Essays on Regional Economics

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Doctoral Thesis

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Abstract

This thesis is, to its nature, somewhat wide in scope. The common denominator for the included essays is regional economics. Within this very wide area of research, the thesis is divided rather sharply between one part regarding trading of emission permits in the international aviation sector and another part concerned with real estate markets. The basis of this thesis is five essays all written for the purpose of peer reviewed publication.

The first topic includes three essays; the first provides an overview of previous emissions trading schemes which allow us to learn for future policy designs when including new sectors or creating new trading schemes. The second essay aims at estimating elasticities for domestic air travel in Sweden. The third essay, takes an analytical approach to scrutinizing the proposed barrier of trade between the international aviation sector and the stationary sources within the EU ETS.

The second topic is motivated by the structural relocations that two municipalities in the northern part of Sweden are currently undergoing. The first essay on this topic, the fourth essay of this thesis, concerns redistributions of wealth that occur when moving a city center. The fifth and final essay approaches the problem of measuring an effect of information on house values with small quantities of data, such as is the case for Gällivare municipality.

Keywords: Regional economics, aviation, emissions trading, hedonic modelling, wealth distribution

Acknowledgement

Although it may look like it glancing at my list of included papers, writing this thesis has not been a solitary venture. Several people have been involved in some way or another during the past 4 years; you all have my greatest appreciation.

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Cover Essay

1. Introduction

This doctoral thesis is based on 5 essays, all within the realms of the somewhat broad topic regional economics. To break it down further, the essays can be divided into two categories. The first three, that were all included in my licentiate thesis, deal with questions related to the inclusion of the international aviation sector in the EU emissions trading scheme. The last two essays concern questions that arise because of current and future changes that two mining communities in the northern part of Sweden are currently going through. Primarily, I have been working from a methodological perspective. To me this makes sense as I view the process of writing a doctoral thesis, primarily as a learning process, rather than a result oriented one. My main goal with the past few years have been to develop the necessary skills, and the toolbox, to conduct research independently; after all, that is what is expected of me in the future. This introductory cover essay will be devoted to issues that have been left out from the included essays, due to different reasons. When writing scientific papers for journal publication, it is only natural to leave out large parts of the work that has been carried out in the process. For example, the methodological approach may include several similar modelling approaches that all lead to the same qualitative conclusions, but only one might be accounted for in the finished paper. However, one of the largest parts of the work, the collection of data, seems to me, the part that receives the least attention in the published paper compared to the effort put into gathering it. This is of course only natural, a lot of time goes into building data bases containing all that we are interested in controlling for when doing quantitative empirical analyses, however, to write about this process in each paper would be tedious and lengthy.

2. Data availability and methodological approach

In this thesis, three of the included essays are of quantitative empirical nature. As mentioned earlier, a major part of conducting empirical analyses lies in the collection and treatment of data. Since this part is generally left out or marginalized in the final product, the publishable article, a greater discussion regarding this crucial part of empirical work will provided here. The discussion is largely derived from the experiences in handling data that I have had during the process of writing these essays.

The starting point of all quantitative empirical analyses is of course availability of useful data. If the problem at hand cannot be measured in a satisfying way, it is simply not a good candidate for quantitative empirical analysis. In some areas, detailed descriptive data is more often than not difficult to come by; individual travel behaviour (Essay 2), to name one; geo referenced transactions of properties (Essays 4 and 5), to name another. The quality of data is of course also of great importance when it comes to the statistical inferences and qualitative conclusions we want to make from the analysis. Ultimately, what we are interested in is to be able to say something about causal relationships between variable. That is, we want to be able to say that A happens, and it causes B to happen, not simply that A and B move together or in opposite directions. Causal relationships are of course hard to prove and it is often argued that experimental data is necessary when we want to talk about causality. For example, Quinn and Keough (2002) argue that;

> "Causality can only be demonstrated by careful research and experimentation,
>
> not by a particular statistical analysis"
>
> (Quinn and Keough, 2002, p. 154).

Experiments are of course available in economics and often conducted in a classroom setting. While experiments of this sort help answer some types of questions, they are not appropriate for others. Rather than conducting large scale experiments, economists often tend

to look for natural experimental settings where two groups, similar to each other, have received different treatment. Comparison between the two groups before and after treatment will allow conclusions on causal effects. The downside is that natural experiments are hard to find. In Essay 5 it is argued that the municipality of Gällivare and the current situation with the mine affecting residential areas can be viewed as a natural experiment. The treatment, in this case the need to evacuate, is only given to a subsample of the entire population. All external effects, such as general economic conditions, would apply to the whole sample, and thus it can be argued that effects taking place at a certain point in time are caused by information regarding evacuation, and not some other underlying factor. Of course, this "natural" experiment is not a perfect controlled experiment in that treatment and control groups were not chosen at random. Some other underlying and unmeasured factor could have spurred this pattern.

All quantitative approaches aimed at making inferences from data concern a limited set of variables of interest and it is assumed that everything else is equal and that the estimated relationship is the true relationship between the two variables if interest. Without conducting controlled experiments, however, we can rarely say that everything else is equal and thus we attempt to control for all that which is assumed not to be equal. Now, in addition to finding measures of the two variables of interest, we also have to find measures of a set of control variables. This leads to even further demands on availability of good and reliable data. One question that follows from this is; what should we do when the data available to us is not perfect? I would like to argue that, even without that perfect data set, we can still find an indication of answers to the questions that we have, and although our results might not be perfectly accurate, they will provide good estimates from which we can draw our conclusions. To me, it becomes immensely important to rely on a sound theoretical base from which we can derive theoretical expectations. After all, acknowledging that we cannot make a perfect

case for causal relationships without generating our data through experiments, at least the reliability of our empirical estimates can be questioned using our expectations. Finding empirical evidence that confirms theoretical expectations builds a stronger case than simply finding empirical evidence that cannot be theoretically explained.

I have yet to come by a dataset containing all that I deem to be relevant and important to answer the questions set out to be answered. Usually, the case is rather that one, and sometimes several variables are available from one single source. Often, the case is that one crucial variable for the analysis can be found from one source, while another can be found somewhere else. Additionally, some variables cannot be found at all, like in essay 2. The analysis would have benefited from information on price developments for different fare categories, i.e. business and economy fares. Such a division would have facilitated the estimation of elasticities divided in business and leisure travellers. Of course, data on different fare categories exist, but it might be difficult to obtain. There are ways to get around data limitations, one of which is using proxy variables, but they are not always clear and to discover them takes effort. Essay 2 uses a crude division based on vacation patterns in Sweden which leads to the possibility of estimating different elasticities for different passenger categories.

In both essay 4 and 5, many variables were available from one direct source. However, since several distance measures were to be included, the data first needed to be geo coded, a time consuming process in itself. Secondly, as we are interested in distance relationships, a decision has to be made with regards to what distances are of interest. Understanding the geographical pattern takes time and effort. While important distances can be drawn from previous literature, these are not given in individual sets of data. We know for example that the distance from homes to employment possibilities are important, hence, an understanding of where these employment possibilities are located is crucial.

The choice of methodological approach can, at least in this thesis, be derived from the availability of data. Air travel passengers responsiveness to changes in fares, or how a particular event in the past affected house values for a certain region both fall well within the realms of being empirically quantifiable, and thus are good candidates for empirical analysis. When the effects of an event taking place in the future are of particular interest, such as the linking of emissions trading schemes, data is of course unavailable. Still, the question regarding what effect a gateway preventing two-way trade may have on the efficiency of the trading scheme is highly quantifiable. Given the lack of data, this question becomes a great candidate for an analytical approach.

As described, the choice between empirical and analytical approaches can, in many cases, be derived from availability of data. If the former is deemed suitable we are faced with yet another decision to make, namely; what empirical approach to use. Numerous methods are available in treating different kinds of data and even after determining what problems need to be corrected for, a number of methods can remain as candidates. A common approach is to include several estimation methods; similar results from all provide a better argument for their robustness. When it comes to the publication process, we choose between journals that are either method or result oriented. Choosing the latter might result in the methodological section being marginalized. As an example, essay 2 looks at the price elasticity of demand for domestic air travel. The study uses an analysis including several macro variables, of which few are stationary over time, several methods would be available to get around this problem. The method used in essay 2 is not widely adopted but the estimates do not differ significantly from more conventional methods, such as a first difference approach. In an early version of this essay, one other method of estimation was included to provide a sense of robustness to the results. However, when the essay went through the review process it was the editor's

request to emphasize the results, rather than the method of achieving them. Of course this sacrifices showing the robustness of the estimated parameters.

Similarly, essay 1, in its unpublished version; used to be somewhat more extensive, however, to make it publishable, it was boiled down to only consist of its bare essentials.

3. Tradable permits

The motivation behind the three first essays of this thesis came from the planned inclusion of the international aviation sector in the EU emissions trading scheme (EU ETS). Essay 1 and 3 are directly related to designs of emission trading schemes, the former in broader terms and the latter dives into a more specific point of policy design. Essay 2 is indirectly related to emission trading schemes in that it concerns possible implications of changes in fares resulting from inclusion of the international aviation sector.

Cap-n-trade systems have their origin in the early 1960's. Influential papers from Coase (1960) and Dales (1968) concern the benefit of reaching efficient outcomes through trade. The driving force behind them is to attain some level of abatement of emissions (or other externality) at lowest possible cost. The belief in the market drives this notion and it is summed up well by the Coase theorem, stating that (given certain assumptions, e.g. no transaction costs) trade will lead to an efficient outcome, regardless of initial property rights. This can be set in perspective to other regimes, such as cap-n-control schemes where an authority sets the abatement level and forces each actor to do their part to reach that goal. The idea behind tradable emission permits is thus to allow companies that have greater possibilities (i.e. lower costs) of decreasing emissions to do so while other companies with less possibilities can purchase permits, rather than having all companies contribute equally in reductions of emissions.

Several questions arise concerning how to design these systems where emission permits can be traded on an open market; How should permits be allocated?; To whom should they be allocated?; and; Should everyone be allowed to trade with each other?

To date, several emissions trading schemes exist worldwide, and it is conceivable that, in the future, some of these schemes will be merged together. It is also conceivable that, sometime in the future, the world could decide upon one large trading scheme including several emissions and emission sources. This will allow trade over greater regions, or across different sectors, thus leading to possibly further reductions in abatement costs. The design issues become more pressing in situations like this, where two already existing schemes will have to mediate to agree upon one design suitable to all. New questions would arise, such as; Does all emissions count the same?; or; Can all regions or sectors trade freely with each other?

The directive[1] from the European Parliament to include emissions stemming from international aviation into the EU emissions trading scheme can be viewed as an early example of such a merge between two trading schemes, even though a trading scheme for international aviation has not existed before. The initial decision was that, from January, 2012, all emissions from air crafts, departing or arriving in the EU (independent of destination or origin) should be accounted for in terms of emission permits. Emission permits was to be delegated through grandfathering, based on average historical emissions. This directive faced large international critique from nations outside the EU and, when this thesis is being written, a decision[2] has recently been made to temporarily postpone the inclusion of emissions stemming from all aviation sources. The aim is however still to include all emissions from the international aviation sector, but currently only emissions stemming from aviation activities within the EU are accounted for. The decision to postpone inclusion of all aviation into the

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[1] Directive 2003/87/EC
[2] Decision 377/2013/EU

EU ETS does not have any impact on the qualitative conclusions drawn from any of the research presented in this thesis.

The inclusion of international aviation in the EU ETS can be viewed as cross-sectorial linking of emission trading schemes, although, as mentioned, international aviation did not have its own trading scheme to begin with there are some important features that lead to questions regarding the future design. The results can also be generalized to apply to any merger between trading schemes or inclusion of new sectors to already existing ones. A pressing issue is that emission reductions from international aviation are not a part of the goals stipulated by the Kyoto protocol. The EU ETS is the means for the EU to reach the goals which are set up under the Kyoto protocol. Existing emission are calculated such that the allowable emissions under the scheme will lead to fulfilling these goals. Thus, including additional permits into the system would potentially jeopardize reaching these goals. Of course, in this specific case, it can be argued that it is unlikely that the international aviation sector would be a net seller of emission permits and the threat is therefore not very realistic. The design policy agreed upon to eliminate this issue has been to introduce a gateway, a trade barrier between the sectors, only allowing one way trade from the EU ETS to the international aviation. The immediate questions, of course, become; At what cost?; and; What are the alternatives?

Summary Essay 1

Aviation and the EU Emissions Trading Scheme - Lessons learned from previous emissions trading schemes

The aim of this essay is to analyze the strengths and weaknesses of four previous and ongoing emissions trading schemes, the EU Emissions Trading Scheme (EU ETS), the US Acid Rain Program, the UK Emissions Trading Scheme (UK ETS) and the Regional Greenhouse Gas Initiative. From these, lessons can be learned regarding how to avoid

potential problems that have showed up in these schemes, but also how to draw advantage of their strengths, when linking the international aviation sector to the EU ETS.

The approach chosen in Essay 1 is focusing the study on five key elements of system design that are of special interest. These are;

- *Method of Allocation* – How should emission permits initially be allocated?

- *Liability* – Who should be held liable for surrendering emission permits?

- *Inter-temporal trade* – Should banking and/or borrowing of permits be allowed?

- *Hot-spots* – Is there a threat of local hot-spots where emissions gather?

- *Trade barriers* – Should international aviation be fully incorporated in trade or not?

Initially these five key elements are discussed from a general point of view. In the following section of the paper, the experiences from previous trading schemes are discussed, keeping the five elements of system design in mind. All of these five elements have not been present in all trading schemes and some have been more noticeable than others. In discussing how potential problems that arose in designing these early trading schemes, lessons can be learned for the future. The review concludes that method of allocation and the trading barrier (the gateway) between international aviation and the stationary sources within the EU ETS need special attention. No previous emission trading scheme has ever introduced a trading barrier between participating actors, and hence, the functionality of such a policy design should be reviewed.

Essay 1 is published in *Energy Policy*.

Summary Essay 2

A demand model for domestic air travel in Sweden

The aim of this essay is to analyse the effects on demand for domestic air travel in Sweden that a potential increase in fares would have. There is a clear link to the inclusion of the international aviation sector into the EU ETS as it is expected to lead to some increase in fares. Contrary to popular belief, even though emission permits are distributed for free, based on historical emissions, research has shown that this still leads to an increase in consumer prices (Wråke et al. 2010). In order to conduct the analysis, necessary data on passenger quantities and fares are gathered from different statistical sources in Sweden. This results in a monthly time series reaching from January 1980 to December 2007. The time series is completed with, what is believed to be, important economic variables such as GDP, population size and price of close substitutes to air travel, such as train ticket prices and the price of cost of driving.

The econometric analysis is based on Baffes (1997) in regards to handling non-stationary independent variables. The estimated models pass the tests proposed by Baffes (1997) and it is concluded that non-stationarity is not a big issue for the analysis. This is also confirmed by similar estimates from a more conventional first difference approach to non-stationarity, this last part is only included in the unpublished version of the paper.

A pressing issue to overcome is the lack of data describing fares for different passenger categories. Fares are only given as one index series for the whole time period and it is not possible to distinguish business from leisure travellers. It is acknowledged that there is no perfect way of getting around this problem. However, one rough estimation method, best viewed as a robustness test of the models, is proposed. Since Swedes traditionally have enjoyed their vacation during summer, and in particular during the month of July, this is used to proxy leisure travellers. A variable, describing air fares during the month of July is

included to provide rough estimates of the difference in price sensitivity between business and leisure travellers.

The results of the analysis suggests that, on the aggregate, the demand for domestic air travel in Sweden is fairly elastic in the short-run and as expected more sensitive to changes in fares in the long-run. The proposed robustness test of the models indicate that leisure travellers are indeed, as expected, more sensitive to changes in fares than their business counterparts. Finally, the cross-price elasticity regarding travel by train is found to be positive. To conclude, the price elasticities of demand are comparable with estimates provided by a study conducted on Norwegian data, a country somewhat similar to Sweden.

Essay 2 is published in *Journal of Air Transport and Management*.

An unpublished version of Essay 2 is also included in this thesis.

Summary Essay 3

Unilateral Linking of International Aviation and Stationary Sources within the EU ETS

This essay analyses the proposed barrier to trade, referred to as the gateway, between the international aviation sub-market and the stationary sources within the EU ETS. In addition, the analysis also acknowledges that emissions stemming from different sources may lead to different damage. In fact, due to the different altitudes from which emissions are emitted, this is a possibility in the special case of aviation and the stationary sources within the EU ETS.

A simplified theoretical model, based on Weitzman (1974; 1978), is developed to analyse the problem. The model takes into account that trade is only allowed in one direction within the trading scheme. *Three* scenarios regarding the damage relations between emissions from different sub-markets are considered. There is a discussion regarding the different damages that greenhouse gases cause depending on what altitude they are emitted at which places this approach in a relevant framework (IPCC, 1999). The *three* scenarios are;

- *Equal damage*, in which it is shown that the gateway potentially results in a loss in cost-effectiveness. This is not unexpected as an infringement on free trade between the participating sectors means that some outcomes are unreachable. If one of the unreachable outcomes is also the most efficient solution, the gateway will result in an efficiency loss.

- *Larger damage from emissions in the aviation sub-market*, in which it is shown that the proposed gateway, without a complementary solution, may result in high damage emissions replacing low damage ones. This result is not surprising, but it emphasizes the necessity of an additional measure to ensure that this will not be the case.

- *Larger damage from emissions in the sub-market for stationary sources*, in which it is argued that the gateway would function in reducing damage from emissions but still lead to a potential loss in cost-effectiveness.

The paper concludes that the gateway, as it is proposed, might benefit from a complementary, or altogether different, solution, such as an exchange rate for emissions permits. It is however acknowledged that further analysis is needed regarding what policy instruments can be used for similar scenarios in the future.

4. Hedonic price models

Essays 4 and 5 both aim at estimating implicit prices resulting from policy decisions. The method used in both essays is based on hedonic modelling and therefore a brief discussion about the usability of such models is in place.

Since Rosen (1974) introduced the idea of hedonic models this theory has been applied on a vast number of areas within the economics literature. The general thought behind hedonic modelling is that any good can be separated into a number of attributes. Formally, this can be illustrated as in (1);

$$y = y_1 + y_2 + \cdots + y_n \tag{1}$$

where y is a certain good and y_i is a particular attribute associated with that good. A simple example is to think about a house. The house in itself is a commodity that can be purchased on the market; however, the house comes with specific attributes attached to it, for example, the number of bedrooms; the distance to important employment centres; or the amount of air pollution in the region where the house is located. The market price of the house will depend on all these attributes. Formally, the price of y can be broken down to the set of implicit prices associated with the attributes. This can be formally illustrated as in (2);

$$p(y) = p(y_1 + y_2 + \cdots + y_n) \tag{2}$$

where p is the price. Consequently, py_i is the price of the *ith* attribute. To return to our previous example of the house, this could be viewed as the price of one bedroom, or the price of having access to clean air and/or natural amenities. Deriving from this theoretical concept, the prices of specific attributes can be estimated using econometric techniques. This is where the strength of hedonic modelling lies. It allows us to estimate the price of an attribute that is not available for purchase on the market, such as clean air.

When estimating hedonic models on the real estate market it is important that data is made available on the market value of real estate. Ideally this should be the transaction price of the property; but, since this is sometimes hard to obtain, some studies have made use of property valuation or aggregated prices (such as regional indices). Additionally, one would like to include as much information as possible regarding property specific attributes, such as number of bedroom, quality of the property and size, to name a few. It is not uncommon that the parameter of interest belongs to some neighbourhood variable, such as a distance gradient, meaning how much more (or less) individuals are willing to pay to live closer (or further away) to some amenity, such as a city centre or a recreational area. In order to include such geographically specific variables the data has to be geo coded. Of course, due to the

sensitivity of geographically coded data it is not always available for research. It is not uncommon to resolve to an aggregate level for municipalities or census tracts. If, like in essay 4, a distance relationship to the city centre is of interest, this distance has to be calculated and included in the hedonic regression as a variable explaining price.

Estimating effects on price from individual attributes of a house can be done in other ways besides resolving to the hedonic regression. One other prevalent method is repeat sales (Yiu and Tam, 2004). The repeat sales method relies on the same property being sold several times over a period of time, naturally, this implies the necessity of larger sets of data than are necessary for the hedonic regression, and hence, with small quantities of data, this method is not feasible.

Hedonic regressions have been prevalent in quantifying the effects of negative externalities using data of property values over time or across geographical space, e.g. in studying the effect of traffic noise (Wilhelmsson, 2000; Cohen and Coughlin, 2008); where proximity to noise pollutants can be included in the hedonic regression; or in studying the effect of neighbourhood crime (Schwarts et al. 2003; Troy and Grove, 2008). Hedonic modelling has also been used as a way to evaluate certain policy decision, such as construction of new railway stations. Both essay 4 and 5 use hedonic modelling to do exactly this, evaluate policies, in both cases with regard to the decision to evacuate large residential areas.

5. Structural re-location of urban areas

Two municipalities in the northern part of Sweden face a similar problem. These two municipalities, Kiruna and Gällivare, have both grown around their respective mining industries since they were founded a little of a century ago. Residential areas have grown around the mines, of course, with faster means of transportation and the expansion of the mines, the towns have spread out over the surrounding land. Mining for iron ore does

however come at a cost, the hollows that are left when extracting iron ore makes the surface ground unstable, this is visible in both communities as deformations on the surface. It has recently come to attention that deformation zones are moving towards residential areas and in order to continue mining activities large residential areas have to be evacuated. The situation faced by the two municipalities, Kiruna and Gällivare, is quite unique. In Gällivare, one community, Malmberget, is largely affected. A decision has been made to completely evacuate this community and relocate the residents and all public services offered there, such as schools and gymnasiums. To date, one area of roughly 140 houses have been evacuated, with the rest to be evacuated in the future. In Kiruna, the main town center will have to relocate. Actions have already been taken and the planning for the new city location has been initiated. As a first step, the new town hall will be in place in 2018. The size of these projects is unprecedented in Swedish history. Projects of this magnitude naturally give rise to a number of questions. Not in the least with regards to what compensatory principles to use when a large number of households have to relocate. A great part of the discussion related to these projects has concerned how to form the compensation in order to achieve fairness, i.e. what is fair compensation to those households who have to leave their houses? Focus has been on those who actually have to move, which spurred a questions and motivated essay 4 of this thesis. What about the households who do not have to move?

The Swedish expropriation act decrees that, in case of expropriation, compensation should be calculated as unaffected market value plus an additional 25 per cent. The 25 per cent could be interpreted as some additional cost (that very well may be psychological) that is associated with having to move, and this part of the law is quite straight forward. The issue here is the term "unaffected". Unaffected by what, and when were prices unaffected? In the previously named cases of Kiruna and Gällivare, this could be interpreted as "unaffected by the mining industry". Of course, taking that interpretation to it's extreme, property values in

this region would be extremely low was it not for the employment possibilities the mine offers and has offered for well over a century. Thus unaffected by the mining industry does not seem to yield a fair ground for compensation. Another interpretation would be "unaffected by the decision to expropriate" large parts of the community; then, at least we have a recent period in time where market values could be considered unaffected. The question would instead become, and an answer to this is attempted in essay 5, when can we say that market values were unaffected by this and how were they affected. It is of course known with some precision when the announcement regarding evacuation was made to the general public and one could easily be lead to think that this date serves a sufficient point in time where we can draw a line between affected and unaffected market values. There is a flaw with this thought, however, as it excludes the possibility of the effect that rumours and expectations may have. Both these communities are fairly small and it is not unthinkable that information could have "leaked" prior to the official announcement.

Other interesting aspects come into play when we talk about fair compensation in a project of this scale. It can safely be assumed that the original intention of the legislation was to apply for normal expropriations issues, which are on a smaller scale, e.g. a new road necessitates some land where there currently may be some houses. In such cases, the effect on the housing stock (that is supply of housing) is marginal and effects on prices in the unaffected stock are probably also marginal. That means to say, compensation to an expropriated household will be sufficient to allow for replacement in terms of a similar property on the market, and the expropriated household will be equally well off. However, when the expropriation is no longer marginal, as compared to the entire stock, the effect on prices in the remaining stock might no longer be marginal. As a matter of fact, it would be reasonable to believe that a negative shock on the housing stock would result in an upward pressure on property prices. If the law is followed, and expropriated households receive

compensation in accordance with unaffected market values they will be expected to purchase a replacement on the market at now affected property prices. The fairness in this can of course be questioned. Adding to this, if unaffected property prices are lower than construction costs for a newly constructed similar house, expropriated households are faced with a rather grave situation.

Summary Essay 4

City relocation and potential wealth loss: A method of measurement and empirical test

The aim of essay 4 is to include even those not directly affected by expropriation into the discussion regarding possible compensations. The foundation of this discussion is the notion that even though some household do not have to leave their houses, a part of the value that they initially paid for, namely proximity to the city center, may be lost with the relocation.

The analysis is twofold, starting out with an analytical approach, based on Alonso's (1964) bid land rent functions on a two dimensional featureless line. The result from this is a measure of efficiency (based on the *Kaldor-Hicks* criterion) with regards to the property values of the indirectly affected, where some face a reduction in wealth (the city will move further away than initially) and some will face an increase (the city will move closer than initially). It is acknowledged that if the aggregated wealth increase to the winners is larger than the aggregated wealth reduction to the losers, the move of the city center is warranted, at least from this limited perspective.

A second step of the analysis is an empirical one. In order to test the performance of the analytically derived measure, it is applied to transaction based data on sales for Kiruna. The spatial Durbin model (SDM) allows estimation of the bid land rent function (property price gradients) from the original location of the city center. Using this estimate of the implicit price of proximity to the city center the aggregated amount paid by all households can be

assessed. By projecting the bid land rent function from the expected location of the new city center the same can be done for the future city. The difference will show whether or not the re-location is *Kaldor-Hicks efficient.*

The results indicate that, from this perspective, it is warranted to move Kiruna, as the winners gain enough to compensate the losers.

Summary Essay 5

Determining when information is capitalized in house values

The aim of this essay 5 is primarily to test an alternative approach to estimating when capitalization in house values takes place. The popular approaches used up to this point have been mainly two.

1. Before and after analysis – This approach uses a known period in time where we believe some event was capitalized in house values. The effect can be studied using data from a period before and a period after. This approach has its drawbacks, the obvious one being that it would perform badly if the breaking point in time cannot be clearly defined. However, when data only exists for two time periods, this approach becomes the only available option.

2. Index creation – Index creation performs well in studying how a certain event has affected house values. Given continuous data, development of house values can be traced over a period of time. This approach does however demand a large sample, in order for the indices to be as precise as possible, with small samples, observations may have to be aggregated to quarterly time periods, and hence, it does not perform as well.

The approach suggested in this essay uses an interactive space-time dummy that takes the value 0 before a certain point in time, and 1 after for a specific region. This variable is systematically re-defined such that the breaking point in time moves forward with increments of 1 month, each time the model is refitted. Hence, it is similar to a before-and-after analysis, but it is performed continuously over the whole observed period. The continuous before-and-

after analysis provides estimates of the systematic space-time dummy that can be studied to find when any certain event has had an effect on house values.

The continuous before-and-after analysis is applied using data for Gällivare municipality in the northern part of Sweden. A part of Gällivare, Malmberget, is to be evacuated due finding of rich quantities of iron ore beneath the residential area. The specific case of Gällivare provides good data on transactions and due to that only one area is affected; this can be viewed as a sort of natural experiment.

Using spatial econometric techniques, 115 models are fitted providing equally many estimates of the systematic dummy variable. Together with the *a priori* information, namely that a public announcement regarding the evacuation was made during spring, 2003, the effect of the announcement on house values can be traced.

The results of this essay suggest that the announcement of evacuation has had a positive effect on house values for the directly affected. This is probably due to the generous legislation in place for expropriation cases in Sweden, where expropriated parties are to be compensated with no less than unaffected market values plus an additional 25 per cent.

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