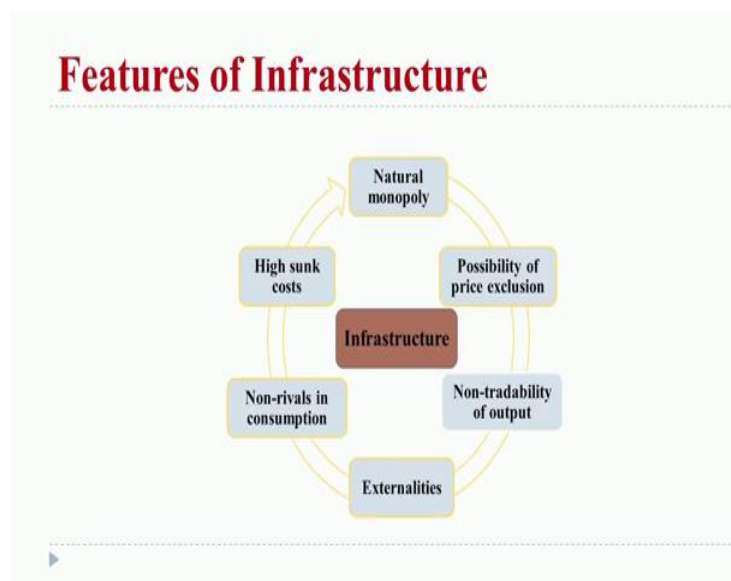


Infrastructure Economics
Department of Social Sciences
Prof. Nalin Bharti
Indian Institute of Technology Madras

Module – 01
Lecture - 02
Features of Infrastructure

(Refer Slide Time: 00:16)



We are going to discuss, what are the major features of infrastructure. First of all as shown in this diagram you can see here, major features or the natural monopoly, possibility of price exclusion, non-tradability of output, externalities, non-rivals in consumption and high sunk cost.

(Refer Slide Time: 00:50)

Infrastructure: Natural Monopoly

- ▶ When one firm can potentially supply market's entire demand for goods and services at most efficient price, it is said to exist natural monopoly
- ▶ When the fixed costs become so large that only one firm can feasibly operate, and the average costs continue to fall over the entire range of production, the one firm will emerge as natural monopoly
- ▶ The production of certain goods and services are subject to scale economies-like Infrastructure facilities
- ▶ The production of infrastructure facilities (like railways, electricity, tele-communications, gas-pipelines and other public-utilities) require a certain minimum scale of production
- ▶ Natural Monopoly is often viewed as market-failure

So, one by one we are going to discuss these points, because it is important to understand how the features of infrastructure play an important role, when infrastructure price has to be decided or infrastructure project has to be completed. So, if we are not going to, if we are not really clear in terms of the features of infrastructure, we are not really able to connect it to the economics of infrastructure behind this. So infrastructure is generally having the natural monopoly as one of the features.

So, what is basically the natural monopoly? Before natural monopoly, we must understand that what is monopoly. Monopoly is a condition in economics, where we find that a single seller is basically able to run the entire production and distribution for large number of customers available in the economy. So, in nutshell in briefly we can see that, when one firm can potentially supply markets demand, entire demand of the market of goods and services at most current price, this particular condition is said to be a natural monopoly.

So, infrastructure build up by the firms each having a feature and that feature is the natural monopoly. So, the production of infrastructure facilities such as railways, electricity, telecommunication, gas pipe lines and other public utilities require a certain minimum scale of production and the production of certain goods and services are subject to have the economies of scale, because when such projects are developed,

developers or the facilitators such as government, they consider that what will be at least number of the subscriber or consumer in the economy.

But, at same time, they do care about the product, the project is developed in a way, that there is no other producer available in the world or available in that particular economy for many years. So, automatically it becomes the matter of monopoly for them to have the price, to have the fees, license for their services. So, when the fixed cost becomes so large, that only one firm can be able to feasible, it will be feasible for one firm to operate and the average cost continued to fall over the entire range of production, the one firm will emerge as the natural monopoly. So, majority of the physical infrastructure developed by different private parties and all or you can say, that developed by the public private partnership today, is not looking for the production for a day or for a year, but they are looking for the facility developed for years for 20 years, 30 years, 40 years and no other substitute or no other competitor is available in that particular area, so that they can compete with the developer of that particular infrastructure.

So, but natural monopoly in economics, in micro economics, natural monopoly is viewed as a market failure, because actually market failure, market failure is a condition, when the suppliers and the demand, the consumer is not ready to have the equilibrium. The demand is higher than the supply or may be the supply is higher than the demand and this happens, when you have the natural monopoly over the production.

A firm becomes a monopoly firm and no other substitute firms are available, no other competitive firms are available in the market, so firm behaves like the price setter. There are two types of price decision in the market, few firms are price maker, few firms are price taker. A firm can become price taker if lots of competitions are available in the market, if large number of firms are working together, firms will be price taker.

But, if there is no firm available in the market, firms behave as a price maker. So, in case of natural monopoly, firms behave as a price maker not as a price taker, so this is one of the major features of natural monopoly.

(Refer Slide Time: 07:06)

Infrastructure: Natural Monopoly

- ▶ Figure 1 shows cost and demand curves of a natural monopoly. The firm produces output Q_1 , where $MC=MR$. At this point the price per unit of production is P_1 and average cost is AC_1 . It is clear from the figure that price is greater than average cost ($P_1 > AC_1$), the profit per unit of output = $[P_1 - AC_1]$.
- ▶ If this natural monopoly starts to operate as perfect competitive firm, the marginal cost pricing [$P=MC$] principle, then it must produce output Q_a and price will be P_a . In this situation, there is a loss ($AC_a - P_a$) per unit of output.

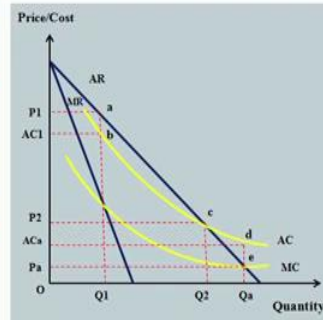


Figure 1: Natural Monopoly

So, if you can see this diagram, the figure 1 shows that, this particular figure shows that, there is a price P_1 price, which is higher than the AC_1 , AC_1 is the average cost of production in this diagram. And we find out that the profit between the P_1 and the AC_1 is the profit earned by this natural monopoly firm. Because, even if in natural monopoly is producing a product on AC_1 price, then also natural monopoly firm is above the price which is equal to marginal revenue equal to marginal cost, which is - where the price is equal to MR and MC ; that is the condition of competition in the market, perfect competition in the market.

But, when the price is AC_1 ; that is also very high level of price compare to the marginal revenue and marginal cost equilibrium. But, when the firm- at AC_1 , the firm is not ready to accept, that AC_1 price also, but firm is charging little more higher price, because the firm is the natural monopoly firm and then, the firm is setting the price of P_1 , which is more higher price compare to AC_1 and that shows the higher or the maximum level of profit, which a firm can really achieve from the market being a natural monopolist in the existing market.

(Refer Slide Time: 08:47)

Infrastructure: Sunk Costs

- ▶ The expenditures that has already made and cannot be recovered even when the firm go out of business
- ▶ Sunk costs may be a barrier to entry into infrastructure development projects for private investors
- ▶ If sunk costs are high relative to marginal cost, price will almost surely exceed marginal cost, even though economic profits are zero

So, this is the first feature which we have discussed. The second feature is the sunk cost involved in the infrastructure projects. What is basically the sunk cost? The sunk cost is basically the expenditure that has already made and it cannot be recovered even when the firms go out of business.

For example, if a firm is building up a flyover, once the flyover is made, even if firm is going out from the business, the cost involved in the making of the flyover, it cannot be recovered, if the flyover is not ready for the city or not ready for the use. The entire cost, which you have involved, which you have incurred, that may be the sunk cost, because if you are not delivering on time, if you are not delivering with a proper quality, if you are not delivering with proper care, then whatever investment you have made, that investment is going to have, that investment, that cost will be sunk cost after some time, because you are not really in the position to continue with the business. So, sunk costs is a barrier to entry, for example more recently I was discussing with one of the road constructor, road construction firm in Bihar and they were saying that due to the non ability of the stone chips, now whatever cost they have incurred the last two years, since the project is not going to complete on time and it will be delayed the project is now delayed.

So, whatever cost they have incurred, that cost is becoming more costly, because the project is not delivered on time and there is a danger of sunk cost, because if it is not

delivered on time there will be the breach of contract between the firm and the regulatory agencies.

And in that case this particular example is one of the example, where any firm which, any firm who wish to continues such projects, they will have the fear or this type of cost involvement is one of the barrier for many firms to enter infrastructure projects. Infrastructure development is not any easy area where anybody can jump in to, but it is one of the risky area infrastructure project developments has lots of risk involved and this is one of the risk involved in infrastructure development.

And this sunk cost example is an example in majority of the infrastructure projects and that is going to become a challenge for the infrastructure development. And this is one of the major features, which makes the infrastructure projects different from other projects. Because, you have to wait for a long time, you have to wait for the raw materials, which is a rare, which is not available everywhere. But, at the same time you have so much of uncertainty in your production if you have lots of if and buts in the production.

So, that way, you are not really considering, you are not really sure that when you are going to complete the project, how you are going to complete the projects and that uncertainty is going to cost a lot some time and if sunk costs are high- relative to the marginal cost price will almost surely exceed the marginal cost even though economic profits are 0. So, this particular example is another example, where we can find out that this is one of the barriers in terms of infrastructure development.

(Refer Slide Time: 13:16)

Cont.

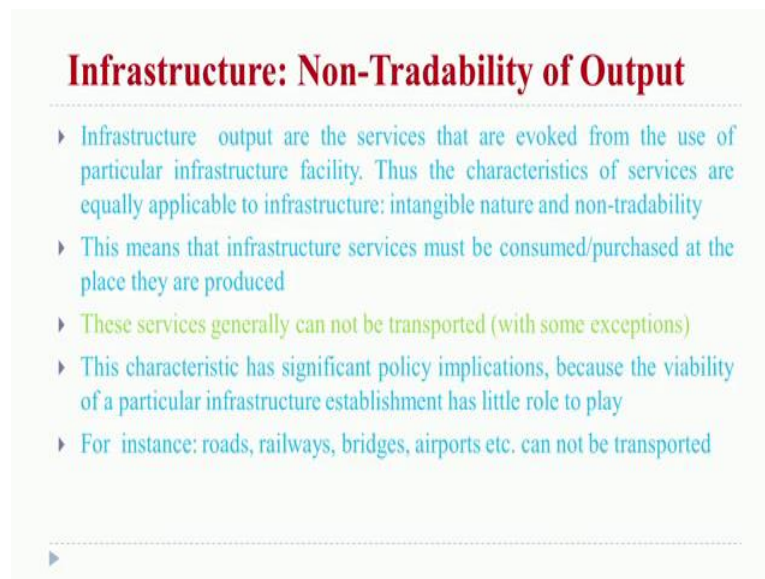
- ▶ Examples of sunk costs include investments in product development, the construction of a specialized production facility, large infrastructure projects etc. Such expenditures cannot be recovered and are therefore essentially irrelevant for any ongoing decisions that the firm must make
- ▶ Sunk costs should not be considered for future investments decisions
- ▶ Examples: telecommunication towers, sewerage, railways etc. have high sunk costs

To continue with this sunk cost examples, examples of sunk cost- includes the investment in product development, the construction of a specialized production facility, large infrastructure projects, such expenditures cannot be recovered and are therefore, essentially irrelevant for any ongoing decisions that the firm must make. So, majority of the road construction projects are facing such problems, because there are there are so many raw materials which is not available in the nearby area and when you are transporting it from the neighbouring part, neighbouring states, neighbouring part of the economy, then also you are not sure about the timing of the receiving of those raw materials and sometimes some of the raw materials are available within your infrastructure development periphery. But, sometime, due to the state intervention or due to the political interference, those raw materials such as stone chips or something is not easy available, and now you have to depend on some other sources, which is completely away from your area of production.

So, what this makes you is nothing except having a very uncomfortable condition in terms of the developing the infrastructure projects. So, sunk cost should not be considered for future investment decisions. If you have a large sunk cost involved, a firm cannot really think for investing again and again. If you have restriction, if you have control on the sunk cost, you are comparatively better in terms of investment, because you know that you are not going to lose a lot of investment.

So, telecommunication towers, sewerage, railways etc. high sunk cost, because if you are upgrading the technology, the old infrastructure is not going to help you; if you are shifting from narrow gauge to broad gauge, then narrow gauge line is not going to help you, you have to rebuild the entire railway line and that is basically the sunk cost the previous projects are basically as a part of the sunk cost.

(Refer Slide Time: 16:02)



Infrastructure: Non-Tradability of Output

- ▶ Infrastructure output are the services that are evoked from the use of particular infrastructure facility. Thus the characteristics of services are equally applicable to infrastructure: intangible nature and non-tradability
- ▶ This means that infrastructure services must be consumed/purchased at the place they are produced
- ▶ These services generally can not be transported (with some exceptions)
- ▶ This characteristic has significant policy implications, because the viability of a particular infrastructure establishment has little role to play
- ▶ For instance: roads, railways, bridges, airports etc. can not be transported

So, this is one of the second feature which we have discussed. The third feature is the non-tradability of output. What is basically non tradability of output? Infra products are different from other manufacturing products. Like if you have some manufacturing manufactured products, for example if you have a company, a firm of producing television sets, the television sets can be transported from or tradable it is the tradable item from one country to other country, one place to other place.

But, when you are building up the flyovers, when you are making the roads, when you are having the airports developed, you cannot really trade. These products are not basically tradable; you cannot really transport your flyovers from one city to other city. The flyovers where you have built up, that flyover is going to continue for as many as many years as you want to continue with proper maintenance.

And there are certain periods for which you can really keep those flyovers or roads and other things, but, you cannot really, these products are not really tradable product like electronic items or the food grain or the other items which is being produced like

garments and other things which you can produce in one part and send it other parts. So, this is another unique feature of a infrastructure products that infrastructure services must be consumed/purchased at a place, where they are produced, that is one of the feature.

But, other products other electronic items, garment, food grains and cereals and other items, it can be consumed not only in the place where it is produced, but majority of the products are basically consumed far away from the area where it is basically produced. So, this characteristic has significant policy implications, because the viability of a particular infrastructure development established, particular infrastructure establishment has little role to play in terms of the outside consumption.

So, infrastructure output are the services that are the evoked from the use of, use of particular infrastructure facility, thus the characteristics of services are equally applicable to infrastructure intangible nature and non-tradability. Intangible means if you are making a television sets, these television sets can be assembled in a country. The components of the television sets can be taken from different parts of the country, equally with the automobile sectors, with the car luxury car or may be the economy car, where you can, one can take the inputs from here and there, different components from here and there and then you can assemble it in some other country. One can read the book by Samuelson, where Samuelson discusses about the BMW example. It can, the components can come from many part of the world, but it can be assembled and produced by a firm and that is the way of reducing the cost of production. But, in case of infrastructure, you cannot really assemble infrastructure in other part of the world and then, you cannot sell it in other part of the world.

Because, you have to have build up the infrastructure, physical infrastructure in the country where you are going to suppose you are going to build up this. You cannot really assemble the infrastructure; you have to build up the infrastructure. So, in todays world of global integration and globalization where so many manufacturing activities are offshore, many firms are producing something in China, in India, or in Bangladesh or in many part of the world, where the low cost of labour is available.


But, at the same time, infrastructure products are not like those manufacturing items that you can produce or offshore or you can assemble somewhere else and you can transport it to somewhere else. So, that is basically one of the major another feature of this

particular infrastructure product, for example, roads, railways, bridges, airport, that cannot be transported at all.

(Refer Slide Time: 21:04)

Infrastructure: Non-Rival Consumption

- ▶ Consumption by an individual does not affect the consumption by others
- ▶ Thus an additional consumer can enjoy the benefits of consuming a good or service without conflicting the benefits of others
- ▶ Zero marginal cost of providing the benefits of a good to an additional consumer
- ▶ For instance: roads and telecomm



(Refer Slide Time: 21:15)

Infrastructure: Price Exclusion

- ▶ The benefits will be provided only to those who pay for the services/goods
- ▶ Price exclusion is a feature of private goods
- ▶ Perfect competition and efficiency merits marginal cost pricing, i.e., $P=MC$, that the prices must be set at marginal cost
- ▶ But, in the case of infrastructure, it will be very difficult to recover the costs of providing the facilities
- ▶ Thus, pricing of infrastructure facilities are not regulated through market forces

So, that is a very different feature and at the same time, I forget to mention that this is also non-tangible item, means you cannot really make these products in a different way in different parts, because you cannot put it in different piece. You cannot put these items in different piece. A flyover is a flyover; you cannot say that flyover 10 percent of

flyover will be used by something somebody, 20 percent of flyovers will be used by some other citizens of this city. A pizza can be divided in 10 parts, because it is tangible, one can have the division of a bottle of Pepsi or Coke, but one cannot have the division of the infrastructure, which is built up and developed.

So, this is one of the major distinctions of this infrastructure products compared to the other manufacturing items. There is also one more feature and that feature is the non rival consumption in infrastructure. What is basically non rival consumption? Rival consumptions are those consumptions, suppose, if I have a glass of Pepsi and if I am taking that glass of Pepsi other cannot take the same glass of Pepsi, because I am finishing it.

So, the consumption or the utility derived by me is my own utility it is not the utility of others and that particular products are basically having the private consumption and there is a rivalry in the consumption whosoever is going first to a cinema hall, they will have the seat first not the person who is going in the last.

So, the person who is going first, they will buy the ticket, there is rivalry in the consumption of a particular film like the person who is running to have a seat in a restaurant, the family which is very fast in going and joining the restaurant, they will certainly have the comfortable seats.

But, the people who are not really able to reach on time, they are not really able to get the comfortable seats even they will not be able to finish to take the meal in the restaurant, because these are the product, which has the rival consumption. Seats are limited, food is limited and there is rivalry in consumption; whosoever is going first, they will get the chance to get it. But, in terms of physical infrastructure such as flyovers or the bridges, it is not the first one who will go in the morning only they will have an opportunity to use that flyover. But, anybody even whosoever is going in the last also they will have the equal opportunity to use that flyover.

And in such situation we are completely different from the private consumption or the private product consumption, the consumption of infrastructure products are not like the consumption of private products, because there is no rivalry in consumption, which is available in the private consumption. So, zero marginal cost of providing the benefits of a good to an additional consumer and producer has no cost involving in providing those

facilities to others. In a restaurant if the capacity is for 50 and if 50 more people are standing outside and the restaurant has the huge cost to involve for entertaining those people.

But in case of roads whether it is one car running or 100 cars running the huge cost is already paid by the company and there isn't any non-rivalry in consumption and there isn't any marginal cost for the marginal cost involved in the adding those customers or adding the additional customers in the consumption such as in telecommunication, once the tower is there, infrastructure is build up whether number of subscribers are one lakh are one lakh five thousand does not make any change.

So, another feature of infrastructure is the price exclusion, the benefits will be price exclusion is a condition when the benefits will be provided only to those who pay for the services and goods. Price exclusion as I have discussed in the case of restaurant food and in case of Pepsi and Coke, the price exclusion is a feature of private goods, when we purchase, when we are purchasing televisions sets for our household, that television set are not really the television sets for anybody else in the that particular city, because; that is the television sets for my own home.

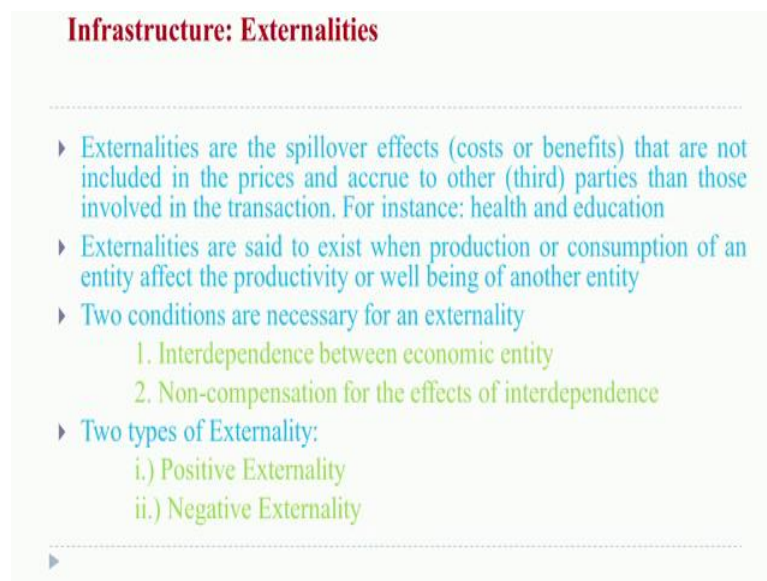
So, we are stopping that price when we are paying the price we exclude the consumption of that particular television sets to other consumer of that particular city. So, we are not including infrastructure is basically inclusive in terms of price once it is build up once it is produced we are basically including others also to use it, we are not stopping anybody to use it.

So, perfect competition and efficiency merits that marginal cost pricing that the price must be set at the marginal cost in case of infrastructure products do work, but in the case of infrastructure, it will be very difficult to recover the cost of providing the facility, because pricing of infrastructure facilities are nor regulated through the market forces, it is not the additional demand which comes on the way. Because, there is not any non-rivalry in consumption, because people are not having any competition in the consumption like in case of private goods, in private goods there is a competition in the consumption.

If a new film comes in the city, large numbers of consumers are really going for watching that movie and only if 100 seats are available, the theater cannot really

entertain more than hundred, so others are, no other choices except to wait for the next show or may be the next day show. But in case of infrastructure, once the infrastructure is ready there is not any additional cost, but at the same time many people do not want to pay for it, many people do not want to have additional demand, because it is not the product where you will have or the supply will have the any competition in the consumption. So, this is one of the completely different feature of infrastructure products.

(Refer Slide Time: 29:15)



Infrastructure: Externalities

- ▶ Externalities are the spillover effects (costs or benefits) that are not included in the prices and accrue to other (third) parties than those involved in the transaction. For instance: health and education
- ▶ Externalities are said to exist when production or consumption of an entity affect the productivity or well being of another entity
- ▶ Two conditions are necessary for an externality
 1. Interdependence between economic entity
 2. Non-compensation for the effects of interdependence
- ▶ Two types of Externality:
 - i.) Positive Externality
 - ii.) Negative Externality

The last, but not least, the externalities which is involved in infrastructure, externalities are basically an economic externalities are the situation where when the two parties are involved in production and consumption. If the impact is on third party, that third party impact is considered or named as the externalities. So, externalities are the spillover effects cost or may be the benefits that are not included in the prices and accrue to other third parties, then those involved in the transaction for instance health and education.

Externalities are said to exist when production or consumptions of an entity affect the productivity or well-being of another entity. If a city is having a very good rose garden, the rose garden may be developed by the municipal corporation or the local bodies for the local people, but anybody any new visitor of that city is equally having the benefit of the rose garden; that is the positive externalities.

If a singer is singing a song a good song in the morning, even if they are he or she is singing inside the home may be for the family member or may be for his own satisfaction, but, whosoever is passing through that road they are also listening that singing and there is a positive impact of such singing, there is not any negative impact. But, if an industry is in the middle of the city and polluting the river nearby that city; that is going to harm not only the local citizen, but that is also going to have harm on the next generation of the people.

And even if that industry is for a particular consumer for example, if leather industry is there and some of the consumers are getting the benefit of that leather industry does not mean that the only the party who are involved in consumption of leather shoes or something leather bags, they are only getting affected, but there is also the impact is on third party, which is who is not really involved in the consumption. So, negative externalities are seen in case of infrastructure. There are positive externalities and negative externalities involved in the infrastructure development products.

Two conditions are necessary for externalities inter dependence between the economic entities and non-compensation for the effects of inter-dependence. So, to sum up, to conclude, we can see here, that infrastructure products are completely different from the private products. Even if infra products are developed by the private bodies and it is more like a private goods, but, at the same time it has many features of public goods. The difference between private goods and public goods are; public goods are non-rival in consumption while the private goods are rival in consumption. Public goods are non-tangible, for example defence. If a country is providing defence to one citizen, the country is equally providing defence to other citizen because, a country cannot stop somebody that you cannot be protected, others will be protected and you cannot be protected. A Street light for example street light, if a city is providing street lights, a city cannot make the rule that this street light is only for those, who are paying for this and this street light is not for those, who are not paying for this.

So, public goods are having the free riding problem people even if they do not want to pay, street lights is being provided to the city. But, at the same time when it comes for the payment of those goods; public goods are facing these days the problem of non-payment. Infrastructure products are having many merits of public goods and this particular

example gives as the idea, that infrastructure products, the feature of infrastructure products are completely different from other private goods and other services.

So, that way we can find out that developing infrastructure is a very challenging task, because there is a sunk cost involved, there are externalities involved, there are spillover effects and that way infrastructure development and maintenance is one of the major challenges. In some of our next lectures we are going to cover these challenges and we are going to discuss more in detail about the infrastructure development and its impact.

Thank You.