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### Financing Methods for High-Speed Rail with Application to Portugal

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# **FINANCING METHODS FOR HIGH-SPEED RAIL WITH APPLICATION TO PORTUGAL**

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## ABSTRACT

High-Speed Rail (HSR) is of substantial and growing interest around the world. The European Union (EU) sees it as an integrating force; China is investing at an extraordinary level and even the U.S. is trying to move forward. Although HSR is expected to shrink the temporal distance between cities, reshape the travel patterns of people toward—we hope—environmentally-friendly ones, create an image effect for the country building it, promote regional economics, etc., HSR is an expensive alternative. It is more capital intensive than other transportation projects in both unit cost (the cost per lane or track km) and total cost. On the other hand, HSR can aid in the formations of megaregions with the potential for economic growth.

This paper discusses the cost characteristics of HSR, analyzes HSR's potential economic influence on megaregions, and identifies megaregion-related revenues that can make HSR more financially viable: specifically, we discuss the use of value capture mechanisms to capture the megaregion economic benefits of HSR in order to finance such systems.<sup>1</sup>

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<sup>1</sup> Related topics, such as crowding out effect of HSR investments, difference between financing HSR and other transportation projects, and innovative financing methods for HSR investments are discussed in Huang, Teng. 2011. Financial Impacts of and Financing Methods for High-Speed Rail in Portugal. Master of Science in Transportation Thesis, MIT, Cambridge, MA.

## 1. PREFACE

The research supporting this paper was conducted as part of the MIT-Portugal Program (MPP). When initially undertaken, HSR was viewed as a viable alternative for the nation of Portugal, both as a domestic system to promote national integration and as part of the TENT-T network intended to integrate the EU. As this is being written, Portugal is experiencing enormous economic difficulties and has asked for a “bailout” from the EU and the IMF. The government has changed and it is unlikely that HSR will proceed in the next several years. RAVE, the organization charged with planning the HSR system in Portugal was eliminated in July 2011. Nonetheless, the research has collected and synthesized a number of approaches to financing HSR investments in Portugal and other nations as well that can be of value, now and in the future, when the economic climate improves.

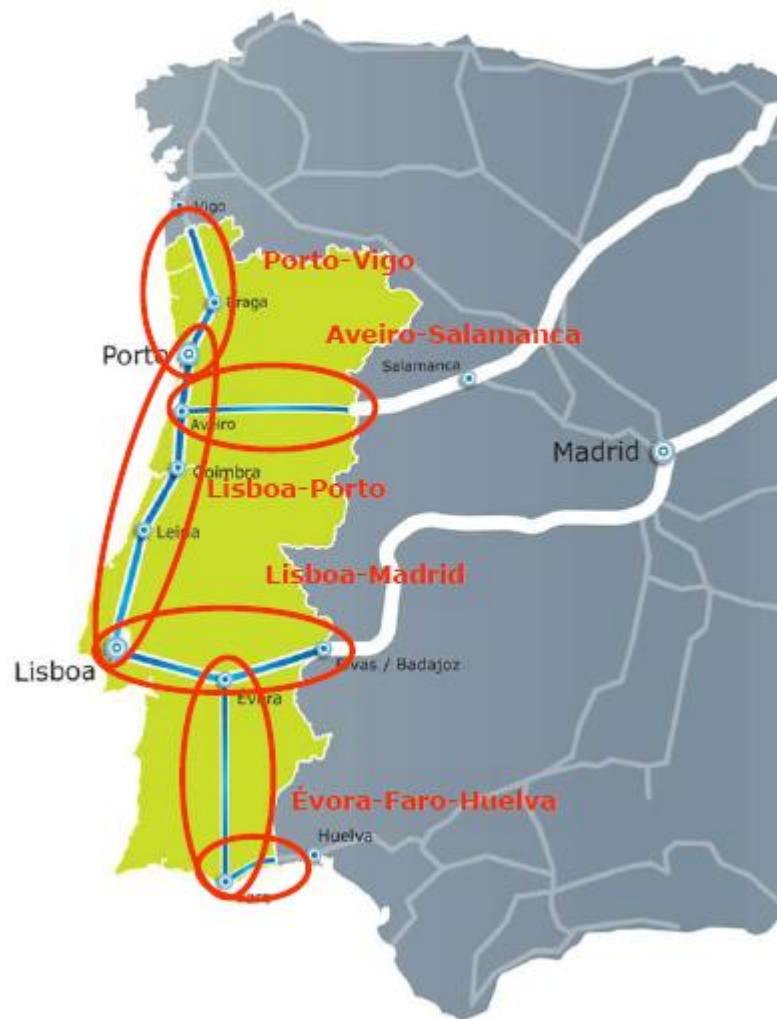
## 2. INTRODUCTION

### High-Speed Rail (HSR) in Portugal

HSR has been used by the EU to promote the integration of Europe. The EU is “developing the most efficient and integrated High-Speed Rail network of the world and it is promoting a rail corridor with preference for freight.” The total length of the Trans-European Transport Network (TEN-T) is “30,000 km, out of which 20, 000 km are expected to be in operation by the year 2020” (1).

Portugal has an ambitious plan for its HSR system, although in the current economic climate, its plans are on hold. It plans to invest in five HSR lines, as parts of the TEN-T network in Europe in the future: Lisbon-Madrid (2013), Lisbon-Oporto (2015), Oporto-Vigo (2013), Aveiro-Salamanca, and Évora-Faro-Huelva (2). The map of the planned Portuguese HSR is illustrated in Figure 1. Portugal has finished financing the Poceirao-Caia HSR project, its first HSR project and part of the Lisbon-Madrid HSR line (3). (Again, economic conditions will delay the construction of this line, to the great consternation of Spain which has already made a major investment in its portion of this international link) Within these planned HSR lines, the Lisbon-Madrid and Aveiro-Salamanca lines, or the East-West lines, are supposed to link Portugal to Spain, while the others are planned to serve the economic development of Portugal itself.

Figure 1 Planned High-Speed Rail Investments in Portugal



Source: RAVE.2008. The Portuguese High-Speed Rail Project: General Overview and Status of the Project. RAVE's Presentation. Lisbon, Portugal. September, 2008.

### Motivation for High-Speed Rail investments in Portugal

According to (4), HSR is becoming more important and popular in the world because “roads and airports become more congested and greenhouse gas levels increase.” They expect HSR to “reshape the travel patterns and activities of people and consequently changing the ways cities develop.” Based on their studies, capacity increase of transportation infrastructure, provision of an environmentally friendly transportation alternative, and promotion of regional economic development are all important motivations for HSR investments (4).

In addition, the building of HSR may also creates an image effect and help promote the reputation of a country. According to (5), the pioneer in HSR which is the Japanese Shinkansen “has also had an image effect, further strengthening the image of Japan as a nation of precision and reliability, not just one of cherry blossoms” (5). In addition, after the earthquake and tsunami crisis on March 11<sup>th</sup>, 2011, the reopening of the Shinkansen service from Tokyo to Sendai on April 25<sup>th</sup>, 2011 may have a symbolic

effect for Japanese people, increasing their confidence in the railways and the country and the government (6 and 7).

The motivations for Portuguese HSR investments are stated by RAVE as “enable a modern, sustainable and efficient transport system; reduce the country’s peripheral position, by connecting Portugal to Europe; contribute to the Atlantic south-west front competitiveness; accelerate the country’s economical and technological development, also at the regional level; contribute to a better modal distribution, both for passenger and freight, changing the actual hegemony of road solutions; and increase mobility and competitiveness of the port, airport and logistics systems” (8).

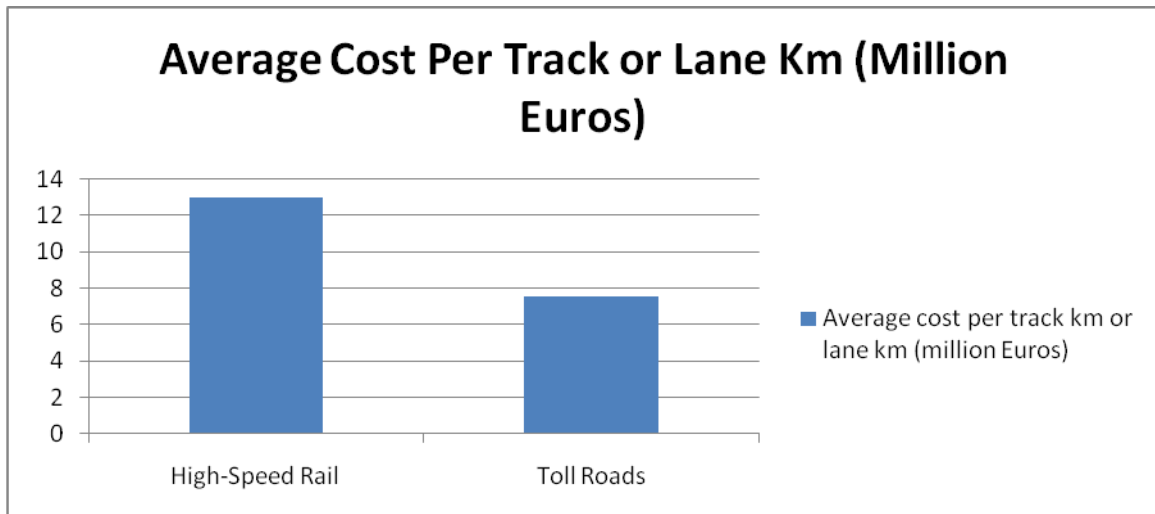
In addition, based on the analysis conducted by RAVE, the building of Lisbon-Porto, Lisbon-Madrid and Porto-Vigo HSR lines can greatly promote regional economic development: long run increases in permanent jobs are expected to reach 56 thousand ; long run GDP is expected to increase by 121 billion Euros, approximately 50% of the estimated GDP in 2010; tax revenues are expected to achieve cumulative increase of 64 million Euros. Furthermore, the building of Portuguese HSR network is projected to bring a positive effect in all regions, promote greater social and economic cohesion between regions, and help Portugal connect more closely to other countries in Europe by integrating in the TEN-T network (2).

However, at the same time, HSR is more capital intensive than other transportation projects in both unit cost (the cost per lane km) and total cost (the details are discussed in Section 2). In order to make Portuguese HSR projects more financially viable, it is important to analyze HSR’s economic impacts on megaregions and identify additional revenues to help finance it, based on its economic impacts (the details are discussed in Section 3 and 4).

### **3. COST CHARACTERISTICS OF HIGH-SPEED RAIL INVESTMENTS**

As illustrated in Figure 2, the average unit cost of HSR infrastructure is about 13 million Euros per track-kilometer, whereas the average unit cost of toll road infrastructure is only about 7 million Euros per lane-kilometer. In addition, the unit cost of one HSR project can vary significantly. For example, the unit cost of the Hokuriku Shinkansen in Japan, is 4 times higher than the unit cost of the Spanish HSR line between Madrid and L érida because of major local topographic differences (9). In addition to the infrastructure costs, rolling stock and signal and communication system are also very expensive.

Figure 2 Cost Comparison of HSR and Toll Roads



Source: FitchRating. 2010. High-Speed Rail Projects: Large, Varied and Complex. Retrieved March, 2011 from [www.fitchratings.com](http://www.fitchratings.com)

According to (9), the total capital costs of HSR projects usually exceed 1 billion Euros, or 1.5 billion USD primarily due to the long distance nature of HSR projects. Therefore, infrastructures costs of HSR investments account for a larger portion of total costs than infrastructure costs of other transportation projects.

In Portugal, the total construction investment for the Poveirao-Caia HSR project is estimated at about 1.359 billion Euros and the life cycle costs of this project are 1.814 billion Euros when discounting all the cash flow back to 2008 using a discount rate of 6.08%.(3).

## 4. HIGH-SPEED RAIL AND MEGAREGION ECONOMIC DEVELOPMENT

### Overview of HSR and Megaregions

HSR has the potential to create a megaregion in Portugal As discussed in Section 1 *Introduction*, HSR can greatly impact economic development on a megaregion scale (e.g. Lisbon-Porto corridor).

Megaregions are defined by Regional Plan Association (2006) as “agglomerations of metropolitan regions with integrated labor markets, infrastructure, and land use systems”, and are defined by Ross (2009) as “network of metropolitan centers and their surrounding areas. They are spatially and functionally linked through environmental, economic, and infrastructure interactions.” (10)

High-Speed Rail may contribute to the formation of megaregions, help integrate both the labor and consumer markets, provide opportunities for larger agglomeration of economic activities, and but also may cause unbalanced growth within the megaregions.

According to (11), “HSR links together many cities and, hence, creates a new type of region or corridor with a high interregional accessibility... cities that are linked together into a band of cities by means of a High-Speed Train connection are transformed to an extended functional region or in other

words an integrated corridor economy.” According to (12), “railway systems have achieved an extraordinary renaissance in the form of High-Speed Trains.... (HSR) shrink geographical space, and thus tie not only half of Britain, but also much of Europe, into a single polycentric Megalopolis.” According to (13), HSR results in the further concentration and centralization of most economic activities in already developed areas.

According to (14), the megaregion developments in response to the connection to HSR networks are supposed to focus on specific development areas. (15) classifies these development areas into “primary, secondary and tertiary development zones” based on their accessibility to and from HSR stations. The details of these development zones are illustrated in Table 1. In the primary development zone, “high-grade office and residential functions can be established and where relatively high increases in land and real estate values are expected.” In the second development zone, the increase in population density and real estate values will be much lower than that in the primary zone. The tertiary development zone is not able to show any direct development effect resulting from the connection to the HSR network, although it can benefit somewhat from better accessibility.

**Table 1 Development Zones in Response to the Connection to HSR Networks**

	<b>Primary development zone</b>	<b>Secondary development zone</b>	<b>Tertiary development zone</b>
<b>Accessibility to and from the HST-station</b>	Direct, 5-10 minutes, on foot or by a transport mode	Indirect, <15 minutes, via complementary transport modes (incl. travel and change time)	Indirect, >15 minutes, via complementary transport modes (incl. travel and change time)
<b>Location potential</b>	Location for high-grade (inter)national functions	Secondary location for high-grade functions. Specialized functions related to specific location (cluster)	Variety of functions depending on specific location factors
<b>Building density</b>	Very high	High	Depending on specific situation
<b>Development dynamism</b>	Very high	High	Modest

Source: (15)

### **The Japanese Shinkansen’s Economic Influence on Megaregions**

Japan’s Shinkansen significantly promote the economic development in megaregions: “Regions served by the Shinkansen generally have higher population and employment growth rates than those without direct Shinkansen service” (5). The average annual growth rates of employments are 1.8 percent in cities with Shinkansen stations and 1.3 percent in their neighboring cities without Shinkansen stations (5).

The promotion effect is more significant in some industries, such as “information exchange industries”: according to (5), the employment growth rates of information exchange industries are 22% in cities with both Shinkansen and expressway and 7% in cities with expressway only. The details of the employment growth of information exchange industries are illustrated in Table 2.



**Table 2 The Employment Growth Rates of Information Exchange Industries (1981-1985)**

	Shinkansen Expressway (%)	& Expressway Only (%)
Business Service (total)	42	12
Information, Investigation, Advertising Services	125	63
R&D and Higher Education	27	21
Political Institutes	20	11
Other	57	28
Banking Services	27	28
Real Estate Agencies	21	3
Total	22	7

Source: (5)

In addition, this promotion effect is also very significant in hotel and food sectors. According to (16), the food and hotel sectors along the Sanyo Shinkansen had also experienced high growth in the 1970s: in Hakata, the terminal of the Sanyo line, the total number of hotels and rooms increased from 20 and 2,060 in 1972 to 40 and 5,320 in 1974 respectively, the year before the Sanyo Line reached there. In Okayama, midway on the Sanyo line, the total number of hotel guests grew from 170,000 in 1971 to 236,000 in 1975, the year when the Sanyo line reached there.

Furthermore, according to (5), Nakaraura and Ueda (1989) found that land value of the commercial areas grew 67 percent after connection to the Shinkansen network. However, this argument was questioned by (5) who considered this figure to be too large.

### **The French TGV's Economic Influence on Megaregions**

The French TGV contributes significantly to the increase of the total business travel on the Paris-Lyon corridor, especially those trips made for sale/purchase of services (4). However, the benefits of economic development due to the building of the Paris-Lyon TGV are not distributed equally between Paris and Lyon: Paris has captured most of the economic development benefits because of the spatial concentration of population there. Lyon also gains some economic benefits, mainly "in the form of an increase in economic cooperation and exchanges with Paris" (4).

According to (5), three years after the launch of the TGV Atlantic (Paris-Le Mans), real estate values and transactions in several communities with stations had experienced significant growth. In Nantes, the connection to the TGV network "has spurred a major redevelopment project near the station as well as helped to produce a 20 percent rent premium on space in the redevelopment area" (5).

### **The German ICE's Economic Influence on Megaregions**

One year since the building of the Hanover-Würzburg ICE and the Kassei-Wilhelmshöhe station, the business of office, retail, and hotel sectors around the Kassei-Wilhelmshöhe station had experience significant growth, with the rent for retail space increasing by 20 percent. In addition, a large part of land bordering the station was developed to "serve information/service sector firms requiring access to the ICE" (4).

## Summary of High-Speed Rail's Economic Influence on Megaregions

HSR's economic impact is most significant on the adjacent area of the HSR station, especially in the primary development zone, defined as areas that can be accessed within 5 or 10 minutes on foot or by a transport mode (15). In this area, we expect the increase of real estate and land values, and the prosperity of service industry, such as "information exchange industries", retail and hotel industries. The "information exchange industries" include information, investigation, advertising services; R&D and higher education; political institutes; banking services; and real estate business.

It is hard to find literature modeling and quantifying the comprehensive regional impacts of HSR. Although only (5) provides quantitative evidence that regions served by the Shinkansen generally have experienced higher population and employment growth rates than those without direct Shinkansen service, we do believe that HSR may influence the regional economic beyond the adjacent area of HSR stations but further research is needed to explicitly illustrate this effect.

## 5. VALUE CAPTURE MECHANISMS AND HIGH-SPEED RAIL FINANCING

In the analysis above, we conclude that although HSR can bring positive economic impacts, especially in the areas adjacent to the HSR station, it is really expensive to build HSR and we need additional revenues to finance HSR investments. Sources of funds to finance this investment are a vital component of any plan to deploy HSR. While in the MIT-Portugal Program research, we were primarily interested in the application of these mechanisms to Portugal, in fact, they are of more general applicability.

According to (17), there are three groups of beneficiaries in transportation investments: the unrestricted general public, restricted non-user beneficiaries (this group of people are definite as "not direct users of transportation facilities but who enjoy benefits because of their enhanced location advantages"), and direct users of transportation facilities. These authors suggest that value capture mechanisms should be used to build transportation projects that benefits restricted non-user beneficiaries.

Value capture, as one type of public financing mechanisms, captures the increase of private land or property values generated by a new public investment typically through special taxes or fees, and use the revenue to pay for that public investment or other public projects. The rationale for value capture is that increments in land or property values (or benefits due to the enhanced location advantages) are wholly or partly attributed to public investments, such as HSR and public transportation investments, instead of private investments. It is justifiable to use taxes, fees, or other fiscal mechanisms to indirectly to capture these value increments and use them to finance the public investments.

Because HSR typically brings economic benefits to the areas adjacent to HSR stations, it is justifiable to use value capture mechanisms to capture the additional, or at least part of the additional economic benefits of HSR development, and use them to finance HSR development. The value capture mechanisms based on HSR's direct economic influences can be divided into four groups: property related charges (including land charges), land development charges, employer charges, and real estate development fees. Tax increment financing, business improvement districts (BID), business rate levy, and land value tax are all property related charges; Development impact tax is a land development charge; Versement Transport is an employer charge; Land lease, and direct development are both real estate development fees. In addition, if future research can model and quantify the comprehensive regional

impacts of HSR, we can use part of consumption taxes and income taxes to help finance the HSR investments.

### Tax Increment Financing

Tax increment financing, or TIF, earmarks the increase in property tax revenues in certain districts, named TIF districts, resulting from a public investment, and use this revenue to finance that public investment or other public projects. Tax increment financing is a property related charge and can be used to cover both the capital costs and operating costs of public investments, e.g., HSR investments (18).

The advantage of TIF is that there is no need to increase the current property tax rate or introduce new tax. Effectively capturing the HSR's economic benefits—the increase of land and real estate value around HSR stations, this tax is a reasonable way for the Portuguese HSR financing. These taxes can be levied to finance Portuguese HSRs whether or not new HSR stations are built. However, at the same time, since the TIF is based on the incremental property value in the TIF district, the taxable value, or the value of tax base is low and unstable, and there is no guarantee for the financial stability<sup>2</sup> for this policy.

### Business Improvement District (BID)/Special Assessment District (SAD)

Business improvement districts (BID)<sup>3</sup> is a defined area within which an additional tax or fee is raised to fund public infrastructure projects within the district's boundaries. Similar to the additional tax or fee in the business improvement district, “special assessment” is the charge levied in a defined geographic area known as a Special Assessment District (SAD). Business improvement district tax and special assessment are both property related charges and can be used to cover both the capital costs and operation costs of public investments, e.g., HSR investments (18). It should also be noted that special assessments are not *ad valorem* taxes<sup>4</sup>: the most important principal of SA is proportionality. The tax burden is spread across all properties within the SADs or BIDs in proportion with the direct benefit the property received from the public improvement (19). Therefore, the vacant land or property in the SADs and BIDs will be taxed the same as well developed land or property in the same spot, providing clear incentives for further development in the SADs and BIDs.

### Business Rate Levy

Business rate levy is similar to the business improvement district tax and special assessment. The only two differences between them are: first business rate levy is tax on local level instead of the level of business improvement district; second this business rate levy focuses more on non-residential properties. This business rate levy has been used to help finance London Crossrail (18).

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<sup>2</sup> Financial stability here is referred as the ability of the policy to generate stable and enough revenue for HSR development.

<sup>3</sup> The scale of Business Development District is generally smaller than local, or municipal scale.

<sup>4</sup> The definition of the *ad valorem* tax (Latin for according to value) is in *List of Definition*. Source: Wikipedia. 2011. Special assessment tax. Retrieved March, 2011 from [http://en.wikipedia.org/wiki/Special\\_assessment\\_tax](http://en.wikipedia.org/wiki/Special_assessment_tax)

## Land Value Tax

Land value tax (or site valuation tax) is “a levy on the unimproved value of land. It is an ad valorem tax on land that disregards the value of buildings, personal property and other improvements”(20). According to (21), this land value tax is the most general type of value capture policy in the world used for the provision for general public goods, including transportation networks (21). Moreover, this land value tax can be levied in different jurisdictions but is generally levied on the state level instead of the local level. For example, this tax is levied in almost all states in Australia as state taxes, and is also levied in the state of Pennsylvania in the US.

## Development Impact Tax

Development impact fees are “one-time charges collected by local governments from developers for the purpose of financing new infrastructure and services associated with new development.” Therefore, from the definition, we can see these fees are levied on the local level. Development impact taxes can be calculated using two methods. The first method is the demand-driven fee calculation, which is based on the estimated demand impact of new developments on transportation network. This method takes into account “the number of new trips generated, the average trip length, and the cost per trip based on the cost to improve the transportation system.” The second method is the improvement-based fee calculation, in which “the average cost of the trips generated by the development is determined by dividing the road (transportation system) improvements budget of a local jurisdiction by the trip generation rate for a proposed land use” (21).

## Employer Tax (Versement Transport)

According to (18), employer taxes are “taxes charging the productivity enhancements derived from increased accessibility, and allowing each firm to have larger catchment’s areas of qualified employees.” The most successful example of employer taxes in the EU or perhaps even in the world is the Versement Transport in France: this tax covered approximately 40% of the total transportation expenditure in France in 2000 (22).

According to French laws, both public and private employers hiring more than nine employees and locating within a region managed by transport authorities may be asked to pay from 0.55% to 2.2% of its total payroll as the Versement Transport. As for Ile-de-France<sup>5</sup>, the tax rates are 2.2%, 1.6%, and 1.3% in central areas, inner ring, and outer ring respectively; as for provincial cities with more than 100,000 inhabitants, the tax rates are 1.75% and 1.0% for areas with fixed track system and without fixed track system; as for provincial cities with less than 100,000 inhabitants, the tax rate is 0.55% (22).

## Land Lease

Land lease is “the most powerful tool used to intervene on the land and housing markets.” In land leases, “the government possesses the right to own, and private developers lease from the government the right to develop, use, transfer, inherit, and benefit from land.” In land leases, the government can determine the type of development rights it grants and the length of grants here (18).

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<sup>5</sup> Île-de-France is the wealthiest and most populated of the twenty-six administrative regions of France, composed mostly of the Paris metropolitan area. It is one of France's administrative regions. Source: Wikipedia. 2011. Île-de-France (region). Retrieved March, 2011 from [http://en.wikipedia.org/wiki/%C3%8Eile-de-France\\_%28region%29](http://en.wikipedia.org/wiki/%C3%8Eile-de-France_%28region%29)

The prerequisite for this land lease policy is that the government still owns the land. Otherwise, the government may have to repurchase the lands back from private owners before the public investments. In the case of Portugal, since most developed lands are owned by Portuguese people, this financing mechanism seems only to be feasible for financing HSRs when new HSR stations are built.

The advantages of leasing land close to HSR stations includes: first it can effectively internalize the increase value of land and real estate due to the building of HSR; second, it complies perfectly with the principal of “beneficiary pays”, and in our definition, it is an equitable financing method for the whole society. However, similar to the development impact tax, this land lease policy is also significantly exposed to the demand risks of new commercial and housing spaces, making corresponding revenues volatile and unstable. To use the land lease as a source of Portuguese HSR financing, we need strong and convincing evidence that Portuguese HSR can actually generate strong economic benefits near HSR station.

### Direct Development

This direct development policy is similar to the land lease policy. The only difference is that in this direct development, lands of HSR stations and some areas close to HSR stations, associated with their development rights, are given directly to HSR developers. If PPP is used as the procurement method, these HSR developers are the private sector in PPP. In the Portugal case, because PPP is highly likely to be used in the Portuguese HSR projects in the future, these land ownerships and direct development rights can be added to the bidding package in the bidding process. The direct development policy provides incentives for the private sector to develop better HSR lines, and provide better HSR services, because better HSR services can help boost businesses in HSR stations and areas close to HSR stations. In return, prosperous businesses in HSR stations and areas close to HSR stations can help increase the attractiveness of HSR compared to other transportation modes, further increasing HSR fare revenues.

Similar to the land lease policy, the prerequisite for this direct development is also that the government still owns the lands. In Portugal, since most of developed lands are owned by Portuguese people, this financing mechanism is only feasible when new HSR stations are built.

### Consumption Tax/Income Tax

A consumption tax is “a tax on spending on goods and services. The tax base of such a tax is the money spent on consumption.” The consumption taxes are usually indirect taxes<sup>6</sup>, but can also be direct taxes. For example, value added taxes and sale taxes are both indirect taxes; while expenditure tax is an indirect tax (23). An income tax is a tax levied on the income of individuals or businesses (corporations or other legal entities)” (24).

However, the prerequisite for using consumption tax or income tax as a value capture means to finance Portuguese the construction of HSR is the positive comprehensive regional impact of HSR construction. Only if further research can model and quantify the comprehensive regional impacts of HSR, consumption taxes, or income taxes, or the increase of consumption taxes and income taxes can be used as appropriate value capture mechanisms for HSR financing.

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<sup>6</sup> Direct tax is a tax paid directly to the government by people on whom it is imposed; indirect tax is a tax collected by an intermediary from people who bears the ultimate economic burden of the tax. Source: Britannica Online (2011). Retrieved June 2011 from <http://www.britannica.com/EBchecked/topic/584578/taxation>

If HSR is able to bring positive comprehensive economic benefits to megaregions that is not yet proved, these consumption tax and income tax are appropriate methods to capture these benefits because both consumption tax and income tax are directly related to the economic condition of megaregions: as the economy of megaregions becomes better, people will have higher income and usually consume more. In addition, these consumption tax and income tax should have good financial stability because of its wide tax base.

### **Value Capture for the Portuguese HSR Building**

It is important to take a close look at characteristics of different value capturing methods before we provide suggestions for Portuguese HSR financing. These characteristics are summarized in Table 3.

**Table 3 Characteristics of Different Value Capture Mechanisms**

<b>Funding methods</b>	<b>Type</b>	<b>Target</b>	<b>Scale</b>	<b>Related economic benefits</b>	<b>Primary legislation</b>	<b>Property type (if property tax)</b>	<b>Ad valorem tax (if property tax)</b>	<b>Current application</b>	<b>HSR station requirement</b>	<b>Financial Stability</b>
<b>Tax Increment Financing</b>	Property tax	Property in TIF district	TIF district	Increase of real estate price near HSR station	No	All property	Yes	United States, United Kingdom, etc.	Both new and old	Medium/low
<b>Business Development District/Special Assessment</b>	Property tax	Property in BIDs and SADs	BIDs and SADs	Increase of real estate price near HSR station	No	All property	No	United States, United Kingdom, Germany, New Zealand, etc.	Both new and old	Medium
<b>Business rate levy</b>	Property tax	Property	Local level	Increase of real estate price near HSR station	No	Mostly non-residential property	No	United Kingdom	Both new and old	Medium
<b>Land value tax</b>	Property tax	Land	Mostly state level	Increase of real estate price near HSR station	Yes	Land only	Yes	Canada, Australia, United States, etc.	Both new and old	High
<b>Development impact tax</b>	Development tax	New development	Local level	Increase of real estate and land value; Prosperity of retail, accommodation and information exchange industries near HSR stations	NA	NA	NA	United States, etc.	Only new	Medium/low <sup>7</sup>

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<sup>7</sup> Continued on next page

<b>Versement Transport</b>	Employer tax	Employer	Region managed by transportation authority, e.g., HSR authority	Increase of real estate and land value; Prosperity of retail, accommodation and information exchange industries near HSR stations	Yes	NA	NA	France	Both new and old, but prefer old	High
<b>Land lease</b>	Direct development	New development	HSR stations and areas close to HSR stations	Increase of real estate and land value; Prosperity of retail, accommodation and information exchange industries near HSR stations	No	NA	NA	Hong Kong, etc.	Only new	Medium/low
<b>Direct development</b>	Direct development	New development	HSR stations and areas close to HSR stations	Increase of real estate and land value; Prosperity of retail, accommodation and information exchange industries near HSR stations	No	NA	NA	Japan, etc.	Only new	Medium/low
<b>Consumption tax/ income tax</b>	Consumption tax/ income tax	Retail business	Nation wide	HSR's indirect economic influence on megaregions	Yes	NA	NA	All the world	Both new and old	High

Source: (25)

From Table 3, we can see no value capture mechanism is superior to the others in all aspects: some have good financial stability, but bad social equity, e.g. land value tax; some has good social equity, but bad financial stability, e.g. tax increment financing; some has good financial stability and good social equity, but requires primary legislation and may have huge public acceptance problems, e.g. Versement



Transport. Different value capture mechanisms may be chosen when different evaluation criteria are used. The only global constraint is whether new HSR stations will be built: if new HSR stations will not be built, development impact tax, land lease and direct development will probably be infeasible (25).

## 6. CONCLUSION

This paper begins by raising the concern that although HSR may increase capacity of transportation infrastructure, provide an environment friendly transportation alternative, and promote regional economic development, HSR is more capital intensive than other transportation projects (25).

To identify additional revenues for HSR building, this paper examines the relationship between HSR and megaregions. This paper concludes that HSR can bring significant economic benefits to the adjacent area of the HSR stations: HSR significantly increases the real estate or land value, and promotes the business of service industry, such as “information exchange industries”, retail and accommodation industries, near HSR stations. However, it is hard to find literature modeling and quantifying the comprehensive regional impacts of HSR (25).

We can use value capture mechanisms to capture these economic benefits in megaregions resulting from the building of Portuguese HSRs, and use these revenues to help finance the Portuguese HSR construction. Considering all financial stability, social equity, and feasibility, we find no value capture mechanisms can be superior to the others in all situations as discussed above.

The decision-making authorities of Portugal should consider the trade-off between different criteria, and choose the most appropriate ones to finance Portuguese HSR. For example, if we consider social equity (“beneficiary pays”) as the most important criterion, tax increment financing, business development district/special assessment, Versement Transport, land lease, and direct development may be chosen assuming new HSR stations will be built. If we consider financial stability as the most important criterion, land value tax, Versement Transport, consumption tax/income tax may be chosen assuming new HSR stations will be built. If we consider feasibility as the most important criterion, tax increment financing, business development district/special assessment, direct development, Land lease, and development impact tax may be chosen (25).

## 7. A CLOSING NOTE

While HSR in Portugal will certainly be delayed, perhaps for years, we hope the information assembled for this paper will have value when economic conditions can allow construction to begin. Also, we hope this compilation can be of value in other nations, currently involved in deploying HSR.

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