**Introduction to System Dynamics Modeling**
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**Lecture – 13.1**
**Bass Diffusion Model**

So, we will begin today's class where we look at and play with the Bass Diffusion Model.

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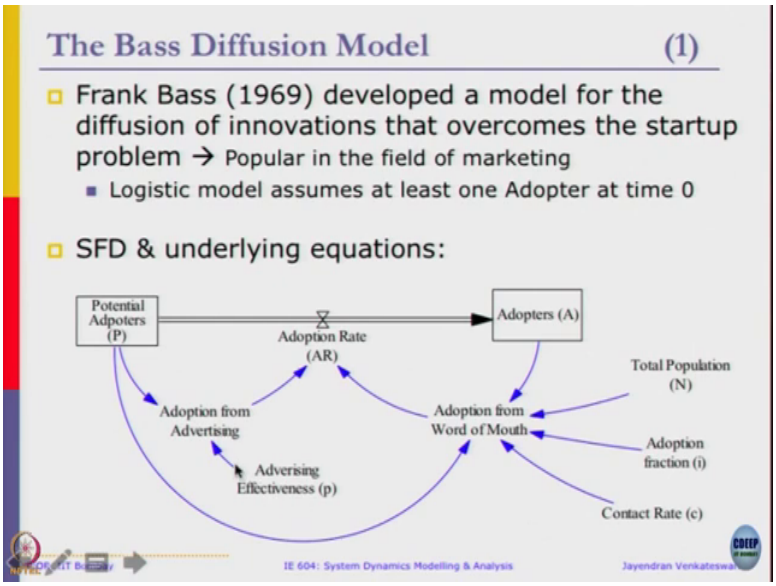


So, last couple of lectures we have been looking at models to do to understand the diffusion process which is available which applicable in many scenarios like spread of epidemics spread of (Refer Time: 00:36) sales of new products and such.

So, this particular model is attributed to Frank Bass. He developed to model for diffusion of innovations to overcome the startup problem where is in the diffusion model that we are say in till now where has to be initial value for the adopters. Adopters if it is 0 means that no innovational occur that actually is one person is purchase a product and then a word of mouth effect happens because of which the products are all sold and all the potential adopters end up buying the products.

But, Bass improved on that model we introducing what is called as a advertising effect where wherein the initial adopters can be 0, but through advertisement the message is sent to the potential adopters which makes them buy the product. So, that is the key contribution done by Bass along with you know various solutions and derivations of that which then became his thesis work now.

This choked flow diagram model that is see on the slide is the Bass diffusion model representation as a stock and flow model. So, we have two things that effects are adoption rate again the population divided into two – potential adopters and adopters. So, that means, eventually all the potential adopter will become adopters. You know adoption rate is governed by you know two factors.

One is adoption for advertising and then adoption from word of mouth and here you can see the adoption from advertising has some potential adoption is coming in and adverting effectiveness also effecting it. And, this adoption from word of mouth is effected by adopters, total population and fraction adopt, adoption fraction contract rate as well as the potential adopters.

So, this model is very similar to the diffusion model that you saw where the adoption rate was equal to the word adoption from the word of mouth. The underlining equation contains remain the same. So, when p is equal to 0 we will have a basic logistic innovation diffusion model sorry, logistic diffusion model. But, if p is greater than 0, then we call it as a Bass diffusion model where adoption rate is nothing, but a some of adoptions and advertising and adoptions from word of mouth. So, let me just slight it out.

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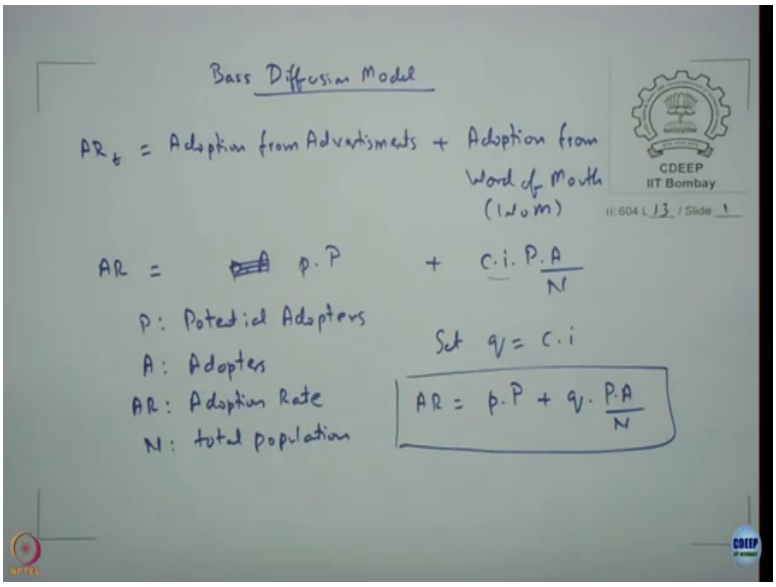


The Bass diffusion model we have adoption rate is nothing but, adoption from advertisements plus adoption from Word of Mouth or WOM in short. AR adoption from advertising is given as a product p times A. Sorry we are using potential adopter just p small p times capital P plus sort of the notation we are using word of mouth is c into i into P into A divided by N; where P is your potential adopters, A is your adopters, AR is here adoption rate, N is the total population, c is the contact rate, i is the ah adoption fraction and p is small p is the advertising effectiveness.

In popular models we you know consider we usually set say q is equal to c into i is a product. So, this is the coefficient for the word of mouth. So, that will make our AR is equal to p small p into capital P plus q into P into A by N. This is the equation that underlies Bass diffusion

model. The small p is a advertising effectiveness and small q is the word of mouth effectiveness or coefficient of advertisement and coefficient of word of mouth.

So, given these two parameters as you can see if even of adopters is 0 still adoption rate can occur because of some effectiveness in advertisement happens to a potential adopters where we can simply overcome the startup problem.

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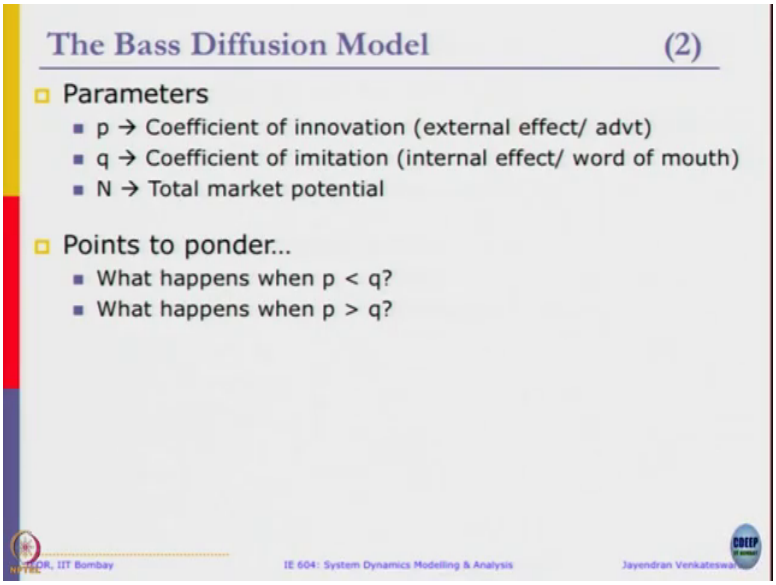


So, given this we can definitely modulate the SV model. So, now, in this Bass model where only three parameters that we need to define. One is p the coefficient of innovation or the advertising effectiveness and q is also called as coefficient of imitation or the word of mouth effectiveness right.

So, words of self explanative imitation is through word of mouth; that means, we just want to copy from others what they have. Innovation you are just looking advertisement and want to tryout the product. So, that is p and q. So, the various phrases use to define p; p is as it showed as it is shown here it represents coefficient of innovation or is it called as external effect or advertising effect, effectiveness advertising various phrases are there. So, with this just this three parameters we can actually model the diffusion of innovation.

Now, the simple thing there we want to tryout is what happens when p is less than q and what happens and p is greater than q to understand the dynamics that is going come in to play so that we can see. See when p is less than q means the effectiveness or advertising is lower than the effectiveness of word of mouth; p is greater than q means of course, effectiveness advertising should be greater than the effectiveness of word of mouth.

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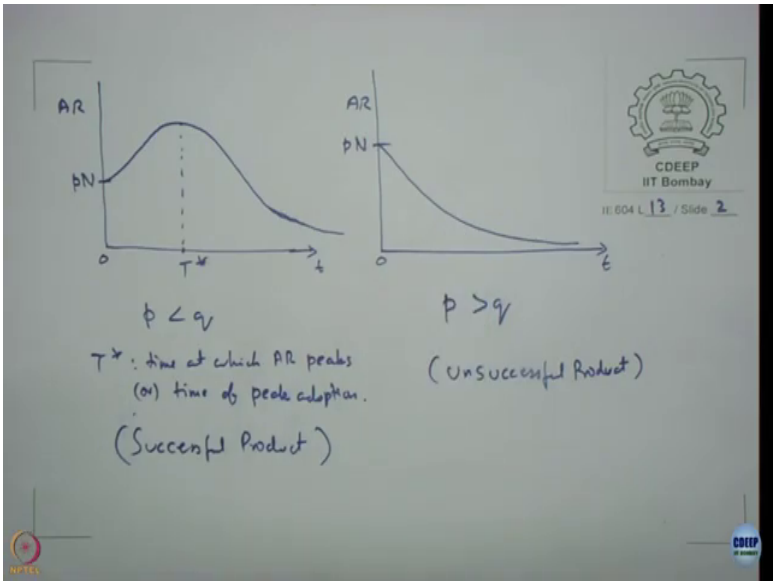

When p is less than q, the adoption rate will show and increase and then it will fall with the peak value while of p is greater than q, then you get a simple goal seeking system right. What will be the y intercept, any guess? See, initially the potential adopters are all the total population are all potential adopters. So, we are going to assume.

So, y intercept is nothing, but p into n here also it is p into n. So, let us just observe the first graph this is graph on the left side when p is less than q it is going to peak at some point and then it is going to fall down. So, let us denote that as T star where T star is the time at which AR peaks or this is the whatever time of peak adoption. So, in this case actually T star is at time 0 or rather if you go for a analytical solution then T star is actually going on the negative side. So, the peak is in the past so, which does not make sense. So, we will assume peak had happened at time 0.

So, this simple graph shows that only word of mouth can actually have my sales increasing my sales is nothing, but a adoption rate continues to increase while only for depended on advertisement then sales are going to keep falling down. Again, by word of mouth a mean a positive word of mouth. And, so, that means, we want the word of mouth happening much earlier and much quicker so that we can actually have a growth in the products.

As compared to advertisement where initially might have large, but then you will get a continuous diminishing sales and no marketing department might want to show this saying that every one there sales actually reducing rather than increasing right. So, we need to get this going as soon as possible.

So, in this case continuing the discussion this case we can call it as a successful product let us say yeah, we call it as successful product and this case we can call it as unsuccessful product. Unsuccessful product the sales is pretty much is dominated by the advertising affects rather than the word of mouth. Suppose assume the same p values are there write the starting point is the same, but if q in this case lesser than this one, in that case and here I am going to reach the population much faster as compared to this case this is going to take me longer time to reach the population.