Provision of Infrastructure: Self-financing as Sustainable Funding

Dirk Löhr[1]

Executive Summary

Grid-bounded infrastructure constitutes the arteries and veins of economic systems, channeling material flows from the cradle (resource exploitation) to use and finally to the grave (disposal sites). However, from an economic standpoint, grid-bounded infrastructure has the features of a natural monopoly. The result is a marginal cost paradox: Although marginal cost pricing of infrastructure services is welfare optimising, it cannot cover the full costs. The problem is lack of coverage of the fixed costs share, which may amount to some 70–80 percent of the full costs in many cases. In this regard, economists developed a series of second-best solutions, which all have some disadvantages and shortcomings. In order to find a first-best solution, we have to leave the beaten tracks.

Regarding railway services, a striking example of an alternative design is the Mass Transit Railway (MTR) in Hong Kong. This business model is based on two pillars: rail and development. This means the company acts not only as a railway operator, but also as a real estate company. Before a new track is constructed, the company buys the land around the future terminals under favourable conditions. In doing so, MTR benefits from value capture around the terminals. This capture of value and land rents makes it possible to cover most of the fixed costs and to gear the transport fares towards the marginal costs. As a result, unlike other railway companies, the MTR is highly profitable and is considered one of the best railways in the world. The business concept of MTR is nothing other than a microeconomic application of the Henry George principle, according to which, under certain circumstances, all the fixed costs of public investments (including social infrastructure) could be covered by land rents.

[1] The views and opinions expressed in this publication are those of the original author(s) and do not necessarily represent or reflect the views and opinions of the Dialogue of Civilizations Research Institute, its co-founders, or its staff members.

Policy Recommendations:

- the conventional way of financing the fixed costs of infrastructure with user fees or taxes is inferior in many regards;
- since the endowment of beneficial infrastructure increases land rents and land values, the fixed costs could be best covered by tapping the land rents and by value capture;
- In doing so, public services could be provided at marginal cost pricing in a welfare-maximising way;
- the application of such a model is possible, for example, through public companies and the use of ground leases.

Keywords: grid-bounded infrastructure; natural monopoly; MTR; Hong Kong; marginal cost pricing; Henry George principle; railway services

1. The Importance of Infrastructure

Much of the differences between developed and underdeveloped nations relate to endowment with and access to affordable infrastructure. Differences in infrastructure endowment are responsible to a large degree for differences in productivity and GDP. Inadequate infrastructure leads to a lack of access to markets, jobs, information and training, creating a major barrier to doing business.

Regarding public infrastructure, a distinction can be made between at least two types of infrastructure facilities: social infrastructure (schools, kindergartens, hospitals, etc.) and technical infrastructure. The latter primarily includes transportation systems, such as subways and streets, water supply and wastewater treatment facilities. Both types of infrastructure determine the patterns of settlement. In particular, technical infrastructure is mostly grid-bounded and reduces the costs of material flows, information and transaction costs—that is, particularly the transportation costs (in a broad understanding) within and between agglomerations. Such grid-bounded infrastructure can be considered as the arteries and veins of the economic system, channeling the material flows from the cradle (resource exploitation) to the production of goods and services, and from there to the grave (disposal sites). Without a suitable infrastructure with modern transport, energy or waste systems, there is no way to bring the economy onto a sustainable path.

However, providing and financing infrastructure is a problem, and not only in developing or threshold countries. In Germany, for instance, the current investment backlog for streets, electricity and the broadband networks is some €160 billion over the next 10 years (IW Köln, 2014). Not included in this calculation are the necessary investments for schools, for a desirable expansion of public transport, for the adaption of the water supply network, etc. According to the American Society of Civil

Engineers (ASCE), the US needs to spend $1.6 trillion before 2020 just to maintain the current poor condition of its infrastructure (Plumer, 2013). In the organisation's latest report, the nation's infrastructure received an overall grade of D+ (Hatcher, 2013).

Subsequently, I want to focus solely on financing grid-bounded infrastructure and its impact on economic performance and productivity. In particular, I will not discuss the possible benefits or risks of a national public infrastructure program arising from direct program spending.[2]

2. Thesis: First-best Solutions are Possible

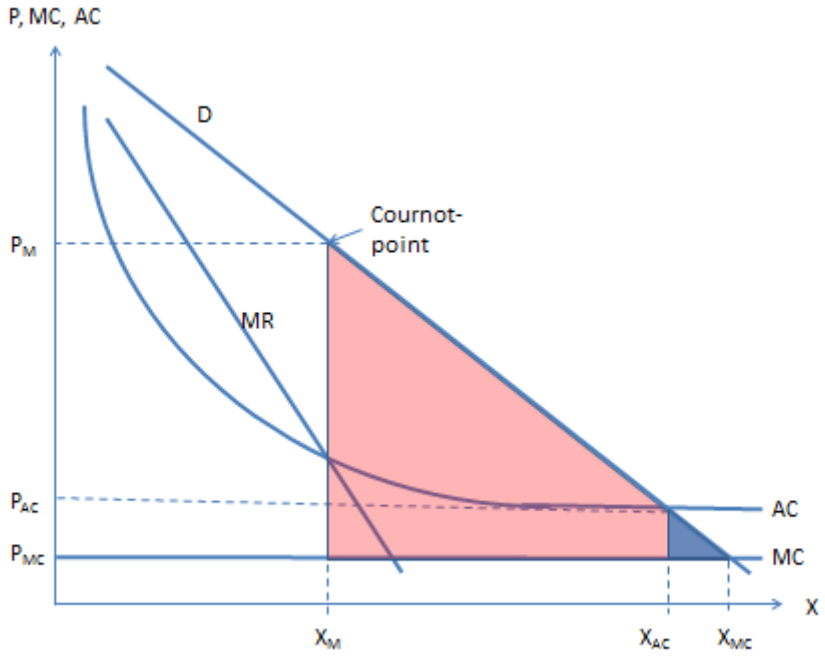
Most economists agree that the first-best solution of providing infrastructure services is at marginal costs (Vickrey, 1948: 218). This means the willingness to pay for marginal infrastructure services is as high as the costs of providing it (Peneder, 1996: 214).

However, conventional economic wisdom suggests that this first-best solution can hardly be achieved. This is why grid-bounded infrastructure has features of a so-called 'natural monopoly' (see Figure 1 below). An important feature of natural monopolies is the subadditivity of costs: Because the average costs of production (AC) decrease with rising supply, one single company can provide the market with lower costs than a certain number of competing companies. Due to the fixed costs of infrastructure, the marginal costs (MC) are permanently lower than the average costs (AC). The share of fixed costs of grid-bounded infrastructure services may easily exceed 70 to 80 percent of the total costs. In the case of the German water supply, for instance, the share of fixed costs is some 80 percent; most of these fixed costs

[2] For more information, see for instance Ganelli and Tervala, 2013.

relate to the grid (Pawlowski, 2009: 287–91). The highest share of the transportation costs of electricity is fixed costs (also some 80 percent; Möllinger, 2009: 9) as well.[3] As a consequence, the desirable marginal cost pricing (P_{MC}) doesn't cover full costs, and marginal cost pricing makes the provider of infrastructure run into a deficit. Figure 1 provides an illustration.

Figure 1: Welfare losses due to natural monopoles



On the other hand, full cost prices (P_{AC}, which cover the average costs) would cause a misallocation and a welfare loss (see the pink and blue triangles in Figure 1) compared with a competitive market. This dilemma appears irrespective of whether the infrastructure services are provided by private or public companies or within a public-private partnership scheme.

[3] Even the costs for electricity production include an increasingly large share of fixed costs (in particular, the production of renewable energy).

This is why economists are searching for feasible second-best solutions. However, the rest of this chapter will show that the dilemma might be solved and first-best solutions might be feasible, if the appropriate political will exists. These arguments are supported by examples, mainly from Germany.

3. Theory Overview: Provision of Infrastructure as a Sustainability Problem

3.1. The Economic Point of View

3.1.1. Private Supply of Infrastructure Services[4]

The worst way to deal with a natural monopoly is unregulated supply by a private supplier. Here, the monopolist will maximise its profits within the Cournot point (see Figure 1 above). Again, this is the point where the marginal revenues (MR) equal the marginal costs (MC). In the case of a supply monopoly, the slope of the function of marginal revenues is steeper than the price-sales function (D). Thus at the Cournot point, the prices are higher and the quantity provided is lower compared with a competitive market, where the marginal revenue function equals the price-sales function. This is why the monopolistic behavior leads to a welfare loss (if no price discrimination is possible), which is even significantly higher than in full cost pricing (see the pink vs. the blue coloured triangles).

In order to ‘tame’ a private monopolist, the price level or the price structure could be regulated. This might be, for instance, full cost prices (P_{AC}) with rate-of-return regulation or price caps for the monopolists. Some important pricing rules are as follows:

- Ramsey pricing: In the case of a homogenous good such as electricity, Ramsey pricing (Ramsey, 1927) results in discriminatory pricing. Here the

[4] This section refers to private monopolists; however, the same problems as those discussed here may arise with public monopolists, if they are commercially oriented.

prices for the use of infrastructure depend on the price elasticity of demand (for critiques of that perception, see section 4 below). This is because the greater the reaction of users in response to a price change, the higher the potential welfare loss. Thus, the higher the price elasticity of demand, the lower the add-on on the marginal costs should be. Within Ramsey pricing, the welfare losses might be reduced significantly.

- Non-linear tariffs (Peneder, 1996: 223). A basic fee should serve to cover the fixed costs, whereas in the ideal case the consumption-based price component should reflect the marginal costs.
- Peak load pricing. Within peak load pricing, the prices change according to the congestion (Boiteux, 1960).

All of these methods have application problems. Ramsey pricing, for instance, suffers from asymmetric information and distributional problems, since the private monopolists might pocket the consumer rents. Non-linear tariffs may expel users with low consumption, since their share of fixed costs in the price may be even higher than that of an average consumer (who already has some 70 to 80 percent). Peak load pricing faces, among others, a regulatory problem if the fees in excess of the marginal costs need to cover the fixed costs: The grid owner may ask himself why he should remove infrastructure bottlenecks if they are a plentiful source of funds? Apart from that, although some of the schemes above (such as Ramsey prices) reduce the welfare losses, no proposal is able to eliminate them.

Another option to control monopolistic power is the installation of competition for the market (instead of competition in the market). Within such ‘Demsetz competition’ (Demsetz, 1968), licenses could be auctioned to those private suppliers that are able to provide predefined infrastructure services at the lowest price. However, there is no reason why infrastructure services should be offered at marginal cost prices, since

competition for the market also means the supplier has to cover the fixed costs. Welfare losses will also appear.

3.1.2. Public Supply of Infrastructure: The Limits of Taxation

One very old approach (Thiemeyer, 1964) to dealing with the problems is to use public companies. This is done in Germany, for instance, very often in the drinking water and wastewater industries. Although the water quality is considered excellent, many economists are critical about the efficiency of the public-owned companies (e.g., Brabänder et al., 2015). Moreover, in order to cover the costs, public-owned companies also have to charge users full cost prices, with welfare losses.

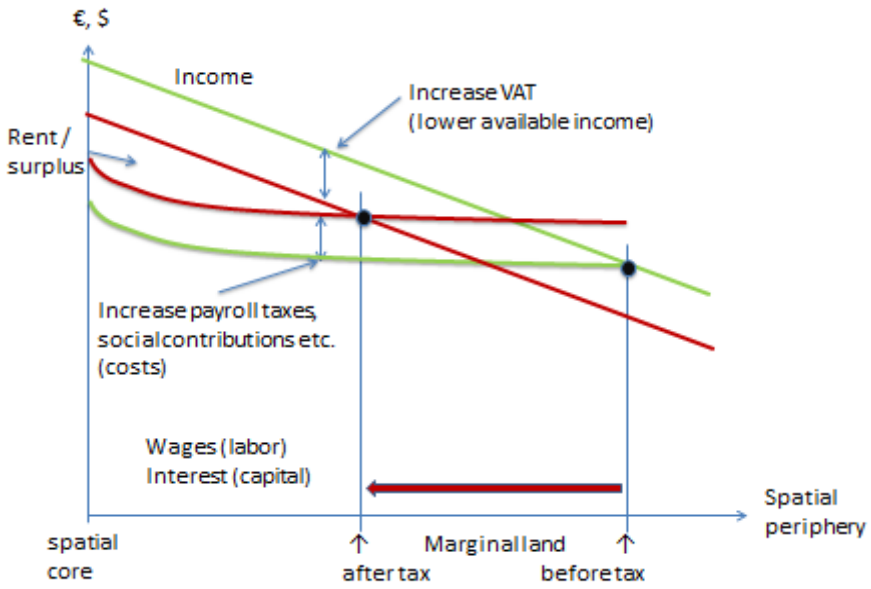
Another possible way to finance infrastructure is by conventional taxation. In doing so, the user is not charged. In general, the problem with a zero price is overuse and the efficiency losses caused by taxation. Both cause a welfare loss. Nonetheless, in many countries free provision of certain infrastructure facilities is common—for instance, in Germany passenger cars don't pay for using the highway.

Common economic wisdom rejects the free provision of infrastructure, mainly due to the problem of overuse. Instead, the discussion is about limiting tax-funded subsidies on the coverage of the fixed costs of infrastructure in order to offer infrastructure services at marginal costs. However, no matter how large the share of tax-funded infrastructure is, the problems are severe. We are talking about 'conventional taxation', which we understand as the taxation of the mobile factors of production, including contributions to public social insurance, as well as the taxation of consumption.

Conventional taxation has only limited possibilities. We know about this phenomenon already from the Laffer curve (Laffer, 2004). However, the American economist Mason Gaffney (2009) added some analysis that provides an even deeper

understanding of the problems of conventional taxation. According to Gaffney (2009: 371), conventional taxes are always taken out of what he calls ‘social surplus’. The spatial approach in Figure 2 illustrates what Gaffney means. The spatial center is located at the lower-left of the figure, and the periphery at the right. In the spatial center, the wages and the costs of capital per person are higher than in the periphery. However, the difference is not as large as the differences in overall income. Due to the mobility of labor and capital, the prices tend to equalise, at least to a certain degree (the arbitrage process is hampered by mobility barriers, particularly for labor; moreover, in the center a surplus for higher qualifications needed is paid). The social surplus is the residual, which is left after the mobile factors of production labor (wages) and capital (interests) are paid out of the national income. Since the spatial differences in GDP are higher than the differences in income of the mobile factors of production, the land rent in the center is higher than in the periphery. The marginal land is where in the periphery the costs of the mobile factors of production can just be covered, and no surplus can be yielded.

Figure 2: The harmful effects of conventional taxation



The land rent, as the difference (residual) between the national income and the costs of the mobile factors of production (labor and capital), is at the same time the maximum public funds. In other words, all types of conventional taxation depress the land rents as social surplus:

- Taxes usually increase the costs (e.g., payroll tax, social insurance contributions) or lower the available income (e.g., VAT; see Figure 2). For instance, according to the OECD, the tax wedge in Germany was the third highest of all OECD countries in 2015 (OECD, 2015). Moreover, indirect taxes have to be added, which are also paid by workers, for the most part. In high-tax countries, the effective land rent (‘kinetic’ land rent) is much lower than the potential land rent (Foldvary, 2012). Finally, the marginal land—the land where the costs of production can just be covered—moves inside, towards the center. The economy gets strangulated from ‘outside’ to ‘inside’ by higher taxation. Gaffney (2009: 371) called this effect ‘ATCOR’: all tax comes out of rent. As a result, the social surplus decreases. This ATCOR effect is widely ignored in the conventional literature on taxation.
- Another effect goes hand-in-hand with ATCOR; this is the ‘EBCOR’ effect: excess burden comes out of rent. Due to taxation, economic actors make ‘detours’, which cost time and resources. Moreover, taxation may discourage economic activities. As a result, income is lower than it would be without taxation. The depression of income causes a depression of the residual (land rent). If, for instance, the marginal excess burden of taxation is some 20 percent and the tax-financed extension of a railway track costs €1 billion, the real costs for the economy are €1.2 billion. In Germany, the

> average excess burden of the current taxation is at present 13%; the marginal excess burden is significantly higher (Loehr, 2016: 153).

The combination of ATCOR and EBCOR are important reasons why Germany as a high-tax country has comparatively low land rents and land values, although it is located in the center of Europe. The land values in Germany are lower than those in Luxembourg or Switzerland, which have lower taxation.

Incidentally, not only conventional taxes but also full-cost-oriented user fees may contribute to the abovementioned ATCOR and EBCOR effects. Transportation costs that cover the full costs also damage the spatial periphery in a similar way as the ATCOR effect does. Moreover, they make people act differently compared with marginal cost pricing for transport services—similar to EBCOR.

In addition, a further reason for the lack of effectiveness is the disincentives caused by conventional taxation. Taxes are defined as forced payments to the state without any claim for compensation. Due to the lack of consideration, economic actors try to avoid taxation—mostly through legal, but sometimes also through illegal means. Moreover, tax money is not earmarked. There is no direct accountability that tax money has to be spent for a certain purpose in a certain way. It flows into a ‘big pot’, from where it might be taken by the administration for all possible purposes. Due to this organised irresponsibility, the taxpayer’s money is often spent in an ineffective and inefficient way.

For these reasons, the capacity of taxation to pay the fixed costs of infrastructure is limited. In order to offset or more than offset these negative effects, the productivity of public investments has to be quite high in order to create a social surplus. Thus, infrastructure investments in peripheral regions particularly result in a misallocation of public funds.

3.2. Social Aspects

Regarding social aspects, access problems are the focus of attention. A lack of access to infrastructure at affordable prices is a problem particularly in many developing and threshold countries. Basic infrastructure such as roads, information and communication technologies, sanitation, electrical power and water remains scarce. For instance, about 2.6 billion people in the developing world are facing difficulties in accessing electricity full time. Moreover, 2.5 billion people worldwide lack access to basic sanitation, and almost 800 million people lack access to water, many hundreds of millions of them in Sub-Saharan Africa and South Asia. Between 1 and 1.5 billion people do not have access to reliable phone services (UN, 2016). However, even highly industrialised countries such as Germany lack infrastructure, although in a different manner. Here, for instance, the broadband extension doesn't work well, particularly in peripheral regions.

There is less of a focus on other distributional problems that occur due to the funding of infrastructure by conventional taxation or full-cost-oriented user fees. For instance, if full cost user fees or taxes are used in order to set up or to maintain infrastructure, the greatest beneficiary is the owner of the surrounding land. For instance, Fred Harrison (2006, p. 172) reports that the extension of London's Jubilee line cost the taxpayer and users some £3.4 billion to build. Harrison refers to Riley (2001, pp. 23–25), according to whom the adjoining land values increased by something close to £14 billion. Thus, a tenant in a well-endowed city has to pay high land rents, which are caused to a high degree by his user fees and taxes, which he also has to pay to the company and the state. This is why conventional taxation and user fees are a redistribution mechanism in favour of the landowners.

3.3. Ecological Impacts

From an ecological standpoint, suboptimal allocation and political disincentives also have environmental impacts. If, for instance, train tickets cover nearly the full costs (as they do in Germany), the resulting high prices make it difficult to divert traffic from the streets onto public transport. As a result, the planning of the cities is also geared towards individual automobile traffic.

Moreover, as a result of the abovementioned funding problems, the German government, for instance, is so far not even capable of maintaining the existing infrastructure—not to mention financing a green transformation of infrastructure. Recently, the energy turnaround in Germany had to be slowed down, also due to a lack of capacity in the transformation grid. And there is another aspect of full-cost pricing: If the consumers as a whole are successful in saving water, for instance, the water bill of all consumers will rise, since the average costs increase.

4. A Neglected Approach: The Concept of Self-funding Infrastructure

Obviously, a pricing of infrastructure services that covers the full costs causes allocation problems. Apparently, the conventional approaches, which finance the fixed costs either through conventional taxation or through user fees, are part of the problem and not the solution. How can these problems be tackled?

One promising approach has hardly been discussed so far: this is the application of value capture schemes and the application of the George-Hotelling-Vickrey theorem (the ‘golden rule of local public finance’, subsequently the ‘GHV theorem’). The rationale of this scheme is to tap land rents in order to reduce the burden of the mobile factors of production, which are ‘labor’ and ‘capital’. Land rents are differential rents, which emerge due to locational advantages, advantages in the intensity of use or advantages in the quality of the site. In particular, the dimension of urban location rent depends on the transportation costs, the density and the radius of

an agglomeration (Geltner et al., 2007: 65). The basic features of the GHV theorem are illustrated in a simplified form in Figure 3.

Figure 3: GHV theorem (simplified version, author's table)

National income				
Composition		**Distribution**		**Features**
Private goods and services	⇔	Wages (labor) Interest (capital)	⇔	Costs
Public goods and services (mainly fixed costs)	⇔	Location rents	⇔	**Social surplus** (residual)

National income contains private as well as public goods and services (see the first column of Figure 3, 'Composition'). Moreover, the prices of all goods and services contain remuneration for the factors of production, which are the mobile factors 'labor' and 'capital' as well as the immobile factor 'land' (see the second column of Figure 3, 'Distribution'). However, the illustration shows that wages and interest are costs—from a macro-economic point of view. They have to be currently reproduced, with the corresponding input of resources. Location rents, by contrast, have a different character. At first glance, they are not costs but a residual. They remain after the costs of labor and capital are paid out of the earned income. This is not a new idea: in the sense of the old economic school of Physiocracy (N.N., 2013), location rents might be interpreted as 'social surplus' (see the third column of Figure 3, 'Features') (Dwyer, 2014: 683).

The GHV theorem has been developed in different variations (e.g., Arnott and Stiglitz, 1979; Atkinson and Stiglitz, 1987; Fu, 2005). One important version considers the municipalities as competing developers who are trying to maximise the social surplus (e.g., Vickrey, 1977). By analogy to the optimal operational sise of a company, each city tries to find the optimal number of inhabitants in order to optimise the provision of the public good, which includes technical as well as social infrastructure services. Like in a producer cooperative, the inhabitants might be considered at the same time as the owners of the 'company' and the consumers of its output. The GHV theorem proves to be quite robust regarding changing the assumptions of the original models (Kirn, 2010: 72).

Figure 3 also illustrates that, at least to a high degree, location rents are not created by the efforts of the landowners. According to Alfred Marshall (1947: 794–804; Gaffney, 1994: 50), besides the forces of nature, spillovers also have to be taken into account, as well as—most importantly—public works, which are mainly infrastructure.[5] This is why land rents and land values in private hands are the result of external effects. In particular, they are created directly or indirectly (e.g., agglomeration of the skilled workforce) by the supply of public goods and services. However, the GHV theorem might be also interpreted the other way round: Under certain conditions, the fixed costs of public services might be covered by the location rents (Arnott and Stiglitz, 1979). Note also that within the GHV theorem, the marginal costs of public goods basically require coverage by user fees. In contrast, conventional taxation socialises income and values that have been created by private actors. This is the precondition for privatising income and values that have been

[5] This also holds true even though the owner of a site may have paid a purchase price to the previous owner of the land (this historical price may differ completely from the present value, by the way).

created by the public—the location rent. Full cost user fees are also paid in favour of the private beneficiaries of land rents.

Conventional taxation—and also full cost pricing of infrastructure services—disconnects this relationship between the fixed costs of public goods and services and the location rents provided by the GHV theorem. In the same way as the decoupling of benefits and costs (external effects) causes market failure in the private sector, the decoupling of government revenues and expenditure is an important reason for state failure. The basic idea of the GHV theorem is to reestablish this connection.

As explained above, due to the ATCOR and EBCOR effects, conventional taxation reduces the social surplus. If, instead, conventional taxes are reduced in favour of a higher tapping of the location rents (a 'tax shift'), the social surplus may even rise. This idea can also be traced back to Physiocracy (Dwyer, 2014: 752). If located in the right place, infrastructure facilities cause a higher productivity of the regional economy. They increase the ground rents and also the value of the land. For instance, the land value in residential areas is normally higher if facilities such as schools and kindergartens are also available. Land rents and land values are also higher if a public transport station is close by. These land rents could be skimmed off without doing any harm to the economy. They could be used to finance the fixed costs of these facilities.

According to the GHV theorem, under specific conditions the fixed costs of infrastructure could be covered completely by land rents—which are created by the provision of infrastructure. This is the principle of self-funding infrastructure (Harrison, 2006). In doing so, infrastructure services could be provided at marginal cost prices. The methods of choice are a land value tax or public ground leases, if they are designed in a sensible way.

Additionally, taxing land is also compatible with the abovementioned Ramsey pricing. Moreover, the Ramsey rule leads straight to the land value tax (Gaffney, 2009: 375–76). However, in contrast to the common perceptions in textbooks, the Ramsey rule refers not only to demand, but also to supply (Stiglitz, 1986,: 403–04). A.C. Pigou, Ramsey's mentor, commented on the Ramsey rule as follows:

> By analogous reasoning it can be shown that, when one source of production yields an absolutely inelastic supply, […] a given revenue can be raised with less sacrifice by concentrating taxation upon this use than by imposing uniform rates of tax on all uses […] If there is any commodity for which either the demand or the supply is absolutely inelastic, the formula implies that the rate of tax imposed on every other commodity must be nil, i.e. that the whole of the revenue wanted must be raised on that commodity. (Pigou, 1928: 105–08)

At least in case of strict land use planning, the supply of land is absolutely inelastic. For this reason, too, Ramsey pricing of infrastructure users (demand side), as discussed above in section 3.1, is an inferior solution.

Hence, a favourable way for a municipality would be to levy a rate on land values to pay for network construction and capital maintenance costs by tender, and then to offer the market by tender at the lowest costs for servicing it according to pre-defined standards. In doing so, private operators might also be involved (public-private partnership; see Laurent, 2005: 211). Land rates would service the capital costs, whereas user charges on throughput would be priced merely at marginal costs (e.g., operational costs plus the wholesale price of the energy, which might be gas, bought at the transmission connection; see Hotelling, 1938; Vickrey, 1977).

Of course, most countries don't provide the legal framework required in order to step forward in this direction. However, by using public companies, important steps in the right direction could be made. In Germany, for instance, municipalities have recognised that some infrastructure facilities (such as public swimming pools) may

only be provided at reasonable costs if they are subsidised by rent-creating activities, such as municipal energy supply (*kommunaler Querverbund*, or multi-utility concept).

5. A Business Model Based on Ground Lease

Without comprehensive fiscal reform, the opportunity of value capture could be seized by public corporations instead of private actors. This is an important modification of the abovementioned multi-utility concept, which was applied in Medieval Europe, e.g., in order to finance bridges—an extremely expensive enterprise to maintain:

> It was normal for a toll to be levied from those using such a bridge, and sometimes as at the Pont St Esprit, from those using the river under it, to help pay for its upkeep and repair. However, tolls by themselves were not adequate to maintain a bridge. Those who planned to build one did not simply have to look for enough funds to build it in the first place, but for an adequate permanent endowment in land. The first years' rents from the bridge's lands paid for the initial building. The fact that the Pont St Esprit and its associated works took forty years to complete was not because medieval masons could not work any faster, but because it needed forty years' income to pay them. The endowment was then intended to pay for the maintenance of the fabric, of the brotherhood and of their chapel. (Spufford, 2002: 177–78)

A modern equivalent to the medieval 'bridge financing' model is the striking example of 'value capture' implemented by Hong Kong's mass transit rail corporation (MTR), a private operator with a majority stake held by the Hong Kong government. Just as medieval bridge operators had endowments of land to establish a sustainable revenue source, MTR owns properties in Hong Kong whose value appreciates as a result of the extension of the transit network. MTR is involved in designing the land use plans; the increase in land values is also a result of high-quality stations, which are seamlessly integrated with surrounding activities. The planning is done as a form of transit oriented development (TOD), which is widely considered to be one of the

most sustainable forms of urban development (Cervero and Murakami, 2008, pp. 19–21).

As a result, MTR is hugely profitable, unlike most mass transit systems in the world. In 2014 and 2015, for instance, MTR realised an operating profit of more than HK $19 billion, of which revenues from property development, rental and management and station commercial businesses represented over 50 percent (www.mtr.com.hk). Since MTR owns the buildings close to the stations of the railway line, the land rents cover huge shares of the fixed costs. This is why MTR can offer low ticket prices, which are geared to the marginal costs. How can such a model be implemented? In every country, the legal conditions are different. However, some general economic guidelines are provided below.

5.1. Where to Apply the Model

Although the MTR model seems to be appealing, there are also economic restrictions to be taken into consideration, which arise as a consequence of the GHV theorem (see Figure 3). The higher the conventional taxation, the higher the hurdle for such a model to overcome. Higher taxation means higher costs for the construction of infrastructure facilities, mainly due to labor-related side costs (payroll tax, social insurance contributions) and possibly also to VAT. Due to conventional taxation, the impacts of infrastructure investments on land rents are smaller than in the ideal GHV world. Particularly in remote areas (spatial periphery), the increased land rents and land values caused by infrastructure are mostly unable to cover the costs of infrastructure. For instance, in a high-tax country such as Germany, measures of urban restructuring, which are often made in order to overcome deficits in the infrastructure of declining cities, can only be covered by an average extent of less than 9 percent by value capture (Interior Ministry of Rhineland Palatinate, 2009: 13).

For this reason, in a world with conventional taxation, only a selective application of the model makes sense: in agglomerations (spatial centers) with a high population density and urgently needed infrastructure. In such central places, comparatively more rents and land value can be created with a given amount of infrastructure capital as compared to a remote place. Value capture is best done here. Each infrastructure project established in this way helps to save tax money and makes cuts of ordinary taxes possible.

However, this model faces a serious problem: Particularly in dense agglomerations, most of the land is used already and covered with buildings. In most cases, it is also in private hands. This is why strategies have to be created to transfer the ownership of the land into public hands.

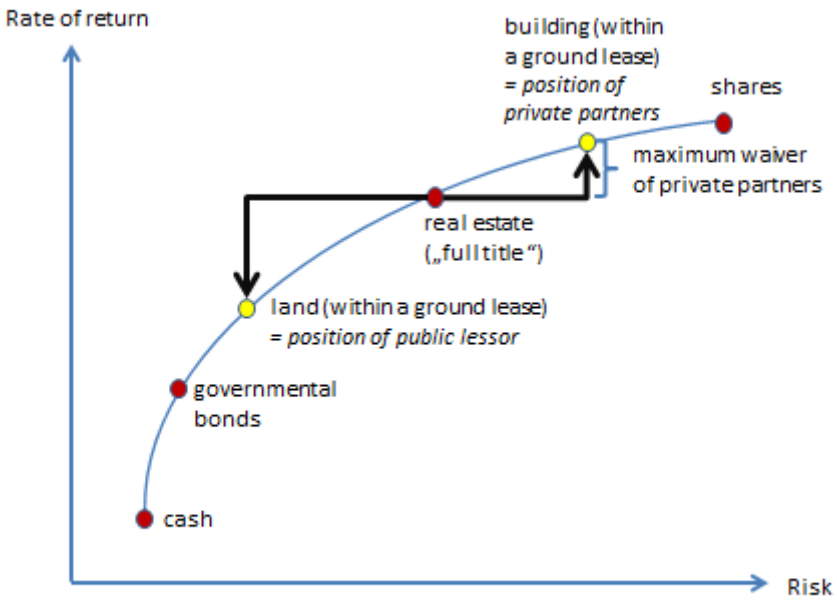
5.2. How to Get the Land

MTR benefitted from land grants by the Hong Kong government. By analogy, a state-owned railway company could receive rights, for instance to use the land under a city area for a subway. However, the legal possibilities to do so differ from country to country.

Generally, it appears even more difficult to obtain ownership of the aboveground areas. However, in contrast to the MTR model, it is not necessary that the public company owns both the land and the buildings. The most important aspect relates to the rights to the land itself, with a suitable land use plan as a further precondition (if possible, oriented toward TOD). That’s because infrastructure facilities don’t increase the value of the buildings but of the locations. Thus, getting the ownership of the relevant land is sufficient in order to pursue a value capture strategy. In doing so, the public company also may save capital, which can be used to scale up the model.

However, what does an appropriate strategy to get the land without buying the buildings look like? The land acquisition could be done by using a buy-and-leaseback scheme. Developed land (with a building on it) should be bought for a ‘before infrastructure’ price. For instance, a railway extension or a metro station should only be offered if a certain percentage of the owners around the station are willing to sell the land to the public company. Afterwards, the land is leased back to the former owner in a ground lease arrangement. Hence, the former owner of the land only owns the building and not the land anymore. But why would the owner of the land agree? The owner of a house without land faces a higher risk and therefore has higher return requirements than an owner of ‘full property’ real estate. Thus, the owner of the real estate needs his returns to be ‘subsidised’ in order to be in the same position as before (see Figure 4 below).

Figure 4: Change of the risk/return profile via ‘unbundling’



However, the public company may do so, and may even subsidise the return requirements of the building owners without making losses. It may apply a similar business model to some institutional investors. Let's take for instance Continuum Capital in Germany (http://www.continuum-capital.de/).[6] The business model of Continuum Capital is also based on sale-and-leaseback: Continuum Capital buys the land from the owner of the property and issues a ground lease to the former owner. In doing so, Continuum Capital even pays a surcharge on the market price of the land, which may be some 50 percent of the market value! Continuum Capital can afford that because the cash flows from ground lease have a different risk/return structure than the cash flows from 'full property' investments. The cash flows from ground leases are more comparable to the risk/return structure of a governmental bond, and even better: First, particularly against the background of the present low-interest phase, the returns from ground leases are significantly higher than those of governmental bonds. Second, due to the rules of reversion, foreclosure and the registration in the land register as a first-rank guarantee, ground leases are 'over-collateralised', at least according to German legislation. Third, due to value adjustments, cash flows from the ground lease are a good inflation hedge.[7] Finally, the administration costs are lower than with 'full property' real estate. Whereas the lessee pays a leasehold fee based on the property rate on the value of the land, Continuum Capital is discounting these cash flows at a significantly lower rate. Hence the cash flow from ground leases has a significantly higher value than the market value of the land share of the property. Subsidised by this surcharge, the owner of

[6] Presentation by M. Jung, Continuum Capital („Einsatz von Erbbaurechtsmodellen zur Optimierung des Anlageerfolgs") at the 3rd Ground Lease Congress (3. Erbbaurechtskongress) of the German Ground Lease Association (Deutscher Erbbaurechtsverband) on 22–23 February 2016 in Hanover, Germany.

[7] Here it is supposed that current leasehold fees are paid – unlike the Hong Kong model, where leasehold fees are paid up-front.

the house can keep his position on the efficiency line within the sale-and-leaseback deal (Figure 4). Regarding his risk/return position, he will not lose. In fact, the owner may even get a liquidity advantage.

It is crucial that the sale-and-leaseback deal has to be based on land values before improvement with public infrastructure. On this basis, the surcharge may be paid to the owner of the building. If the land rent and land value increases as a result of the infrastructure investment, this surplus should basically cover the fixed costs of the infrastructure (depreciation and/or amortisation of loans, interest rate). By using a ground lease scheme, it is assured that the public purse also benefits from future value gains. A similar scheme could also be provided by facilities that do not have the features of a natural monopoly, such as schools, kindergartens, etc.

5.3. Governance Aspects

The process shouldn’t be managed by the municipality but by a public-owned company. This way, decisions could be made more flexibly and according to economic needs. However, good corporate governance (with skilled people on the supervisory board) is essential.

The public company is an affiliation of the municipality. The municipality, on the other hand, can be considered as being owned by the inhabitants. Hence the relationship to the citizens is comparable to the relationship of a consumer cooperative with its owners. This is important for the capital costs, since the relationship might be considered as a cross-guarantee system. Since the inhabitants are simultaneously the owners and the consumers of infrastructure services, the risk premium in the capital costs might be significantly lower than in the usual schemes of public-private partnerships. Moreover, the public company should work in close

collusion with the planning authorities in order to achieve the benefits of a TOD-designed agglomeration.

6. Conclusion

I have demonstrated that the problems of funding grid-bounded infrastructure emerge particularly with regard to covering the high share of fixed costs. At present, they are covered either by conventional taxation or by user fees. This is why the desirable marginal cost pricing of public infrastructure services is hardly possible at present.

This problem could be solved on the basis of the George-Hotelling-Vickrey theorem, which leads to the concept of self-financing infrastructure: Infrastructure increases the land rents and land values. This appreciation might be sufficient in order to fund the infrastructure. The method of choice is a land value tax in combination with other tools to skim off the rents of natural resources.

If such a radical policy shift is not feasible, a single municipality could also step forward by using public companies. The crux is not only to provide infrastructure services, but also to work as a real estate company and to integrate the project into a reasonable planning scheme. Such projects could be fostered by public land grants (e.g., for subways), if this is legally possible. Moreover, sustainable value capture could be achieved by sensibly designed ground leases. Particularly in high-tax states, the applicability of such a value capture model is limited, since the effects of infrastructure investments on land rents are dampened. However, such a ground lease value capture model should work, at least within spatial centers and urgently needed infrastructure facilities.

Dirk Löhr
Professor for Taxation and Ecological Economics at the Trier University of Applied Sciences, Environmental Campus Birkenfeld, Germany

References

Arnott, R. J., and J. E. Stiglitz. (1979). Aggregate Land Rents, Expenditure on Public Goods, and Optimal City Size. *Quarterly Journal of Economics*, 93, 471–500.

Atkinson, A. B., and J. E. Stiglitz. (1987). *Lectures on Public Economics.* London: McGraw-Hill.

Boiteux, M. (1960). Peak-Load Pricing. *The Journal of Business*, 33, 157–179.

Brabänder, F., C. Kammlott, and D. Schiereck. (2015). Zum langfristigen Erfolg der Investitionspolitik kommunaler Energieversorgungsunternehmen im Zuge der Energiewende. *Zeitschrift für öffentliche und gemeinwirtschaftliche Unternehmen*, 38, 278–300.

Cervero, R., and J. Murakami. (2008). Rail + Property Development: A Model of Sustainable Transit Finance and Urbanism. Working paper, UC Berkeley Center for Future Urban Transport. Available at: http://www.its.berkeley.edu/sites/default/files/publications/UCB/2008/VWP/UCB-ITS-VWP-2008-5.pdf.

Cullmann, A., M. Nieswand, M., C. Stiel, and M. Zschille. (2016). Kommunale Energie- und Wasserversorgung im Fokus. *DIW Wochenbericht*, 20, 448–53. Available at: https://www.diw.de/documents/publikationen/73/diw_01.c.533987.de/16-20.pdf.

Demsetz, H. (1968). Why Regulate Utilities? *Journal of Law and Economics*, 11, 55–66.

Dwyer, T. (2014). Taxation: The Lost History. *The American Journal of Economics and Sociology*, Annual Supplement, 73, 664–988.

Foldvary, F. (2012, June 30). Why Rent Matters: The Hidden and Suppressed Economic Rent. WEAI Conference, San Francisco; Taxes I session. Available at: http://studylib.net/doc/7444415/rent-wea-12.

Fu, S. (2005). Essays on Urban Agglomeration Economies. Ph.D. Dissertation, Boston College, Massachusetts, USA.

Gaffney, M. (1994). Land as a Distinctive Factor of Production. In N. Tideman, (Ed.), *Land and Taxation* (39–102). Shepheard-Walwyn: London.

Gaffney, M. (2009). The Hidden Taxable Capacity of Land: Enough and to Spare. *International Journal of Social Economics*, 36, 328–411.

Ganelli, G., and J. Tervala. (2015). The Welfare Multiplier of Public Infrastructure Investment. IMF Working Paper WP/16/40, February. Available at: https://www.imf.org/external/pubs/ft/wp/2016/wp1640.pdf.

Geltner, D.M., N.G. Miller, J. Clayton, and P. Eichholtz. (2007). *Commercial Real Estate*. Mason, OH: Cengage Learning.

Harrison, F. (2006). *Wheels of Fortune – Self-funding Infrastructure and the Free Market Case for a Land Tax*. London: The Institute of Economic Affairs.

Hatcher, W. (2013). The Importance of Infrastructure. Available at: http://patimes.org/importance-infrastructure/.

Hotelling, H. (1938). The General Welfare in Relation to Problems of Taxation and of Railway and Utility Rates. *Econometrica*, 6, 242–69.

Interior Ministry of Rhineland Palatinate (Germany). (2009). Ausgleichsbeiträge in Sanierungsgebieten. Mainz, Germany.

IW Köln. (2014). Infrastruktur zwischen Standortvorteil und Investitionsbedarf. Cologne, Germany. Available at: http://www.iwkoeln.de/wissenschaft/veranstaltungen/beitrag/pressekonferenz-infrastruktur-zwischen-standortvorteil-u nd-investitionsbedarf-145161.

Kirn, T. (2010). Anreizwirkungen von Finanzausgleichssystemen. Ph.D. Dissertation, University Potsdam. Frankfurt: Peter Lang Verlag.

Laffer, A. B. (2004). The Laffer Curve: Past, Present, and Future. *Backgrounder*, 1765. Available at: http://www.heritage.org/research/reports/2004/06/the-laffer-curve-past-present-and-future

Laurent, J. (2005). *Henry George's Legacy in Economic Thought*. Cheltenham/Northhampton: Edward Elgar.

Loehr, D. (2016). Sustainable Public Finance: Double Neutrality Instead of Double Dividend. *Journal of Environmental Protection*, 7, 145–59. Available at: http://www.scirp.org/journal/PaperInformation.aspx?PaperID=63326.

Marshall, A. (1947). *Principles of Economics*. 8th ed. London: Macmillan.

Möllinger, C. (2009). Eigentumsrechtliche Entflechtung von Übertragungsnetzen. Frankfurt: Peter Lang.

N.N. (2013, October 11). Who Were the Physiocrats? *The Economist*. Available at: http://www.economist.com/blogs/freeexchange/2013/10/economic-history-0.

OECD. (2015). Taxing Wages 2015 – Germany. Available at: http://www.oecd.org/germany/taxing-wages-germany.pdf.

Pawlowski, L. (2009). Der Preis des Wassersparens. KAKorrespondenz Abwasser, Abfall, 56, 287–91.

Peneder, M. (1996). Wettbewerb und Regulierung netzgebundener Infrastrukturleistungen: Telekommunikation, Energieversorgung und Schienenverkehr. *Wirtschaft und Gesellschaft*, 22, 213–29.

Pigou, A.C. (1928/1947). *A Study in Public Finance*. 3rd ed. London: Macmillan.

Plumer, B. (2013, March 19). America's Infrastructure gets a D+. That's not as bad as it sounds. The Washington Post (Wonkblog). Available at: https://www.washingtonpost.com/news/wonk/wp/2013/03/19/good-news-americas-infrastructure-is-now-5-percent-less-shoddy/.

Ramsey, F. (1927). A Contribution to the Theory of Taxation. *The Economic Journal*, 37, 47–61.

Riley, D. (2001). *Taken for a Ride*. London: Centre for Land Policy Studies.

Spufford, P. (2002). *Power and Profit: The Merchant in Medieval Europe*. New York: Thames & Hudson.

Stiglitz, J. E. (1986). *Economics of the Public Sector*. New York: W.W. Norton & Company.

Thiemeyer, T. (1964). *Grenzkostenpreise bei öffentlichen Unternehmen*. Wiesbaden: Springer Fachmedien.

UN. (2016). Sustainable Development Goals, Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation. Available at: http://www.un.org/sustainabledevelopment/infrastructure-industrialization/.

Vickrey, W. (1948). Some Objections to Marginal-Cost Pricing. *The Journal of Political Economy*, 56, 218–38.

Vickrey, W. (1977). The City as a Firm. In M.S. Feldstein et al. (Eds.), The Economics of Public Services: Proceedings of a Conference Held by the International Economic Association at Turin, Italy (334–43). London: Macmillan.