-0.53	-0.54	-0.46
RBS	-1.39	-1.54	-1.36	-0.85	-0.46	-0.62	-0.66	-0.73	-0.47	-0.11
SAFF	0.12	-0.21	-0.61	-0.54	-0.76	-0.89	-0.96	-1.18	-1.45	-0.43

SAIN	1.81	1.55	1.24	1.09	1.00	0.83	0.85	0.74	0.46	-0.37
SAS	0.21	-0.03	-0.21	-0.26	-0.32	-0.23	0.02	0.13	0.45	0.15
SBI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.40
SCAR	-1.48	-2.05	-1.41	-0.34	-0.20	0.05	0.23	1.17	1.02	1.46
SCOT	0.08	0.06	-0.34	-0.43	-0.41	-0.11	-0.50	-0.71	-0.74	-0.51
SHEP	0.13	-0.01	-0.46	-0.60	-0.31	0.15	0.16	-0.01	-0.06	-0.42
SKIP	0.43	0.01	-0.36	-0.42	-0.06	0.49	-0.03	0.05	-0.06	0.06
SMLE	1.68	1.43	1.14	0.79	0.75	0.71	0.70	0.38	0.28	-0.50
STAF	0.06	-0.30	-0.87	-0.84	n/a	n/a	n/a	n/a	n/a	n/a
STRY	0.18	-0.12	0.14	0.06	0.09	0.01	0.06	0.04	0.13	-0.27
SUN	1.69	1.23	0.81	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TAC	-0.29	-0.51	-0.86	-0.17	0.37	0.27	0.38	0.42	0.19	-0.26
TCHR	1.34	1.02	0.70	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TRIO	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TSCO	1.93	1.76	1.39	1.27	1.29	1.21	1.26	1.44	1.19	0.66
TURK	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.47
ULSB	-1.35	-1.41	-0.79	-0.78	-0.93	-0.67	-0.61	-0.92	-1.38	-0.59
UNIV	-1.58	-1.81	-1.23	-1.31	-1.43	-0.60	-1.74	n/a	n/a	n/a
VERN	-0.58	-0.77	-0.91	-1.08	-1.22	-1.29	-1.33	-1.43	-1.56	-0.42
WESL	n/a	n/a	n/a	n/a	1.54	1.48	1.41	1.04	0.91	0.07
WEST	0.97	0.90	0.90	1.24	0.85	0.63	0.76	0.92	0.78	0.05
WLB	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.34	-0.56
WOOL	0.29	0.45	0.94	0.40	0.69	0.73	0.70	0.43	n/a	n/a
YBNK	-0.75	-1.05	-1.11	-1.08	-0.99	-0.09	-0.15	-0.31	-0.64	-0.56
YORK	0.84	0.63	0.94	0.83	0.85	0.67	0.54	0.50	0.45	-0.05

Appendix Q – BM Measure 1, individual calendar years (£50k deposit level)

Bank	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AAL	-0.87	-0.82	-0.72	-0.06	-0.14	-0.72	-1.07	-1.36	-1.78	-0.18
AALG	-3.38	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ABBE	-0.56	0.48	0.52	0.47	1.18	1.10	1.08	0.93	1.48	1.00
AIRD	-1.17	-1.26	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BAB	-1.07	-0.41	-0.39	-0.45	-0.57	-0.81	-0.70	-0.38	0.96	-0.43
BARC	-1.35	-0.89	0.01	0.42	0.76	0.65	-0.10	0.34	0.57	0.45
BARN	0.34	0.43	0.23	0.16	-0.02	-0.15	-0.51	-0.88	-0.81	-0.20
BATH	-0.13	-0.35	-0.22	-0.19	-0.09	0.62	0.58	0.46	0.73	0.47
BAW	-0.14	0.46	0.23	0.21	0.10	-0.05	n/a	n/a	n/a	n/a
BEV	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.81	-0.89	-0.58
BMID	-0.49	-0.75	-0.35	-0.33	-0.38	-0.65	n/a	n/a	n/a	n/a
BOCY	0.29	0.06	-0.13	-0.19	-0.46	-0.48	-0.43	-0.39	-0.43	-0.54
BOIG	-0.23	0.11	0.12	0.08	0.09	0.02	0.07	0.11	-0.01	-0.70
BOIN	-0.63	0.05	-0.27	-0.50	-0.43	-0.53	-0.48	-0.44	-0.39	0.26
BOS	0.96	0.54	0.41	0.31	1.34	1.27	1.37	1.68	1.99	0.72
BRIT	0.65	0.68	0.97	0.79	0.82	0.76	0.65	0.84	0.71	0.40
BUCK	1.75	1.17	0.80	0.63	0.73	0.85	0.81	1.36	1.35	0.64
CAMB	0.17	-0.03	-0.43	-0.44	-0.45	-0.48	-0.65	-0.67	-0.68	-0.43
CATH	0.95	n/a	n/a	n/a	n/a	n/a	-0.57	-0.68	-0.86	n/a
CHEL	-1.61	-0.38	0.33	0.33	0.22	0.10	0.07	-0.04	0.19	0.75
CHGL	-1.58	-1.66	-1.66	-1.48	-1.31	-1.46	-0.79	-0.01	0.51	0.21
CHOR	0.10	-0.24	-0.73	-0.66	-0.70	-0.73	-0.02	0.04	0.28	-0.20
CHSE	-0.24	0.54	0.72	0.68	0.47	0.21	0.08	-0.21	-0.38	-0.53
CHSM	-1.76	-2.07	-2.03	-1.78	-2.06	-2.12	-2.17	-2.52	-2.64	-0.75
CITI	0.76	0.49	-0.13	-0.26	-0.22	-0.26	0.15	0.34	1.31	1.94
CLAY	-0.39	-0.95	-1.23	-1.13	n/a	n/a	n/a	n/a	n/a	n/a
CLYD	-0.05	-0.67	-0.96	-1.17	-0.52	-0.78	-0.88	-1.05	-1.09	-0.66
COD	0.56	0.36	0.12	0.10	0.05	0.02	0.07	0.06	0.09	0.09
COOP	0.87	0.47	0.24	-0.31	-0.54	-0.22	-0.35	0.35	0.62	0.06
COUT	-0.32	-0.53	n/a	n/a	n/a	-0.23	-0.18	-0.17	-0.72	-0.36
COV	-0.23	0.10	0.10	0.32	0.60	0.89	0.80	0.61	0.52	-0.16
CUMB	0.28	0.03	-0.37	-0.18	-0.04	0.18	0.31	0.34	0.23	0.31
DAOH	n/a	0.05	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
DARL	-0.52	-0.60	-0.73	-0.52	-0.73	-0.90	-0.89	-0.94	-1.11	-0.63
DERB	-1.00	-1.24	-0.79	-0.64	-0.48	-0.58	-0.44	-0.18	-0.16	-0.39
DUD	0.58	0.50	-0.10	-0.10	-0.09	0.15	0.39	0.41	0.37	-0.19
DUNF	1.43	1.08	0.89	0.67	0.61	0.53	0.52	0.36	0.07	-0.60
EARS	-0.21	-0.58	-0.77	-0.87	-0.91	-1.31	-0.99	-1.14	-1.37	-0.62
ECO	0.26	0.08	-0.03	-0.05	-0.16	-0.18	-0.18	-0.30	-0.07	0.05
EGG	1.62	1.10	0.03	-0.19	-0.97	-1.46	n/a	n/a	n/a	n/a
FIRD	0.52	0.48	-0.30	-1.13	-1.33	-1.39	-1.42	-1.44	-1.61	-1.08
FTB	0.24	0.08	-0.13	-0.22	-0.28	-0.33	-0.28	-0.24	-0.59	-0.73

FURN	-0.01	-0.14	-0.38	-0.36	-0.31	-0.38	-0.35	-0.29	-0.45	-0.29
HANL	-3.38	-3.10	-0.89	-0.91	-1.13	-1.28	-1.25	-1.24	-1.28	-0.25
HAR	0.26	-0.16	-0.15	-0.17	-0.29	-0.42	-0.45	-0.44	-0.62	-0.43
HARP	0.29	-0.09	-0.43	-0.27	-0.34	-0.30	0.84	0.68	0.86	0.77
HFC	-0.41	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HLFX	-0.17	0.07	-0.26	-0.24	-0.32	-0.44	-0.42	-0.43	-0.34	-0.04
HOAR	-0.44	-0.64	-0.88	-0.92	-0.91	-0.98	-0.93	-0.94	-1.12	-0.53
HOLM	0.93	-0.15	-0.31	0.45	0.77	0.62	0.65	0.56	0.58	0.58
HSBC	-0.63	-1.12	-0.69	-0.43	-0.49	-0.67	-0.77	-0.32	-0.52	-0.69
IPS	0.54	0.49	-0.08	-0.37	-0.64	-0.75	-0.75	-1.04	-0.67	-0.03
JHB	1.64	1.10	0.66	0.61	0.54	0.52	0.57	0.61	0.36	-0.25
KENT	0.34	-0.09	0.94	0.46	0.10	-0.23	-1.07	-1.52	-1.08	-0.57
LAIK	-1.77	-1.51	-1.63	-1.69	-1.98	-2.08	-2.03	-1.99	-2.01	-0.77
LAMB	n/a	0.90	0.49	0.24	-0.47	-0.52	0.43	n/a	n/a	n/a
LBRO	-0.11	-0.38	-0.65	-0.92	-0.99	-1.17	-0.82	-0.66	-0.84	0.00
LEED	1.08	0.92	1.02	0.82	0.74	0.66	0.58	0.38	0.14	0.49
LEEK	-0.60	-0.90	-1.13	-1.07	-0.91	-0.98	-0.93	-0.89	-1.09	-0.39
LTSB	0.52	0.21	0.42	0.30	0.19	0.57	0.56	0.59	0.50	0.72
MANC	-1.45	0.84	1.03	0.97	0.90	0.64	0.38	0.35	-0.02	-0.34
MANS	0.45	0.43	-0.18	-0.23	-0.35	-0.41	-0.49	-0.59	-0.79	-0.39
MARH	0.36	-0.06	-0.41	-0.43	-0.44	-0.68	-0.67	-0.77	-0.72	0.35
MARS	0.44	0.11	-0.01	0.02	0.13	0.15	0.08	0.06	0.15	-0.24
MELM	0.42	0.06	-0.18	-0.11	0.79	n/a	n/a	n/a	n/a	-0.71
MERC	-0.45	-1.00	-1.13	-0.96	-0.71	-0.85	-0.77	n/a	n/a	n/a
MLB	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.69
MONM	0.04	-0.23	-0.53	-0.53	-0.42	-0.55	-0.54	-0.42	-0.35	-0.19
NAP	-0.13	-0.36	-0.13	0.32	0.45	0.15	0.11	0.21	0.22	-0.30
NATC	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.40
NATS	n/a	n/a	n/a	n/a	1.40	1.32	1.27	1.01	0.73	0.08
NATW	-0.91	-1.16	-1.18	-1.19	-0.74	-0.62	-0.70	-0.83	-1.01	-0.14
NBNK	0.16	-0.09	-0.49	-0.51	-0.52	-0.28	0.41	0.83	-0.29	-0.69
NEWB	0.49	0.29	0.04	0.06	0.20	0.16	-0.01	-0.04	-0.15	0.07
NEWC	-0.26	-0.44	-0.49	-0.57	-0.77	-0.18	-0.77	-1.03	-1.28	-0.64
NOTI	0.39	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOTT	-0.08	-0.44	-0.53	-0.47	-0.73	-0.95	-0.46	-0.73	-0.76	0.93
NRCK	-0.89	-2.01	-1.20	-1.24	-1.76	-2.13	-2.15	-1.18	-0.27	0.70
NWDE	1.02	0.73	0.43	0.42	0.28	0.15	0.13	-0.01	-0.15	-0.53
OTB	0.25	0.24	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PO	n/a	n/a	n/a	n/a	n/a	n/a	1.82	1.86	1.99	1.02
POP	-1.65	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PORT	0.71	0.45	0.44	0.52	0.79	0.57	0.41	0.24	n/a	n/a
PRIN	-0.72	-1.03	-1.13	-1.13	-0.68	-0.72	-0.80	-0.88	-1.17	-0.65
PROG	0.81	0.51	0.37	0.39	0.44	0.28	-0.05	-0.19	-0.16	0.10
RBS	-1.24	-1.41	-1.28	-0.67	-0.20	-0.37	-0.41	-0.54	-0.27	0.08
SAFF	0.14	-0.18	-0.48	-0.33	-0.56	-0.68	-0.76	-0.97	-1.19	-0.47

SAIN	1.68	1.43	1.22	1.15	1.00	0.76	0.66	0.57	0.36	-0.37
SAS	0.09	-0.16	-0.40	-0.34	-0.45	-0.48	-0.33	-0.21	0.15	0.14
SBI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.31
SCAR	-0.76	-1.53	-1.72	-0.67	-0.55	-0.30	-0.09	0.85	0.78	1.43
SCOT	-0.05	0.14	-0.13	-0.17	-0.16	0.01	-0.39	-0.74	-0.73	-0.53
SHEP	0.01	-0.10	-0.43	-0.49	-0.32	-0.01	-0.01	-0.17	-0.18	-0.43
SKIP	1.66	1.29	1.02	1.04	0.99	0.92	0.95	-0.10	-0.43	-0.55
SMLE	1.06	0.81	0.62	0.35	0.30	0.27	0.25	-0.06	-0.11	-0.61
STAF	0.49	0.25	-0.14	-0.04	n/a	n/a	n/a	n/a	n/a	n/a
STRY	-0.44	-0.45	1.27	1.12	1.14	1.07	1.11	1.08	1.19	0.63
SUN	1.51	1.02	0.67	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TAC	0.08	-0.13	-0.38	0.18	0.59	0.49	0.39	0.42	0.22	-0.25
TCHR	0.71	0.40	0.17	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TRIO	-0.38	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TSCO	1.83	1.89	1.62	1.58	1.59	1.52	1.57	1.75	1.55	1.12
TURK	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.51
ULSB	-0.57	-0.33	-0.12	-0.26	-0.49	0.06	-0.01	-0.36	-0.63	-0.12
UNIV	-0.71	-0.93	-0.57	-0.86	-1.08	-0.50	-1.55	n/a	n/a	n/a
VERN	-0.81	-0.99	-1.09	-1.14	-1.25	-1.38	-1.49	-1.61	-1.64	-0.51
WESL	n/a	n/a	n/a	n/a	1.09	1.04	0.96	0.60	0.51	-0.04
WEST	0.39	0.76	0.97	0.82	0.40	0.19	0.44	0.66	0.56	-0.04
WLB	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.72	-0.50
WOOL	0.14	0.29	0.74	0.33	0.67	0.72	0.61	0.36	n/a	n/a
YBNK	-0.82	-1.20	-1.22	-1.29	-0.88	0.77	0.53	0.35	0.04	-0.66
YORK	0.31	0.04	0.47	0.42	0.44	0.28	0.13	0.09	0.09	-0.06

Appendix R – ECM results (Chapter 6)

Rank	Bank	ECT	Lag
1	NBNK	0.977	4
2	ECO	0.254	6
3	CHGL (***)	0.110	10
4	PRIN	0.050	4
5	MANS (*)	0.045	2
6	CUMB	0.038	3
7	FURN (*)	0.031	2
8	YBNK	0.029	4
9	CLYD	0.028	4
10	LBRO	0.026	3
11	LTSB	0.022	4
12	JHB	0.017	4
13	HLFX	0.010	4
14	CHOR	0.009	4
15	ULSB	0.008	9
16	RBS	0.005	4
17	SAS (**)	0.003	6
18	NOTT	0.003	2
19	HANL	0.002	4
20	MONM	0.001	2
21	CHSM	0.001	4
22	HOAR	0.000	4
23	PROG	-0.001	5
24	COD	-0.005	4
25	IPS	-0.010	5
26	KENT	-0.015	4
27	LEEK	-0.017	4
28	TAC	-0.017	2
29	HARP	-0.017	4
30	VERN	-0.017	6
31	SCAR	-0.020	1
32	LEED	-0.021	4
33	DUD	-0.022	4
34	ABBE	-0.026	2
35	BOIN	-0.027	2
36	CITI	-0.028	2
37	BOS (*)	-0.030	2
38	BOCY	-0.031	4
39	TSCO (**)	-0.032	6
40	EARS (**)	-0.034	2
41	HOLM	-0.045	8
42	COOP	-0.077	7

43	NATW (***)	-0.084	6
44	AAL	-0.093	6
45	LAMB	-0.094	1
46	SAIN	-0.107	6
47	BUCK (**)	-0.115	6
48	NAP	-0.122	3
49	FIRD (**)	-0.170	2
50	STRY	-0.171	5
51	BARC	-0.172	6
52	HAR	-0.190	4
53	MARS	-0.206	6
54	BATH (**)	-0.220	6
55	FTB	-0.228	4
56	CHEL	-0.232	9
57	UNIV (**)	-0.235	9
58	YORK	-0.241	6
59	MARH (**)	-0.248	9
60	NEWB (*) (**)	-0.266	2
61	NEWC	-0.267	3
62	BARN	-0.272	7
63	LAIK (**)	-0.295	2
64	BRIT	-0.298	8
65	BOIG	-0.304	9
66	CAMB (**)	-0.318	2
67	NRCK (**)	-0.323	9
68	DARL (**)	-0.350	2
69	WEST	-0.384	9
70	COV (**)	-0.409	2
71	HSBC (**)	-0.412	2
72	SCOT (*) (**)	-0.420	2
73	NWDE	-0.464	4
74	SAFF	-0.612	10
75	MANC	-0.620	7
76	MELM (**)	-0.758	2
77	CHSE (*)(**)	-0.796	2
78	MERC	-0.808	1
79	WESL (*) (**)	-0.932	1
80	BAB (**)	-1.043	3
81	SMLE	-1.200	4
82	DUNF	-1.311	4

Appendix S – Asymmetric ARDL results (Chapter 7)

BANK	p	q	BASE +	BASE -
AAL	2	8	-0.434	2.34
ABBE	8	8	2.539	-1.557
BAB	6	6	2.426	-2.21
BARC	3	6	1.554	-0.039
BARN	3	4	2.564	-0.869
BATH	3	8	1.355	-0.437
BOCY	4	5	4.093	-0.841
BOIG	5	6	1.312	-4.295
BOIN	8	6	4.066	-0.649
BOS	6	7	2.564	-0.429
BRIT	7	7	1.391	-1.019
BUCK	5	5	3.85	-0.283
CAMB	5	3	3.629	-1.21
CHEL	7	8	1.639	-1.303
CHGL	4	8	4.599	0.238
CHOR	2	5	3.475	-0.904
CHSE	2	3	1.227	-1.533
CHSM	4	5	6.055	-0.679
CITI	6	4	3.863	-0.478
CLYD	3	3	6.044	-1.127
COD	5	3	3.054	-0.92
COOP	3	6	4.672	-1.624
COV	2	2	1.958	-1.002
CUMB	5	3	3.617	0.244
DARL	5	4	3.337	-0.535
DERB	7	6	3.078	-0.131
DUD	7	7	2.525	-0.218
DUNF	3	4	2.149	-1.576
EARS	5	2	4.37	-0.933
ECO	4	3	2.228	-0.642
FIRD	4	2	5.677	-1.991
FTB	4	2	3.292	-1.513
FURN	2	2	2.871	-0.49
HANL	2	2	2.974	-0.453
HAR	3	4	2.394	-0.996
HARP	2	2	1.221	-0.825
HLFX	5	5	3.408	1.334
HOAR	7	5	4.63	-1.101
HOLM	5	5	-0.231	0.885
HSBC	4	2	2.906	-0.959
IPS	3	4	3.046	-0.839
JHB	4	3	2.261	-1.163

KENT	2	3	2.298	-1.529
LAIK	6	2	5.871	-1.541
LBRO	5	3	3.951	-0.83
LEED	4	2	1.564	-0.535
LEEK	3	4	4.13	-0.723
LTSB	4	2	3.221	-0.513
MANC	7	3	2.455	-2.407
MANS	8	6	2.888	-0.919
MARH	2	6	2.766	0.464
MARS	6	7	2.023	-0.665
MELM	5	4	-2.996	3.276
MERC	7	8	2.996	-3.561
MONM	8	4	2.688	-0.665
NAP	6	7	1.132	-0.516
NATS	6	7	9.32	-0.837
NATW	6	5	5.255	-0.517
NBNK	5	3	4.819	0.315
NEWB	4	6	1.43	-0.594
NEWC	3	2	2.971	-2.873
NOTT	2	2	2.646	-0.053
NRCK	8	4	4.078	1.224
NWDE	5	6	2.017	-1.131
PORT	3	4	2.018	-1.317
PRIN	4	2	4.797	-1.143
PROG	5	6	1.453	-0.504
RBS	2	2	1.961	0.149
SAFF	2	5	2.433	0.062
SAIN	2	8	1.106	-1.483
SAS	7	6	2.496	-0.531
SCAR	2	2	1.943	0.463
SCOT	5	5	3.244	-1.081
SHEP	8	4	3.987	-1.414
SKIP	3	2	2.403	-1.068
SMLE	5	7	1.712	-1.703
STRY	8	5	1.314	-0.6
TAC	5	6	-0.605	1.893
TSCO	6	4	1.474	-0.664
ULSB	7	6	3.83	-1.064
UNIV	6	6	4.015	-2.806
VERN	4	5	3.839	-0.481
WESL	2	2	0.647	-1.173
WEST	6	5	1.104	-1.288
WOOL	6	6	1.928	-2.175
YBNK	6	5	8.542	-0.85
YORK	3	2	1.83	-1.04

Appendix T – Symmetry tests for the NARDL (Chapter 7)

Bank	F_{pss}	LR Wald (Base)	SR Wald (Base)	LR Wald (Price)	SR Wald (Price)	LR Wald (Output)	SR Wald (Output)
AAL	3.11	2.006 [0.162]	1.145 [0.289]	18.65 [0.000]	1.837 [0.181]	8.774 [0.005]	6.213 [0.016]
ABBE	5.06	5.255 [0.026]	0.04471 [0.833]	10.5 [0.002]	0.3688 [0.546]	14.72 [0.000]	1.025 [0.316]
BAB	5.57	0.1221 [0.728]	0.6119 [0.437]	9.36 [0.003]	0.7706 [0.384]	1.497 [0.226]	22.35 [0.000]
BARC	2.64	5.41 [0.023]	0.01776 [0.894]	0.1309 [0.719]	9.237 [0.003]	1.173 [0.283]	0.9194 [0.341]
BARN	3.84	32.6 [0.000]	1.044 [0.310]	0.987 [0.323]	0.1064 [0.745]	0.07398 [0.786]	0.4645 [0.497]
BATH	6.63	30.86 [0.000]	4.286 [0.043]	21.24 [0.000]	6.091 [0.017]	2.791 [0.101]	2.783 [0.101]
BOCY	2.49	20.39 [0.000]	1.312 [0.256]	1.951 [0.167]	0.3142 [0.577]	0.01487 [0.903]	0.3459 [0.558]
BOIG	10.24	29.91 [0.000]	0.03822 [0.846]	17.18 [0.000]	2.602 [0.112]	0.001774 [0.967]	7.782 [0.007]
BOIN	33.64	83.26 [0.000]	0.2972 [0.588]	6.859 [0.011]	3.477 [0.067]	0.3407 [0.562]	1.118 [0.294]
BOS	2.61	65.5 [0.000]	0.3194 [0.574]	15.18 [0.000]	2.899 [0.094]	0.0282 [0.867]	2.349 [0.131]
BRIT	5.59	1.448 [0.234]	1.647 [0.205]	0.7321 [0.396]	1.667 [0.202]	0.3729 [0.544]	1.417 [0.239]
BUCK	4.83	343.3 [0.000]	1.075 [0.303]	59.02 [0.000]	8.637 [0.004]	0.4479 [0.505]	4.504 [0.037]
CAMB	5.31	71.4 [0.000]	0.6993 [0.405]	3.528 [0.064]	1.484 [0.227]	0.3101 [0.579]	0.007145 [0.933]
CHEL	1.89	0.5355 [0.468]	1.751 [0.192]	24.54 [0.000]	0.04029 [0.842]	4.886 [0.032]	2.058 [0.158]
CHGL	7.07	70.83 [0.000]	0.1024 [0.750]	19.48 [0.000]	10.49 [0.002]	0.3686 [0.546]	1.506 [0.225]
CHOR	7.04	61.21 [0.000]	0.2558 [0.614]	23.53 [0.000]	3.49 [0.066]	0.2546 [0.615]	1.931 [0.169]
CHSE	19.87	9.68 [0.002]	7.721 [0.007]	70.88 [0.000]	0.8781 [0.351]	0.429 [0.514]	0.1138 [0.737
CHSM	5.63	88.08 [0.000]	3.163 [0.079]	36.06 [0.000]	18.58 [0.000]	2.309 [0.133]	0.4672 [0.496]
CITI	4.78	40.94 [0.000]	0.1353 [0.714]	2.84 [0.096]	6.734 [0.011]	8.61 [0.004]	0.355 [0.553]
CLYD	2.46	34.23 [0.000]	4.306 [0.041]	4.061 [0.047]	0.1836 [0.669]	3.217 [0.076]	0.568 [0.453]
COD	4.07	50.34 [0.000]	0.003315 [0.954]	7.153 [0.009]	1.116 [0.294]	0.2359 [0.628]	0.3871 [0.536]
COOP	3.95	14.49 [0.000]	3.911 [0.052]	0.522 [0.472]	3.702 [0.059]	0.9063 [0.344]	0.04692 [0.829]
COV	9.42	24.49 [0.000]	5.15 [0.025]	8.577 [0.004]	0.9461 [0.333]	9.231 [0.003]	1.352 [0.248]
CUMB	2.71	19.38 [0.000]	0.4927 [0.485]	7.384 [0.008]	0.7047 [0.404]	0.0004426 [0.983]	0.02595 [0.872]
DARL	4.6	23.87 [0.000]	0.1028 [0.749]	6.88 [0.010]	1.339 [0.251]	1.636 [0.205]	2.991 [0.088]
DERB	2.22	27 [0.000]	0.3501 [0.556]	19.55 [0.000]	2.028 [0.159]	0.128 [0.722]	1.561 [0.216]

DUD	4.25	10.73 [0.002]	0.7044 [0.405]	7.673 [0.008]	1.872 [0.177]	0.00716 [0.933]	3.46 [0.068]
DUNF	24.22	51.51 [0.000]	5.193 [0.025]	3.114 [0.081]	0.04657 [0.830]	4.62 [0.035]	1.191 [0.278]
EARS	5.56	54.72 [0.000]	0.7208 [0.398]	12.68 [0.001]	0.861 [0.356]	0.4905 [0.485]	2.786 [0.099]
ECO	9.12	33.64 [0.000]	1.961 [0.165]	17.96 [0.000]	2.676 [0.106]	0.06004 [0.807]	0.02148 [0.884]
FIRD	4.23	4.771 [0.032]	0.002569 [0.960]	0.07516 [0.785]	2.489 [0.118]	0.7678 [0.782]	1.062 [0.306]
FTB	6.83	45.41 [0.000]	1.825 [0.180]	4.354 [0.040]	0.7968 [0.374]	0.176 [0.676]	0.9514 [0.332]
FURN	6.11	79.02 [0.000]	0.1585 [0.691]	18.65 [0.000]	0.8956 [0.346]	0.1438 [0.705]	2.65 [0.107]
HANL	3.93	67.03 [0.000]	2.117 [0.150]	14.89 [0.000]	2.296 [0.134]	3.965 [0.051]	4.538 [0.037]
HAR	8.7	101.7 [0.000]	2.638 [0.108]	21.93 [0.000]	6.304 [0.014]	6.266 [0.014]	0.1361 [0.713]
HARP	3.69	0.3314 [0.566]	0.2291 [0.633]	9.896 [0.002]	0.01203 [0.913]	4.105 [0.046]	0.002561 [0.960]
HLFX	9.11	23.23 [0.000]	1.27 [0.263]	6.495 [0.013]	5.981 [0.017]	0.6137 [0.436]	0.2194 [0.641]
HOAR	7.95	124.7 [0.000]	0.04411 [0.834]	26.43 [0.000]	19.38 [0.000]	10.06 [0.002]	0.002373 [0.961]
HOLM	2.79	0.3069 [0.581]	0.6969 [0.407]	4.772 [0.032]	0.005958 [0.939]	1.533 [0.220]	1.167 [0.284]
HSBC	4.68	26.81 [0.000]	5.151 [0.026]	2.576 [0.112]	4.933 [0.029]	10.91 [0.001]	0.02527 [0.874]
IPS	4.67	56.76 [0.000]	0.565 [0.454]	5.91 [0.017]	4.743 [0.032]	1.973 [0.164]	1.383 [0.243]
JHB	6.4	36.2 [0.000]	1.18 [0.280]	4.125 [0.045]	1.33 [0.252]	0.7292 [0.395]	0.5094 [0.477]
KENT	8.47	9.265 [0.003]	10.62 [0.002]	13.32 [0.000]	0.9056 [0.344]	7.628 [0.007]	1.85 [0.177]
LAIK	2.45	5.39 [0.023]	2.321 [0.132]	2.439 [0.123]	0.01448 [0.905]	0.1 [0.753]	1.461 [0.231]
LBRO	2.88	24.05 [0.000]	13.9 [0.000]	5.055 [0.027]	1.576 [0.213]	1.314 [0.255]	4.711 [0.033]
LEED	6.2	46.87 [0.000]	0.281 [0.597]	2.738 [0.101]	2.146 [0.146]	0.3395 [0.562]	5.018 [0.027]
LEEK	7.08	119.4 [0.000]	4.121 [0.046]	24.51 [0.000]	24.86 [0.000]	3.072 [0.083]	1.481 [0.227]
LTSB	8.5	103.9 [0.000]	3.543 [0.063]	29.6 [0.000]	0.1438 [0.705]	18.46 [0.000]	2.819 [0.097]
MANC	6.85	0.006445 [0.936]	0.1176 [0.733]	7.338 [0.008]	1.044 [0.310]	7.273 [0.009]	1.46 [0.230]
MANS	4.6	20.33 [0.000]	0.03068 [0.862]	5.987 [0.017]	6.82 [0.011]	10.21 [0.002]	6.303 [0.015]
MARH	7.25	79.93 [0.000]	3.192 [0.078]	7.137 [0.009]	2.401 [0.126]	19.44 [0.000]	11.65 [0.001]
MARS	9.46	41.73 [0.000]	0.3039 [0.584]	23.49 [0.000]	0.1899 [0.665]	3.127 [0.082]	15.13 [0.000]
MELM	1.61	0.002678 [0.959]	0.2199 [0.640]	0.07713 [0.782]	0.1888 [0.665]	0.07251 [0.788]	0.5955 [0.443]
MERC	5.11	0.2263 [0.646]	0.9534 [0.354]	0.2393 [0.636]	0.08959 [0.771]	0.07922 [0.785]	0.2134 [0.655]
MONM	6.49	42.74 [0.000]	7.541 [0.008]	17.22 [0.000]	2.656 [0.107]	0.5294 [0.469]	4.232 [0.043]

NAP	2.04	1.919 [0.171]	0.4745 [0.494]	4.671 [0.035]	0.5422 [0.464]	5.471 [0.023]	2.558 [0.115]
NATS	3.16	97.13 [0.000]	0.3648 [0.548]	11.16 [0.001]	0.3004 [0.586]	24.52 [0.000]	0.001446 [0.970]
NATW	5.86	305 [0.000]	1.27 [0.264]	70.32 [0.000]	4.155 [0.045]	21.06 [0.000]	0.809 [0.371]
NBNK	4.32	5.184 [0.025]	0.3889 [0.535]	5.048 [0.027]	0.493 [0.485]	1.675 [0.199]	0.9928 [0.322]
NEWB	2.35	4.395 [0.040]	0.006332 [0.937]	0.2111 [0.647]	3.084 [0.084]	0.6301 [0.430]	2.588 [0.112]
NEWC	6.42	0.02764 [0.868]	10.42 [0.002]	0.02254 [0.881]	3.21e-08 [1.000]	12.13 [0.001]	0.2312 [0.632]
NOTT	3.85	43.67 [0.000]	0.5281 [0.469]	10.71 [0.001]	0.1252 [0.724]	0.2808 [0.597]	0.05929 [0.808]
NRCK	6.74	56.58 [0.000]	2.583 [0.112]	8.454 [0.005]	0.4781 [0.491]	38.14 [0.000]	2.094 [0.152]
NWDE	2.86	10.99 [0.001]	0.0449 [0.833]	2.273 [0.136]	1.665 [0.201]	0.06334 [0.802]	0.1759 [0.676]
PORT	2.96	1.162 [0.286]	0.8273 [0.367]	8.844 [0.004]	1.286 [0.262]	3.539 [0.065]	0.002748 [0.958]
PRIN	3.19	50.87 [0.000]	3.098 [0.082]	8.375 [0.005]	0.4462 [0.506]	1.605 [0.208]	2.567 [0.113]
PROG	2.85	3.673 [0.060]	2.827 [0.097]	2.724 [0.104]	0.497 [0.483]	1.404 [0.240]	7.903 [0.006]
RBS	2.23	2.171 [0.144]	0.6614 [0.418]	2.307 [0.132]	0.2895 [0.592]	0.5329 [0.467]	0.1318 [0.717]
SAFF	3.84	17.51 [0.000]	0.9576 [0.331]	7.024 [0.010]	3.848 [0.053]	1.179 [0.281]	3.196 [0.078]
SAIN	2.95	4.591 [0.037]	0.07536 [0.785]	12.99 [0.001]	3.382 [0.072]	0.2607 [0.612]	0.3544 [0.554]
SAS	3.21	14.47 [0.000]	0.06974 [0.793]	10.05 [0.002]	3.391 [0.070]	0.03494 [0.852]	1.581 [0.213]
SCAR	2.55	1.521 [0.221]	1.633 [0.205]	10.01 [0.002]	0.6566 [0.420]	1.336 [0.251]	0.8701 [0.353]
SCOT	4.25	15.51 [0.000]	0.07986 [0.778]	1.471 [0.229]	2.075 [0.154]	0.02771 [0.868]	2.419 [0.124]
SHEP	3.28	34.76 [0.000]	0.3091 [0.580]	4.1 [0.047]	0.04899 [0.825]	10.01 [0.002]	0.05981 [0.807]
SKIP	3.83	20.79 [0.000]	0.08654 [0.769]	4.713 [0.032]	0.9588 [0.330]	5.688 [0.019]	1.178 [0.280]
SMLE	7.33	0.005113 [0.943]	14.13 [0.000]	37.7 [0.000]	2.941 [0.092]	25.11 [0.000]	7.356 [0.009]
STRY	2.6	7.351 [0.009]	1.036 [0.312]	0.3106 [0.579]	1.381 [0.244]	1.319 [0.255]	0.1765 [0.676]
TAC	5.06	1.116 [0.295]	0.7597 [0.784]	5.769 [0.019]	17.66 [0.000]	1.776 [0.187]	3.547 [0.064]
TSCO	9.51	63.98 [0.000]	3.815 [0.054]	11.56 [0.001]	10.35 [0.002]	1.564 [0.215]	2.172 [0.145]
ULSB	3.27	22.87 [0.000]	0.7254 [0.398]	5.189 [0.026]	5.159 [0.027]	23.26 [0.000]	0.9515 [0.333]
UNIV	3.01	0.1222 [0.729]	3.776 [0.062]	0.5734 [0.455]	1.166 [0.289]	0.1923 [0.664]	0.03991 [0.843]
VERN	2.62	25.01 [0.000]	6.753 [0.011]	3.995 [0.049]	0.422 [0.518]	0.007449 [0.931]	0.467 [0.497]
WESL	11.95	17.86 [0.000]	19.66 [0.000]	16.98 [0.000]	0.02764 [0.869]	0.2439 [0.624]	0.3053 [0.583]
WEST	4.42	0.2959 [0.588]	0.9035 [0.345]	2.596 [0.112]	0.01273 [0.910]	0.026 [0.872]	0.3969 [0.531]

WOOL	4.78	0.01119 [0.916]	0.6472 [0.426]	0.7599 [0.389]	0.4359 [0.513]	6.274 [0.017]	14.67 [0.000]
YBNK	5.91	76.85 [0.000]	5.742 [0.019]	48.67 [0.000]	11.54 [0.001]	28.18 [0.000]	2.228 [0.140]
YORK	4.75	7.638 [0.007]	0.002997 [0.956]	0.2728 [0.603]	17.37 [0.000]	0.8153 [0.369]	0.3238 [0.571]

Appendix U – Constrained NARDL results (Chapter 7)

Bank	p	q	L_{Base}^{+}	L_{Base}^{-}	Nature of symmetry (Base)	F_{pss}
AAL	2	8	-2.581	2.581	LR and SR symmetry	2.98
ABBE	8	8	2.87	-1.089	LR asymmetry, SR symmetry	3.23
BAB	6	6	2.294	-2.294	LR and SR symmetry	5.26
BARC	3	6	2.083	-0.381	LR asymmetry, SR symmetry	6.38
BARN	3	4	2.52	-0.766	LR asymmetry, SR symmetry	7.98
BATH	3	8	1.276	-0.533	LR and SR asymmetry	7.59
BOCY	4	5	4.305	-1.157	LR asymmetry, SR symmetry	11.8
BOIG	5	6	1.235	-3.599	LR asymmetry, SR symmetry	10.24
BOIN	8	6	4.234	-0.572	LR asymmetry, SR symmetry	40.13
BOS	6	7	2.596	-0.548	LR asymmetry, SR symmetry	7.77
BRIT	7	7	1.058	-1.058	LR and SR symmetry	9.75
BUCK	5	5	3.622	-0.34	LR asymmetry, SR symmetry	9.85
CAMB	5	3	3.823	-1.401	LR asymmetry, SR symmetry	10.52
CHEL	7	8	1.269	-1.269	LR and SR symmetry	4.17
CHGL	4	8	4.239	0.403	LR asymmetry, SR symmetry	8.74
CHOR	2	5	3.424	-0.916	LR asymmetry, SR symmetry	11.57
CHSE	2	3	1.136	-1.512	LR and SR asymmetry	16.29
CHSM	4	5	5.997	-0.23	LR asymmetry, SR symmetry	8.45
CITI	6	4	4.075	-0.676	LR asymmetry, SR symmetry	5.87
CLYD	3	3	5.533	-0.433	LR and SR asymmetry	3.93
COD	5	3	2.887	-0.877	LR asymmetry, SR symmetry	9.94
COOP	3	6	4.135	-1.565	LR asymmetry, SR symmetry	5.26
COV	2	2	1.971	-0.991	LR and SR asymmetry	11.61
CUMB	5	3	3.696	0.092	LR asymmetry, SR symmetry	8.94
DARL	5	4	3.211	-0.821	LR asymmetry, SR symmetry	9.89
DERB	7	6	2.91	-0.285	LR asymmetry, SR symmetry	3.73
DUD	7	7	2.47	-0.445	LR asymmetry, SR symmetry	5.09
DUNF	3	4	2.095	-1.493	LR and SR asymmetry	25.08

EARS	5	2	4.512	-0.926	LR asymmetry, SR symmetry	8.88
ECO	4	3	2.086	-0.829	LR asymmetry, SR symmetry	18.72
FIRD	4	2	5.502	-1.774	LR asymmetry, SR symmetry	6.66
FTB	4	2	3.037	-1.35	LR asymmetry, SR symmetry	14.04
FURN	2	2	3.001	-0.571	LR asymmetry, SR symmetry	9.33
HANL	2	2	3.034	-0.584	LR asymmetry, SR symmetry	17.8
HAR	3	4	2.357	-1.034	LR asymmetry, SR symmetry	10.76
HARP	2	2	0.726	-0.726	LR and SR symmetry	6.86
HLFX	5	5	3.443	0.785	LR asymmetry, SR symmetry	11.58
HOAR	7	5	4.438	-1.068	LR asymmetry, SR symmetry	11.29
HOLM	5	5	-0.39	0.39	LR and SR symmetry	6.67
HSBC	4	2	3.251	-1.205	LR and SR asymmetry	4.75
IPS	3	4	3.058	-0.699	LR asymmetry, SR symmetry	7.8
JHB	4	3	2.254	-1.068	LR asymmetry, SR symmetry	12.6
KENT	2	3	2.128	-1.386	LR and SR asymmetry	7.47
LAIK	6	2	5.417	-2.916	LR asymmetry, SR symmetry	6.81
LBRO	5	3	4.089	-0.484	LR and SR asymmetry	3.36
LEED	4	2	1.714	-0.63	LR asymmetry, SR symmetry	11.06
LEEK	3	4	4.119	-0.454	LR and SR asymmetry	8.2
LTSB	4	2	3.226	-0.44	LR asymmetry, SR symmetry	9.29
MANC	7	3	2.088	-2.088	LR and SR symmetry	7.2
MANS	8	6	3.061	-0.919	LR asymmetry, SR symmetry	5.86
MARH	2	6	2.554	0.461	LR asymmetry, SR symmetry	10.29
MARS	6	7	1.963	-0.861	LR asymmetry, SR symmetry	16.77
MELM	5	4	1.128	-1.128	LR and SR symmetry	1.24
MERC	7	8	3.022	-3.022	LR and SR symmetry	1.06
MONM	8	4	2.645	-0.865	LR and SR asymmetry	6.19
NAP	6	7	0.659	-0.659	LR and SR symmetry	2.16
NATS	6	7	5.928	0.095	LR asymmetry, SR symmetry	1.5
NATW	6	5	5.104	-0.532	LR asymmetry, SR symmetry	7.28
NBNK	5	3	5.926	2.071	LR asymmetry, SR symmetry	7.07

NEWB	4	6	1.41	-0.644	LR asymmetry, SR symmetry	5.25
NEWC	3	2	2.775	-2.775	LR symmetry, SR asymmetry	12.8
NOTT	2	2	2.593	-0.027	LR asymmetry, SR symmetry	5.58
NRCK	8	4	3.342	0.801	LR asymmetry, SR symmetry	6.74
NWDE	5	6	2.236	-1.354	LR asymmetry, SR symmetry	6.41
PORT	3	4	1.686	-1.686	LR and SR symmetry	1.81
PRIN	4	2	4.727	-0.763	LR asymmetry, SR symmetry	10.01
PROG	5	6	1.085	-1.085	LR and SR symmetry	3.42
RBS	2	2	1.041	-1.041	LR and SR symmetry	3.18
SAFF	2	5	2.583	-0.395	LR asymmetry, SR symmetry	4.43
SAIN	2	8	1.114	-1.345	LR asymmetry, SR symmetry	5.74
SAS	7	6	2.726	-0.606	LR asymmetry, SR symmetry	5.61
SCAR	2	2	-0.194	0.194	LR and SR symmetry	3.89
SCOT	5	5	3.845	-1.206	LR asymmetry, SR symmetry	10.75
SHEP	8	4	4.019	-1.225	LR asymmetry, SR symmetry	5.8
SKIP	3	2	2.301	-0.925	LR asymmetry, SR symmetry	7.77
SMLE	5	7	1.529	-1.529	LR symmetry, SR asymmetry	3.38
STRY	8	5	1.36	-0.715	LR asymmetry, SR symmetry	5.78
TAC	5	6	-0.83	0.83	LR and SR symmetry	6.14
TSCO	6	4	1.482	-0.604	LR asymmetry, SR symmetry	15.29
ULSB	7	6	4.06	-1.089	LR asymmetry, SR symmetry	4.08
UNIV	6	6	2.287	-2.287	LR and SR symmetry	3.72
VERN	4	5	3.994	-0.7	LR and SR asymmetry	3.36
WESL	2	2	0.588	-1.168	LR and SR asymmetry	26.23
WEST	6	5	1.054	-1.054	LR and SR symmetry	8.16
WOOL	6	6	1.774	-1.774	LR and SR symmetry	4.71
YBNK	6	5	8.656	-0.764	LR and SR asymmetry	5.9
YORK	3	2	1.801	-1.063	LR asymmetry, SR symmetry	7.95