NON-ADDITIVE MARKET DEMAND FUNCTIONS: PRICE ELASTICITIES WITH BANDWAGON, SNOB AND VEBLEN EFFECTS

Amy Heineike and Paul Ormerod

Abstract

In a remarkable article published in 1950, Leibenstein extended the standard theory of consumer demand by relaxing the assumption that the consumption of any individual is independent of others. We discover important qualifications to Leibenstein's findings on price elasticity in the presence of Bandwagon, Snob and Veblen effects, though in general they are confirmed. We then analyse the impact of assuming that consumers are connected on networks other than the completely connected graph implicitly assumed by Leibenstein. The results are surprisingly resilient to assumptions about network topology, although for any level of price, demand is lower when the assumption of complete connectivity is relaxed.

1. Introduction

Standard consumer choice theory assumes atomised individuals exercise choice in an attempt to maximise utility subject to a budget constraint. In this approach, given an individual's tastes and preferences, decisions are taken on the basis of the attributes of the various products, such as price and quality.

In recent decades, the conventional theory has of course been extended to allow for factors such as the cost of gathering information (Stigler 1961), asymmetric information across agents (Akerlof 1970), imperfections in the perception of information and limitations to consumers' cognitive powers in gathering and processing information (Simon 1955). So decisions are not necessarily made in a fully rational way, but are nevertheless based on the (perceived) attributes of the products, without direct reference to the choices of others. (Of course, the latter can affect choice indirectly by their effect on relative prices.)

In a remarkable article published in 1950, Leibenstein made important steps in extending the standard theory of consumer demand in what is arguably an even more fundamental way. He relaxed the assumption that the consumption of any individual is independent of the consumption of others and considered the implications for market demand curves of such behaviour.

Leibenstein pointed out that there was a literature, going back over a century even at the time at which he wrote, in which the utility function of one individual contains the quantities of goods consumed by other individuals. Leibenstein's contribution was to analyse this in a formal way for the first time. He

examined how the price elasticity of the market demand function is affected by non-additive preferences.

Leibenstein identified three key ways in which the decisions of others might impact directly on the behaviour of an individual and hence affect the price elasticity of the market demand curve. First, the 'bandwagon' effect, defined as being when the demand for a commodity is increased due to the fact that others are also consuming the same commodity. There is, of course, a large and growing literature on this phenomenon across a wide range of practical examples (for example, Schelling 1973, Arthur 1989, De Vany and Wallis 1996, Salganik et.al. 2006, Ormerod 2007). However, such literature usually focuses solely on this social influence effect – termed 'binary choice with externalities' by Schelling – and neglects the role of price.

Less has been written on Leibenstein's other channels of influence, namely what he terms 'snob' and 'Veblen' effects. By the snob effect, he refers to the extent to which the demand for a product is decreased owing to the fact that others are also consuming the same product. And by the Veblen effect, he means the extent to which the demand for a product is increased because it bears a higher rather than a lower price. The former is a function of the consumption of others, the latter is a function of price.

A wider literature on non-additive preferences has developed, but this research does not draw out the implications for the price elasticity of the market demand function. Becker (1974), for example, proposed a theory of social interactions in which the individual can, by his or her decisions, alter the monetary value to the agent of the relevant characteristics of others, but did not examine the consequences for aggregate demand curves. Pollack (1976) examined a model in which individual

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demand is positively related to the past consumption of other agents – a form of bandwagon effect – but his focus was on the impact of the distribution of income and expenditure on consumption, and not on the impact of interactions on aggregate price elasticity. Basman et.al. (1988) suggest that post-World War Two consumer expenditure data offer support for Veblen's hypothesis on preference formation. Bagwell and Bernheim (1996) argue that if Veblen effects exist, traditional analysis of taxation policy can lead to highly misleading conclusions. Hopkins and Kornienko (2004) analyse the Veblen effect in the context of Nash equilibrium to show, perhaps unsurprisingly, that each individual spends an inefficiently high amount on the status good.

Leibenstein drew three conclusions about the shape of the market demand curve: First, if the bandwagon effect is the most significant effect, the demand curve is more elastic than it would be if this external consumption effect were absent. Second, if the snob effect is the predominant effect, the demand curve is less elastic than otherwise. Third, if the Veblen effect is the predominant one, the demand curve is less elastic than otherwise, and some portions of it may even be positively inclined; whereas, if the Veblen effect is absent, the curve will be negatively inclined regardless of the importance of the snob effect in the market.

There are two main purposes of the paper. Firstly, to analyse the validity of Leibenstein's conclusions using, as he implicitly did, a completely connected network. Secondly, to check their robustness by extending the analysis to consider three types of network which research, primarily over the last decade, has shown to be particularly important in social, economic and cultural contexts, that is the scale free, small world and random networks.

Section 2 gives a brief overview of networks. Section 3 describes the model, and the section 4 shows the results of introducing the Veblen effect, since this extension of the standard demand model is least affected by network configuration. Section 5 describes the impact of the bandwagon and snob effects with a completely connected network, making them directly comparable to those of Leibenstein. Section 6 introduces the effects of different networks. In economic terms in this context, networks which are not completely connected introduce asymmetries into the sets of information which different agents use in their purchase decisions.

2. Networks: an overview

An implicit assumption made by Leibenstein is that the consumers are connected in what would now be described as a completely connected network. We describe agents as being connected if the decision of one enters into the demand function of the other. So on a completely connected network, the decision of any given agent is affected by the decisions of every other agent.

In economic terms, we can obviously think of this as implying that agents have access to complete information about the decisions of others. In social terms, it means that they not only have access to this information, but that they choose to take everyone else's decision into account.

The assumption of a completely connected network is a particularly restrictive one in the light of recent theoretical and empirical advances in networks. (A valuable introduction to recent socio-economic uses of network theory is Durrett 2006). For our purposes, we consider networks where any given agent is only connected to a subset of all others. Again, we can think of this in economic terms as being a situation of asymmetric information in that agents have access to different information about the

decisions of others, or we can think of it in social terms as meaning that agents choose to take account of only a subset of all other agents.

First, a random network, in other words, any given agent is connected to another (i.e. takes account of the decisions of the other) at random with probability p. At first sight it might seem an unusual assumption to make in a social context. But the assumption that agents are connected at random is made by many standard models of epidemiology (for example Murray 1989), and random copying has been shown to offer a good explanation of data patterns observed in the evolution of tastes (for example, Bentley and Shennan 2005, Shennan and Wilkinson 2001).

Second, a small world network (Watts and Strogatz 1998), such networks can essentially be thought of as overlapping groups of 'friends of friends' and have been shown to be important in social and economic contexts (for example, Ormerod and Wiltshire 2009). Small world networks consist of a network of vertices whose topology is that of a regular lattice, with the addition of a low density μ of connections between randomly-chosen pairs of vertices. This latter can be either an addition to the connections on a regular lattice or can replace the relevant number of such connections.

Third, a scale free network, these are networks whose degree distribution follows a power law, at least asymptotically. That is, the fraction $P(k)$ of nodes in the network having k connections to other nodes is distributed for large values of k as $P(k) \sim k^{-\gamma}$. Empirical examples include the distributions of both internet links (Barabási-Albert 1999) and sexual partners (Liljeros et al., 2001).

3. The theoretical model

We consider the demand for a consumer product and populate the model with N consumers. The basic demand function for each agent is well behaved:

$$U_i = a_i - P \qquad\qquad (1)$$

Choice: $w_i = $ 1 (buy) if $U_i > 0$, or

0 otherwise

The a_i are selected at random and represent the heterogeneous tastes of the agents. The sum of the individual demands w_i represents the market demand. We assume that the size of the market is small compared to consumers' incomes and can therefore reasonably ignore the difficulties which the Sonneschein-Mantel-Debreu theorems (for example Sonnenschein 1972) raise for the shape of aggregate demand functions. The demand curves for each individual agent are well-behaved, and we assume that the sum of these is also well-behaved.

For convenience, we bound P in [0,1]. We assign an a_i at random to each agent and then vary the level of P to obtain the overall demand at different levels of price. We solve the model a number of different times, each time with a different random draw for the values of the a_i, and present results averaging across all of the individual model solutions. In the results below we set N = 1000, and carry out 100 separate solutions of each variant of the model.

The exact shape of the market demand curve using (1) varies depending upon the distribution from which the a_i are drawn. For example, drawing from a normal distribution with mean = 0.5 and standard deviation = 0.1, we obtain a market demand curve which resembles an S-shaped curve in reverse, but

which is nevertheless downward sloping throughout with respect to price. The most straightforward result is obtained when the a_i are drawn from a uniform distribution on [0,1], when the market demand curve is a linear throughout. We use this assumption in the results below, since its simplicity makes comparisons clearer with more complicated versions of (1). Figure I shows the aggregate demand curve under these assumptions. We represent demand as the proportion of all consumers who buy, so this varies between 0 and 1.

To introduce the bandwagon and snob model we change the U function to:

$$U(i,t) = a_i - P + c_i * Z_i (t-1) \qquad (2)$$

where $Z_i (t-1)$ = proportion of neighbours of agent i buying the product at time ($t-1$)

in the bandwagon model $c_i > 0$, and for the snob model $c_i < 0$

The 'neighbours' of agent i are defined as being the agents to which that agent is connected i.e. he or she pays attention to their decisions.

The Veblen effect is introduced as follows:

$$U(i) = a_i - P + c * P^d \qquad (3)$$

In other words, overlaying the standard negative effect of price on demand is a further term which leads to demand increasing as price rises, enabling consumers to display conspicuous consumption.

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where we examine the effects of selecting different values of *c* and *d*, where *d* is the exponent of *P*. We assume that these take the same values across all agents, though an extension would be to allow for these to vary across agents.

4. The Veblen effect

This is straightforward to analyse, and the conclusions are identical to those of Leibenstein. Note in addition that (3) does not depend on the structure of the network on which the agents are connected, it is purely a function of price. Figure II sets out a selection of results. The results where c = 0 are simply those of the basic demand function (1) and are included for purposes of comparison.

5. Bandwagon and snob effects on a completely connected network

The results in this section are obtained with a completely connected network, in other words each agent is assumed to pay attention to the purchase decisions of all others. This is the assumption made in the original Leibenstein paper, although at the time it was not described in network terms.

There are two technical aspects of the model to consider in simulations of equation (2). First, whether in any given step of the model agents make decisions in sequence or simultaneously. In the latter, all agents consider the external demand effect in the previous period, *Z (t-1)*, and the price in the current period, and make their decisions on the basis of this information.

In the former, an agent is chosen at random to make a decision on the basis of this same information. However, the sampling is continued without replacement until the decisions of all agents at time (t) are

known. So in this case, apart from the first agent chosen at random, agents receive increasing amounts of information about external demand at time (t).

The second point relates to the initial conditions which we assume for external demand, *Z*, at time zero. In principle this could take any value between 0 and 1, and we examine the sensitivity to results to this assumption.

Bandwagon

The results obtained when this effect is taken into account are in fact robust with respect to both of the technical points made above. The only point to note is that if Z(0) is assumed to equal 1, for high C and P=1, a second solution of demand equal to 1 can be seen. This reflects a situation where everyone will purchase if and only if everyone else purchases.

In general, the results confirm those of Leibenstein, with a distinct refinement. Figure III plots the results for when external demand *Z* takes an initial value of zero.

The results are in line with those shown by Leibenstein. The important difference is that while he states that this means:

(1) If the bandwagon effect is the most significant effect, the demand curve is more elastic than it would be if this external consumption effect were absent.

There are actually two distinct regions in which the effects take hold. At first, price increases are not matched by demand falls since the presence of a large pool of external demand creates a bandwagon effect that keeps the demand high. At low prices, therefore, demand is completely inelastic. After a certain critical point, however, the demand curve becomes more elastic, as consumers are deterred not only by price, but of the loss of demand from other consumers at the same time. The point is determined by the strength of the bandwagon effect.

Snob

The results here are sensitive to the assumption which is made about the order in which agents choose, or, to put this into an economic context, the information set which agents have when making their choices. If all agents decide simultaneously using information solely on *P(t)* and *Z(t-1)*, the model oscillates and never settles to a solution. Allowing agents to choose in sequence and updating the information on *Z* does give stable solutions. The exact shape of the demand curve given the a_i and c_i is slightly sensitive to the order in which the agents choose, so no two solutions are exactly identical, but in general there is very little difference between any two separate solutions.

In this case, apart from the above point, the results match exactly those of Leibenstein, namely: 'If the snob effect is the predominant effect, the demand curve is less elastic than otherwise.'

For low prices, the snob effect suppresses demand, as price rises, demand falls but the extent of the demand suppression falls leading to a smaller elastic effect at all price levels.

6. Alternative assumptions about agent networks

Here we consider the effects of network types which are known to be empirically important, and in which agents do not take into the account the decisions of all other agents. Again, to repeat, this could arise either because agents have asymmetric information and are not aware of the decisions of all other agents, or because they choose not to take account of the decisions of other agents even though they may have this information.

There is a very wide range of network types and parameterisations which could be considered. But the task can be bounded in two ways. First, as already noted, we limit our examination of network types to three which are known to be important in social and economic contexts, namely random, small world and scale free.

Second, in terms of the bandwagon and snob effects, our interest is in how the decisions of each agent are affected by those of the other agents to which he or she pays attention. In the completely connected network, each agent takes account of what everyone else has done. Our interest is in examining the effect on market demand functions when agents are influenced by the decisions of only a sub-set of the total number of other agents. This immediately restricts the range of parameters of each kind of network to be examined, since a wide range of values will lead to the formation of a giant cluster in the network, when the network then approximates the properties of a completely connected network. So it is only worth examining relatively low values of the relevant parameters.

A way of formalising the similarity of any given network parameterisation to that of a completely connected network is to calculate the average path length of the network. Average path length is a

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fundamental concept in graph theory, and defines the average number of steps along the shortest path for all possible pairs of network nodes. It is a measure of the efficiency with which, for example, information can percolate across a network, the shorter the average path length the more efficient it is. For a completely connected network, the average path length is by definition equal to 1. Each agent is connected directly to every other agent.

We therefore focus our analysis on the effect on the market demand function of different values of the average path length of the network. We illustrate this in two ways. First, using a random network and varying the probability that any two agents are connected is varied (by 'connected', we mean in the economic context that an agent pays attention to the purchase decision of the other). Secondly, by examining the effect of different kinds of network.

The results are illustrative and further work could undoubtedly be carried out, but a clear pattern emerges.

Table I sets out the typical average path length of a random network when the probability of connection between agents is varied.

These calculations are performed for a network containing 1000 agents. The average path length does vary with the number of nodes (agents) in the network, but not dramatically. The scaling is around log(n) for the random network, with small world scaling between log(n) and n depending on the value of p , and scale free scaling of order (log(n)/loglog(n)) (Albert and Barabasi 2002).

Figure V shows the results obtained using a random network with different values of the probability of connection when the bandwagon effect is assumed to exist.

The networks show similar behaviour to that of a completely connected network, but with lower demand for any given price in each case. Further, the lower the value of the average path length, the closer the demand curve becomes to that of the completely connected network and, conversely, the higher it is the more the demand curve begins to approximate that when there are no network effects present at all.

The rationale for this is straightforward. In equation (2), any given agent is only influenced in his or her immediate purchase decision by a subset of other agents, *Z(i,t)*. When the size of Z(i,t) is larger it is more likely that when one agent changes to a purchasing decision, there is another agent within Z(i,t) who was close enough to wanting to purchase that the agent's choice pushed them to decide to purchase too. Increasing the connectivity of the network can therefore facilitate cascades of behaviour where individuals are influenced by their neighbours and in turn influence more neighbours. Long average path length indicates that these cascades are likely to be broken, since the cascade becomes dependent on agents who can be influenced easiest being directly connected together and agents with low preference for the product being somehow out of the way.

Table II shows average path lengths for various parameterisations of the other types of networks we consider. We in normalise the comparisons by choosing parameters such that the average degree in each network is equal to 4. The model is again populated by 1000 agents.

Figure VI plots the results.

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The lowest demand occurs for small world, followed by scale free and then the random network. We see that the small world network, which in this case has a very long average path length, is indeed furthest from the complete network in final demand. However the order between the scale free network and the random network is surprising since the scale free has shorter average path length than the random network and therefore could be expected to transmit information more efficiently.

This can be understood by considering how agents with very large numbers of connections, the hubs, in the scale free network behave. Hubs are very difficult to influence, since the scale of impact is measured by the proportion of their neighbours who purchase and they have many neighbours. Once they have decided to purchase, however, they are able to heavily influence many other agents, since they are likely to represent a significant proportion of their neighbour's connections. Therefore, while hubs are important in reducing path length, they are not efficient transmitters of purchasing decisions. Final overall demand is likely to be very dependent on whether those individuals happened to have a high initial preference for the product.

For the snob model in Figures VII and VIII we see a similar dynamic at work, although the differences appear to be less pronounced. Networks with long average path lengths end with a final demand more similar to one in which no network effects are present, while the more connected networks approach the results of the complete network.

The difference between networks becomes even less apparent when we compare the different network types. In the bandwagon model there is a strong positive feedback which can extenuate the differences between similar initial conditions. For the snob model, however, the feedback is negative, which means

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that any increase in purchasing in one part of the network is matched by a decline in purchasing elsewhere. It is therefore very difficult to find a network configuration which would change the final demand from that of the complete network to any large extent. The largest deviations occur when there are few connections between agents, the price is high and demand is low. In these cases the snobs can be insulated from each other, so that they do not reduce their demand in response to knowledge that other people are in fact making the same purchasing decisions as them. In this case any lowering of the number of connections is an effective enabler of demand.

7. Conclusion

Sociologists for a long time have emphasised the importance of interactions with other agents in the evolution of individual preferences. The relevant literature in economics is rather sparse, and the assumption of independent preferences and additive market demand functions is still used widely by economists in practice. Increasingly, however, as information about the behaviour and tastes of other agents becomes much more readily available through, for example, the internet, the assumption of completely independent individual preferences becomes less realistic in a wide range of consumer markets.

As long ago as 1950, Leibenstein analysed the implication for market demand functions, and in particular price elasticities, when individual preferences are non-additive. He examined three distinct ways in which agents might interact in the shaping of preferences. The 'bandwagon' and 'snob' effects, when the demand for a commodity by an agent is, respectively, increased or decreased due to the fact that others are also consuming the same commodity. And the Veblen effect, which he defined as the

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extent to which the demand for a product is increased because it bears a higher rather than a lower price.

Leibenstein assumed that each agent takes into account the preferences of all other agents in forming his or her decision. So that agents not only have information about the behaviour of all others, but they take this into account in their own decisions. In the modern terminology of graph theory, the agents form a completely connected network.

We find that in general, under these assumptions, that Leibenstein's results bear scrutiny, but with some important qualifications. For example, under the assumption of a bandwagon effect, the demand curve is more elastic than it would be if this external consumption effect were absent. But there are actually two distinct regions in which the effects take hold. At first, price increases are not matched by demand falls since the presence of a large pool of external demand creates a bandwagon effect that keeps the demand high. At low prices, therefore, demand is completely inelastic. After a certain critical point, however, the demand curve becomes more elastic, as consumers are deterred not only by price, but of the loss of demand from other consumers at the same time. The point is determined by the strength of the bandwagon effect.

For the snob effect, the results match exactly those of Leibenstein, namely: 'If the snob effect is the predominant effect, the demand curve is less elastic than otherwise.' However, the results here are sensitive to the assumption which is made about the order in which agents choose, or, to put this into an economic context, the information set which agents have when making their choices. If all agents decide simultaneously using information solely on current price and the preferences on all other agents in the previous period, the model oscillates and never settles to a solution. Allowing agents to choose in

sequence and updating the information available to each agent on the preferences of others does give stable solutions.

We extend the analysis by connecting agents on three types of network which have been shown recently to be important in social, cultural and economic contexts, namely a random network, a small world network and a scale-free network.

In these types of network, agents do not take into the account the decisions of all other agents. This could arise, for example, because agents have asymmetric information and are not aware of the decisions of all other agents, or because they choose not to take account of the decisions of other agents even though they may have this information.

A way of formalising the similarity of any given network parameterisation to that of a completely connected network is to calculate the average path length of the network. Average path length is a fundamental concept in graph theory, and defines the average number of steps along the shortest path for all possible pairs of network nodes. It is a measure of the efficiency with which, for example, information can percolate across a network, the shorter the average path length the more efficient it is.

We focus our analysis on the effect on the market demand function of different values of the average path length of the network. We illustrate this in two ways. Firstly, using a random network and varying the probability that any two agents are connected is varied (by 'connected', we mean in the economic context that an agent pays attention to the purchase decision of the other) and secondly, by examining the effect of different kinds of network.

The results are illustrative and further work could undoubtedly be carried out, but a clear pattern emerges. With either the bandwagon or snob effect assumed to exist (the Veblen effect depends simply on price and so the network structure has no effect), the networks show similar behaviour to that of a completely connected network, but with lower demand for any given price in each case. Further, the lower the value of the average path length, the closer the demand curve becomes to that of the completely connected network and, conversely, the higher it is the more the demand curve begins to approximate that when there are no network effects present at all.

There is a difference between the bandwagon and snob effects. In the bandwagon model there is a strong positive feedback which can extenuate the differences between similar initial conditions. For the snob model, however, the feedback is negative, which means that any increase in purchasing in one part of the network is matched by a decline in purchasing elsewhere. It is therefore very difficult to find a network configuration which would change the final demand from that of the complete network to any large extent. The largest deviations occur when the price is very high and so demand is very low, and it is easier to insulate snobs from knowledge that other people are in fact making the same purchasing decisions as them.

The results are therefore surprisingly resilient to the assumptions made about network topology, although for any given level of price, overall demand is lower when the assumption of complete connectivity is relaxed.

Perhaps the most important practical implication of this analysis is that in the presence of bandwagon effects – which clearly exist in many markets especially those related to popular culture – the market demand curve is horizontal over rather large ranges of price. The task for companies involved in such

markets is to discover the point at which price begins to dominate network effects, and to price accordingly.

1. Amy Heineike, aheineike@gmu.edu; Centre for Social Complexity, George Mason University, Fairfax, VA, USA

2. Paul Ormerod, pormerod@volterra.co.uk; Volterra Consulting, 135c Sheen Lane, London SW14 8AE, UK

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TABLES

Table I Comparison of mean path lengths for a random network (averaged over 10 generated networks)

Random network, p of connection (with N=1000)	0.002	0.004	0.006	0.008	1 (Complete Network)
Mean Path Length	9.29	5.22	4.08	3.57	1

Table II Comparison of mean path lengths for the network models used in the network. All apart from the complete network have a mean degree of 4.

Network (with N=1000)	Small World (k=2,p=0.01)	Random (p=0.004)	Scale free (k=2,m=2)	Complete
Mean path length	19.63	5.22	4.10	1

FIGURES

Standard Model, ai distributed uniformly on (0,1)
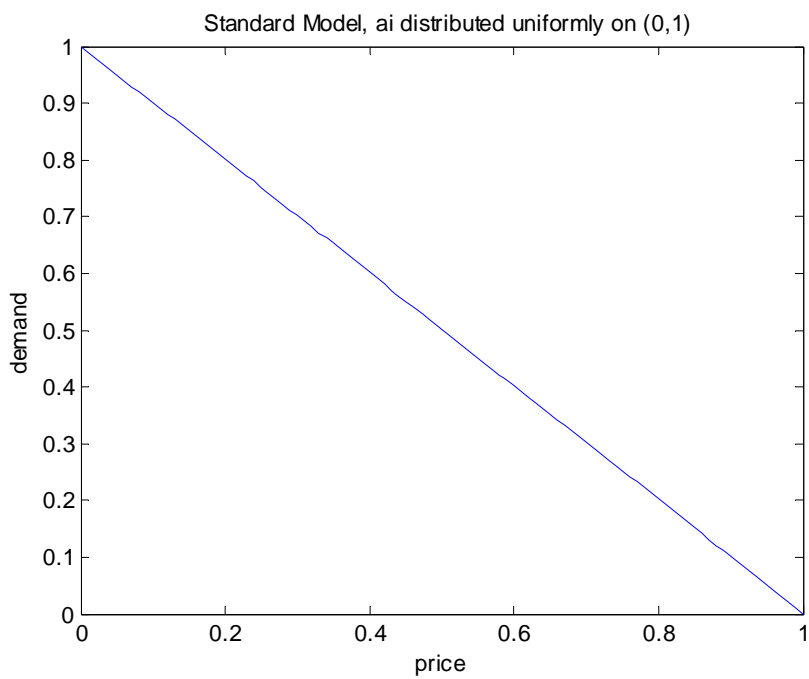
Figure I *Market demand curve, $U_i = a_i − P$, a_i drawn on a uniform distribution on [0,1]. Demand is the proportion of all agents choosing to buy at any given price. 1000 agents, results averaged over 100 separate solutions of the model*
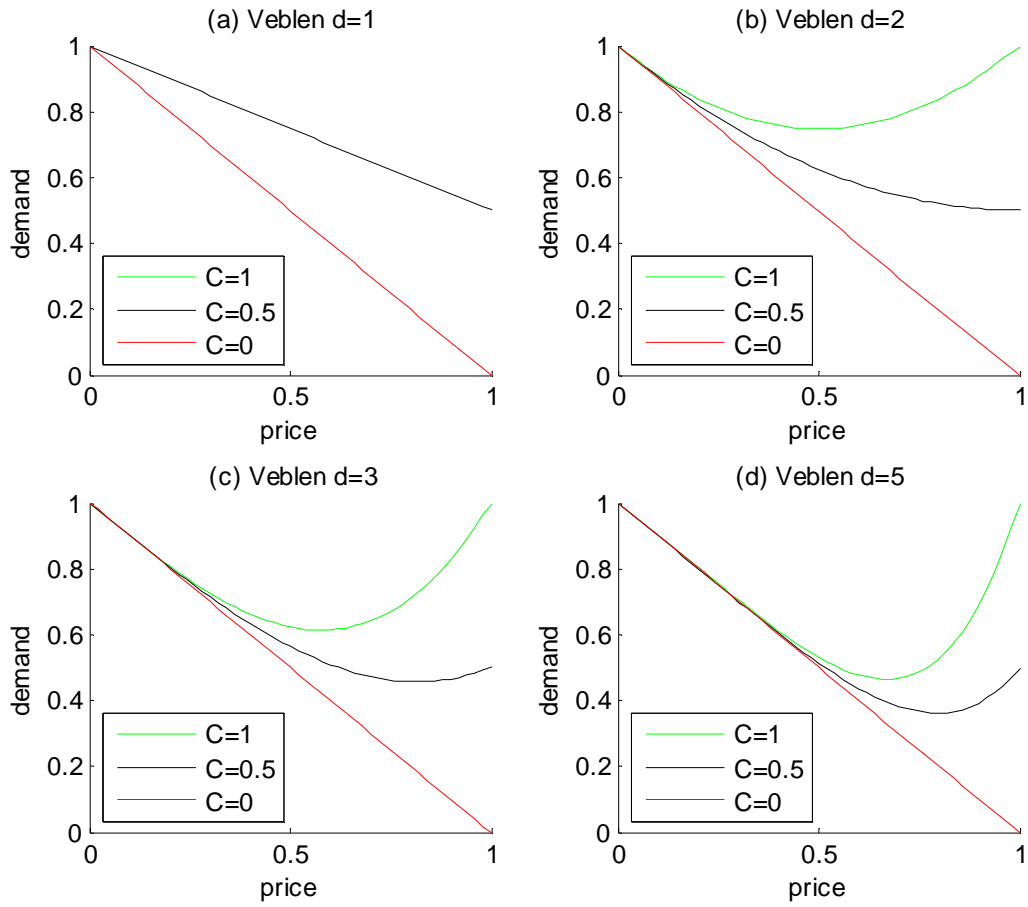
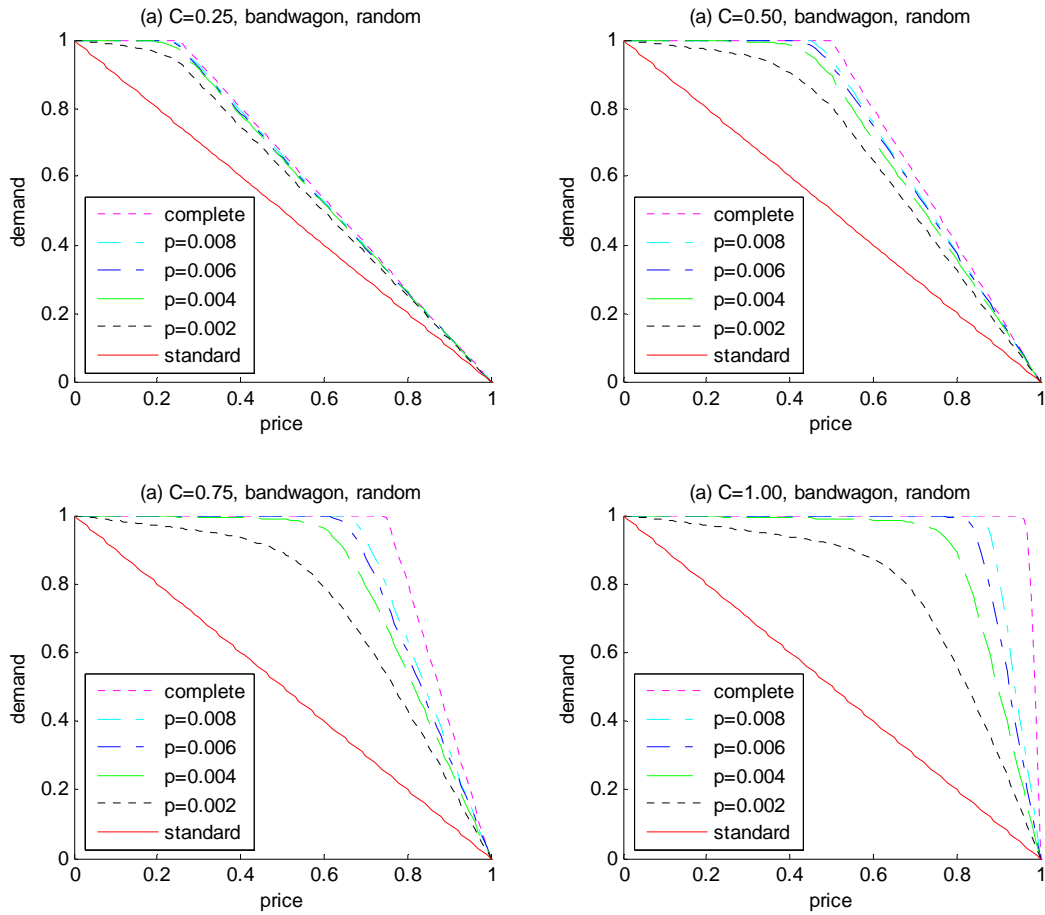**Figure II** *Market demand curve, $U(i) = a_i - P + c * P^d$, a_i drawn on a uniform distribution on [0,1].*

Demand is the proportion of all agents choosing to buy at any given price. 1000 agents, results averaged

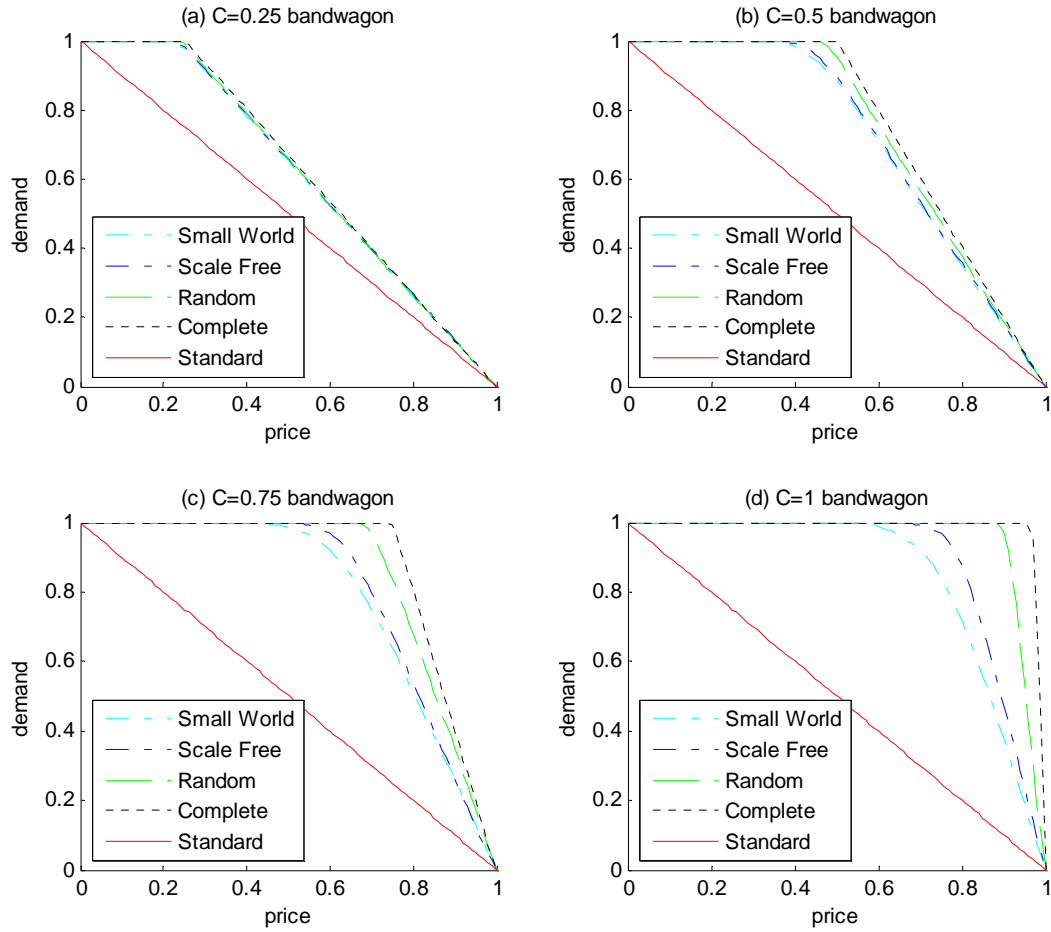*over 100 separate solutions of the model. C=0 is the basic demand function*
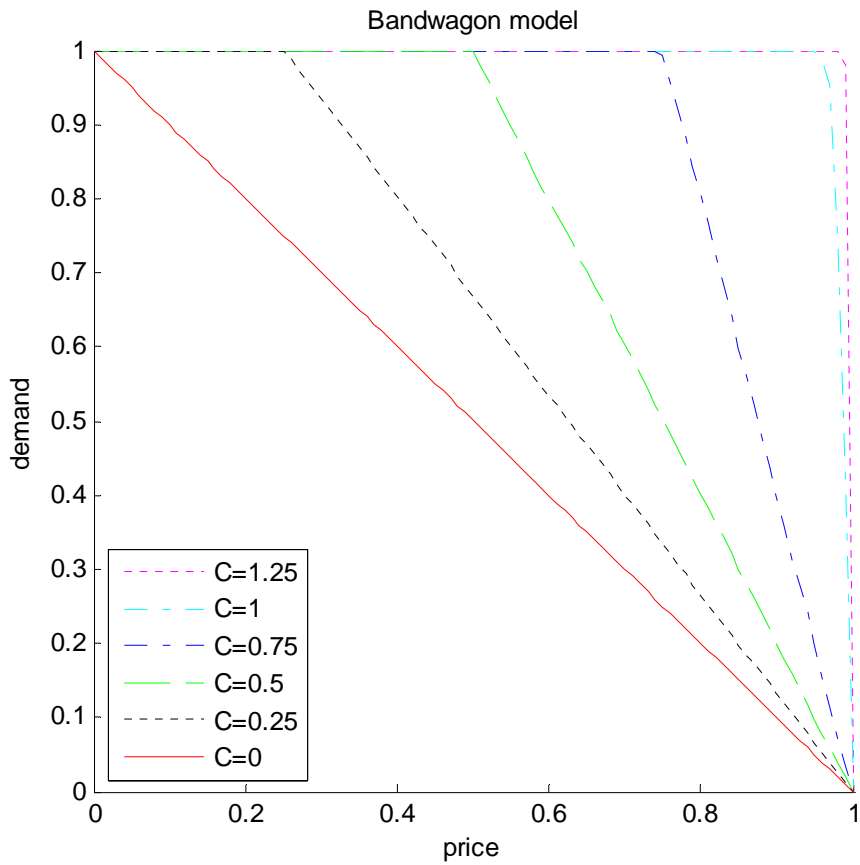
Figure III *Market demand curve, $U(i,t) = a_i - P + c_i*Z^i(t-1)$, a_i drawn on a uniform distribution on*

[0,1] $c_i > 0$, $c_i=C$ for all agents. Demand is the proportion of all agents choosing to buy at any given price.

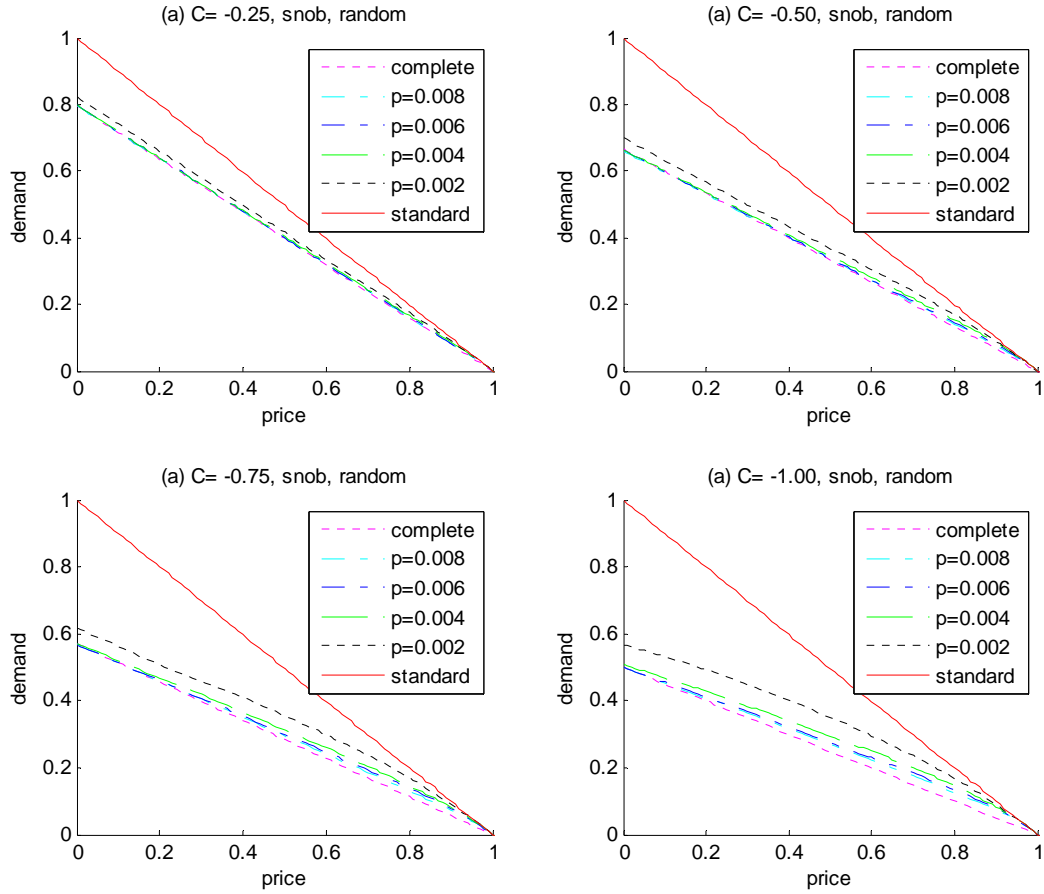*1000 agents, results averaged over 100 separate solutions of the model*
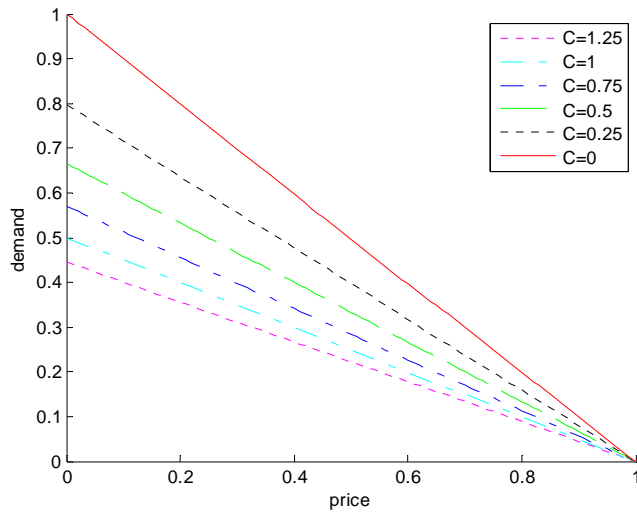
Figure IV *Market demand curve, $U(i,t) = a_i - P + c_i*Z^i(t-1)$, a_i drawn on a uniform distribution on*

[0,1] $c_i < 0$, $c_i = C$ for all agents. Demand is the proportion of all agents choosing to buy at any given price.

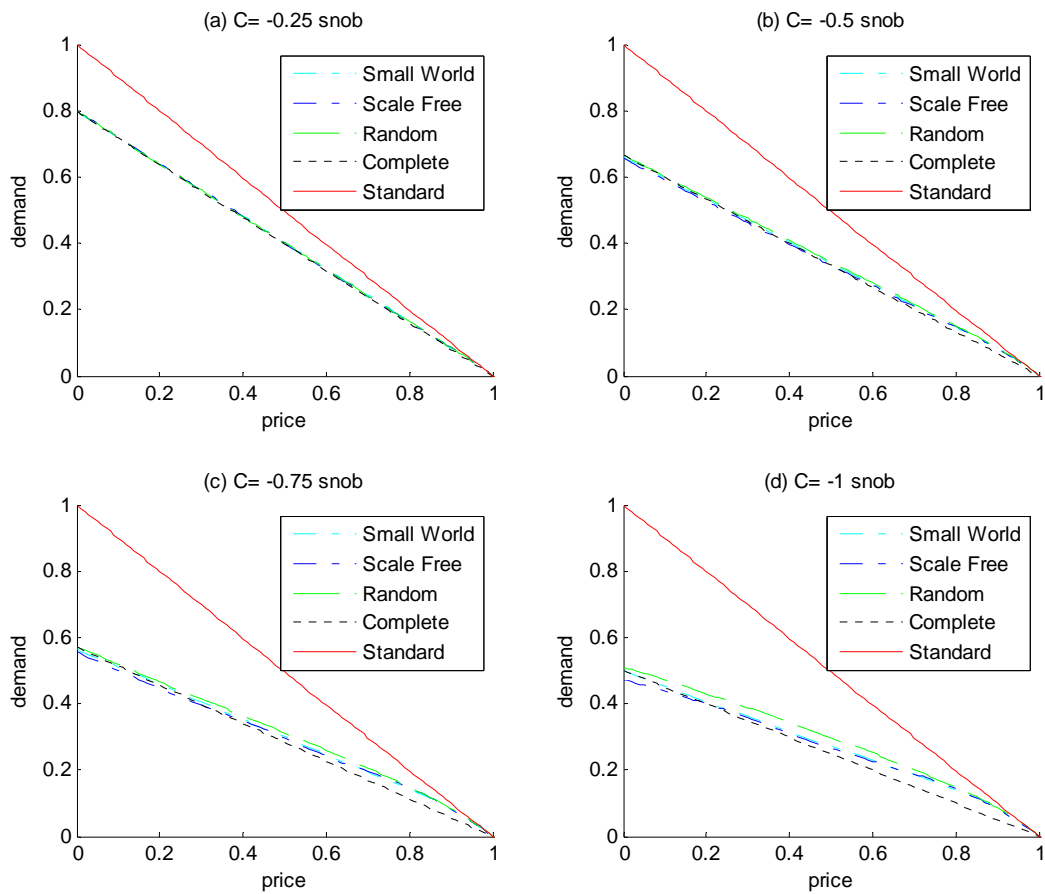*1000 agents, results averaged over 100 separate solutions of the model*

Figure V *Market demand curve, $U(i,t) = a_i - P + c_i * Z^i (t-1)$, a_i drawn on a uniform distribution on [0,1 c_i < 0, c_i=C for all agents. Demand is the proportion of all agents choosing to buy at any given price. 1000 agents, results averaged over 100 separate solutions of the model. Results for random network with probability of connection=p.*

Figure VI   *Market demand curve, $U(i,t) = a_i - P + c_i*Z^i(t-1)$, a_i drawn on a uniform distribution on*

[0,1 c_i < 0, c_i=C for all agents. Demand is the proportion of all agents choosing to buy at any given price.

1000 agents, results averaged over 100 separate solutions of the model. Random graph has p=0.04,

Scale free k=2, small world k=2 and rewiring p=0.01.

Figure VII   *Market demand curve, $U(i,t) = a_i - P + c_i * Z^i(t-1)$, a_i drawn on a uniform distribution on*

[0,1] $c_i < 0$, $c_i = C$ for all agents. Demand is the proportion of all agents choosing to buy at any given price.

1000 agents, results averaged over 100 separate solutions of the model. Random graph has p=0.04,

Scale free k=2, small world k=2 and rewiring p=0.01.

Figure VIII   *Market demand curve, $U(i,t) = a_i - P + c_i * Z^i (t-1)$, a_i drawn on a uniform distribution on [0,1] $c_i < 0$, $c_i = C$ for all agents. Demand is the proportion of all agents choosing to buy at any given price. 1000 agents, results averaged over 100 separate solutions of the model. Random graph has p=0.04, Scale free k=2, small world k=2 and rewiring p=0.01.*