European Integration: Is it on track? A study of railway prices.

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Abstract

This thesis aims to investigate if there is a monetary cost associated with interstate travel by rail within the European Union and how this differs from intrastate railway travel in the Union. The paper makes use of two economic theories, Transaction cost theory and Ramsey pricing, to help explain the effect we find. A linear regression is applied to our dataset containing 1050 observations and we find a statistically significant cost attributed to interstate travel by rail within the Union. This implies that there are still barriers present limiting the Unions goal towards a single market and the free movement of goods and people. The effect we find can be explained both by differences in price elasticity of demand between consumers and the presence of different transaction costs limiting integration.

Keywords: Railway prices, Ramsey pricing, Transaction cost theory, European integration, price discrimination, interstate travel

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1. Introduction

In this chapter of the paper the main question will be presented as well as the background, the delimitations of the paper and previous research on the topic.

1.1 Background

Since the inception of the European Union, the promotion of free movement of goods, services, labour and capital has been a cornerstone of the development of the Single Market. As said in the 2nd paragraph of the 2012/34/EU Directive (European Union, 2012) the integration of the transport sector of the Union is an essential element of the completion of the internal market. In particular the railways are an important piece in the process of achieving sustainable transport within the Union.

Even though the importance of sustainability is mentioned, the integration of the European railways is primarily focused on reaching free movement of goods and people. However, the lack of interoperability and cooperation has made this development slow. Despite the efforts to allow for an open-access railway market, state-owned or controlled corporations still hold a dominant position in the market. This could be due to the fact the policy decisions and technical aspects, such as control-systems, are closely related to the state in many countries. Because of this, the European Commission has a limited ability to create and regulate a competitive railway market (European Commission, 2016).

In order to amend the problems due to interoperability, the European Commission and representatives of the rail industry have signed several memoranda, with the purpose of developing and implementing the ERTMS (European Rail Traffic Management System) as well as setting up the ERA (European Railway Agency). This to facilitate the harmonization and monitoring of the railway system as well as setting common goals in safety matters. The ERA now holds the exclusive rights to grant vehicle permissions (locomotives and wagons) for interstate operation within the Union (European Parliament, 2020).

1.2 Previous Research

Rietveld (2012) studied the barriers associated with spatial interaction in Western European border regions. It was found that the cost associated with interstate travel in these regions is dependent on several factors. Among them, the differences in fiscal policy and institutional structures as well as differences in language and culture. These broader factors are boiled down to five main reasons: *preferences, public sector regulations, institutions, information,* and *transport costs.*

Preferences mean that consumers generally prefer domestic products and services rather than foreign. This is not only true for consumers but firms as well. This is due to differences in culture, ethics and language which makes it difficult for firms in different nations to cooperate. The government is also said to prefer domestic goods when acting as the final consumer.

The *public sector regulations* address the differences in taxation and other barriers, such as the cost of getting a visa. These costs have been heavily focused on reducing in common markets such as the EU.

Institutional differences are describing the barriers caused by different institutional structures in countries. This includes the need for different certifications when introducing a foreign product, meeting specific requirements for said product and the cost associated with adapting products for use in a specific nation. A well-known example would be the difference in which side of the road one drives, between the UK and the rest of the EU.

Informational costs speak of the fact that information systems, newspapers and other informational outlets are specifically aimed at a national audience. Acquiring and translating this information produces costs in terms of time and money.

The *transportational costs* are related to the supply of transportation and communication. An extra monetary cost is produced in the lack of cooperation between domestic and international firms. Rietveld observes that the national railway companies lack cooperation and coordination which results in higher relative cost of interstate travel.

Other transportational costs associated with time, rather than money, is that domestic transportation is often developed earlier and is therefore more efficient. In the railway setting, high-speed railways are usually domestic and become international at a later stage. This means that intrastate travel is comparatively quicker. There are also costs related to transportation infrastructure. Such as railways having different voltages in different countries requiring a change of trains and carriages at the border. Another example could be that there are different gauges, also forcing changes of train set.

Rietveld analyses the border effect as a measure of flow of traffic, infrastructure supply density and traffic intensity on and off borders. Using a social welfare cost benefit analysis, Rietveld concludes that non-cooperative behaviour in governments on interstate links has a negative effect on the social welfare of both countries. This is due to the pattern of governments ignoring positive welfare spillover into a neighbouring country since the welfare gained by domestic taxpayers is the only factor measured or perhaps cared for. Then the will and purpose of investment into interstate transport infrastructure and the social welfare benefits of such investments might be overlooked. That would in turn lead to a misallocation of domestic versus international investment and therefore a less efficient and costly interstate transportation system (Rietveld, 2012).

1.3 Purpose

The two most common reasons for these citizens to engage in interstate travel are work-related and family reasons. Free movement of people, one of the cornerstones of the development of the Single Market, enables economic growth within the Union by travel and interstate shopping. Both workers and member states have potential benefits of a mobile workforce allowing for efficient matching of skills within the Unions labour market. In order to promote these potential benefits, there is demand for an efficient railway sector to enable smooth interstate travel to further develop the Single Market (European Commission, 2014). According to European Parliament (2019), given that the current free movement trend continues they estimate this to contribute to a potential 53 billion Euro GDP gain per year. The EU is implementing policy and infrastructure in order to promote the Single Railway Market. Rietveld (2012) found that there are border effects in terms of traffic density and infrastructure supply. This paper aims to examine whether these effects can be seen on the consumer prices on intra EU interstate travels as well as identifying possible reasons, using economic theory, as to why these costs exist.

1.4 Question

Is there a monetary cost associated with interstate travel by rail within the European Union? How does this differ from the cost of intrastate railway travel in the Union?

1.5 Delimitations

The data used for this paper only contain trains departing on Thursdays, on three separate dates. This was done in order to standardize the data and to some degree avoid the differences in travel patterns between weekends and weekdays. Among these differences are a shift of peak hours from AM and PM peaks on weekdays to a midday peak on the weekends (Hunt, 2005). Another delimitation is that almost (see *table 6* in Appendix) all the train trips were gathered using a single booking site, Raileurope.com. The booking site does, however, contain tickets from a large number of operators and samples were tested against the specific railway companies own sites to ensure that the pricing was the same on both sites. During the collection of the data, it was found that less than 5 percent of the trips collected contained a private railway company on some part of the journey. Since the number of private companies was negligible and the fact that only parts of the journeys were operated by these companies, it is in this paper assumed that all trips were operated by state-owned railway companies. This paper also uses only one ticket type, so to speak, a regular ticket. The tickets had different names depending on the railway company, but they provided the same services. The tickets are non-flexible, second-class tickets. The question of this paper does not focus on intermodal competition. A variable was however collected which does encompass intermodal competition in some sense, the number of flights the same day. These were collected from a single source, Expedia.com. Since it is not the focus of the paper, it was deemed to portray the existence of intermodal competition even though it does not fully encompass the matter.

Lastly, it is worth mentioning a limitation to the paper. This paper was written, collected, and produced during the Covid-19 pandemic. This is a situation that may have affected several variables in ways which are not entirely certain. Such as the number of flights, departures and so on.

2. Theory

This paper will make use of two economic theories. The Transaction cost theory and the Ramsey pricing theory.

The Transaction cost theory will primarily use the works of Oliver H. Williamson but also include the works of Ronald Coase as well as others. The theory emphasizes the costs associated with engaging in a transaction. The groundwork for the theory was presented by Ronald Coase in his 1937 paper *The Nature of the Firm* in which he argued that the main reason behind forming firms instead of acting as individuals was to be able to overcome some of these costs (Coase, 1937). The reasoning behind the application of Transaction cost theory on this particular question can be boiled down to an article in the Maastricht Treaty. In Article 3(c) of the Treaty (1992) it is said that the internal market of the EU shall be characterized by the abolition of barriers to the free movement of people, goods, services, and capital. Since the more obvious barriers such as tariffs and customs have been removed, any barrier that remains must be due to some other intangible reason. If there is a monetary barrier to interstate travel within the Union then this paper will look to the more intangible costs proposed by this theory to find an answer.

The Ramsey pricing theory is named after Frank P. Ramsey and has its foundation in the problem of optimal taxation. It was later developed by other scholars to apply to the context of state-owned enterprises who seek to maximize economic efficiency rather than profits. In order to fully understand the Ramsey pricing theory there will also be a short description of price discrimination.

2.1 Transaction cost theory

Transaction cost theory intends to shed light on the factors that cause cost, beyond the more purely quantifiable aspects of production economics, such as the factors of production (labour and capital for instance). Instead, Transaction cost theory applies a microanalytical examination of economic organization (Williamson, 1985). The originator of the theory, Ronald Coase, argues that the main reason for establishing a firm, rather than acting as an individual, is to minimize the cost of using the market's price mechanism i.e., transaction costs. The underlying reasoning is that if a firm can organize itself to produce the goods and services it requires internally then the cost of, for example, gathering information on a resource or monitoring an outside contractor can be minimized. However, the cost of using the market will always be existent when using the market and the minimization of these costs are of great importance to the success and efficiency of the firm (Coase, 1937).

Oliver E. Williamson (1981, p.552) defines a transaction as “when a good or service is transferred across a technologically separable interface”. Williamson argues that the associated transaction costs arise due to lack of harmony between the entities which take part in the transaction. A parable to this could be a system of cogwheels. If the cogwheels are well-fitted and well-kept the system will run smoothly. However, if gravel should find its way into the gears it will cause friction and the system will no longer run as smoothly. The gravel in this parable represents transactional costs (Williamson, 1985).

This lack of harmony between market actors can be explained by a few factors and assumptions. One assumption is that humans are subject to bounded rationality, meaning that humans act rationally but do not have access to all knowledge and do not have the ability to perfectly process the knowledge they do have access to. Another factor is that of asymmetric information and the risk associated with it. Asymmetric information is simply the fact that buyers and sellers (or the two actors in any type of contract on a market) do not possess identical information. If that is the case, one party might use the information unknown to the other in order to secure greater benefits for themselves i.e., they could act opportunistically. This risk is often called a moral hazard. If a party in a transaction perceives there to be a great moral hazard, an insecurity regarding whether the other party will fulfil their obligations, there are incentives to monitor the other party to ensure the fulfilment of said obligations. The act of monitoring another organization would demand resources and therefore costs for the monitoring organization (Rodrigues et al, 2012).

However, moral hazards are not a constant. They are determined by the existing relationship between the parties. The parties can develop an interdependence if the contract is a long-term one or if the transaction is frequently repeated. Long-term relationships make it harder for the parties to depart from their obligations since the costs of doing so are increased if there should be a dispute between the two. If a relationship has been built over a long period of time there is also the aspect of trust involved, which decreases the perceived uncertainty and risk and therefore also the costs. Both trust and interdependence play a role in how high the transaction costs are (Williamson, 1985). Rietveld (2012) states that there is a lack of cooperation between national railway companies. If there is a lack of cooperation and informational exchange then it would be logical to assume that the trust between these companies does not develop as much as it could, given greater cooperation. It would then follow that the transactional costs are greater due to the absence of cooperation and building of trust.

Another aspect of the perceived costs of a transaction are related to the degree of complexity in the commodity or service being traded and agreed upon. The higher the degree of complexity the higher the costs and need for monitoring in order to ensure that the agreement is maintained by the parties engaged in the transaction. As an example, the costs of monitoring an interstate agreement on transportation would be greater than that of monitoring the activities of a national railway company. That is due to the complexity of the service (Rodrigues et al, 2012).

Relating to the example of monitoring an interstate agreement, the costs of such a transaction would most likely also be subject to the issue of asset specificity. Asset specificity arises if there is a need for investment by one or all parties to support the transaction. Due to the risk of one party acting opportunistically and not fulfilling their end of an agreement can greatly impact the costs to the other party if the transaction required a substantial amount of investment. These investments could also be impossible to re-deploy which would further increase the costs of the party subject to opportunistic behaviour (Rodrigues et al, 2012). Asset specificity can be exemplified by the fact that railway operations have developed differently over time in different countries. Countries differ in gauge width, electrification standards and signalling systems, which makes running an interstate railway line require specific investments to circumvent these issues (European Commission, 2008).

According to Williamson (1983), assets specificity has some multidimensional properties and goes on to specify four dimensions of specificity: site specificity, physical asset specificity, human asset specificity and dedicated assets. Site specificity arises if an asset is impossible or highly expensive to move, such as a coal mine which is only useful if located in an area with coal available. Physical asset specificity is a factor if there is a need for highly specified tools or machinery specifically designed for the asset. Human asset specificity is concerned with the requirement of highly specialized human skill and knowledge. Dedicated assets represent investments that are made in order to sell a significant amount to a specific customer. If the underlying supply-agreement should end prematurely it would result in costs since it would lose some or all value if deployed to alternative uses (Williamson, 1983). If two countries, or national railway companies, invest in a standardized gauge for the railway between the countries, they must also invest in trains for this new gauge and perhaps other investments, such as educating train drivers to use these trains etc. If they should suddenly close the railway, there is no other use for the investments made.

Asset specificity is related to the idea of hold-up. The greater the asset specificity involved in a transaction, i.e., the greater the investments made into a transaction by a party, the greater the dependence of this party becomes towards the other party involved in the transaction. For example, if great investments have gone into infrastructure to support a railroad then not using said railroad would mean a loss of the entire investment in some sense. The parties which have invested in, say a railroad tunnel, become dependent on one another to use the tunnel in order for them to not lose out on their investment (Rodrigues et al, 2012).

2.2 Price discrimination – Ramsey pricing

Norman, Pepall & Richards (2014) define price discrimination as being able to sell the same product to different buyers at different prices. Price discrimination can be implemented by firms in different ways and divided into three degrees of prices discrimination. Third-degree price discrimination is when a monopolist charges a higher price for consumers with a lower price elasticity of demand and a lower price for consumers with a higher price elasticity of demand. One example of this would be train operators charging a higher price to passengers travelling at peak hour than those travelling off peak hours.

When a monopolist wants to implement third-degree pricing, they must deal with three problems: the identification problem, the arbitrage problem, and the market power problem. The identification problem being that one must have some easily observable characteristics such as age, income, or education to identify their price elasticity of demand. The arbitrage problem being that the monopolist must be able to prevent consumers who are offered a lower price of reselling their product to the consumers charged a higher price. Lastly the market power problem being that the firm must have a dominant market share. In our case when examining train prices for journeys within the EU it is a reasonable assumption that the firms we encounter have a dominant market share. It is also reasonable to assume that the arbitrage problem is solved due to how train tickets are sold.

Other forms of price discrimination are first degree or personalized pricing where the firm can solve both the identification problem and arbitrage problem and therefore extract all consumer surplus into profit. There is also second-degree price discrimination where the pricing mechanism itself is meant to make consumers self-identify themselves and their willingness to pay for the product (Norman, Pepall & Richards, 2014).

Ramsey pricing is a method to implement price discrimination. It was first presented, or at least implicitly in 1927 by Frank P. Ramsey. It offers a mathematical solution to a problem that many state-owned enterprises deal with, which is the case for most of the railway companies in the EU. It aims to provide a guide for optimal pricing where prices equal to marginal costs does not cover total costs. Instead, these enterprises want to solve the constraint where its revenue should cover total costs, in other words break even or any other given profit requirement given that it maximizes economic efficiency (Baumol & Bradford, 1970).

Baumol and Bradford (1970) further developed rules for what happens when price equals marginal cost is not an option due to it resulting in negative profits. In other words, the second-best option or Ramsey pricing. Although the naming somewhat indicates it to be suboptimal, second best coming from it being second best to price equal to marginal cost, it might still be optimal. They describe it as:

> the systematic deviations between prices and marginal costs that the theorem calls for may truly be optimal because they constitute the best, we can do within the limitations imposed by normal economic circumstances (Baumol & Bradford, 1970, p.280).

These prices found using the Ramsey pricing theorem are Pareto optimal meaning that they obtain a set output and purchase quantities that makes it impossible to achieve a situation where one individual gets an increase in welfare without anyone else getting a decrease (Baumol, 2008).

Braeutigam (1979) identifies three factors that impact the decision for a regulated firm regarding pricing. First, it might be the case that when a firm adopts a price equal to marginal cost, profits might be negative. This is particularly true for firms that are characterized by economies of scale with high fixed cost, which is the case for railway companies. Second, it might be difficult to assign certain costs from production that are shared by multiple services being sold in a definite manner. Lastly, in the third factor he states that the pricing policies adopted might affect market structure as there might be more firms competing in the market.

The mathematical formula for describing this set of problems has been presented in multiple versions with many different notations but are more or less the same. Baumol (2008) presented the problem accordingly where a producer supplies n commodities then in order to achieve Pareto optimality given a profit constraint, prices p_j must satisfy:

(1)

$$\frac{p_j - mc_j}{p_n - mc_n} = \frac{mr_j - mc_j}{mr_n - mc_n}, (j = 1, \dots, n-1),$$

$$\Sigma_{j=1}^{n} p_j y_j = c(y_1, \dots, y_n) + k$$

Here k is a constant which is the profit requirement for the firm, c(.) is the firm's cost function and mc_j and mr_j are the marginal cost and marginal revenue of output *j*. If the firm's goods are assumed to be neither complements nor substitutes in demand, then the problem above can be rewritten into what has given Ramsey pricing its third name, the inverse elasticity formula:

(2)

$$\frac{\frac{(p_j - mc_j)}{p_j}}{\frac{(p_n - mc_n)}{p_n}} = \frac{E_n}{E_j}, (j = 1, \dots, n-1),$$

$$\Sigma p_j y_j = c(.) + k$$

Baumol (2008) provides a clear example as to what the implications of this inverse elasticity formula are. If we take an example where a firm produces two goods *i* and *j*, then *i* is a good with demand highly elastic and *j* is a very inelastic good. This could for example be two train tickets from point A to point B, where one departing 08:00 is considered inelastic and the other one 14:00 is considered highly elastic. If we assume that the firm were to sell these goods at $p_i = mc_i$ and $p_j = mc_j$ this would result in a loss, i.e., negative profits. Since it is a good which has high demand elasticity a small increase in price for this product would result in relatively large decrease in demanded quantity. Since good *i* has such a high price elasticity of demand an increase in price will cause relatively small increases in revenue.

But if we were to instead increase the price for good *j* by the same amount as for *i*, then this increase would cause a smaller decrease in demanded quantity meaning a larger increase in revenue. If the prices $p_i = mc_i$ and $p_j = mc_j$ are to be considered Pareto optimal quantities, then any deviation from this optimality will result in a welfare loss. But to minimize this loss in welfare and still meet the profit requirement most of this burden should be bestowed upon p_j.

To summarize, a firm looking to maximize welfare subject to a budget constraint will raise prices above marginal cost in an inverse relationship to the price elasticity of demand. Meaning products with low price elasticity should be priced higher, in the example above p_j and vice versa for products with high price elasticity to reach the revenue goal while still maximizing welfare. In other words, railway companies should implement third degree price discrimination to achieve their optimal prices for their goods. Price elasticity of demand is a central part for a firm to consider who wants to implement Ramsey pricing (Wilson, 1993).

Braeutigam (1979) further developed this idea discussing the role of cross price elasticities to the optimality condition. This becomes highly relevant when looking to implement a pricing structure like Ramsey pricing in a setting where intermodal competition exists. Although it is not the main part of this paper to examine this effect on ticket prices, it cannot be ignored either. For many of our journeys travelling by car, bus or airplane are highly relevant alternatives. As will be presented in chapter 3, we included one variable to measure intermodal competition. We will not deep dive into this extension of the problem. Instead we will state that his discussion concluded that information is a central problem that one should be aware of when seeking to implement Ramsey pricing in a situation with where intermodal competition exists. To make use of the Ramsey pricing cross price elasticity is highly relevant, but this information might not always be available thus making it hard to make use of the rules derived.

Tye and Leonard (1983) offers a critique that goes in line with Braeutigam (1979) that information uncertainty has a central role in the relevance of Ramsey pricing and why it perhaps lacks footing in a practical context. Tye and Leonard (1983, p.448) says that Ramsey pricing "was developed to solve a precisely formulated problem in a theoretical context." What he refers to is that the cornerstone of the theory lies in that one must know the price elasticity of demand for each good. But this requires that railway companies have precise information about this to be able to decide which tickets should be priced higher and by how much. The benefits lie in being able to price discriminate and charge different prices. This means to make use of the theoretical benefits train operators must be able to solve the identification problem presented earlier with great precision to implement Ramsey pricing. When facing uncertainty regarding price elasticity, the end goal of maximizing economic efficiency becomes harder to achieve.

2.3 Statistical theory

This paper will use a linear OLS regression to compute results. Since this method is presumed to be known to all readers, there will be no detailed description of this. However, the underlying data was found to be heteroscedastic and there will therefore be a brief discussion concerning the issue of heteroscedasticity. Given the fact that the data was collected by hand and that it contains several variables this chapter will also briefly discuss the Ramsey RESET-test for misspecification.

2.3.1 Heteroscedasticity

Heteroscedasticity occurs when the residuals in the data have the same variance. In a homoscedastic dataset the residuals have a constant variance, which can be expressed in the following manner:

$$Var(e_i) = \sigma^2$$

In the case of heteroscedasticity, the residual variance is not the same for all observations. This can be expressed in several ways depending on the nature, but an expression which allows for all types of heteroscedasticity is as follows (Westerlund, 2005):

$$Var(e_i) = \sigma_i^2$$

The presence of heteroscedasticity means that the OLS estimates are no longer the lowest variance estimates and inference and hypothesis testing is unreliable. To correctly test hypotheses in a dataset with heteroscedasticity one can use the White-estimator, which makes inference possible by calculating a robust Variance-Covariance Matrix (Westerlund, 2005).

To test for heteroscedasticity this paper will use the Breusch-Pagan test, detailed in the 1979 paper entitled *A Simple Test for Heteroscedasticity and Random Coefficient Variation*. The test is readily available in most econometric software (Breusch & Pagan, 1979).

2.3.1 Ramsey RESET-test for misspecification

The RESET test or Regression specification error test is used to test whether the regression has been incorrectly specified. This is tested by estimating the dependent variable's value given the regression. This estimated value is then put into an auxiliary regression squared. The auxiliary regression the significance of the squared estimated values of the dependent variable. If they are found to be insignificant then the null cannot be rejected and there are therefore no signs of misspecification. If the null is not rejected, i.e., it is found to be significant, then there are signs of misspecification. The misspecification is often caused by using a linear regression when it is non-linear (Westerlund, 2005).

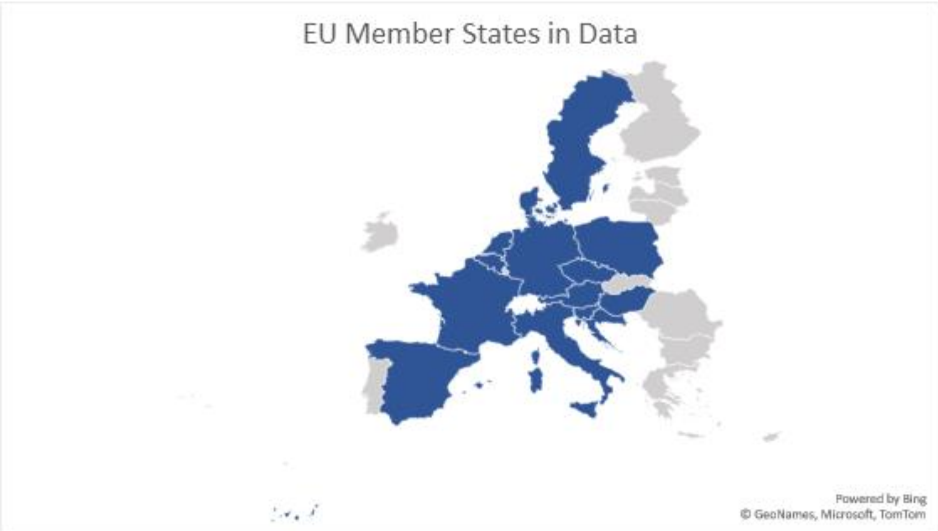
3. Method

Our choice of method to answer the question in this paper "Is there a monetary cost associated with interstate travel by train within the European Union?" consists of a data gathering process which was then analysed using a regression to see if there is a measurable effect. Literary studies of economic theory presented in chapter 2 will then be used in order to analyse the results of the regression and to draw conclusions.

The data used in this paper was gathered between 2020-11-19 and 2020-11-25. The data set contains a total of 1050 observations across three departure dates (2020-12-03, 2020-12-17 and 2021-01-07) and 31 different train lines. Departure dates were on the same weekday, Thursday, for all journeys to limit the effect that weekend travels might have on prices. The last collection date was chosen because after this date many lines did not have available tickets yet. All train tickets are adult tickets and non-flexible. 25 out of 31 routes were collected from the online booking site Raileurope.com. This website was chosen due to the fact that for each journey we could follow the exact route on a map and count the number of border crossings. The remaining 6 routes were all intrastate journeys with no risk of involving a border cross. The data regarding flights was collected from Expedia.com.

Our selection of which train lines to include was first made with regards to their length of travel. We decided to separate into three groups: short which included routes that were between approximately 200-300 km, medium which were approximately 500-600 km and long which were approximately 800-900 km. The second goal was to include an approximately 50/50 split with regards to intrastate and interstate. 572 observations were intrastate which represents 54.5 percent of all observations. The remaining 478 or 45,5 percent of the observations were routes which included one or two border crosses, i.e., interstate journeys. 14 out of the 27 member states of the Union are included in the data set (*see Figure 1)*. Apart from the most relevant variable to test in this paper, *BorderCross*, multiple other explanatory variables were included which were thought to influence the price. In *figure 1,* the blue states are states from which data has been collected, grey states are the remaining EU member states.

Figure 1:



In table 1 all the variables collected which are included in the regression is presented as well as a description for each.

Table 1:

Variable	**Description**

Price	The prices were collected on the booking sites. If needed, the prices were converted to Euro (See *table 5* in Appendix). The prices were given for the entirety of the trip e.g., a train departing from Berlin and going to Paris with a change in Frankfurt am Main would have a single price and not separate prices for Berlin – Frankfurt and Frankfurt – Paris.
BorderCross	This variable measures how many times a given trip crosses a border into another EU country.
DurationHour	Measures the duration of a trip in hours. So, a trip of 1 hour and 30 minutes would have a value of 1.5.
Changes	The number of changes during a given trip. A value of 0 means that the train will travel directly from departure to arrival location. Any number above 0 means that there are changes of trains.
TimeToPeak	This variable specifies the time, in hours, from the departure time until one of two (the one closest in time) peak hours. The peak hours chosen for this report are 08:00 and 17:00. The International Labour Office (2004) specifies that most people go to work between 07:00 and 09:00 and go home between 16:00 and 18:00, so the chosen peak hours are in the middle of these intervals.
DaysToDeparture	The number of days between the date when the data on a given trip was collected and the date of departure.
No_FlightsSameDay	The number of flights between the departure and arrival location on the same day as a given trip.

No_Departures	The number of departures on the line during the same day as a given trip.

In *table 2* descriptive statistics is presented for each variable to provide an easy overview of the data set used.

Table 2:

Variable	**Average**	**Std. Dev.**	**Max**	**Min**
Price	41.1	27.7	177.9	7.8
BorderCross	0.58	0.71	2	0
DurationHour	5.74	3.74	24.73	1.8
Changes	0.93	1.29	10	0
TimeToPeak	2.25	1.56	7.33	0
DaysToDeparture	28.24	14.6	50	9
No_FlightsSameDay	16.42	16.41	60	0
No_Departures	17.84	11.65	37	0

4. Results

These results were produced using the White estimator to correct for heteroscedasticity and both models were tested using the Ramsey-reset test as well as other tests for the models' stability.

Table 3:

Variable	**Coefficient**	**Std. Dev.**
C	37.10***	2.77
BorderCross	7.20***	1.95
DurationHour	2.52***	0.33
Changes	-1.47*	0.87
TimeToPeak	-1.88***	0.40
DaysToDeparture	-0.02	0.06
No_Departures	-0.44***	0.07
No_FlightSameDay	-0.14**	0.06
Adjusted R^2 = 0.326 N = 1050 * = significant at 10% confidence ** = significant at 5% confidence		

*** = significant at 1% confidence

The regression, using a linear OLS estimation found the results in *Table 3*. The adjusted R-Squared is 32.6 percent which indicates that the model has an explanatory power on the prices of 32.6 percent. All variables apart from the *DaysToDeparture*, *No_FlightsSameDay* and *Changes* were found to be significant at all levels of significance. *No_FlightsSameDay* was found to be significant on all levels apart from the 1 percent level. *Changes* were found significant only in the 10 percent level of significance. Lastly, *DaysToDeparture* was not found significant in any level of significance.

The *DaysToDeparture* variable has a particularly high p-value (around 42 percent) which makes it highly insignificant and therefore an additional regression was run which excludes this variable (see *Table 4*).

Table 4:

Variable	**Coefficient**	**Std. Dev.**
C	37.74***	2.67
BorderCross	7.01***	1.90
DurationHour	2.56***	0.33
Changes	-1.51*	0.87
TimeToPeak	-1.90***	0.40
No_Departures	-0.43***	0.07
No_FlightsSameDay	-0.12**	0.05

Adjusted R^2 = 0.326

N = 1050

* = significant at 10% confidence

** = significant at 5% confidence

*** = significant at 1% confidence

The results of the additional regression produce an almost exactly identical R-Squared of 32.6 percent. The results find that the effect of *No_FlightsSameDay* still cannot be rejected at the 10 percent or the 5 percent significance level. *Changes* also maintain a significance at the 10 percent level. So, there is a possibility that these variables influence the price. There is no change in the inference of the other variables which are all still significant at all levels of significance.

The *BorderCross* variable has an effect of around 7.1 in both regressions. This indicates that if we hold a trip constant in all other variables and increase the number of borders crossed by one, the price of that trip would increase by approximately 7.1 Euro. Given that the average cost is 41 Euro that would entail an increase of almost 18 percent just for crossing the border. Comparing the average does not mirror a real situation, however, it can be a helpful exemplification of the effect of a variable.

Moving on to the *DurationHour* variable, it is found that it has a significant effect of approximately 2.54. The same intuition as previously applies here as well. That is, adding another hour to the duration of the trip holding all other variables constant would increase the price of the trip by 2.54 Euro.

The *Changes* variable has a negative effect on the price. The effect is around -1.5, which means that if one change were to be added to an arbitrary trip holding all other variables constant, it would decrease the cost of said trip by 1.5 Euro. However, the effect is only significant in the 10 percent level of significance and there is therefore a greater possibility of the variable having no effect.

The effect of the *TimeToPeak* variable also has a negative effect on the price of the trip of 1.9. So, increasing the variable by one unit holding all other variables constant will result in a lower price for the trip. This means that if a train departs one hour further away from the specified peak hours, the price would be 1.9 Euro lower than for the trip which is closer to the peak hours.

The *No_Departures* variable is significant on all levels and has a coefficient of around -0.43. That is, if another departure were added on the same day, with the same departure and arrival that would decrease the price of the train trip observed holding all other variables constant. The more departures the same day, the cheaper the tickets so to speak.

Moving on to the *No_FlightsSameDay*. Since it is only found to be significant at the 10 percent and 5 percent level of significance in both regressions. There is a possibility of this variable having no effect on the prices, but the chance of that is lower than for the *Changes* variable. If not rejected, the interpretation of the effect is that if an additional flight would be added on the same day as an arbitrary train trip, the price of the train trip would decrease by approximately 0.13 Euro holding all other variables constant. This is a minor change in price and as said, it could possibly be equal to 0 and have no effect.

5. Analysis

In this chapter the results found in the previous chapter will be analysed variable by variable using the theoretical framework described in the theory chapter.

5.1 Border cross

The effect of crossing a border when travelling by train as we presented in our results was statistically significant and caused a higher price. This does both contradict and is in line with what we would expect from theory presented earlier. Firstly, we will expect this to cause railway companies to set a higher price if we look towards Transaction theory and especially complexity. As we described in the background, the European Commission have made efforts to develop the tools for smooth interoperability when travelling across borders. This includes many complex technical regulations that are included in delivering of the goods, in this case the tickets being sold. There could also be costs associated with monitoring due to the complexity of the service provided. Interstate railway travel is a complex service and must interact with national and regional railway transportation due to the nature of railways.

There is a need for infrastructure to monitor and coordinate this complex web of trains throughout Europe. This issue is not a matter of a railway company deciding when to go and where, but several railway companies and authorities across several countries who need to coordinate in order to facilitate smooth travel. A monitoring setup for such a complex service will therefore also include several actors and could induce higher costs due to the upkeep of this monitoring structure. Rietveld (2012) and the European Commission (2016) mentions that there is a lack of cooperation between the national railway companies of Europe. Overcoming the complexity and ensuring smooth travel is a task which requires cooperation between countries and companies responsible for operating the trains and tracks. This lack of cooperation can also be related to issues of trust as mentioned in 2.1.

Another explanation of this finding can be attributed to asset specificity from Transaction theory. This follows from the reasoning that interstate travel by train is a complex good and therefore requires specific assets to operate. As presented in 2.1 there exists four dimensions to asset specificity and we find it reasonable to assume the presence of all in an interstate journey contributing to a higher cost. Asset specificity would in the context of interstate travel be, for example, that a train that is inoperable on a different track due to it being adopted to meet regulations for interstate travel. This would mean this asset, the train, is tied to this specific journey and it would be very costly or perhaps impossible to move it to another journey.

This also ties into site specificity; a railway is highly site specific. A railway between two locations is hardly ever moved and if it would be moved and put down in another location there would be great costs associated. Since the tracks in themselves are close to immovable, if the traffic on said train should be cancelled that would mean that the railway would become worthless or at least lose most of its value, indicating high amounts of site specificity as well as the existence of dedicated assets. Dedicated assets could also come in the form of specific train types, such as high-speed, which are only suited for a specific connection and cannot cheaply or easily be redeployed.

From this follows that there might be costs attributed to physical specificity that this train is fitted with. For trains to be able to travel interstate they require a vehicle authorisation from the ERA which require member states to invest in these trains (European Union Agency for Railways, 2020). This should therefore in theory result in a higher price. Another issue which ties into physical specificity is the fact that technical specifications differ from country to country. Rietveld (2012) mentions that the railway connection between Spain and France has different gauges. The connection between Germany and The Netherlands also suffer from a similar issue, in this case they use different voltages. Overcoming these differences would either require investment into trains which are capable of using two different gauges or voltages. Or it would mean a change of trains at the border. Either way, reasonably it would cause raised costs for interstate travel.

Human specificity would also cause this good to have a higher cost since interstate travel requires railway companies to have a specific workforce dedicated to cross travel which are educated to meet the standardized requirements. From October 2018 all train drivers need to have an EU train driver licence to operate interstate and by the end of that year 84 percent of train drivers in the Union had said licence (European Union Agency for Railways, 2020). Another factor of human specificity might be that in order for a train crew to properly do their task they must be, at least, somewhat educated in another language. If a train crosses between, for example, France and Germany the crew should be able to communicate with all, or most, of the passengers. That would require some basic education in another language which would in turn present a greater cost for the railway company.

The presence of moral hazards as described in theory could very well be part of the explanation of these higher prices found for crossing borders. But as described earlier these costs are reduced as the relationship matures or is frequently repeated. There could therefore very well be the case that these costs are not present, or it would be reasonable to assume that they might be reduced in the future. That is due to the presence of the European Union and the actions taken to harmonize the internal railway market. However, the lack of cooperation between railway companies indicates that there are challenges and that moral hazards present for these companies. The EU and the ERA would intuitively be ideal platforms in which to reduce the asymmetrical information and moral hazards. Rietveld (2012) concludes that national governments do not consider welfare spillover into another country, since investment into railways are paid for by the national populace through taxes. So, there might not be incentives to use these platforms to their full potential due to this national view on welfare effects. A shift towards a more EU-centric view on the effects of cooperation might be necessary to facilitate cooperation.

As there is an increase in price for crossing one border during a train journey, this could be interpreted as the different railway companies operating interstate have identified these consumers as having relatively lower price elasticity of demand. That is if we assume that they have implemented Ramsey pricing.

There might be several factors determining these consumers' price elasticity of demand for these tickets. One that could contribute to the conclusion these railway companies have made would be if these consumers were working in a neighbouring country. As stated in the 2019 Annual Report on Intra-EU Labour Mobility this workforce consists of 1.5 million people that each day travel to another country for work (European Commission, 2019). This places them in a situation where they might be dependent on this form of travel and may cause them to be less sensitive to an increase in price. This could be due to that they would weigh this price increase against the cost attributed with finding a new job that does not involve interstate travel. At least one could argue that in the short term this group are less sensitive to an increase in price. However, in the long term this group might be more inclined to revaluate their work situation and the costs attributed to it due to interstate travel.

One group of people that might be more sensitive to an increase in price are people travelling with holiday purposes. As presented by Eurostat (2017), 50 percent of all trips with one overnight stay was made with the purpose of holidays, leisure, and recreation. It is not unreasonable to assume that this group of people have less of a need to make these sorts of trips and thus they have a relatively higher price elasticity of demand compared to other groups travelling interstate. If the cost attributed with interstate travel is increased, it is reasonable to assume that this group would lower their quantity consumed.

Another purpose for interstate travel that is common is that of visiting family in another EU country. As presented by Eurostat (2017), 34 percent of all trips with one overnight stay was made with the purpose of visiting friends and relatives. Again, this is a form of travel where consumers might have low price elasticity of demand. People's willingness to pay to see their loved ones one could be speculated to be rather high and the only real alternative is by other forms of travel such as by car or plane.

The third most common purpose of the trip presented by Eurostat (2017), was that of Professional/business. Again, these are similar groups of people to those who work cross-border and are assumed to have rather low-price elasticity of demand. This is because they weigh the increase in price for their ticket against the potential gain from doing that business related trip. Although, the same logic can be applied here that in the long term this group might be more inclined to revaluate their costs attributed to it due to interstate travel.

It is difficult to say if the railways companies adopt Ramsey pricing in their tickets. People travel interstate for different reasons and therefore have different price elasticity of demand. Here the identification problem presented in 2.2 when firms looking to implement price discrimination becomes highly relevant. The railway companies must be able to identify each customer by some easily observable characteristic and that might be a difficult task with regards to interstate travel. For this variable it seems unlikely that the railway companies have managed to do so and therefore the discussion presented earlier about implementing Ramsey pricing with uncertain price elasticities is highly relevant. It is therefore difficult to say if the effect we found can be explained by the railway companies implementing Ramsey pricing, but it offers some level of explanation for our findings.

5.2 Duration

Duration has a significant effect on the price. The addition of one hour would, according to our model, result in a raised price of approximately 2.5 Euro. Intuitively the reasoning for this is that a relatively longer trip requires staff to be in service for a longer time and other costs, such as electricity, would go up. If we look towards a transaction cost perspective, there is not really any intuition as to why the cost increases with increased duration. Other than perhaps that the complexity increases. With a greater duration one could expect that the amount of coordination with other trains and their timetables would come into play and cause a greater cost.

Ramsey pricing can perhaps help explain the effect on the price we find. If we return to the different groups of travellers presented as most common interstate travellers. One can assume that those who work in another country and make the trip frequently wants to minimize their travel time. This can of course be said for other groups as well, for example holiday travellers, but as workers frequently repeat the journey, they have more to gain from lowering their travel duration. Holiday travellers might be more willingly to sacrifice a bit of time for a lower price as they only make the trip once. From this reasoning it might be the case that workers have a lower price elasticity of demand with regards to duration and the opposite might be true for holiday travellers. In other words, workers are willing to pay a slightly higher price to get faster from point A to point B since over time this adds up for them. Whereas holiday travellers can sacrifice a bit of time for a lower price. This then presents an opportunity for railway companies to implement price discrimination which then might explain our findings.

5.3 Changes

Our findings that the changes of a journey did lower the price can be directly attributed to Transaction cost theory. As soon as there are more parties involved gravel seems more likely to appear in the system and causing a higher price. If a journey involves one or more changes this requires the coordination of more parties to complete your journey. A journey that travels from point A to B in a direct route is reasonable to assume to be less complex than a journey travelling from point A to B including multiple stops. These stops might involve the coordination of many different trains to make interchanges between different stops smooth. A change will most likely also mean that either the personnel, train or operator being changed, or a variety of these being changed. For this to operate smoothly this requires complex time scheduling as well as a well-structured communication between involved parties. However, since the results were only significant at a 10 percent level of significance there is the possibility of it having no effect.

We can also make use of Ramsey pricing to further explain this occurrence we find. One assumption would be that consumers prioritize a journey with no or at least as few as possible stops as this simplifies their involvement in the journey. When keeping all else equal, comparing two journeys where the number of changes increases, we find that the price decreases. This seems to indicate that railway companies have identified that consumers have relatively high price elasticity of demand for changes and therefore priced these journeys lower.

5.4 Time to peak

For this variable Transaction cost theory provides little guide as to why this variable gives its results. Instead, we search for an explanation in Ramsey pricing. As the variable increases, meaning the journey departs further away in time from our two specified peak hours, price decreases. This can be explained by the fact that the consumers interested in those tickets can be assumed to be mostly people commuting to and from work. These consumers have little flexibility as to when they can travel, and this means they are very much bound to these times of the day. Therefore, it is not unrealistic to assume they have a lower price elasticity of demand than consumers who are more flexible and can choose more freely when to travel. This has resulted in railway companies charging a lower price for the consumers whom they have identified as having higher price elasticity of demand, in other words people not bound to traditional working hours for their travels.

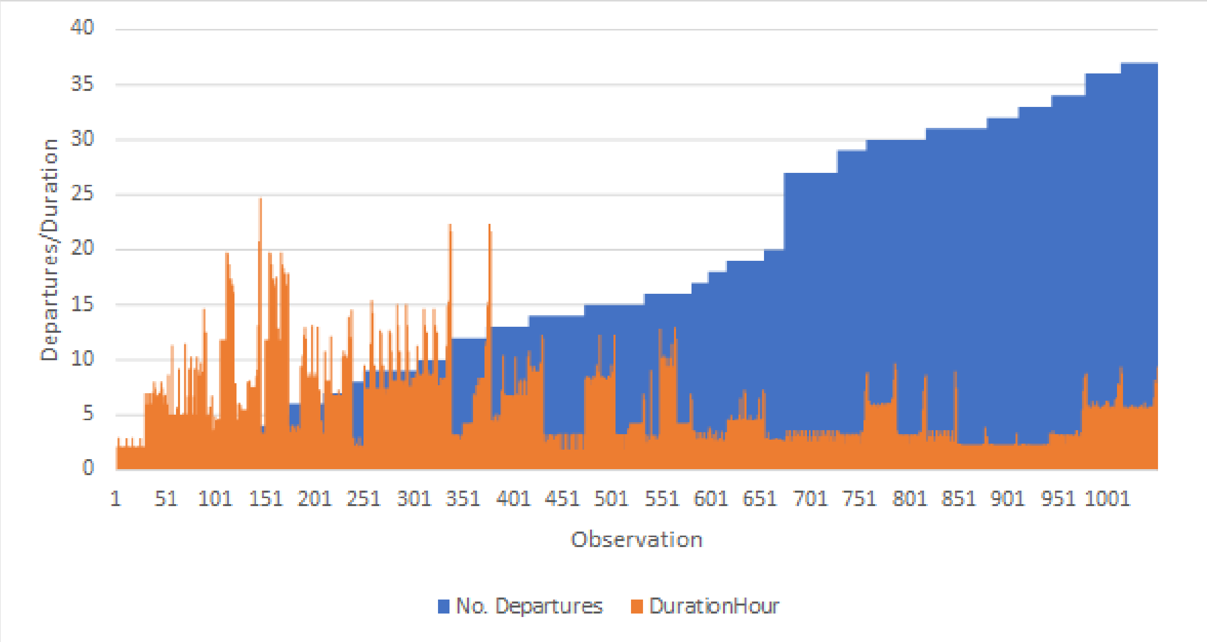
5.5 Days to departure

For this variable we did not find any statistically significant effect. This could be due that railway companies have found that it is impossible to implement Ramsey pricing. Perhaps when a consumer purchases their ticket in relation to departure does not reveal enough information for the railway companies to make use of and therefore make it impossible for railway companies to price discriminate according to this variable. This could then be viewed as a confirmation of Tye and Leonards (1983) critique presented in 2.3 where they claim that the difficulty in identifying price elasticities makes the pricing strategy hard to implement. It could also be an effect of the absence of transaction costs that cause this variable to be zero. Perhaps the transaction costs with regards to time left until departure has been reduced causing this variable to be zero.

5.6 Number of departures

The number of departures on a specific train line has a negative effect on the price of tickets on the particular line. Looking towards Transaction cost theory it is stated that the parties involved in a transaction can develop an interdependence if the transaction is frequently repeated. That in turn lower the transaction costs. Intuitively that seems reasonable. One would assume that the process has been given greater room to streamline. Workers gain more experience, flaws in the system are more easily detectable since there are more observations. It could also be a sign of lower complexity if the train line has more departures.

Figure 2:



As can be seen from *Figure 2*, there is a clear tendency for trips with longer duration to have fewer departures. As mentioned in 5.2, a longer duration could mean greater complexity and therefore greater transactional costs. So, it is then reasonable to deduce that trips with shorter duration are less complex and that the amount of traffic, the frequency, has a streamlining effect. This is in line with our results, a shorter trip with a greater number of departures should be a cheaper one and the transactional costs are therefore lower. The same effect shows when only examining the interstate trips. So, cities that are located closer together tend to have a more frequent exchange and therefore more efficient procedures. However, if two cities are located near each other but in different nations they still face a border effect which would raise the cost towards consumers and offset some or all the streamlining effects which are to be gained from frequent exchanges.

5.7 Number of flights the same day

Depending on the level of significance chosen the results of this variable is unclear. Even if the effect of this variable is to be viewed as statistically significant the effects are relatively small. Ramsey pricing and its implications for this type of journey where intermodal competition exists as presented earlier in 2.2 would mean that there exists competition between these two types of travel. As there is a decrease in price as the number of flights the same day increases this can be interpreted as that the railway companies have identified that there exists a cross price elasticity for demand between these two types of travel. Therefore, they lower the price for journeys where competition is high, and consumers have many alternatives. Even though it was not the main purpose of this paper to investigate this it is possible that it has an effect price.

6. Conclusion

To answer the question posed in this paper; Is there a cost present when crossing a border within the European Union by train? The answer given by our data and analysis is yes. This extra cost of interstate travel could be explained by the transactional costs discussed in the analysis. To exemplify, these extra costs can be derived from the lack of interoperability between countries (different gauges and voltages). There is also the issue of complexity. Operating and monitoring the European railway network is a complex task performed by several actors and nations. There are possibilities to lower these costs through further cooperation and integration within the European Union. The work to overcome the transaction costs can be continued through the harmonization of procedures, technical regulations, and policy. The fact that the European Union is not a state, but a Union of sovereign nations will perhaps make it impossible to fully overcome the uncertainty and lack of harmony that lay the groundwork for these differences. Perhaps the cultures and languages are barriers that persist and are slow to overcome between these sovereign nations. The differences have been illustrated by the mentioned lack of cooperation between national railway companies and governments. As Rietveld (2012) said, governments tend to ignore positive spillover effects into other nations. An integration of the welfare analysis within the nations of the European Union could in fact promote investment to decrease these border costs. If the effect of investments were to be evaluated at an interstate level instead of an intrastate level, the total welfare of the Union can be increased.

Relating to the aspect of national governments ignoring the welfare spillover, the EU has made efforts to open the market to private actors. This was mentioned in the background of the paper. If the dominant position of state-owned railways companies is diminished, the issue of prioritizing the national taxpayers could be circumvented. That could in turn lead to a situation where this issue is overcome since private companies are not dependent on ensuring the welfare of a national populace. Then again, with an open market there could be issues of coordination as the number of actors increase. That could then lead to increased complexity of the service and thereby, greater costs. The effects of this are unknown at this date.

However, these costs can also be explained by the Ramsey pricing theory. If these extra costs are an effect of the pricing of public monopolies due to demand elasticities, there is really no way for the EU to legislate their way out of these costs. It is simply due to the structure of demand and the market itself. This structure of demand may change and factors such as globalization and sustainability may alter the way in which the demand for railway traffic and transportation in general. Also, the subject of intermodal competition can be viewed as a solution to this problem. The increased competition between the different modes of travel for interstate journeys as we found can have a negative effect on price. It might be the case that this level of competition might eliminate the effects we speculated might cause consumers to have low price elasticity of demand. Interstate workers that today have no real alternative for transportation to get to work might in the future be able to compare trains with other forms of transportation. This might then change their price elasticity of demand for these products making it impossible for railway companies to implement price discrimination for this group.

Another group we identified to have low price elasticity of demand were those traveling to another EU country for professional/business matters. As has been on the agenda in the last year due to the pandemic, the need for these trips have been questioned with regards to their importance. The implementation for different types of digital solutions to replace these trips have been explored in the past year. It is not impossible that this group of consumers get a higher price elasticity of demand for interstate travel as they might look for different alternatives for these trips. How this might conclude is hard to tell now though. This might go both ways since it might be the case that railway companies find that these trips are not that necessary as once thought. This would result in higher price elasticity of demand for these journeys. If the increase in price we found in our results can be explained by railway companies adopting Ramsey pricing, they would have to lower the prices for these interstate journeys. But it can also be the case that professional/business travellers did not come to this conclusion and instead there will be a large increase in demand for these journeys and price elasticity of demand will lower. And again, if the increase in price we found for interstate travel can be explained by railway companies adopting this pricing strategy they can then increase prices further.

The distinction regarding whether the cost of interstate travel within the EU is a phenomenon that can be explained by a demand structure or by the lack of harmonization and transaction cost is a complex one. A reasonable way to look at this, given the results in this paper, is that both the factors described in Transaction cost theory as well as Ramsey pricing theory influence these interstate prices.

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8. Appendix

In *table 5*, a record of all exchange rates used are presented.

Table 5.

Line	**Currencies**	**Exchange rate**	**Date**
Malmö – Stockholm	SEK to EUR	0,098512	25th of November 2020
Warsaw – Gdansk	PLN to EUR	0,223783	25th of November 2020
Prague – Brno	CZK to EUR	0,0381519	25th of November 2020
Zagreb – Rijeka	HRK to EUR	0,132279	25th of November 2020
Zagreb – Split	HRK to EUR	0,132279	25th of November 2020

All exchange rates were collected from xe.com, which is a part of the Euronet Worldwide, one of the largest money transfer businesses in the world (XE, 2020).

In *table 6*, a full record of the booking sites used for each train line are presented.

Table 6.

Line	**Source**
Amsterdam-Paris	raileurope.com
Barcelona-Lyon	raileurope.com

Barcelona-Madrid	raileurope.com
Barcelona-Toulouse	raileurope.com
Berlin-Stuttgart	raileurope.com
Berlin-Warsaw	raileurope.com
Berlin-Wien	raileurope.com
Brussels-Cologne	raileurope.com
Budapest-Stuttgart	raileurope.com
Copenhagen-Berlin	raileurope.com
Dusseldorf-Amsterdam	raileurope.com
Hamburg-Brussels	raileurope.com
Ljubljana-Maribor	potniski.sz.si
Malmö-Berlin	raileurope.com
Malmö-Stockholm	SJ.se
Marseille-Vienna	raileurope.com
Milan-Naples	raileurope.com

Munich-Stuttgart	raileurope.com
Paris-Hamburg	raileurope.com
Paris-Nice	raileurope.com
Prague -Brussels	raileurope.com
Prague-Brno	cd.cz
Stuttgart-Paris	raileurope.com
Toulouse-Bordeaux	raileurope.com
Warsaw-Gdansk	intercity.pl
Warsaw-Hamburg	raileurope.com
Vienna-Dresden	raileurope.com
Vienna-Hamburg	raileurope.com
Vienna-Innsbruck	raileurope.com
Zagreb-Rijeka	hzpp.hr
Zagreb-Split	hzpp.hr