Firm Organization and Market Structure: Centralization vs. Decentralization

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Abstract

The profitability of a firm is jointly determined by it's organizational structure and the market structure. To explore the effects of market factors on optimal organizational structure we develop a real-time information processing model of a multi unit firm in a dynamic duopoly environment. Our model is the first to match with recent empirical finding We find *decentralization* dominates for products with short lifecycles but in general there is no unique optimal organization structure over time - when product market competition is intense, *decentralization* outperforms centralization in the initial phase of the product lifecycle, *centralization* is superior in the intermediate phase, and *decentralization* outperforms again at the final phase. Thus organizational change also appears to be a natural part of the lifecycle as well as a response to economic shocks. Moreover, we also find that the performance of *decentralization* is superior when: (i) consumer tastes are more homogenous; (ii) consumers are more sensitive to store practices; and (iii) a larger number of markets are served.

Keywords: Organizational Structure; Decentralization; Market Structure; Product Market Competition; Real-time Information Processing.

1 Introduction

It is now a standard tenet of strategic management (Brickley et al. 2007, Saloner et al. 2000) that the performance of a firm is jointly determined by its internal environment (organizational structure) and its external environment (market structure).

'Organizational structure' specifies the architecture of an organization, which affects the quality of decision making. The two organizational forms that we will discuss in this paper are *'centralization'* and *'decentralization'*. Under centralization decision making authority is vested in the headquarters; while under decentralization decision making is delegated to the local managers, who have superior local information (Kruisinga 1954).

'Market structure' consists of the factors in a market which affect the payoffs of firm decision making. Product market competition is argued to be one of the most important factors in market structure — other factors that will be discussed in this paper include the distribution of consumer

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tastes, consumer sensitivity to firm operations, and the number of markets that the organization serves.

Understanding the relationship between organizational structure and market structure is important because the external and internal environments work together to determine the profitability of the firm. Thus, there is not a single best organizational structure for a firm, instead, we are looking for the best fit between organizational structure and market structure (Roberts 2004). The focus of this paper is on the following research question: how does the market structure affect a firm's optimal organizational structure?

Only a small and recent literature has studied the relationship between organizational structure and market structure, and has done so in the context of learning in differentiated products markets.

Meagher (1996) pioneered the single market analysis which explores the relationship between organization structure and market structure as described by a real-time information processing model for the case of a dynamic *monopoly/monopolistic competition*. Meagher emphasizes that firm performance is determined by the interaction of organizational structure and the rate of change in the stochastic market environment. The natural interpretation, and one frequently made in empirical and case study papers, is that more competition produces a faster changing environment.

The other pioneering contribution (Chang and Harrington 2000) independently developed a monopoly model based on consumer search and information pooling. Chang and Harrington (2003) makes a seminal contribution by enriching the market environment to include explicit product market competition through the use of game theory. They draw the conclusion that centralization tends to outperform decentralization when product market competition is intense. However, the opposite result has been found a in number of empirical papers, that product market competition favors decentralization (Mendelson 2000, Delmastro 2002, Acemoglu et al. 2007, Bloom et al. 2007, Guadalupe and Wulf 2007, Meagher and Wait 2008).

Thus neither existing approach is entirely satisfactory. Meagher (1996) gives the correct empirical prediction but competition is not explicitly modeled, while Chang and Harrington (2003) is theoretically appealing due to explicit competition but does not match the data. The essential mechanism at work in Chang and Harrington (2003) is the trade off between more aggregate information under centralization against less disaggregated information under decentralization (with disaggregated data being of higher quality). Put very coarsely a tradeoff between quantity and quality of information in decision making. In Chang and Harrington (2003) the only cost of centralization is the loss of quality through aggregating information.[1] In reality it is well understood that centralization's aggregation process incurs other costs relative to decentralization, of which delay is one of the most prominent. We argue that centralization produces delay in decision making because individuals have limited capacities in communicating, formulating and processing information, known collectively as 'bounded rationality'. We will show that including bounded rationality, in addition to the factors previously modeled, will produce predictions consistent with the existing empirical findings.

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[1]This impacts both decision making and implementation.

'Bounded rationality' was first suggested by Simon (1955). The concept of bounded rationality revises the traditional 'rational choice theory' to account for the fact that perfectly rational decisions are often not desirable in practice due to the finite computational resources available for making them. It is alsoobserved by Van Zandt (1999) that it is especially important to recognize the bounded of rationality of economic decision makers in studying the economics of organization.

The economies of today's industrialized nations are dominated by giant firms, each with thousands or tens of thousands of employees. A single person cannot be cognizant of everything in such a firm. Hence, instead of treating a firm as a unitary 'entrepreneur', bent on maximizing profit, we should consider a firm as an organization of economic agents of bounded rationality (Radner 1992).

To synthesize Chang and Harrington (2003) and Meagher (1996), this paper develops a real-time information processing model in a dynamic duopoly environment, which allows us to consider the effects of product market competition as well as the cost of delay. In this computational model of multi business unit firms (referred to as chain stores in the literature), consumers keep searching among stores for a better match, and store managers continually search for better practices. The headquarters and store managers are treated as information processors, and it takes time for them to process information. This information processing delay may result in unprofitable decisions which are computed from the lagged information.

The major finding of this paper is that the choice of organizational structure is affected by the market structure, but there is no single organizational structure which is optimal at all stages of the industry's life cycle. Thus we find organizational change is not solely due to major shocks but is a natural part of the life cycle. When the product market competition is more intense, the relative performance of decentralization is superior in the early business phase, centralization is superior in the middle phase, and decentralization is again best in the final phase[2].

The organization of the paper is the following. Section 2 presents the computational model used. Section 3 presents the simulation design. Section 4 discusses the results. Finally, Section 5 concludes.

2   Computational Model

Our major extension to the model of Chang and Harrington (2003) is to consider bounded rationality on the part of the organization. In particular we assume that information processing takes time inducing delay between the observation of information and the implementation of decisions based on that information.

To synthesize Chang and Harrington (2003), Meagher (1996) and Van Zandt and Radner (2001), a reduced form of the real-time decentralized information processing model has been developed for the duopoly case as described below. For ease of comparison we begin be describing the Chang and Harrington (2003) market model which we also use.

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[2]The existing empirical studies are weak on time series results, however Delmastro (2002) is consistent with our findings in showing firm age is also important in understanding the decentralization choice.

2.1 Market Setup

There are two chains a and b competing in M distinct geographic markets. Each chain is modeled as a corporate headquarters (HQ) and M stores. Each store serves one single market. For each chain, there are two organizational structures available: '*centralization*' and '*decentralization*', which are denoted by 'C' and 'D' respectively.

The operations of each store are viewed as a bundle of practices/attributes over N dimensions, such as ease of access, selection and quality of products, style of trading, service offered, and so on (Lancaster 1966, Group 1995). Specifically, the operations of chain j's store in market h in period t is fully described by an N-dimensional vector $z^{j,h}(t) \equiv (z_1^{j,h}(t), z_2^{j,h}(t), ..., z_N^{j,h}(t)) \in \{1, 2, ..., R\}^N$, where $z^{j,h}(t)$ is the overall operations of the store, $z_k^{j,h}(t)$ is the practice for the kth dimension of the store's operations, and R is number of feasible practices for each the N dimensions.[3]

There is a constant number of total consumers Y in all markets, and $C = Y/M$ consumers in each market. Each consumer i is defined as a bundle of preferences over these N dimensions of the store's operations, $w^i \equiv (w_1^i, w_2^i, ..., w_N^i) \in \{1, 2, ..., R\}^N$, which is drawn independently across dimensions and markets. Each consumer's type is drawn from a triangular density distribution over $\{S_h - G, ..., S_h + G\} \subset \{1, 2, ..., R\}$, where S_h denotes the mean of the market h, and G denotes intra-market heterogeneity/dispersion, which measures how different the consumers' tastes are within a market. The means of adjacent markets are equally spaced at distance α, for example, the difference of the means between market h and it's adjacent market $h + 1$ is given by $\alpha = |S_{h+1} - S_h|$, where α is inter-market heterogeneity, and the mean of the middle market is $S_{middle} = R/2$.

2.2 Organizational Structure and Decision Making

Store managers continually search for better practices through generation, evaluation and implementation of innovation ideas. This process is described in the following.

2.2.1 Generation of Innovation Ideas

Innovation is modeled as a random search carried out in a fixed space of ideas. In each period, each store generates one idea. An idea is created by randomly selecting a value from {1,...,R} over a randomly selected dimension from {1,...,N}.

Consider an example with 5 dimensions and 100 feasible practices. Suppose that the current store practice is $(24, 77, 43, 52, 12)$, and an adoption of an innovation involves changing the practice in the second dimension from 77 to 59. Then the new store practice becomes $(24, 59, 43, 52, 12)$.

2.2.2 Evaluation and Implementation of Innovation Ideas

In Chang and Harrington (2003)'s model, no information processing delay has been modelled. It is assumed that information processing is effortless and occurs on the spot.

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[3]Choices on each dimension are made independently and are not constrained by technology.

However, Radner (1993) suggests that it takes time to process information. To quantify the cost of delay, we need a temporal decision problem in which current decisions are computed from lagged information(Van Zandt 2003).

Thus, a reduced form of real-time information processing model is adopted, where the HQ and store managers are treated as information processors with limited processing capacities. It is assumed that it takes one period for each information processor to process one piece of information, for example, to evaluate one new idea. Under Centralization, only the HQ has the authority to evaluate and implement new ideas, while under decentralization, each store manager is delegated to evaluate and implement the new ideas generated by himself without any interference from the HQ.

Following Chang and Harrington (2003) it is also assumed that the HQ does not have detailed information on individual stores' markets. The HQ's evaluation of innovation ideas is based on aggregate information about the current consumer base and profits for the whole chain. Inter-store learning is relatively effective under centralization in the sense that it promotes the spillover of profitable ideas across all the stores under the chain. However tailoring strategies to local conditions is not possible under centralization.

All periods are classified into two types: *information processing periods (IPP)* and *operating periods (OP)*. During IPPs, the HQ/store managers generate and evaluate the new ideas while no implementation of new practices takes place (sales continue with the existing practices). At the beginning of each OP, a new practice from the last IPP is implemented, and at the end of each OP, the information about the current profit and consumer base will be collected for evaluation purposes in subsequent IPPs.

Under centralization, during IPPs the HQ will: (i) take M periods to sequentially evaluate all new ideas sent by the store mangers (based on the information received at the end of the last OP period), and (ii) implement the most profitable idea throughout the whole chain at the beginning of the next OP (if it increases the chain's overall profit). If no idea increases the chain's overall profit, all of the ideas are discarded. Similarly, under decentralization, during IPPs each store manager takes 1 period to evaluate his own idea (based on the information collected at the end of the last OP period), and implements it at the beginning of the next OP if it increases his store's profit, otherwise, the idea is discarded.

Note that the processing cycle under centralization is different from the processing cycle under decentralization. Under centralization, the processing cycle, whose length is $M+1$, contains M IPPs and 1 OPs, while the processing cycle under decentralization is two-periods long, which contains 1 IPP and 1 OP. Therefore, centralization involves a longer delay than decentralization by $M-1$ periods.

In the centralization (respectively decentralization) case, the evaluation of innovation ideas is based on the consumers base $\gamma^{j,h}(t-1)$ (respectively $\gamma^{j,h}(t-M)$), who consumed from the store in the last OP.

Under decentralization, store managers have the authority to implement ideas, while, under

centralization, this authority rests uniquely with the HQ. The HQ does not have detailed informa-
tion of store's markets so that it either implements a practice throughout the chain or not at all.
This implies that centralization imposes uniform practices across all the stores in the chain. Once
an innovation idea is implemented, the store's practice in the specified dimension is changed to the
new value.

2.3 Consumer Search and Demand

2.3.1 Consumer Search

Bounded rationality on the part of consumers suggests that consumers cannot be thinking about
which store to purchase from every hour, or even every week, due to their 'attention budget'.
Instead, a consumer rethinks such decisions from time to time, regularly or at some random intervals
(Radner 2003).

In our model, consumer search proceeds as follows. In each period, with probability $Q \in [0, 1]$,
a consumer engages in search, which involves searching both stores in the market, and then buying
from the store which gives him the best utility. With probability $1 - Q$, he does not search and
buys from the store that he purchased from in the previous period.

Note that if $Q = 0$, then each consumer has absolute loyalty to his current store, in such a case,
no consumer searches or switches stores in any period, and each chain acts as a monopolist. On
the other hand, if $Q = 1$, then all consumers search in each period, but it does not necessarily lead
to zero loyalty, as they may search without switching stores.

2.3.2 Demand/Consumption

The distance between a consumer's ideal store practices and store's actual practices is called the
'preference distance', which is measured by a function of Euclidian distance, $\sum_{k=1}^{N} (z_k - w_k)^2$.

A consumer ranks stores according to this preference distance. A small distance indicates
that the store's actual practices stay close to the consumer's preference, which implies that the
consumer's utility is high. On the other hand, a large distance implies that the store's actual
practices are far away from the consumer's ideal practices, which leads to a low consumer utility.
A consumer's decision on which store to purchase from is based on the rank of preference distance.
A consumer buys from the store with smaller preference distance.

Once a consumer decides which store to purchase from, the number of units demanded by the
consumer depends on the preference distance as well — demand is specified as

$$\left[A - \tau \sum_{k=1}^{N} (z_k - w_k)^2 \right]^2. \tag{1}$$

Demand is decreasing in the preference distance, so that a consumer buys more if he is more
satisfied by the store practices. A is fixed at the lowest value which ensures positive demand for

each consumer:[4] $A = \tau(R/2+G)^2 N$. Where τ is the transportation cost/salience coefficient, which measures the sensitivity of consumers responding to store practices.

Defining $\gamma^{j,h}$ to be the set of consumers that are shopping at chain j's store in market h in period t, then this store's profit in period t is specified as

$$\pi^{j,h}(t) = \sum_{i \in \gamma^{j,h}} \left[A - \tau \sum_{k=1}^{N} (z_k - w_k)^2 \right]^2 \tag{2}$$

This is the sum of consumers' demands as the price is set to one, and costs are normalized to zero. A chain's profit is the sum of profits of all the stores in the chain.

For the purpose of comparison, all the profits are scaled to one, by dividing each store's nominal profit $\pi^{j,h}(t)$ by $A^2 * C$.[5]

3   Simulation Design

3.1   Parameters

Simulations[6] were run with sets of parameters with different values[7], as shown in Table 1. For each set of parameter values, the computational experiment consists of X replications of the procedures over T periods as described in Section 2.

Each replication involves a randomly drawn market set-up and generation of innovations, so each replication is independent of the rest.[8]

For each replication, there are four scenarios which are simulated, denoted by CC, CD, DC and DD. The first entry gives the organizational structure of Chain a, while Chain b's organizational structure is given by the second entry. For example, CC/DD describes the market where both chains are centralized/decentralized; CD is where Chain a is centralized while Chain b is decentralized, and DC is where Chain a is decentralized while Chain b is centralized.

Let $V_C(O)$ denote the average profit of a centralized chain across all the replications X over the T periods, given the other chain's organizational structure O, and O can be either centralization or decentralization. Similarly, $V_D(O)$ denotes the profit of a decentralized chain.

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[4]$(R/2+G)$ is the maximum distance between a consumer's preference and store's actual practice in each dimension.

[5]$A^2 * C$ is the maximum demand/profit which a store can get, which assumes that all the consumers in the market buy from the store, and the preference distance is zero for each of them.

[6]It would be nice to have closed form equations for the results but these stochastic learning problems are prohibitively complex. Existing closed form results only extend to a static single market stochastic model with no learning and no organizational design issues (Meagher and Zauner 2004) or dynamic stochastic models with no competition (Meagher et al. 2003).

[7]The simulation program is written in MatLab.

[8]For each replication, the same initial practices and the same sequence of ideas for each store are used under both organizational forms, so that we are able to control for two sources of randomness.

Table 1: Table of Model Parameters Used in Simulations:

Parameters	Values
Number of Replications (X)	$\{1, 800\}$
Number of Periods (T)	$\{961\}$
Number of Markets (M)	$\{3, 5, 7\}$
Number of Total Consumers (C)	$\{1995\}$
Number of Dimensions (N)	$\{2\}$
Feasible Practices for Each Dimension (R)	$\{100\}$
Inter-market Heterogeneity (α)	$\{2, 4, 6, 10\}$
Intra-market Heterogeneity (G)	$\{10, 25, 40\}$
Transportation Cost (τ)	$\{0.1, 0.5, 0.9\}$
Consumer Search Probability (Q)	$\{0, 0.1, 0.2, 0.4\}$

3.2 Initialization

In the first period, due to the empty consumer base, the evaluation of ideas based on an existing consumer base is impossible. Thus a decentralized store implements the innovation idea generated by itself without evaluation, while under centralization, HQ implements a randomly generated idea throughout the chain.

In the second period, each chain starts from an information processing period following the pattern described in the Section 2.

On the other side of the market, it is assumed that in the first period, all the consumers are randomly assigned to stores and buy from the store with which they are matched.

There are M distinct markets, which are defined as

$$\{S_1, ..., S_{middle}, ..., S_M\} = \{\frac{R}{2} - \alpha(M-1)/2, ..., \frac{R}{2}, ..., \frac{R}{2} + \alpha(M-1)/2\}$$

Where $S_1, ..., S_{middle}, ..., S_M$ also denote the 'Consumer Peak' in Market 1,...,Middle Market,...,Market M respectively.
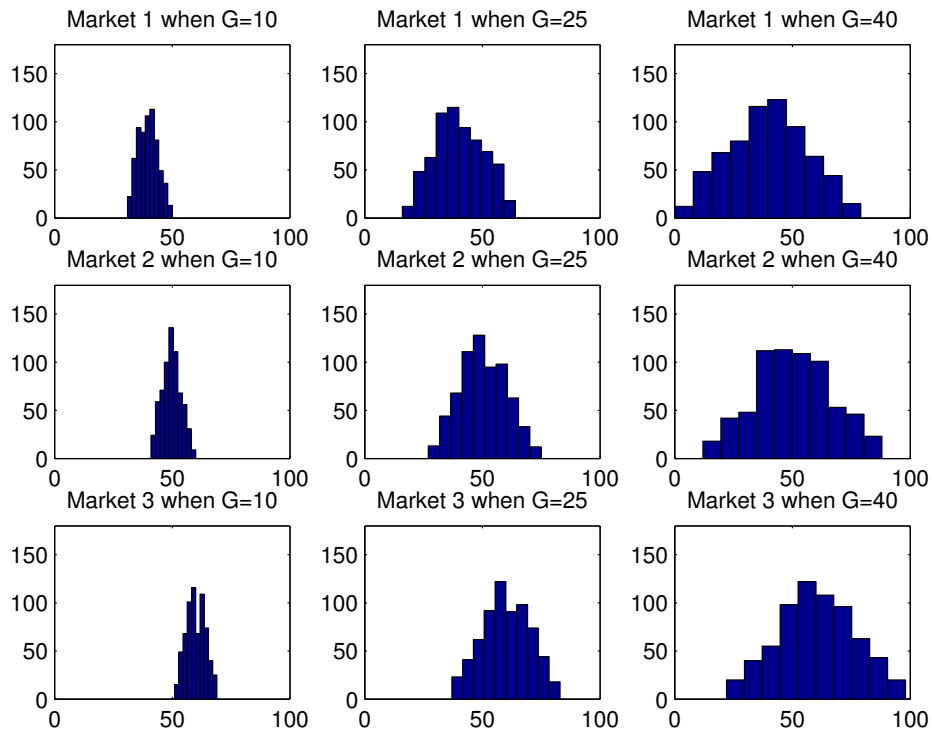
Figure 3.2 gives an example of the triangular consumer density over one dimension in $M = 3$ different markets with inter-market heterogeneity $\alpha = 4$ and different intra-market heterogeneity $G = \{10, 25, 40\}$. It is shown that, for each row, from the left to the right with increasing *intra-market heterogeneity/dispersion* G, the consumers are more heterogenous, represented by a more spread out consumer density; while for each column, from the top to the bottom, the consumer peak moves to the right due to the *inter-market heterogeneity* α.

4 Results and Analysis

This section is organized as follows. Section 4.1 describes the life cycle pattern of the results. Section 4.2 analyzes the relationship between organizational structure and the product market competition. Section 4.3, 4.4 and 4.5 analyze the relationship between organizational structure and other factors in the market structure.

The experiments in this section assume, unless noted otherwise, $M = 5$, $Y = 1995$, $\alpha = 4$, $G = 25$, $N = 2$, $Q = 0.2$, $\tau = 0.5$, $T = 961$, $X = 800$, while the other parameter values can be found in Section 3.1

Figure 1: Triangular density of consumers in the $M = 3$ markets when $\alpha = 10$ and $G = \{10, 25, 40\}$

(NOTE: This figure shows the triangular consumer density over one dimension in $M = 3$ different markets with inter-market heterogeneity $\alpha = 10$ and different intra-market heterogeneity G. The rows of the figure shows the consumer density in Market 1, Market 2 and Market 3 respectively. For each market, from the left to the right, the consumer densities with different intra-market heterogeneity are shown.)

4.1 Organization and the Industry Life Cycle

Figure 2(a),2(b) and 2(c) plot time series for the difference of chain profits between a centralized and a decentralized organization, given that the competing chain is centralized (respectively decentralized) for $\alpha = \{2, 4, 6\}$. It is shown that for each value of α, the pattern of the differential profit curve when the competing chain is centralized and when the competing chain is decentralized are similar, and they both move downwards given a increasing value of α, which implies that organizations tend to decentralize more when the markets become more heterogenous regardless the organizational structure of the competitor. This is natural because decentralization enables each store's manager to adapt the practices to it's own market while the uniform practices imposed by centralization are less likely to be profitable over all markets when the markets are highly heterogenous.

Figure 2(a) shows that when $\alpha = 2$, centralization slightly outperforms decentralization. Attention should also be paid to Figure 3, which plots chain consumer base and demand per capita under centralization and decentralization respectively, when the competing chain is decentralized[9]. In conjunction these two figures show that even though centralization tends to have a larger consumer base than decentralization, decentralization is still superior in satisfying it's consumers which is demonstrated in a higher demand per capita. This result is consistent with Chang and Harrington (2003), who find that decentralization tends to have higher consumer satisfaction but a smaller loyal consumer base.

It has been shown that for each value of α, the pattern of the differential profit curve when the competing chain is centralized and when the competing chain is decentralized are similar. However much of the variability occurs in the first 25 periods followed by a long right hand tail, where not much happens. As an alternative, in Figure 4 we plot curves with $log(Time)$ on the X-axis, rather than $Time$, which enables us examine the differential profit trend in the early periods of a business more effectively.

Decentralization tends to outperform centralization in the early phase as evidenced by the two curves dipping below zero in the early periods. This is because each store is immature during the early phase of the industry life cycle and it is very likely for a store to effectively learn from its own idea as most new ideas turn out to be profitable. On the other side of the market, the customers are highly active in changing stores in response to a better match during the early periods. Decentralization also tends to outperform centralization due to it's ability to make more prompt decisions to match the changing consumer base. Conversely, the delay associated with centralization prevents the chain from targeting the correct group of consumers, because the group of consumers who consumed from the chain a few periods ago can be totally different from the consumers who are consuming from the chain in the current period.

At the second phase, centralization starts performing better, shown by the curves rising to take positive values. In this stage, most of the consumers are more stable, that is they do not change their store even with searching, so the cost of delay becomes less important. On the other hand, as stores move away from highly suboptimal practices, finding profitable ideas becomes more difficult. As a result, the inter-store learning associated with centralization starts becoming important, since it allows stores to choose from a larger set of innovation ideas. Thus, centralization performs relatively better in this stage, because inter-store learning, which is effectively achieved by centralization, promotes the spillover of profitable ideas across the chain.

In the final phase, where organizations and the industry have become mature, the curves start to flatten out, which means centralization is not as favorable as in the second stage. In this period stores begin to hit the limit of centralization because the uniformity of practices imposed by centralization prevents stores from approaching their own global optimum. The advantage of 'local adaptability' under decentralization starts to appear critical at this point, which allows stores to tailor their practices to the local market in order to

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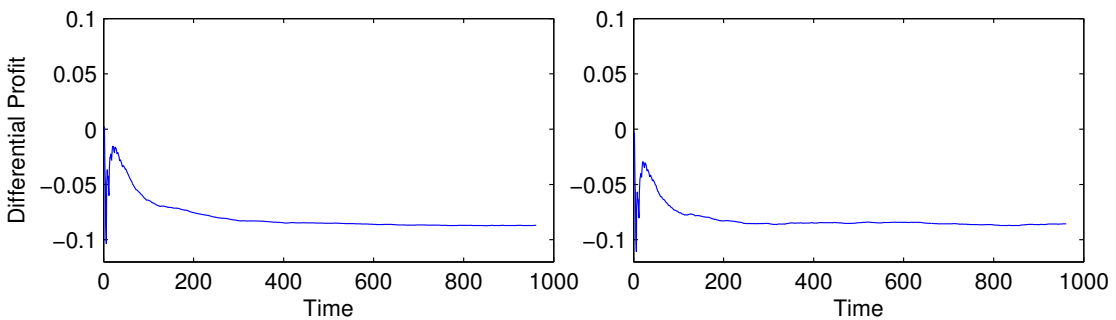[9]The curves look similar when the competing chain is centralized.

Figure 2: Differential Profit between Centralization and Decentralization when the Competing Chain is Centralized/Decentralized, given $\alpha = \{2, 4, 6\}$, $G = 25$, $Q = 0.2$, and $\tau = 0.5$

(a) $\alpha = 2$

(b) $\alpha = 4$

(c) $\alpha = 6$

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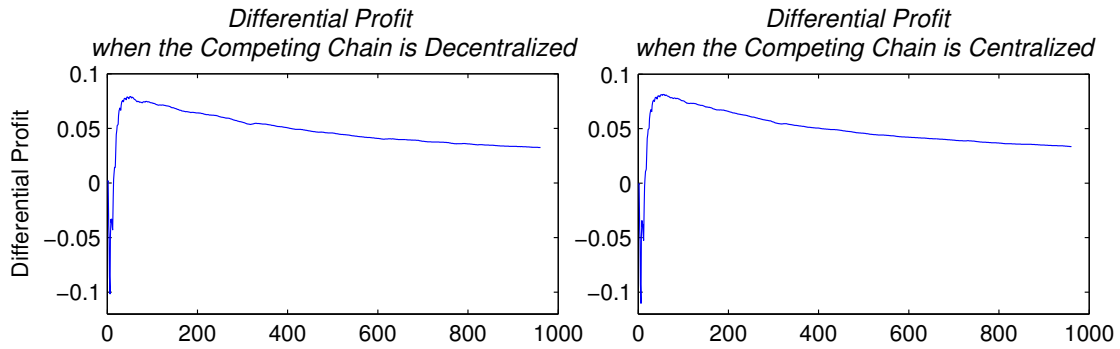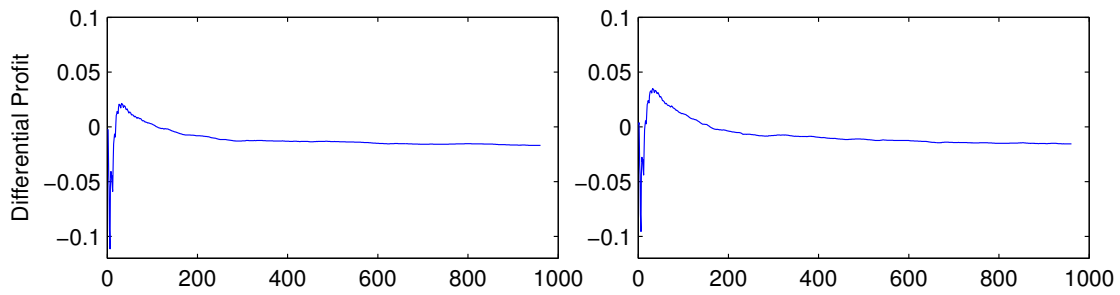
Figure 3: Consumer Base and Demand Per Capita under Centralization and Decentralization when the Competing Chain is Decentralized, given $\alpha = 2$, $G = 25$, $Q = 0.2$, and $\tau = 0.5$
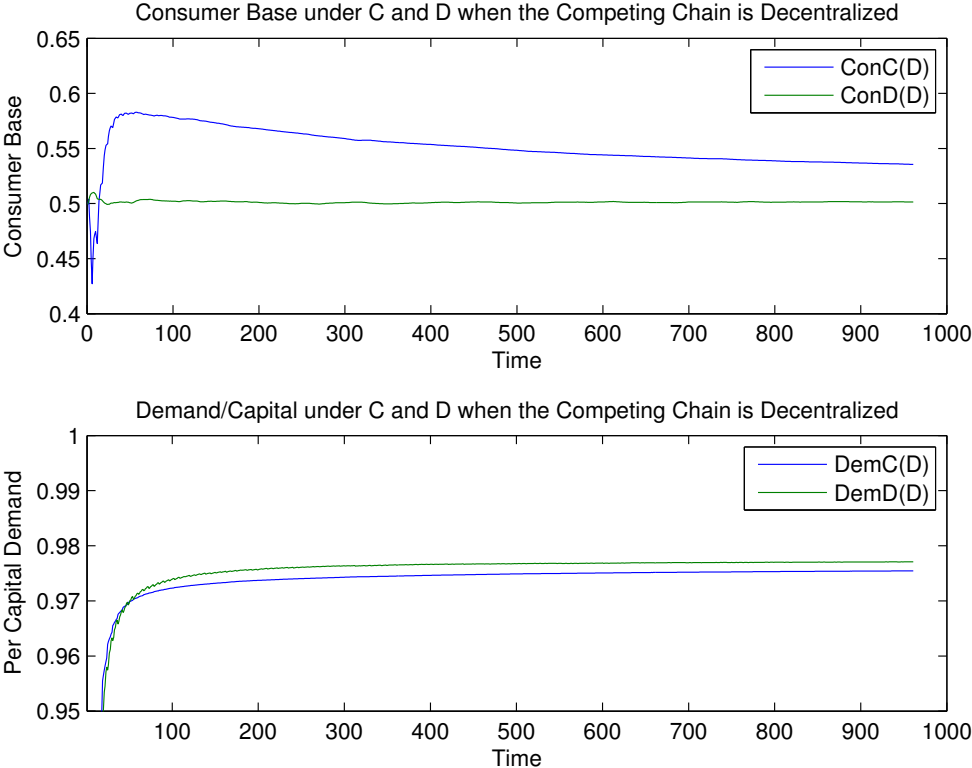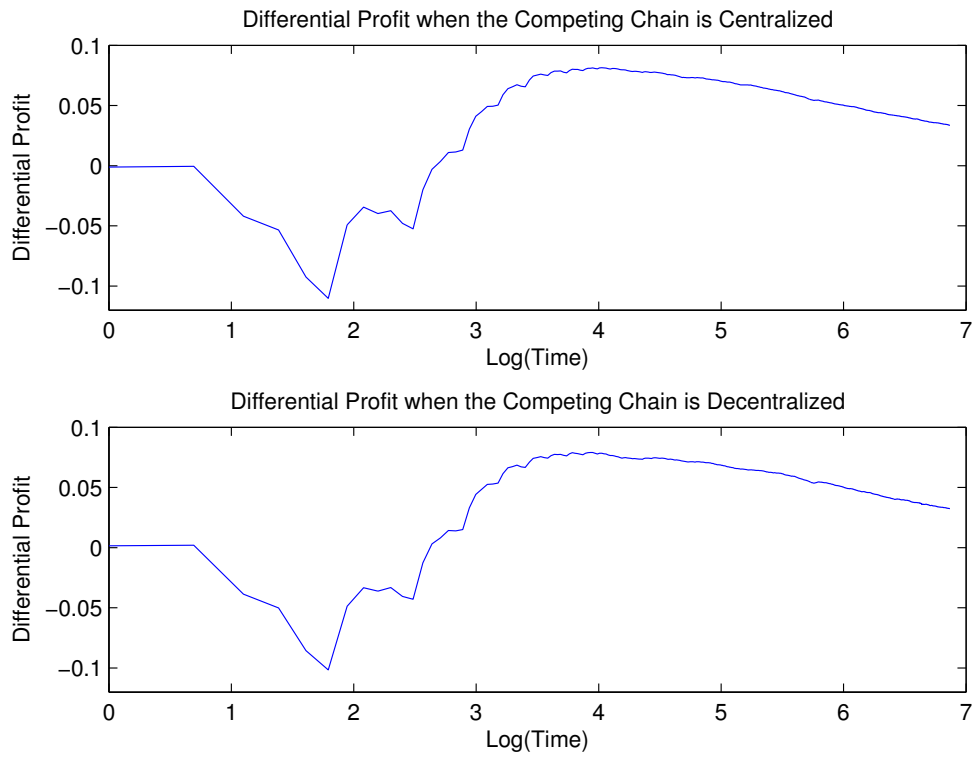
Figure 4: Differential Profit between Centralization and Decentralization when the Competing Chain is Centralized/Decentralized, given $\alpha = 2$, $G = 25$, $Q = 0.2$, and $\tau = 0.5$

achieve their global optimum.

There are two ways to interpret the implications of these results for the real world. First firms could sum profits over the relevant periods and choose the organization which yields the greatest profits. As we will see below the optimal choice will depend on the market conditions. A second more nuanced interpretation is that, subject to organizational change not being too costly, we should expect to see chances in organization over time. Changes which are due to the natural evolution of an industry/product market not as a result of unanticipated shocks. Casual empiricism seems to confirm this prediction and Delmastro (2002) finds firm age plays a role in his large scale statistical analysis. However there is still a need for long duration panel studies of decentralization to investigate this issue more fully.

4.2   Organizational Structure and the Product Market Competition

Product market competition is arguably one of the most important factors describing market structure. However, there has been a long controversy over the relationship between organizational structure and the product market competition in both theory and in the real world.

Chang and Harrington (2003), as a representative theoretical paper, shows that centralization performs better, relative to decentralization, when competition is more intense

> "by initially capturing those consumer types who are most prevalent in the market, a centralized chain tends to tailor their practices to them, which not only serves to retain those consumer, but also attracts similar consumers from other stores" Chang and Harrington (2003, p.542).

Put differently, centralization performs relatively better in the early periods in terms of attracting consumers. This superior consumer base serves as a competitive advantage of centralization, which is sustained over the long term (Chang and Harrington 2003).

However, several empirical papers show that there is a robust positive correlation between product market competition and decentralization (Mendelson 2000, Delmastro 2002, Acemoglu et al. 2007, Bloom et al. 2007, Guadalupe and Wulf 2007, Meagher and Wait 2008). An explanation discussed by Acemoglu et al. (2007) is that falling behind competitors may be more costly to a firm in a competitive environment, which encourages delegation to local managers who have superior local information. Meagher and Wait (2008) argue that decentralization is favoured because competition increases the costs of delay. In order to mitigate the cost of delay, decentralization performs relatively better when the product market competition is more intense.

We will now investigate these issues of market structure raised by the empirical literature in the context of our model.

Recall that in this paper, the intensity of competition is measured by the consumer search probability Q (Stahl 1996). When Q is approaching zero, there is no competition in the market, as each consumer has absolute loyalty to her favourite store, in that case, each store acts as a monopolist (Axell 1977, Stahl 1996). On the other hand, when Q is approaching one, each consumer searches in every single period, which results in a intense product market competition (Salop and Stiglitz 1977).

PROPERTY 1. *As product market competition becomes more intense (a larger value of the consumer search probability Q) the amplitude of the profit differential between centralization and decentralization is increased in the first two phases of the industry life cycle.*

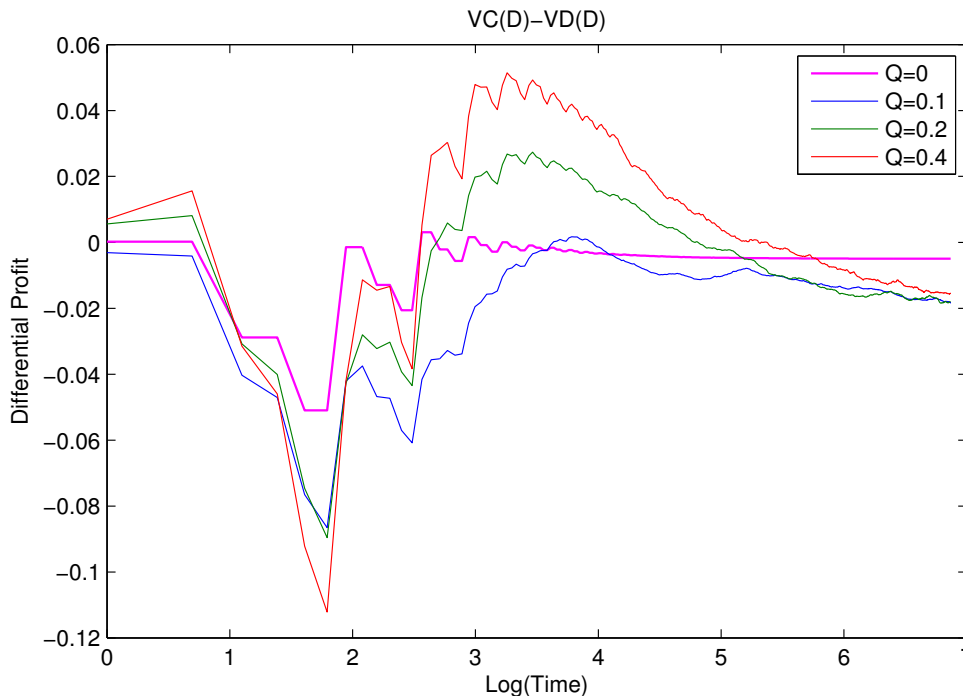Figure 5: Differential Profit and Product Market Competition Q

Figure 5 plots the time series for the average difference in chain profits between a centralized and a decentralized organization given that the competing chain is decentralized.[10] The figure shows that each curve follows the industry life cycle pattern specified in Section 4.1. Furthermore, as the consumer search probability Q increases, the relative performance difference between centralization and decentralization becomes more pronounced, but only in the first two phases. In the final phase the affect of different positive levels Q becomes negligible.

Our inclusion of real time information processing considerations produces different costs of delay for the two organization forms under consideration. Under centralization, the HQ is the only information processor who evaluates all the innovation ideas coming from all the store managers, which involves a longer delay ($M - 1$ periods) than decentralization. When the consumer search probability is high, a store's consumer base is changing quickly over time, so that the group of consumers who are consuming from the store in the current period can be extremely different from the group of consumers who purchased from this store a few periods earlier. This leads to the information about the store's consumer base, on which the evaluation of innovation ideas is based, becoming obsolete very quickly.

It is widely accepted that centralization is associated with a greater cost of delay (Aoki 1986) and competition motivates prompt decision making (Aghion and Tirole 1997, Meagher et al. 2003). In the early periods of our model, search leads consumers to change their favourite stores frequently. The better a store or a chain understands its own current consumers, the more likely it can effectively satisfy and retain these consumers. Under centralization, intense competition, in terms of high consumer search probability, makes the information about the current consumers become obsolete quickly as the group of consumers on which

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[10]From section 3.1, it is shown that the differential profit curve is similar when the competing chain is centralized and decentralized.

the evaluation is based is different from the group of consumers who actually consume from the chain. Consequently, the practices adopted by a centralized chain may be mismatched with the targeted consumer base which the chain is supposed to pursue. Hence, the relative performance of decentralization is superior when the product market competition is intense. This is not only because decentralization utilizes local adaptability, but also because it takes advantage of fresher information about its consumers, which allows it to make more prompt and accurate decisions in order to satisfy its consumers more effectively.

In the second life cycle phase, consumers have largely settled down and finding profitable innovations becomes harder for the organizations. The advantage of mutual learning associated with centralization becomes dominant. Centralization dominates because failing to find profitable ideas is harmful to the organization. This need is more urgent under a highly competitive market because because falling behind competitors can be extremely dangerous when the product market competition is intense. Again competition heightens the effect identified in the original industry life cycle analysis of section 4.1.

In the last phase chains/stores tend to find the globally most profitable ideas. The impact of competition on the relative performance of centralization and decentralization disappears over this phase because practices converge to their appropriate limits and the importance of learning disappears. Decentralization dominates in this phase because the uniform practices imposed by centralization limits an organization's ability to tailor its practices to each market in order to satisfy the consumers.

Thus drawing the simple conclusion that an organization should be centralized or decentralized when product market competition becomes more intense is misleading, because there is no unique organizational structure which is suitable for an organization over it's whole business life. The appropriate choice of organization will be largely driven by how much of the industry life cycle we have identified is expected to actually materialize. That is, if the the learning process is likely to be truncated early because of an advance in technology, then more weight is attached to the first phase of our model and decentralization becomes more attractive as competition increases. Mendelson (2000) shows this increasing performance premium for decentralization for what he terms high clock speed products — high tech products where technological innovation leads to frequent new generations of products in addition to incremental product refinements.

A second empirical implication is that increased competition should be associated with more organizational change (between centralization and decentralization). Our results show that increased competition increases the returns to having the appropriate organizational form (decentralization or centralization). Real firms will have a distribution of idiosyncratic costs or impediments to organizational change such as unionization, technology, regulation, culture etc. Hence as competition increases more firms will find in worthwhile to incur their idiosyncratic costs and go through the change process appropriate to the current life cycle phase of their industry.

4.3   Organizational Structure and the Consumer Tastes

Recall that the intra-market heterogeneity G measures how different consumers are in a market. A small G indicates that the tastes of consumers within a market are relatively homogenous, while a large G means the market is relatively spread out with heterogeneous consumer tastes.

PROPERTY 2. *Decentralization performs relatively better when consumer tastes are more homogenous in the market (as described by a small intra-market heterogeneity G.)*

Figure 6 plots the difference of profits between a centralized and decentralized chain when the competing chain is decentralized, which shows that the differential profit curve shifts down when the intra-market

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Figure 6: Differential Profit and Intra-market Heterogeneity G
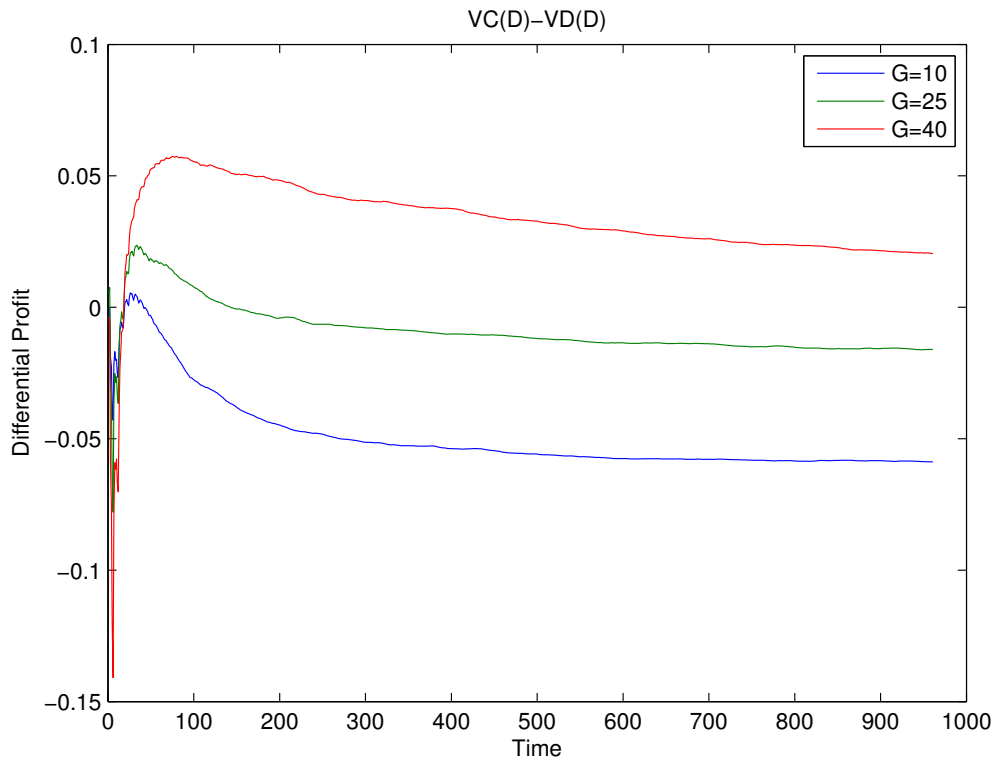
heterogeneity G becomes smaller, which demonstrates that the relative performance of decentralization is superior when the consumers in the market are more homogenous in their tastes.

Figure 7 plots the three different profit landscapes in the middle market $(M-1)/2$ when $G = \{10, 25, 40\}$ respectively given the practice of Chain a's store in this market over the Nth dimension changing from $\{1,...,R\}$, while the practices over other dimensions and Chain b's dimensions are kept fixed. It is shown that when the intra-market heterogeneity G is small, such as $G = 10$, the profit landscape appears to be relatively steep; when G increases to 40, the profit landscape becomes much flatter. This shows that when the market is more homogenous, a slight deviation from the global optimum will lead to a large drop in profit. Thus, the local information possessed by store managers is especially important when consumer tastes are more homogenous in the market, which allows each store to adapt to the global optimum in its own market.

In Figure 7, attention should also be paid to the global optimum of the profit landscape shown in the label in each sub-figure. When the consumer tastes in the market are homogenous with a small G, in order to achieve the global optimum, the store tends to locate closer to the middle of the market, which is known as the consumer peak. However, the uniformity of practices imposed by centralization prevents store from achieving this global optimum.

We conclude that when consumer tastes are relatively homogenous in a market, decentralization does not only satisfy consumers better but also tends to have a larger consumer base. This is because, when the consumers are relatively homogenous in a market, a practice which satisfies the consumer types who are most prevalent in the market will also tend to satisfy many other consumers in the market. Thus, decentralized store utilizes its superior local information to satisfy its current consumers, and, in turn, to satisfy most of the consumers in the market effectively.

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Figure 7: Profit Landscapes and Intra-market Heterogeneity G
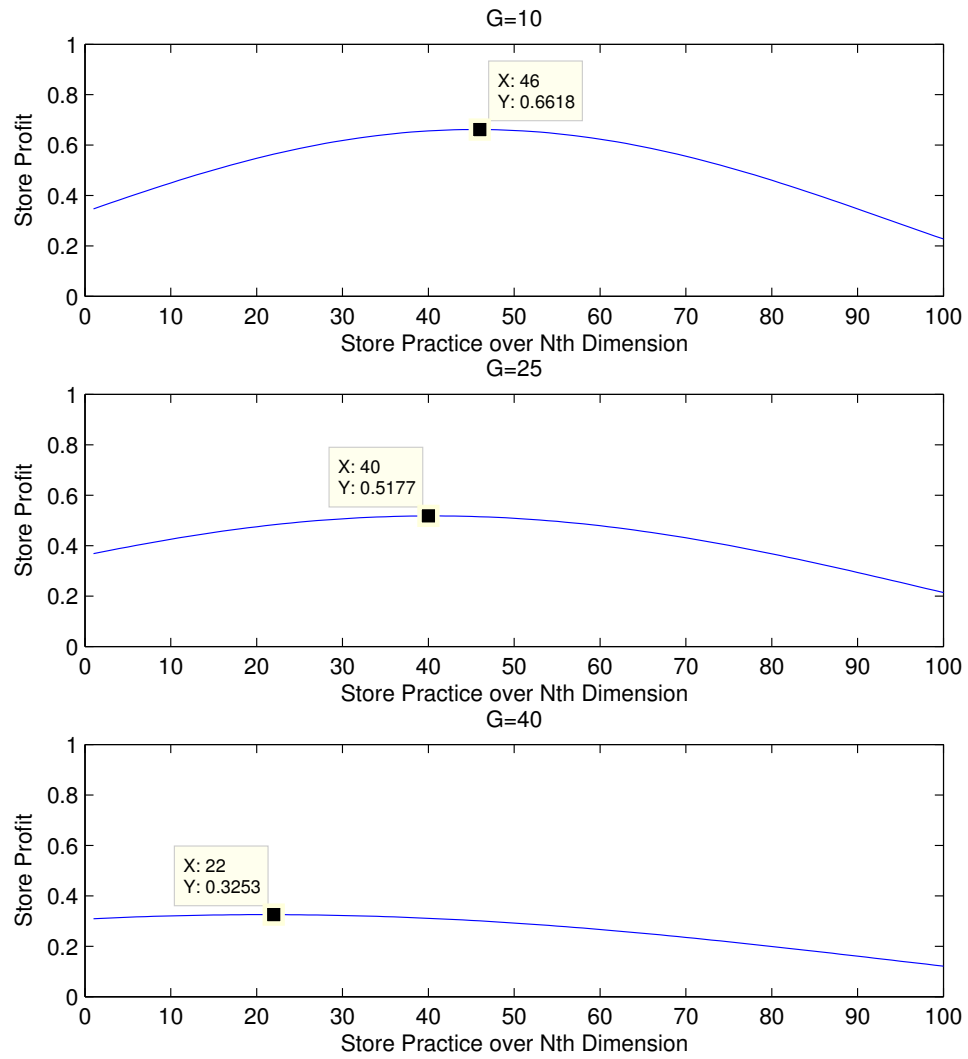
4.4 Organizational Structure and the Consumer Sensitivity

Recall that τ denotes the transportation cost/salience coefficient, which measures the sensitivity of consumers' demand in response to store practices. With a larger value of τ, a consumer is more sensitive to store practices, so that the same increase in the preference distance would lead to a larger drop in consumer demand. On the other hand, a smaller value of τ implies that the consumer is less sensitive to store practices.

PROPERTY 3. *The relative performance of decentralization is superior when consumers are very sensitive to store practices, which is captured by a relatively large τ.*

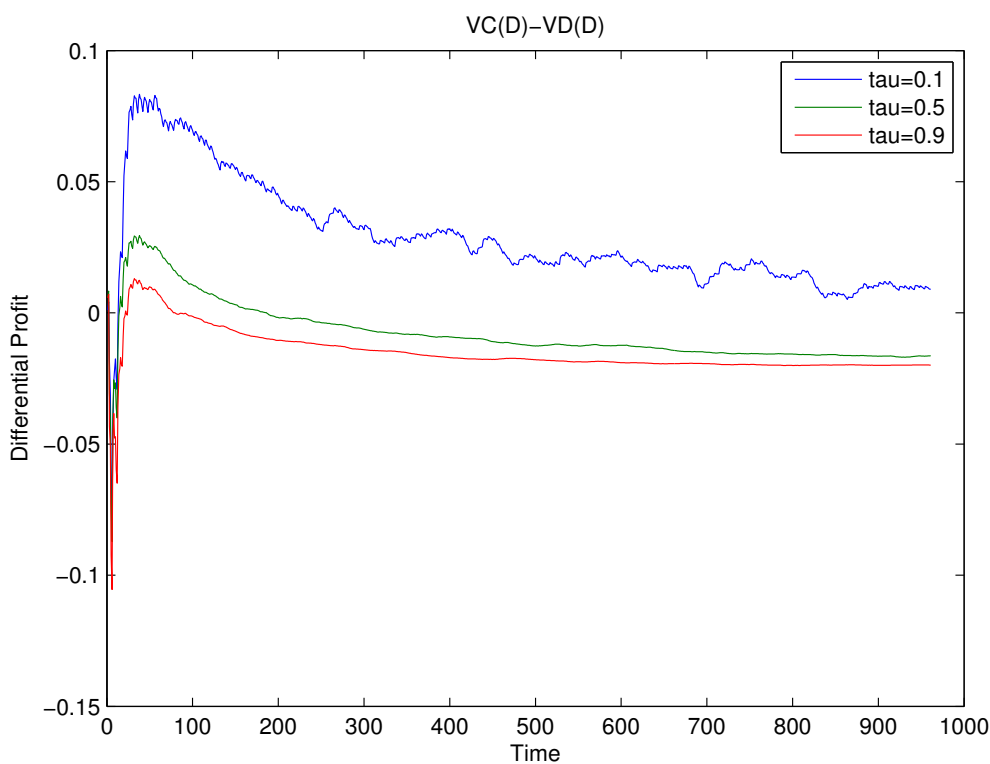Figure 8: Differential Profit and Consumer's Sensitivity τ

Figure 8 plots the difference of profits between centralization and decentralization when the competing chain is decentralized. The curve shifts down when τ becomes larger, which demonstrates that when consumers are more sensitive to store practices, decentralization performs relatively better.

When the τ is relatively large, individual consumer satisfaction and hence per capita demand for close consumers becomes relatively important compared to the size of consumer base. Thus, a chain would rather focus on satisfying it's current consumers rather than having a larger consumer base. Recall the conclusion drawn in section 3.1, that centralization tends to have large consumer base while decentralization tends to satisfy it's consumers better. In turn, decentralization tends to perform relatively better when τ is relatively large.

4.5 Organizational Structure and the Number of Markets

Recall that M stands for the number of markets that each chain is serving. The number of markets determines the tradeoff between the cost of delay and the benefit of mutual learning under centralization. When M becomes larger, it takes more periods for the HQ to evaluate all the ideas, which aggravates the cost of delay associated with centralization. On the other hand, it also enables a larger pool of new ideas, which strengthen the advantage of mutual learning under centralization. The consequence of this tradeoff is summarized as follows.

PROPERTY 4. *The relative performance of decentralization is superior when the chain is serving a relative large number of markets M.*

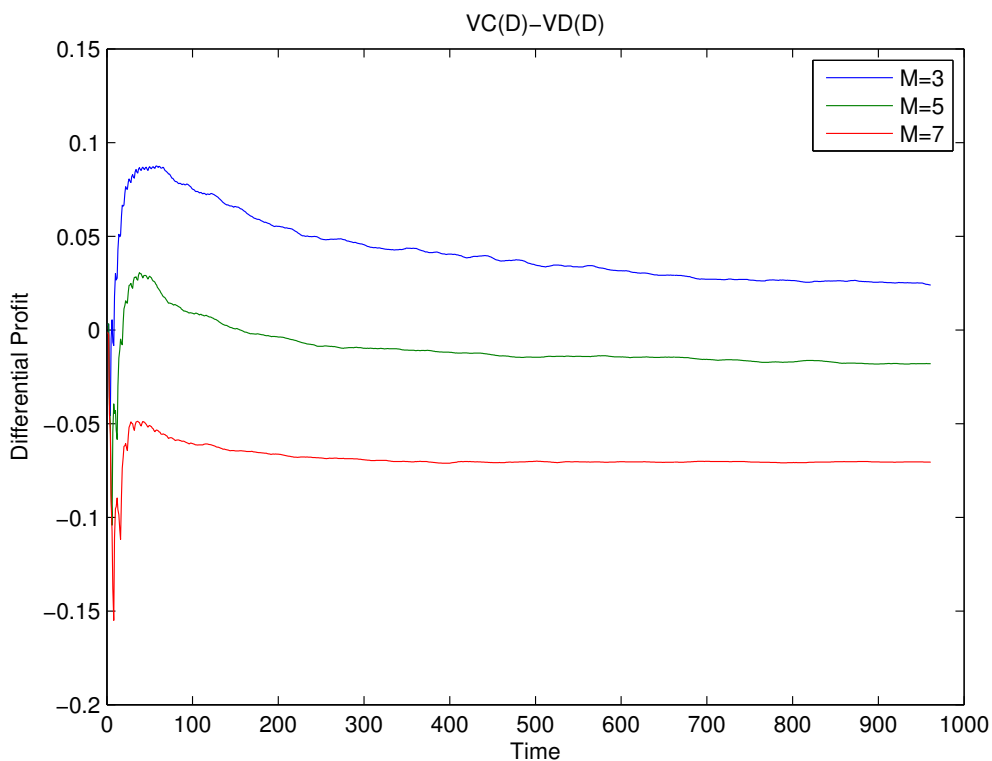Figure 9: Differential Profit and the Number of Markets M

Figure 9 plots the average differential profit when the competing chain is decentralized. The curve shifts down when M becomes larger, which demonstrate that decentralization performs relatively better when a chain is serving a relatively larger number of markets.

Two contributing factors for this result are discussed here. Firstly, there is the direct affect (identified above) between the increased cost of delay imposed by a larger M and the benefit of mutual learning. It takes one period for a decentralized organization to evaluate and implement one idea, while it takes M periods for a centralized organization to evaluate its ideas and implement one. When the organization needs to serve a large number of markets, centralization becomes less effective due to a longer delay. With a longer

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delay, it becomes harder for a centralized organization to correctly estimate the expected profit, and in turn to evaluate a new idea. At the same time the value of new ideas is capped above by the finite maximum profit available in the model.[11]

Secondly, a larger M makes the uniformity of practices imposed by centralization less profitable. A uniform practice which increases one store's profit becomes less likely to suit the other stores in the chain when M grows larger due to the greater inter-market heterogeneity. For example, when there are $M = 3$ markets, the inter-market heterogeneity between the first and last market is 2α, while in the case of $M = 7$ markets, the inter-market heterogeneity between the first and last market grows to 6α.

The empirical evidence supports this result with exporting firms in the same industry (who on average will serve more markets than non-exporting firms) being more likely to have a decentralized structure (see Meagher and Wait 2008). Globalization is likely to have additional impacts on organizational structure through mechanisms such as culture and scale. None the less, the empirical evidence suggests that the increasing cost of delay through centralization of activities in many markets is a first order effect.

5   Conclusion

This paper has examined the relationship between a firm's optimal organization structure and the market structure with explicit mathematical models of both firm organization (and the induced decision making routines) and the competitive process. To incorporate bounded rationality we developed a reduced form, dynamic real-time decentralized information processing model for the duopoly case. This model allows us to consider the cost of delay (Meagher 1996) as well as product market competition (Chang and Harrington 2003).

The importance of the delay/speed is well understood in the applied management literature. For example, Fisher et al. (1994) argues that the superior performance of firms like Wal-Mart, The Gap, The Limited and Benetton is largely due to their ability to manage demand uncertainty using an 'accurate response' strategy. This implies that using more recent information and reacting to the changing consumer base more promptly serves as a competitive advantage for a firm. The need for timely decision making favors decentralization because it reduces the lag between the receipt of information and decision making.

Although this positive relationship between decentralization and product market competition is now well documented empirically it has only been briefly discussed in some organizational textbooks (for example, Brickley, Smith and Zimmerman (2004)) and no theoretical work to date supports this argument. Conversely, Chang and Harrington (2003) shows a contradictory result with their simulation model, that product market competition favors centralization when information pooling (and not delay) is the issue.

Our first major finding is that the optimal organizational structure depends on the life cycle phase of the industry. Initially decentralization dominates as quick action is paramount in exploiting 'low hanging fruit'. In the middle phase the shared learning facilitated by centralization becomes optimal as profitable innovations become harder to find. Finally, decentralization dominates again as full tailoring to local conditions becomes necessary to extract the last remaining profits. It follows that decentralization tends to be superior when

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[11]Demonstrating this tradeoff between the denigration in information from delay and the asymptotic properties of the set of innovations is beyond the scope of this paper, however we give the following sketch of the issues. The cost of delay is always increasing in M. On the other hand, the value of ideas are necessarily bounded since profits are bounded in this model. Now the expected value of the most profitable innovation from a set of M random innovations must be increasing in M, but it is also bounded above by the maximum profit. Thus the expected value of the most profitable innovation must asymptote and will tend towards concavity in M in the sense of approximately diminishing returns.

product market competition is more intense and the life cycle is short. This finding is confirmed by Mendelson (2000)'s empirical analysis. To the degree that technological innovation has accelerated in the last decade or so with the spread of ICT and given that globalization has tended to increase competition, our results are consistent with the common trend towards decentralization found in Rajan and Wulf (2006). Our results also show that the returns to the optimal organizational choice increase with competition.

Secondly, we find that decentralization performs relatively better in a market where consumer tastes are more homogenous. Based on superior local information, by tailoring its practices to the consumer types who are most prevalent in the market, decentralization can satisfy many other consumers if the consumer tastes in the market are similar. We also find that the relative performance of decentralization is superior when a larger number of markets are served. These results are consistent with the empirical finding of a positive correlation between exporting and decentralization (see Meagher and Wait 2008).

In conclusion our model fits well with existing empirical findings and there is ample opportunity to investigate the organizational impacts of additional aspects of market structure and business strategy. For example future research might make the consumer search probability endogenous[12]; or introduce strategic market research (Peter and Olson 2005).

References

Acemoglu, Daron, Philippe Aghion, Claire Lelarge, John Van Reenen, Fabrizio Zilibotti. 2007. Technology, information, and the decentralization of the firm. *Quarterly Journal of Economics* **122**(4) 1759–1799.

Aghion, Phillipe, Jean Tirole. 1997. Formal and real authority in organizations. *Journal of Political Economy* **105**(1) 1–29.

Aoki, M. 1986. Horizontal vs. vertical information structure of the firm. *American Economic Review* **76**(5) 971–983.

Axell, B. 1977. Search market equilibrium. *The Scandinavian Journal of Economics* **79**(1) 20–40.

Bloom, Nicholas, Raffaella Sadun, John Van Reenen. 2007. The organization of firms across countries. London School of Economics.

Brickley, James, Clifford W Smith, Jerold Zimmerman. 2007. *Managerial Economics and Organizational Architecture*. 4th ed. McGraw-Hill/Irwin.

Chang, M. H., J. E. Harrington, Jr. 2000. Centralization vs. decentralization in a multi- unit organization: A computational model of a retail chain as a multi-agent adaptive system. *Management Science* **46**(11) 1427–1440.

Chang, M. H., J. E. Harrington, Jr. 2003. Multimarket competition, consumer search, and the organizational structure of multiunit firms. *Management Science* **49**(4) 541–552.

Delmastro, M. 2002. The determinants of the management hierarchy: evidence from italian plants. *International Journal of Industrial Organization* **20** 119–137.

Fisher, M. L., J. H. Hammond, W. R. Obermeyer, A. Raman. 1994. Marking supply meet demand in an uncertain world. *Harvard Business Review* 83–93.

Group, Mintel International. 1995. *Customer Loyalty in Grocery Retailing*. Mintel International Group Limited, London.

Guadalupe, Maria, Julie Wulf. 2007. The flattening firm and product market competiton: The effect of trade costs and liberalization. Columbia University.

Kruisinga, H. J. 1954. The balance between centralization and decentralization in managerial control. *Proceedings of an International Study-Conference*.

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[12]For example, consumers only search if the utility that she receives from her favourite store falls below a certain level (Radner 2003).

Lancaster, K. 1966. A new approach to consumer theory. *Journal of Political Economy* **74**(2) 132 –157.

Meagher, K. 1996. Managing change and the success of niche products. *Santa Fe Institute Working Paper* **96-08-066**. Santa Fe Institute Working Paper 96-08-066.

Meagher, K, H Orbay, T Van Zandt. 2003. Hierarchy size and environmental uncertainty. M Surtel, S Koray, eds., *Advances in Economic Design*. Springer Verlag, Heidelberg, Germany, 439–457.

Meagher, Kieron, Andrew Wait. 2008. Who decides about change and restructuring in organizations? Available at SSRN: http://ssrn.com/abstract=1271754.

Meagher, Kieron, Klaus Zauner. 2004. Product differentiation and location decisions under demand uncertainty. *Journal of Economic Theory* **117**(2) 201–216.

Mendelson, Haim. 2000. Organizational architecture and success in the information technology industry. *Management Science* **46**(4) 513–529.

Peter, J. P., J. C. Olson. 2005. *Consumer Behaviour and Marketing Strategy*. McGraw- Hill Irwin, NY.

Radner, R. 1992. Hierarchy: The economics of managing'. *Journal of Economic Literature* **XXX** 1382–1415.

Radner, R. 2003. Viscous demand. *Journal of Economic Theory* **112** 189–231.

Radner, Roy. 1993. The organization of decentralized information processing. *Econometrica* **61**(5) 1109–1146.

Rajan, Raghuram G, Julie Wulf. 2006. The flattening firm: Evidence from panel data on the changing nature of corporate hierarchies. *The Review of Economics and Statistics* **88**(4) 759–773.

Roberts, John. 2004. *The Modern Firm: Organizational Design for Performance and Growth*. Clarendon Lectures in Management Studies, Oxford University Press, USA.

Saloner, Garth, Andrea Shepard, Joel Podolny. 2000. *Strategic Management*. 1st ed. Wiley.

Salop, S., J. Stiglitz. 1977. Bargains and ripoffs: A model of monopolistically competitive price dispersion. *Review of Economic Studies* **44** 493–510.

Simon, H. 1955. *A Behavioral Model of Rational Choice*. Models of Man, Social and Rational: Mathematical Essays on Rational Human Behavior in a Social Setting, Wiley, New York.

Stahl, D. O. 1996. Oligopolistic pricing with heterogeneous consumer search. *International Journal of Industrial Organization* **14** 243–268.

Van Zandt, T. 1999. Decentralized information processing in the theory of organizations. Murat Sertel, ed., *The Enterprise and its Environment*, *Contemporary Economic Development Reviewed*, vol. 4. Macmillan Press, London, 125–160.

Van Zandt, Timothy. 2003. Real-time hierarchical resource allocation. INSEAD.

Van Zandt, Timothy, Roy Radner. 2001. Real-time decentralized information processing and returns to scale. *Economic Theory* **17** 497–544.