When a Fad Ends:
An Agent-Based Model of Imitative Behavior

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Throughout society there are instances of seemingly irrational imitative behavior, or fads. Everyone can identify a fad when they see one yet there is no comprehensive economic theory to explain their origins or demise. There are several theories that discuss why people replicate the choices of other agents in the economy, but none that are specific to the lifecycle of a fad. This paper is able to specify the conditions under which a fad develops. We present a model that analyzes the interaction of several types of agents in a complex market environment, from the initial product choice, through the period of peak popularity, to the eventual demise of the fad.

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Introduction

Tickle-Me-Elmo, Barney, Rubik's Cube and the Hula Hoop. Products such as these are referred to in popular culture as fads. They have many things in common. Each was purchased by a substantial portion of the population, and was a part of the consciousness of an even greater amount of people. The products became popular quickly, and remained popular for only a short period of time. These characteristics are typical of goods that are called fads.

Why do some goods become fads? It is not merely enough for large numbers of people to purchase the same product for it to be a fad. If that were true, then anyone who eats at McDonald's or shops at Target is participating in a fad. However, nobody has ever called doing these things a fad. Not every product that was quickly accepted can be called a fad either. This could mean that the processes underlying the spread of fads is different than any other idea or product, or that there are differences in the actual product itself. What does calling a product a fad mean? This is a difficult question to answer rigorously as few academics, especially economists, have looked at fads.

One existing definition of a fad is that fads are "seemingly drastic swings in mass behavior without obvious external stimuli" (Bikhchandani, Hirshleifer, and Welch, (BHW) 1992). This definition does not answer the question of why a fad occurs, or why it ends. It is merely descriptive of what occurred in goods that are ex-post termed fads. It implies that many people must utilize a fad product or idea and those fads come and go very quickly. However, "without obvious external stimuli" does not explain how a fad comes into being. In addition this part of the definition of a fad is not able to help classify what goods are fads, and which are not, since the stimuli to which it refers are

subjective. What is obvious and external to some may be hidden to others. Tickle-Me-Elmo was introduced in the summer of 1996, and it wasn't until Christmas of that year that it turned into a fad. By the middle of the next year, popularity and sales had sharply waned, although the product was still available (EPM Fad Study (1998)). Is it true that there were no 'obvious external stimuli' that caused this product to become a fad? Or can we specifically define underlying characteristics that lead to fads.

The process behind fads has not yet been clearly defined in the economic literature. The aim of this paper is to rectify this by presenting a concise model of the lifecycle of a fad. Additionally the characteristics of both fad items and the people who acquire them are explored to further the understanding of what makes, and breaks, a fad.

Background

Behavior that is the same among people or groups that are disparate in geography, income, or gender has generated a lot of interest among economists. Progressively more sophisticated theories have evolved. Two of these have been applied to fads in the past, although they were not necessarily constructed specifically with fads in mind. The first is network externalities (Katz and Shapiro (1985)). Here, people choose whether to buy a product by maximizing their utility under complete information, with the caveat that their utility is partially dependent on how many other people have also chosen to buy the product. The most common example of a network externality is a telephone system. Each additional person who purchases a telephone increases the usefulness of purchasing a phone to everyone. This model can explain why products diffuse slowly through the economy at first, and then faster as a critical number of users are reached, and then remain in existence at a steady demand. However, network externalities cannot explain

why goods rapidly exit the marketplace. The introduction of a newer, better product being introduced has been proposed as an explanation for the disappearance of products, but it is difficult to see how this applies to products termed fads. What better product replaced the Hula-Hoop? Planned obsolescence (Choi (1994)) is another suggested reason, but this is mainly concerned with successive generations of the same product, rather than entirely new ones. In addition, it does not cover the full range of goods and services available. Most fad products are arguably still inherently useful to people irrespective of how many others own the same product. For example, miniskirts are still clothing, and therefore useful, even if they aren't popular. However, their sales fluctuate wildly. Therefore most instances of goods that follow a fad lifecycle cannot be explained by network externalities.

The second current explanation for collective behavior is information cascades. Agents are faced with a choice to adopt or reject a given good or asset. They receive a signal about the worth, or value, of the item they are contemplating. However, this signal is subject to incomplete information. Given the fact that their own signal could be incorrect or useless (Anderson and Holt (1997)), they determine the expected value of adopting based on the decisions of the prior individuals. In some cases, the signals of the previous players can be inferred from their observable actions. If the expected value is larger than the cost of adoption, they choose to adopt, even if their own signal was in opposition to their final decision. The three original papers that introduce information cascades are those of Banerjee (1992), Bikhchandani, Hirshleifer and Welch (1992), and Welch (1992). The first two explicitly state that their model can be used for fads, while the third focuses on the stock market. In all of these setups the agents are deciding

whether to adopt an item that could be good or bad for individual welfare. They do not know the true value of the good. Once they have decided to adopt or reject, their decision cannot be reversed based on their own experiences of the good. They can only discard a good that may have a negative impact on their utility when the cascade is broken. This occurs when information is publicly released that the good is not actually beneficial. Once people learn that they made a "bad" choice the negative cascades can be broken. This assumption of requiring incorrect information to persist in the model until rectified by some outside agency is a strict one, not necessary to solve the problem, and could lead to the incorrect conclusion that a great proportion of herd-like behaviors, including fads, eventually end because it became known that they were bad for the people involved in them. This is usually not the case; if not actually beneficial for individuals and society, most fads are at least benign. Therefore a new theory must evolve.

Product Life-Cycles

The graphs below show the life cycle for two products, one that has commonly been referred to as fad, the Rubik's Cube, and one that has not, clothes dryers.

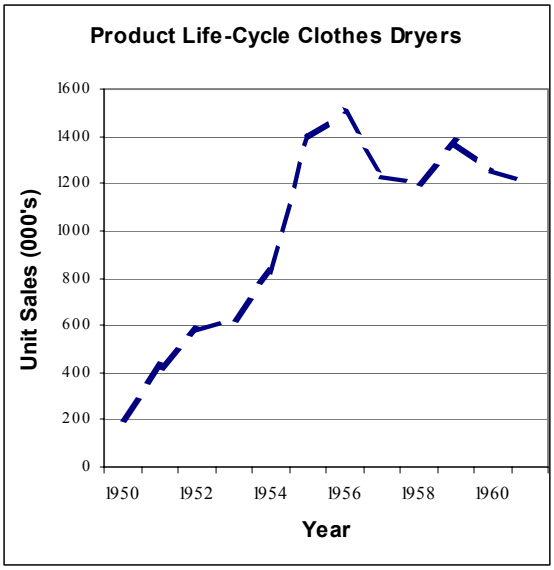

Figure 1
Source: Bass, Frank M.(1969)

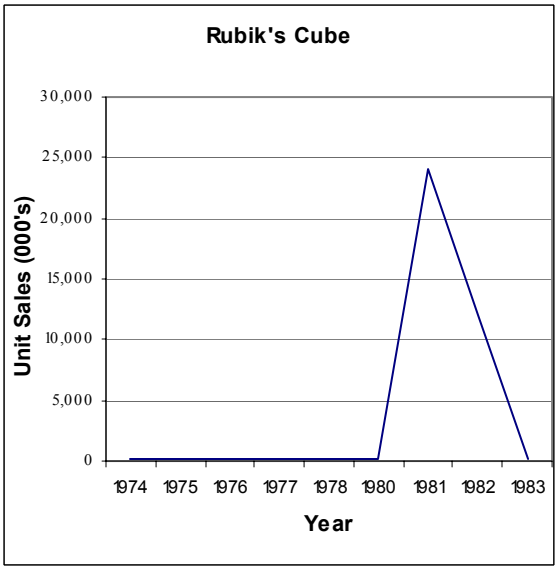

Figure 2
Source: EPM Fad Study (1998)

The life-cycle of durable goods was described by Bass (1969) to be a bell-shaped curve. Figure 1 shows unit of sales of clothes dryers, which shows a bell-shaped type curve emerging gradually over 12 years. In contrast the graph of the Rubik's cube (Figure 2) is a very spiky increase from the marginal sales pattern that had been evident for 6 years, and then falling off again after 2 years. This is the fad life-cycle described by Raugust (1998). It is this fad pattern that we attempt to explain in this paper. It is the rapid acquisition over a short period of time, with a quick drop off, that is the hallmark of a fad.

Model

We start by determining a more rigorous definition of what a fad is. The anthropologists Aguirre, Quarantelli, and Mendoza (AQM, 1988) list specific defining characteristics of fads that we shall use to help generate the model. The first set of items is referred to as the descriptive characteristics, and is that a fad should be (1) Homogenous (2) Novel, and (3) Odd. The last set of items is how the fad develops, called the career of a fad. Here fads should be (1) Sudden, (2) Rapidly Spread, (3) Quickly Accepted, and (4) Short Lived[1]. Note the similarity to BHW's definition (discussed in the introduction); one could argue that AQM's definition is simply an elaboration of BHW's. However, it too is merely descriptive, rather than explanatory.

We shall restrict our analysis to fads that exist in products, rather than in other areas such as ideas, for sake of simplicity of nomenclature. The life cycle of a fad is most curious. At first, a product exists either in a small sector of the economy, or only in the

[1] The final characteristic they list is one that we will not employ, that fads are Nonutilitarian. They do not use this in the strictest economic sense, but define a fad as "lacking in consequentiality for their participants," and "frivolous." Economic utility does not rely on a good not being frivolous, but only providing some measure of "happiness" to its owner. Therefore all fads can be considered to have utility.

stores. The majority of people haven't heard of it. Then, suddenly, seemingly inexplicably, everyone knows about it, and must make the decision whether or not to purchase it. There is a period where a large number of people do become part of the fad and then just as quickly it either disappears from the shelves, or becomes a footnote in history rather than a currently popular good. Normal demand patterns do not explain this.

We propose a model with several heterogeneous economic actors, or agents. These agents each have a different set of behaviors. Broadly these behaviors allow them to be classified into one of two groups, although within each group the agents remain heterogeneous. These are termed the Fad Setter and the Fad Follower, based on their roles during a fad. As we will see, however, their behavior often results in outcomes other than fads.

1. Fad Setters

Fad Setters (FS) are the people who have access to the newest, most interesting, products available. They could be thought of as the people who specialize in the discovery of new products. In addition, due to some characteristic such as age, status, wealth, or popularity they are known to be the people who others wish to emulate. They choose products independently of any other Fad Setters that may be present, but their decision to stop using a good is dependent on the actions of the Fad Followers.

As mentioned above, it is not necessarily true that the Fad Setter will cause a fad to start in every situation, but they do choose a good in every time period. The source for their acquisitions is a random stream of goods, which we call 'proto-fads'. This emphasizes their possibility of becoming fads, but is not intended to limit their eventual acquisition pattern to only fads. FS's maximize their current utility by choosing one of

the proto-fads they are presented. This utility value is based on many things, including the combination of the usefulness and novelty of the item. The FS's see this composite as one value, which they compare to the value of any good they might currently own. At this point, they will choose the first good they see that is higher in utility value than the good they own. They will hold this good and receive positive per-period utility from it until they choose to stop utilizing the product. This will occur when the number of FF's in the economy who have acquired the same product reaches some threshold value. Since the utility of the good is based partly on its novelty, the more people involved in it reduce this novelty. This is why the FS's don't want to have products that a large number of FF's have. The following equations characterize the choice set of the Fad Setter:

$$\underset{(+,\ -)}{\text{Max}}\ U_t(V(FF))$$

U_t = Fad Setter Utility

$$U_t = \begin{cases} V & \text{if } FF < S_{FS} \\ 0 & \text{if } FF > S_{FS} \end{cases}$$

V = current utility value of Fad to Fad Setter
FF = number of Fad Followers currently in fad
$\mathbf{S_{FS}}$ = Switch Value, or the number of Fad Followers whose presence cause the Fad Setter choose to leave

2. Fad Followers

Fad Followers also have a preference for new and interesting goods, but they don't know how to find them. A reason for this could be because they only find goods interesting if other people also have them. Alternatively they could wish to only have goods that the Fad Setters have, because they wish to emulate the Fad Setters, or because they don't have access to the newest goods, don't have the time or resources to invest in discovering the new goods, or are inherently less able to discern the newest goods than

the Fad Setters. So, instead they search among their neighbors looking for a good that has a higher utility value than the one they currently possess. This utility is a private value and varies over time and is not connected to any sort of societal utility value of the good. Ideally, they would like to be able to observe the choice of a FS directly, but they can only see the choices of agents within a certain distance from themselves. If they find a good within this distance that has a utility value higher than the one they currently possess they will acquire it.

Currently they are not limited by income for the actual purchase of the goods. It is unlikely that a budget constraint would change the outcome of the model, since the price of fads is typically small when compared to a person's total wealth. Therefore this is not a restrictive assumption.

Once FF's acquire a good they will hold it until its value falls below some threshold value. When the Fad Setter chooses to leave the product, the product's value to the FF's begins to decay. This decay rate has interesting implications that will be discussed later in the paper. The FF's cannot see the FS directly, but they are aware of the presence of a FS in the model. They can also become aware of the absence of the Fad Setter without needing direct contact. This is the cause of why the good decays. When the good decays, eventually its value will fall below the threshold value of the FF. This threshold value represents the point at which the good has either lost usefulness, or had become uninteresting. The exact amount of the threshold value will be different for different goods. However when any good's value falls below the threshold value of the Fad Follower, that agent will leave that good. The actions of the Fad Follower are summarized in these equations:

Max F_t (V)

F_t = Fad Follower Utility

$$F_t = \begin{cases} V & \text{if FF} < S_{FS} \\ V - (d * V) & \text{if FF} > S_{FS} \end{cases}$$

d = rate of decay of good.
The FF will leave the fad if the value of F_t falls below T_{FF}, the threshold value.

Motion

Fad Setters pick a fad that has utility value *V*. They will keep this product, receiving a value of *V* in each time period. When the number of Fad Followers reaches S_{FS}, the switch value defined above, they will leave this good, ending their role in the current fad. Fad Followers look at the goods their neighbors have, and if the utility value of one of the goods is higher than their present good, they will acquire that good. If the values are lower, they will remain with their present good. Each good the FF sees has a probability of being a Fad Setter good. This probability depends on how many other agents have already acquired, and still maintain, the FS good. Regardless of whether the good they see is the Fad Setter good they seek they always pick the highest valued good they see. Fad Followers continuously search for higher valued goods, and all Fad Followers choose simultaneously, based on the good their neighbor had in the last time period. If the Fad Setter leaves in a time period, then the good immediately begins to decay. After the good's utility value drops below T_{FF}, the FF's threshold, the Fad Follower will leave the good. This threshold is different for every Fad Follower. Below is a graphical representation of this process, illustrating the effect of the interaction of the agents on the good's utility value for both the Fad Setter and the Fad Followers.

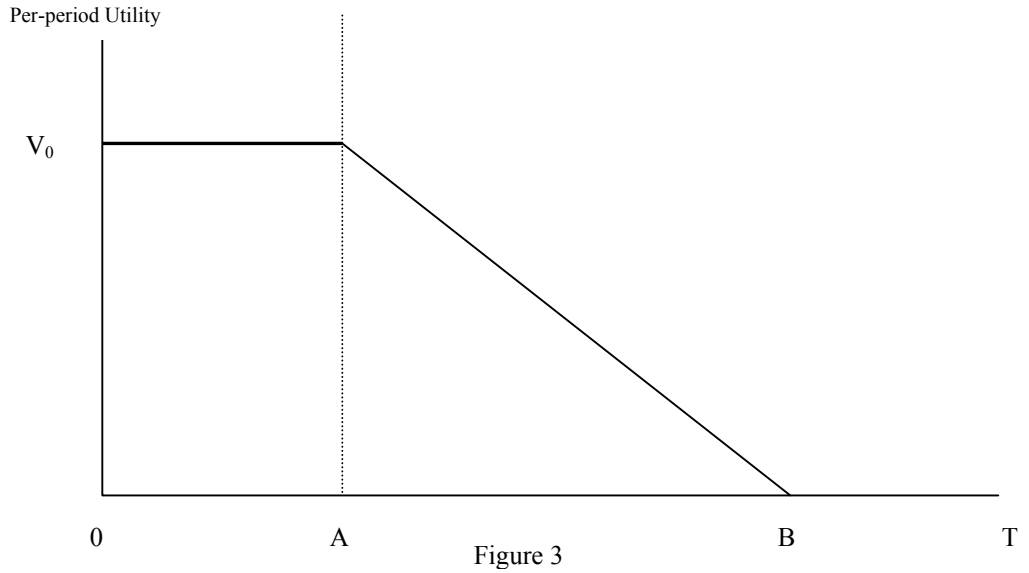

Figure 3

From 0 to point A, the utility value of the good *V*, is constant and the same for the Fad Setter, and any Fad Followers who are currently own the good. At point A, the switch value S_{FS}, is reached, and the good's value begins to decay. After point A, only FF's are a part of the good. At point B, the good has lost all of its utility value.

Methods

A. Agent – Based Modeling

Agent-based modeling uses computer-generated decision-making units, called "agents", that are programmed with simple rules to emulate decisions made in the real world. The behavior of the agents is then analyzed to develop insight into how these decisions might be made in the real world. The emergent properties, or behaviors that were not expected being observed due to the agent's interactions, of these models are also quite interesting. The life-cycle of fads depends highly on the interactions among the people who begin the fads, and those who popularize them. This makes agent-based modeling a logical choice for analyzing the behavior. The dynamics involved, which

lead to the result of being able to capture the fad purchase pattern, are complicated enough that analytical models become intractable, and sometimes impossible, to solve.

B. Model Specifications

There are four parameters of interest that we analyze to determine possible causes for a fad life cycle pattern; utility value of the good (V), the threshold limit of Fad Setter (S_{FS}), the threshold value of the Fad Follower (T_{FF}), and the rate at which value of the good of the FF's will decay in each time period following the exit of the Fad Setter (d).

The utility here represents different aspects of the good's value to the person consuming it. In this model V stands for the per-period net utility. V can range from 0 to 5000. We break the analysis of the goods down into three broad categories: Low Valued goods, values lying between 0 and 1000, Medium Valued goods, with values that lie between 1000 and 4000, and High Valued goods, whose values are higher than 4000 up to the maximum of 5000.

The switch proportion of the Fad Setter, or S_{FS}, can take a value between 0 and 1. It is randomly determined for each Fad Setter at the beginning of each simulation. If it is zero, then the Fad Setter will leave the good if at least 0 percent of the Fad Followers acquire the same good. If it is 1 the Fad Setter will only leave if 100 percent of the Fad Follower agents have the same good. The values in between correspond to the percentage of Fad Followers that must have the same good to cause the Fad Setter to leave.

The decay rate of the good, d, also takes a value between 0 and 1. This is the amount that the utility value of the good that the Fad Followers possess decays in each

successive time period after the Fad Setter leaves. The decay value works in conjunction with the next parameter, the threshold value of the Fad Follower, T_{FF}.

T_{FF} ranges between 0 and 500 and is randomly determined for each agent in each simulation. This parameter represents when the good becomes boring, or no longer useful to the Fad Follower. If the value of the Fad Follower's good falls below this number, they will leave that good. This number is also randomly assigned to each Fad Follower in each simulation. Every Fad Follower has a different threshold amount.

In this model we fix the amount of decay and then allow the other parameters to vary. This is done for with only one Fad Setter, and also with two Fad Setters. The *d* values were held fixed within each simulation, and were varied in increments of .05, between the values of 0 and 1 inclusive, across the 21 simulations. Within a simulation, there were 100 runs of the model. Every run resets V, S_{FS}, and T_{FF}. A run consists of 50 iterations, which allows the behavior patterns resulting from the interactions of the agents to become fully evident.

Results

We find several interesting results. Most important to note is the fact that the model generates product life cycles that are similar to fads. However it can also encompass other life-cycles, such as complete diffusion, and a product that fails to take hold in a market. Products will fail to take hold when V has a Low value. This is shown in Figure 4 for one values of *d*, but is representative of the entire spectrum of *d* values.

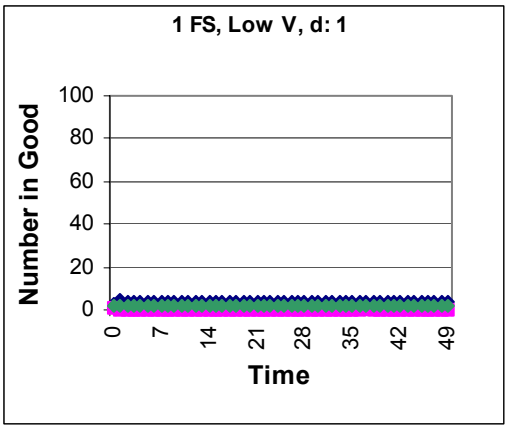

Figure 4

In terms of overall analysis, *V* has few interesting implications except for this striking feature. Regardless of the other three parameters, threshold value, switch value or decay value, if the *V* of the "Fad Setter" type agent is too low initially, the good will not become a fad, or in fact a successful product of any type. It is prudent in these instances to think of the Fad Setter as simply an entity of novel, not necessarily useful, products. Since the Fad Setters don't wait for the highest possible utility valued product, it is possible for them to acquire products that will fail to take hold in the larger population. The effects of having utility values in the other two ranges will be discussed in conjunction with the analysis of the other parameters.

The exact effect of variations in the threshold amount, T_{FF}, will not be analyzed in detail. In general, holding all other parameters constant, if the threshold is higher, the Fad Follower will leave sooner; if it is smaller, the Fad Follower will exit later. The actual length of time the product remains viable is due to the speed at which the good value decays, combined with the existence of a threshold.

A. One Fad Setter

Figures 7 through 12 analyze the results of simulations with one Fad Setter and varying parameter values. The fad life-cycle is present when *V* is high enough to allow the product to enter and take hold in the market and the *d* parameter is between .4 and 1. Shown below are graphs of both a Medium Valued *V* and a High Valued *V* with a high decay rate (*d* = .75).

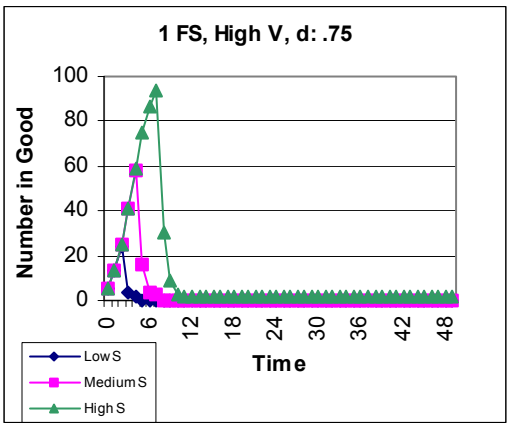

Figure 7

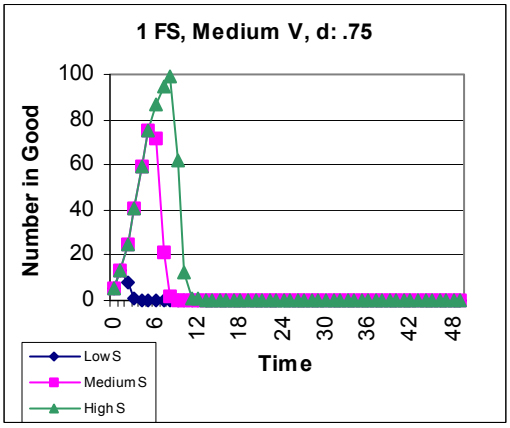

Figure 8

The fad pattern is very evident here. All three levels of the S_{FS} parameter exhibit the spiky, rapid acquisition, short-lived nature that is characteristic of a fad for both the High Good (Figure 7) and the Medium Good (Figure 8). As S_{FS} becomes smaller, the fad is unable to penetrate as large a segment of the population and lower the length of time that the fad remains in the population. Note that the Medium S_{FS} Figure 8 spikes higher to the right than that of Figure 7, which has a higher *V*. This is likely due to a lower average threshold of the Fad Followers in the Medium *V*. This would allow more people to enter the fad even after the Fad Setter has left. This fad life-cycle will continue to appear until the level of *d* gets at or below .40. The graphs below show the product pattern for a *d* level of .40.

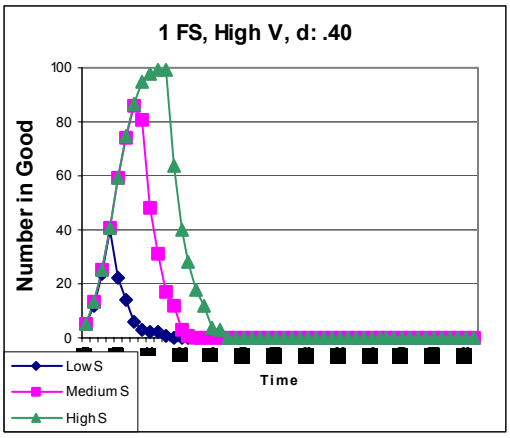

Figure 9

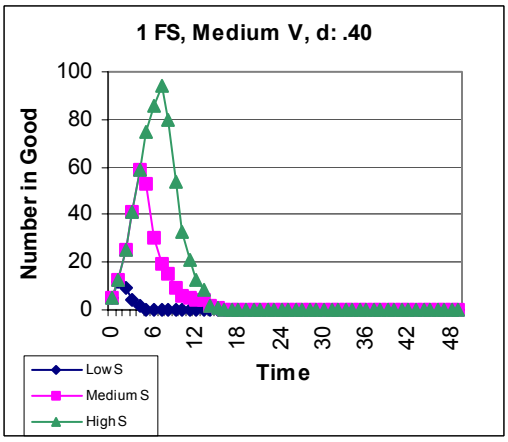

Figure 10

Again, the lower the S_{FS} parameter is in size, the more spiky acquisition of the product. With both a high S_{FS} and V (Figure 9), the smoother bell shaped pattern of the durable good starts to become apparent. However, with a Medium V (Figure 10), the fad pattern still takes hold. As the decay, d, gets smaller and smaller the durable pattern emerges more. At a d of .15 this pattern can be clearly seen. The bell-shaped pattern of goods is very apparent here at all S_{FS} levels, although High and Medium S_{FS} make it most obvious. Both the High (Figure 11) and Medium (Figure 12) V exhibit this pattern.

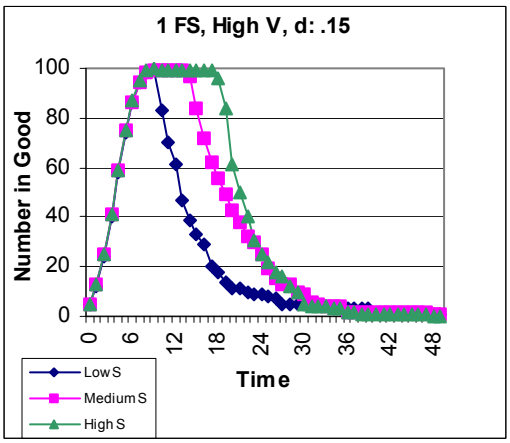

Figure 11

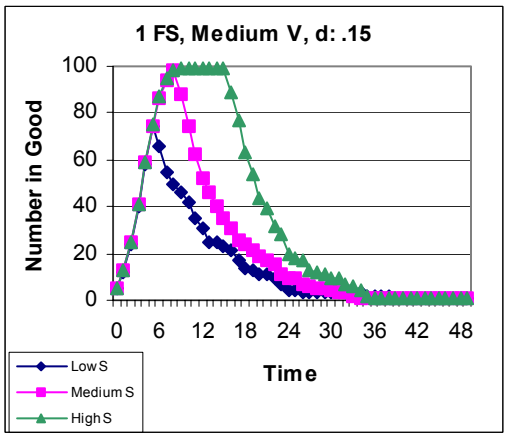

Figure 12

B. Two Fad Setters

Figures 13-20 show the results when there are two Fad Setters. Each Fad Setter will have a different V and S_{FS} value. The Fad Followers within the system still have varying T_{FF}, and the value of d is the same for both Fad Setters. However, each good's value will decay independently. With two Fad Setters the patterns that are seen are still identifiable, with some surprising twists. Below are the graphs for a Decay of .75.

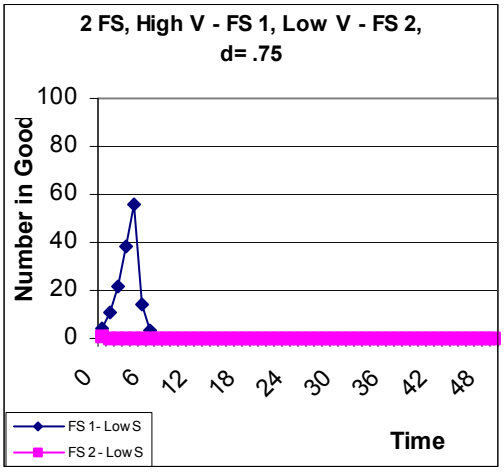

Figure 13

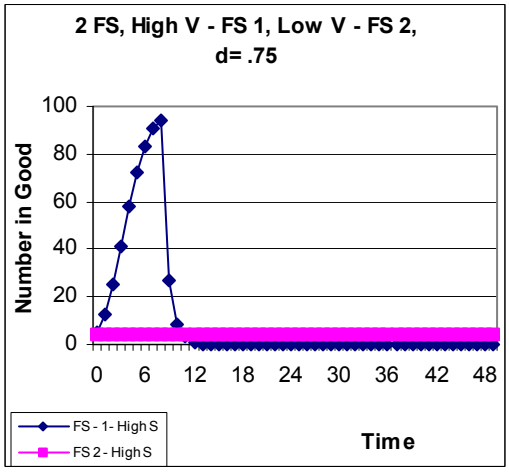

Figure 14

Recall that with one Fad Setter, this d level showed clear fad life-cycle behavior (Figure 7). This pattern is also evident when one Fad Setter has a High V, and the other has a Low V (Figures 13 and 14). Here the low utility value of the second Fad Setter's good essentially eliminates its presence in the economy. The fad pattern is seen in the acquisition of the first Fad Setters Good. However, it is a different picture when both of the Fad Setters have viable goods (Figures 15 and 16).

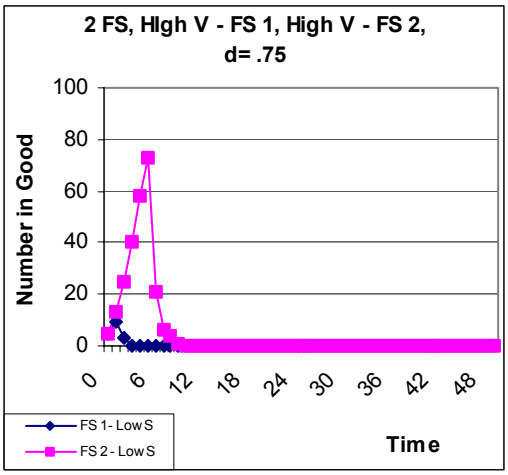

Figure 15

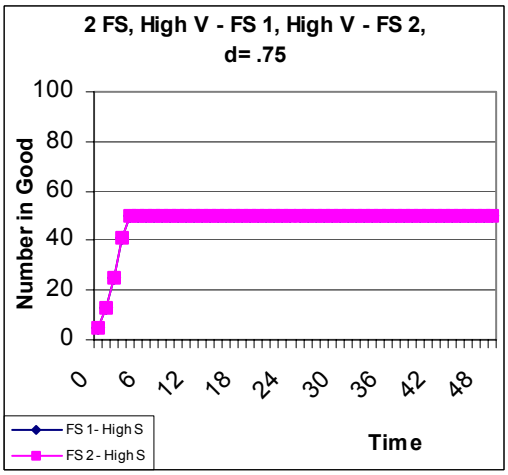

Figure 16

When the S_{FS} parameter of Fad Setter 1 is low (Figure 15), the second Fad Setter captures some of the market, causing a fad, even though she has a low S_{FS} as well. When both Fad Setters have high S_{FS} levels the story is quite different (Figure 16). Here, a fad cannot develop because the Fad Setters never leave the good. Fad Followers acquire each good and then never chose to leave. This is due to the fact the goods never lost utility value, because the Fad Setter for their good never left. This is a very interesting result. One possible interpretation for this is that when there are two competing goods in the marketplace, each one attracts a loyal following, and since the good never reaches the penetration levels that it would if it had no competition, those who enjoy never feel pressured to leave by their distaste for conformity or by its lack of novelty. Lower levels of *d* also result in interesting patterns of behavior.

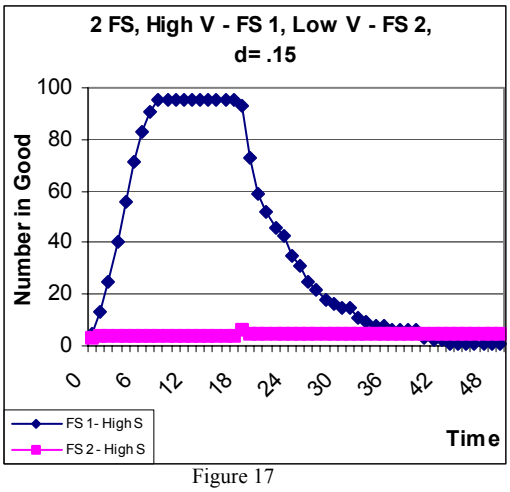

Figure 17

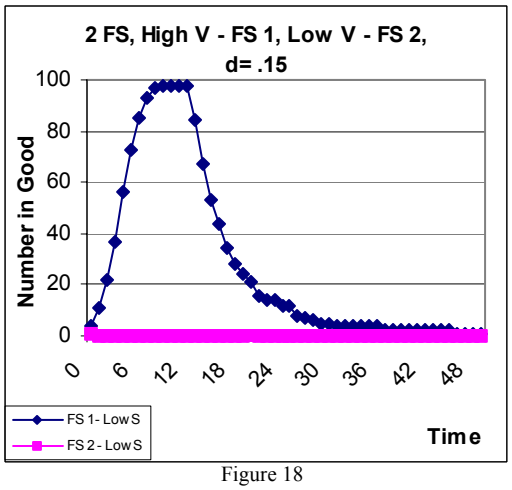

Figure 18

Again when one of the Fad Setter's good is Low valued, then the pattern discussed above in the one Fad Setter case emerges (Figures 17 and 18), regardless of the value of S_{FS}. However, when both of the Fad Setter's goods are High, interesting patterns again are seen (Figures 19 and 20).

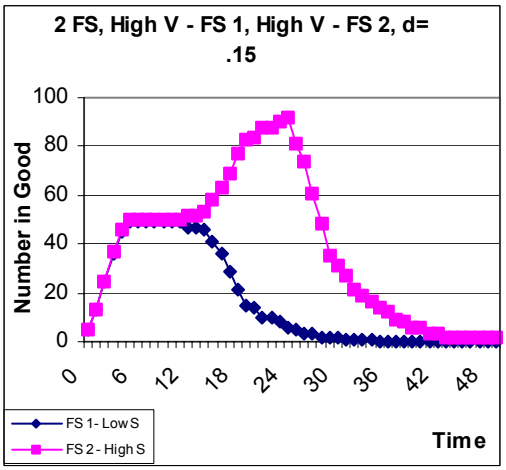

Figure 19

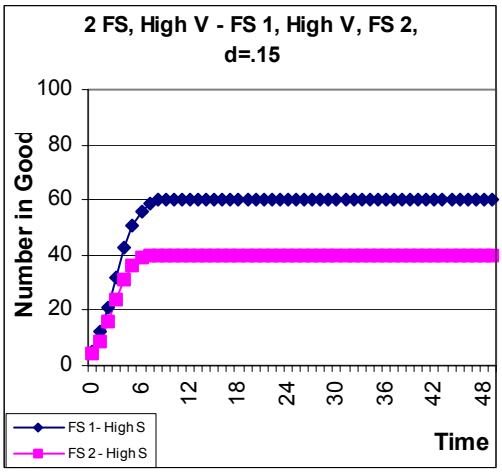

Figure 20

In the case where FS1 has a low S_{FS} value (Figure 19), and FS2 has a high S_{FS} value, the second Fad Setter takes the Fad Followers from the first Fad Setter once the first Fad Setter's good begins to decay. This alters the shape of the curve, but it can still be seen.

Once the number of FF's in the population reaches the second FS's S_{FS} value, the FF's begin to slowly exit. It is likely though, that the presence of the first Fad Setter extended the life of the second Fad Setter's good, since his S_{FS} value was reached much later than if all the Fad Followers had been a part of his good from the beginning. This implies that fads last longer when there are other fads going on. In the case where both Fad Setters have High switch values (Figure 20), a pattern similar to the one seen in Figure 16 develops. The products enter the market and never leave, with each of the Fad Setters maintaining a lock on their part of the population.

Discussion

This paper has created the framework for a new model of behavior. It models behaviors that are usually called fads. In addition it is also able to explain non-fad behavior. Goods that do not become fads can be useless or boring to everyone, as evidenced in this analysis by products with a very low value. However, many goods do not fit into this pattern. A lot of goods do not become fads because they maintain their usefulness for longer periods of time, and people tend not to become bored with them. Goods that become fads are characterized by having decay rates that are very high. This decay rate could represent how likely a new good is to be replaced by a more useful good, or how quickly people become bored with the good. The amount of the initial utility value of the good will affect how far into a population the fad can penetrate. This analysis has quantified what most people already know; that goods that become fads are really neat the first three times one plays with them, or hear the song on the radio, but that after a while, the novelty wears off and the good doesn't have enough substance to become a classic good that is enjoyed by all ages, or passed down from generation to

generation. Here we present a simple solution to see that a fad is the result of the same type of behavior that causes any other good to be purchased. It is the characteristic of the good, and the interaction of the various agents with their neighbors that causes the peculiar pattern of behavior that is called fad. Now that the characteristics are defined, they can be looked for in real life products. If the parameters that have been shown in this paper to lead to fads can be determined for actual products, then the ability to analyze and possibly predict fads can become a reality.

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