FACTOR DEMAND AND MARKET POWER

Magnus Sjöström

Abstract

This thesis consists of five self-contained papers on factor demand and market power.

The main objective of **Paper [I]** is to analyze potential effects on the Swedish forest sector of a continuing rise in the use of forest resources as a fuel in energy generation. The background to the problem can be found in the commitments Sweden has made concerning energy policy. Two such commitments are the phase-out of nuclear power, and a decision that the Swedish energy system should be sustainable. However, an increasing use of forest resources as an energy input may have effects outside the energy sector. In this paper we attempt to consider this by estimating a system of demand and supply equations for the four main actors on the Swedish roundwood market; forestry, sawmills, pulpmills, and the energy sector.

In **Paper [II]**, we specify and estimate a dynamic factor demand model for the Swedish pulp industry. The model is estimated using firm specific Translog cost functions, and panel data from 1972 to 1990. We find weak evidence of adjustment costs for capital. Short- and long-term elasticities are calculated and the variances are estimated using the bootstrap technique. The results suggest that the user cost of capital is a significant determinant of pulp industry investments, while output level is not. We also find that pulp industry investments are insensitive to variations in the price of electricity.

Paper [III] proposes a flexible form of adjustment cost function, which allows for constant, linear, concave, or convex costs of adjustment. An empirical illustration shows that the flexible form can detect both convex and non-convex adjustment costs. Furthermore, the flexible form permits testing for the experience effect on adjustment cost.

The objective of **paper [IV]** is to analyze the price development and price formation for wood fuel used by the Swedish district heating sector. According to previous research there is a significant potential for increasing the use of wood fuel in Sweden, at a fairly moderate cost. The basic question raised in this paper is then why this potential is not realized. Specifically we propose a methodology for testing whether the reason is that market imperfections are present. According to our results we cannot reject the efficient market hypothesis for all years.

The objective of **Paper [IV]** is to test for market power on the market for biofuels. To achieve our objective we employ a statistical model and make use of the idea of Granger causality. We use a panel data set of plant specific input prices and quantities of wood chip covering a sample of Swedish district heating plants. If past values of quantity contribute significantly to the determination of price, quantity is said to Granger cause price, which we will treat as a sign of market power. According to our findings this effect is present and we conclude that the investigated plants to some degree has market power in the market for wood chips.

Keywords: demand and supply, dynamic factor demand, adjustment costs, bootstrap, panel data, market power.

A Note on the Economics of Thank You

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Abstract

In this note I express my gratitude to my supervisor and many colleagues. The note also contains a love and support part and a request to the world.

Keywords: thanks, love and support, supervisor, teaching

*The author would like to thank three anonymous referees for valuable comments on this note.

1 Introduction

A long time ago my little brother really took me by surprise. I sat in my room playing with my Big Jim action figure. My little brother was in his room, probably playing with the green tape recorder our grandmother gave him for Christmas. Suddenly I heard him shout: "No, no don't hit me..!". Before long, our mother stood on the door step to my room and told me not to hit my brother and then pretend to be innocent. I probably deserved it. Today, when I put the last words to this thesis I feel just as surprised. I finally did it!

Many people have contributed to this thesis and the rest of this note is organized as follows. The next section is devoted to my colleagues. Section 3 is the love and support part, and Section 4 contains a humble request to the world. The reference list expresses my gratitude to some additional people, both faculty and others.

2 Thanks to colleagues

I have really enjoyed discussing economics with my supervisor Runar. He has an excellent ability to pedagogically break down, at least in my opinion, complex stuff to the simple and nice Cobb-Douglas case. In addition, he always manages to do this on his whiteboard without rubbing out anything already written there. Being a natural resource economist, he might do this just to illustrate the fact that most resources will never be completely consumed. From time to time I have been confused on a higher level but Runar always seems to sort things out.

In addition to being my supervisor, Runar, together with Kalle and Keith Gilless, provided me with the opportunity to visit UC Berkeley. Thank you for that experience.

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Thank you Tommy for being a good friend and for interesting discussions during our work with papers [II] and [III]. In addition, I would like to express my gratitude to Tommy for putting my attention on Berkeley, Daft Punk, and decent skiing. Hopefully we will get the opportunity to further investigate the essence of the TSP error message: "Attempt to use a series which is not a series as a series" in the future.

Thanks also to Jörgen, Kalle and Kurt for helpful comments on paper [V], and to Marie for proof reading and helpful guidance with practical matters involved with finishing this thesis.

Before we turn to the 'love and support' part I would like to express my gratitude to one non-economist who has broaden my perspectives and challenged my economics skills with tricky questions and never ending discussions. Thank you Jens!

3 Love and support

I wish to thank my family for long distance support during the years. A special thanks to Malin and Hugo for putting the work with the thesis in perspective and for reminding me that life contains more than playing with TSP and SWP. Hugo has done this by trying to eat (first best) and tear apart (second best) drafts of the last paper in this thesis, but also by every morning waking me up with a big smile. Malin has done this in many ways, for example by ending my sometimes long shifts at the department by simply telling me that it is time for the evening tea. Thanks for those and many other moments.

4 A request to the world

This thesis is probably a small step for mankind but one big step for me. I have a small request to the world; please address me as 'Doctor Magnus' for, say, one week after my dissertation. After that, Magnus will do just fine again.

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Aronsson, T., Thanks for Comments on Drafts of Paper [V], *Bang-Bang Solutions to Door Closing.*

Bask, M., Thanks for Useful Suggestions on Drafts of Paper [V]. *Tiny Economics Letters.*

Gunnarsson, H., Thanks for Providing Me with the Opportunity to See what Is behind the KLEM Model and for Interesting Discussions in the Sauna, *Concave and Convex Loops.*

Johansson, Ö., Thanks for Inspiring Me to Use Internet in My Teaching, *Flexible Free Heel Skiing.*

Lundberg, J. Thanks for Interesting Discussions in the Office and in the Mountains, *Demand and Supply of Sleeping Bags.*

Umeå in May, 2004
Magnus Sjöström

This thesis consists of an introductory part and five self-contained papers. In the introduction, the papers are referred to by the numbers in brackets.

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[II] Lundgren, T. and M. Sjöström, 1999, A Dynamic Factor Demand Model for the Swedish Pulp Industry - An Euler Equation Approach, *Journal of Forest Economics* 5, 45-67. (Reprinted with permission from Elsevier)

[III] Lundgren, T. and M. Sjöström, 2001, A Flexible Specification of Adjustment Costs in Dynamic Factor Demand Models, *Economics Letters* 72, 144-150. (Reprinted with permission from Elsevier)

[IV] Brännlund, R., P-O. Marklund, and M. Sjöström, 2004, Evaluating Market Efficiency without Price Data: The Swedish Market for Wood Fuel. *Applied Economics*, 36, 31-39. (Reprinted with permission from Taylor & Francis Ltd)

[V] Sjöström, M., 2004, Biofuels and Market Power - The Case of Swedish District Heating Plants.

1 Introduction

The five papers in this thesis can be separated into two categories. Papers [I]-[III] concern factor demand in both a static and a dynamic setting, and paper [IV] and [V] deal with market power. Although the two categories of papers at a first glance seem to be unrelated, a second glance reveals a connection. The glue that tie them together is the Swedish forest sector, but also to some extent issues related to energy policy. Furthermore, all papers use similar econometric techniques, which also ties them together.

The background to the papers in this thesis can be found in the commitments Sweden has made concerning energy policy. Two such commitments are the phase-out of nuclear power and a decision that the Swedish energy system should be sustainable, i.e. it should be based on renewable resources. One of the main policy tools to achieve the goal of a renewable based energy system is to promote the use of bioenergy. In order to implement a massive substitution from nuclear power towards biofuels, forest resources that may have an alternative value will have to be considered for energy purposes. In addition, the phase out of nuclear power in combination with the fact that the electricity market has been opened up for international competition may increase the price on electricity, as Sweden, in an international perspective, has had a remarkable low price on electricity. The forest sector is one of the major industries in Sweden, and its well-being is crucial for the balance of the whole economy. Apart from being the main user of biomass originating from the forest, the forest industry is Sweden's largest consumer of electricity and changes in the price of electricity may have a great impact. Thus, a policy aiming at intensifying the use of biomass in the energy sector may affect the forest industry through stiffer competition, and thus higher prices of biomass inputs, but also through higher electricity prices.

Paper [I] focus on possible effects on the pulp and sawmill industry that may be associated with a significant increase in the use of biofuels in the heating industry. A system of short-run demand and supply equations for the four main actors on the Swedish roundwood market is estimated. The supply side of biomass is represented by forestry, whereas the demand for various biomass assortments are represented by the sawmills, the pulpmills and the energy sector. In paper [II] we specify and estimate a dynamic factor demand model for the Swedish pulp and paper industry. Dynamic factor demand is introduced together with adjustment costs. Empirical failures with quadratic adjustment costs, motivate a flexible specification that may detect different kinds of factor adjustment costs. In paper [III] we propose a flexible adjustment cost specification that allows for lumpy (constant), linear, quadratic/convex, or concave, adjustment costs. Our specification is used on the same data set as in paper [II] and on a panel of aggregate data for Swedish manufacturing as a comparison.

District heating and the use of biofuels are important parts of the Swedish policy to reduce the use of non-renewable resources, and in the long run to phase out nuclear power in the production of heat and electricity. According to Lönner et al. (1998), there is a significant potential for increasing the use of wood fuel in Sweden, at a fairly moderate cost. One reason to why this potential is not realized could be possible market imperfections such as monopsony/oligopsony. Paper [IV] and paper [V] use two different statistical approaches and different data sets to detect the degree of market power in the wood fuel market. In paper [IV] we compare estimated shadow prices with observed average prices and relate a significant difference to market power. In paper [V] we use the idea of Granger causality to investigate if the consumed quantity of wood chips affects the price of wood chips. We argue that such dependence can be treated as a sign of market power.

The rest of this introductory chapter is structured as follows. Section 2 presents the theoretical and empirical background to the papers and section 3 offers a summary and conclusion for each paper.

2 Methodologies

2.1 Factor Demand

Factor demand modelling has been performed in both static and dynamic setups. The static models do not take into account the intertemporal aspect of factor demand; there is no sluggishness over time when changing the input towards a new desired level. The dynamic models, however, impose some kind of adjustment process when changing the input level. This adjustment process can be introduced either in the theoretical model or in the econometric model.

In paper [1] we use a static approach and estimate a system of demand and supply equations for the four main actors on the Swedish roundwood market; forestry, sawmills, pulpmills, and the energy sector. According to our results, the own-price supply elasticity for biofuels is close to zero. In addition, our results suggest that biofuel and pulpwood is complementary products, as the cross-price supply elasticity of pulpwood and biofuel is positive. One explanation for this result is that there is a joint production of pulpwood and biofuel, i.e., a higher price of pulpwood increases pulpwood supply, but also increases the supply of wood residues (biofuels), as a side effect.

The dynamic framework can be divided into three subgroups: first-, second- and third-generation dynamic models of factor demand. The first two of these model frameworks apply a distributive lag to an econometric equation, derived from "static" theory. The third-generation models incorporate adjustment costs to justify lags or sluggishness when altering the level of inputs.

First-generation dynamic models are single-equation models using partial adjustment processes for the input studied (see, for example, Koyck, 1954). Studying capital demand, this means that lagged values of investment are incorporated as explanatory variables. These models are often criticized for the lack of theoretical underpinnings, i.e. dynamics are introduced in an ad hoc fashion. However, they are attractive because of their simplicity, and many studies show that they explain investment behavior reasonably well.

Second-generation dynamic models incorporate interrelated factor demands into a firm's demand responses, but the role of economic theory is still limited since economic factors affecting the time path of adjustment are not formally introduced. However, second-generation dynamic models take into account that there may be interdependence between different factor demands. This is neglected in the first-generation models. A seminal paper on interrelated factor demands is Nadiri and Rosen (1969).

Third-generation dynamic factor demand models are based explicitly upon dynamic optimization. They incorporate adjustment costs for quasi-fixed (fixed in the short-run) inputs of production, and therefore allow for well-defined and theoretically sound measures of short- and long-term elasticities. The two basic questions concerning adjustment costs are: what is the source of adjustment costs, and what are the structures of these costs? Adjustment costs are here defined as output foregone due to changes in the capital or labor stocks. These costs may occur if production needs to be shut down during installation of new capital, or if new personnel needs training and education. See Hamermesh and Pfann (1996) for an extensive review of the literature on adjustment costs in factor demand models. The theoretical foundations of third-generation dynamic models are mainly drawn from Lucas (1967a and 1967b), Lau (1976), and McFadden (1978). For a comprehensive overview of this theory consult Berndt and Field (1981).

The purpose of papers [II]-[III] is to study forest industry factor demand in a dynamic setting. In paper [II] we assume that firms operate in a stochastic environment, have rational expectations, and maximize the expected future discounted flow of profits by minimizing the expected discounted flow of costs. The adjustment process used in paper [II] is in line with third-generation-type factor demand models. We study factor demands, with emphasis on capital demand, for 20 pulp plants during the period 1972-1990.[1] The results in paper [II] suggest that the cost of capital is a relevant determinant for pulp firm investments. In paper [II] there is a selection problem, in that the sample on individual plants does not include the plants that exited during the period studied. At the macro-level we could then observe lower total activity, while we might well observe higher activity within surviving firms.

[1] The model in this paper is based on Pindyck and Rotemberg (1983a), and Pindyck and Rotemberg (1983b).

Another result in paper [II] is that changes in the price of electricity do not seem to affect investment spending very much. This result implies that if electricity prices increase as a consequence of Sweden's decision to phase out nuclear power, the impact on pulp firms' investments will be moderate. In other words, the analysis provides little evidence supporting the belief that investments in capital- and energy-intensive industries, such as the forest industry, will be significantly dampened as a consequence of Sweden's decision to phase out nuclear power. Furthermore, the results in paper [II] suggest that convex adjustment costs for capital and for labor may not be an appropriate assumption when modeling factor demands for pulp firms. This particular finding revealed a need for a more flexible adjustment cost function which can detect different kinds of adjustment costs.

The firm's intertemporal behavior, in dynamic factor demand models, will be affected by the shape of the adjustment cost function. For example, convex investment adjustment costs will penalize large investments and promote gradual change in the capital stock, while linear adjustment costs give a bang-bang type of solution. Therefore, assumptions about the functional form of adjustment costs are critically important. In the literature five different types of adjustment costs have been suggested:

(1) Lumpy or fixed, i.e. there is a lump-sum cost for taking action.

(2) Linear adjustment costs; adjustment costs are proportional to the change in the input.

(3) Concave adjustment costs; imply economics of scale in changing the input.[2]

(4) Convex adjustment costs; imply that the adjustment costs are increasing at an increasing rate with the size of the change in an input.

(5) Concave-convex adjustment costs; for small changes in an input there are increasing returns to scale, but eventually the adjustment cost curve bends off.[3]

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[2]See, for example, Jorgensen and Kort (1993) or Rotschild (1971) for a discussion on the concept of concave adjustment costs and their implications for the investment behavior.

[3]See Jorgensen and Kort (1993) or Davidson and Harris (1981) for theoretical analyses

Lumpy costs could possibly occur in combination with the other types of adjustment costs. Also, asymmetry has been introduced, implying different shape of the adjustment cost function when, for example, investing or disinvesting.

In paper [III] we propose a flexible adjustment cost function that can detect both convex and non-convex adjustment costs. This implies that we do not have to make the "correct" ex ante assumption about adjustment costs. The flexible function simply adapts to the type of adjustment cost that is suggested by the empirical data. Examples of other recent empirical applications using a flexible adjustment cost function can be found in Whited (1998), and Barnett and Sakellaris (1998).

The results from estimating the flexible adjustment cost function, using both firm level and industry level data, suggest that adjustment costs are linear in the rate of investment and net hirings for Swedish pulp mills. Also, the results suggest that adjustment costs are convex in net hirings of labor and linear in the rate of investment for industry level data. Furthermore, we find evidence supporting the existence of "learning" effects. For example, in manufacturing the size of the labor force and capital stock has a negative impact upon adjustment costs. We conclude that the flexible specification proposed in paper [III] can detect both convex and non-convex adjustment costs. This feature makes it suitable for use in empirical dynamic factor demand modeling, where the standard quadratic adjustment usually performs poorly.

2.2 Bootstrap

In paper [II] and [IV] we end up with measurements which are nonlinear combinations of the estimated parameters. This might make it mathematically cumbersome to calculate the exact variance of the measurements. In the literature three basic alternative methods for estimating the standard error are discussed; the Fieller method, the delta method, and the bootstrap method. The first two are asymptotic methods where the Normal distribu-

and discussions of concave-convex adjustment costs.

tion is used as an approximation, whereas the bootstrap method is based on the empirical distribution. The Normal approximation implies an assumption of symmetry. If the bootstrap method is used, however, no prior assumption concerning symmetry has to be made.

The bootstrap method, in its simplest form, can shortly be described as follows. Let θ be the parameter of interest and $\mathbf{x} = (x_1, x_2, ...x_n)$ the random sample to use. In order to calculate the variance of the estimate $\widehat{\theta} = s(\mathbf{x})$, with the bootstrap method, we resample data from the original data set. Let $\mathbf{x}^* = (x_1^*, x_2^*, ...x_n^*)$ be one such resample obtained by putting probability $1/n$ on each observation and random sample n observations with replacement. In the same way as we estimated $\widehat{\theta}$ from the data set $\mathbf{x}$, we can estimate $\widehat{\theta}^* = s(\mathbf{x}^*)$ from the resampled data set $\mathbf{x}^*$. This procedure can be repeated several times and for each new resample we will obtain a new estimate of θ. If the procedure is repeated B times we will end up with B estimates of θ. Let $\widehat{\theta}^*(b)$ be the estimates based on subsamples $b = 1, 2, ...B$. The standard error for the estimate $\widehat{\theta}$ can then be derived by the sample standard deviation of the B replications. For an introduction to the bootstrap technique see Efron and Tibshirani (1993).

2.3 Market Power

The empirical literature of market power dates back to Bain (1951). Following his work, the structure-conduct-performance paradigm (SCPP) focused on cross section studies of firms or industries. According to the SCPP approach firm or industry profits, as reported in the accounting data, can be related to structural measures as concentration indices.

Since the introduction of the "new empirical industrial organization", market power has frequently been tested within structural models. Typically, the conduct of a firm or an industry is treated as unknown parameters to be estimated jointly with cost and demand parameters. The determination of price and quantity is based on behavioral equations which are linked to, for instance, the theory of oligopoly. See for instance Appelbaum (1982), Bresnahan (1981), Porter (1983), and Roberts (1984) for an introduction to the early papers in this field. A survey of empirical papers in this area can be found in Bresnahan (1989). A large number of the empirical market power papers concern monopoly and oligopoly. Examples of studies of market power in input markets are Atkinson and Kerkvliet (1989), and Bergman and Brännlund (1995).

An alternative approach is put forward by Brännlund et al. (1999). They use VAR and the Granger causality approach on Swedish price and quantity data for various paper products to test what they label 'the small open economy hypothesis'. The line of argument is that if quantities do not contribute to the explanation of future prices, the small open economy hypothesis for the Swedish forest sector is supported. In paper [V] we follow the latter method and use Granger causality to test for market power. One advantage with this approach is that no restrictive assumptions concerning demand, costs, and market behavior are needed, which is the case when a structural model are used. Granger causality tests have been used in several papers and the main part concerns the relation between different economic activities and economic growth. For example Choe (2003) investigates if foreign direct investment and gross domestic investment promote economic growth, Atukeren (1994) tests the relation between exports and economic growth, and Chen (1993) focuses on the relation between defence spending and economic growth.

Although district heating and the use of biofuels are important parts of the Swedish policy to reduce the use of non-renewable resources, possible market power in the district heating sector has not, to our knowledge, been investigated in the literature. In paper [IV] and paper [V] we use two different and unique plant level data sets to detect possible market power in the wood fuel market. Unfortunately the data sets makes it impossible to use the standard structural approach and instead we use a statistical approach to detect possible market power. In paper [IV] we estimate the shadow price of wood fuel, i.e. the marginal valuation of wood fuel, and compare this to the observed average market price. A significant positive difference between the shadow price and the observed price would thus imply market power. According to constructed bootstrap confidence intervals this difference is significant only for three out of eight years, implying that too small quantities of wood fuel are traded. For the other years the difference is not significant, implying that we cannot, on statistical grounds, reject the efficient market hypothesis for all years. In paper [V], we test the presence of Granger causality between the use of wood chips as an input, at the firm level, and the corresponding firm specific price of wood chips. If we find that quantity "Granger cause" price, we will treat this as an indicator of market power. According to our findings this effect is present and we conclude that the investigated plants to some degree have market power in the market for wood chips.

3 Summaries of the papers

Paper [I] Biofuels and the Forest Sector - An Econometric Model for the Swedish Forest Sector

The main objective of this paper is to analyze potential effects on the Swedish forest sector of a continuing rise in the use of forest resources as a fuel in energy generation. The background to the problem can be found in the commitments Sweden has made concerning energy policy. Two such commitments are the phase-out of nuclear power, and a decision that the Swedish energy system should be sustainable, i.e. it should be based on renewable resources. However, an increasing use of forest resources as an energy input may have effects outside the energy sector. In this paper we attempt to consider this by estimating a system of demand and supply equations for the four main actors on the Swedish roundwood market; forestry, sawmills, pulpmills, and the energy sector. The purpose of the paper is thus to analyze the effects on each of these markets as a result of a switch in energy policy, towards an increase in the use of biofuels. The data we use are time series of aggregate data covering the period between 1967 and 1994 and we estimate the demand and supply functions using 3SLS and GMM. According to our results, the own-price supply elasticity for biofuels is close to zero. In addition, our results suggest that biofuel and pulpwood is complementary products, as the cross-price supply elasticity of pulpwood and biofuel is positive. One explanation for this result is that there is a joint production of pulpwood and biofuel, i.e., a higher price of pulpwood increases pulpwood supply, but also increases the supply of wood residues (biofuels), as a side effect.

Paper [II] A Dynamic Factor Demand Model for the Swedish Pulp Industry - An Euler Equation Approach

In this paper, we specify and estimate a dynamic factor demand model for the Swedish pulp industry. Firms are assumed to have rational expectations, and costs of adjustment are assumed to arise when the capital stock is altered. We estimate a translog restricted cost function together with an Euler equation for a quasi-fixed input and the cost share equations for the flexible inputs, using two-stage instrumental variable estimation technique. The data we use is a panel data set spanning over the period 1972 to 1990. We find weak evidence of adjustment costs for capital. The average marginal adjustment cost is about 10 percent of the price of capital. All of the estimated own-price elasticities are negative, and the empirical cost functions have all the desired properties from theory. Short- and long-term elasticities are calculated and the variances are estimated using the bootstrap technique, as the elasticities are highly nonlinear functions of the estimated parameters and cost shares. Interestingly, we find no evidence supporting the belief that investments will be dampened if the price of electricity increases as a consequence of the nuclear phase-out. The capital demand elasticity with respect to the price of electricity is inelastic and positive, which implies a slight increase in pulp industry investment spending if the price of electricity increases. Our interpretation is that, in the long run, firms will replace some of its existing machinery with less energy-intensive machinery when the price of electricity rises. The results suggest that the user cost of capital is a significant determinant of pulp industry investments, while output level is not. The quadratic adjustment costs specification is statistically significant only in one of the four estimated models, which may be due to problems with the functional specification of adjustment costs.

Paper [III] A Flexible Specification of Adjustment Costs in Dynamic Factor Demand Models

Empirical failures of quadratic adjustment costs in dynamic factor demand models, especially when imposed on microeconomic data, motivate a more flexible functional form that can detect different kinds of adjustment costs. In this paper we propose a flexible adjustment cost function, which includes quadratic adjustment costs as a special case. In an empirical illustration we use two different data sets: (1) a panel of 20 Swedish pulp mills (plant level), and (2) a panel of 15 industries from Swedish manufacturing (industry level). The plant level data set contains annual observations for the period 1972-1990, and the industry level data set contains annual observations for the period 1974-1996. The plant level data are the same as in paper [II]. The parameters of the flexible adjustment cost function are estimated through Euler equations for capital and labor, which are derived from a dynamic optimization problem. The results show that adjustment costs are linear in the rate of investment and net hirings for Swedish pulp mills. Furthermore, the results suggest that adjustment costs are convex in net hirings and linear in the rate of investment for Swedish manufacturing. We also find evidence supporting the existence of experience or "learning" effects.

We conclude that the flexible specification proposed in this paper can detect both convex and non-convex adjustment costs. This desirable feature makes it suitable to use in empirical dynamic factor demand modeling where the standard quadratic adjustment cost specification usually performs poorly.

Paper [IV] Evaluating Market Efficiency without Price Data: the Swedish Market for Wood Fuel

The overall objective of this paper is to analyze the price development and price formation for wood fuel used by the Swedish district heating sector. According to Lönner et al. (1998), there is a significant potential for increasing the use of wood fuel in Sweden, at a fairly moderate cost. The basic question raised in this paper is then why this potential is not realized. Specifically we propose a methodology for testing whether the reason is that market imperfections are present. As a first step the shape of the technology in the Swedish district heating sector is estimated for the period 1989 to 1996. In the second step we combine the estimated technology and the assumption of cost-minimizing firms to calculate shadow prices, i.e., marginal valuation of wood fuel in this sector. If the average shadow price significantly deviates from the average observed price we may conclude that this market is functioning inefficiently due to imperfections. According to constructed bootstrap confidence intervals this difference is significant only for three out of eight years, implying that too small quantities of wood fuel are traded. For the other years the difference is not significant, implying that we cannot, on statistical grounds, reject the efficient market hypothesis for all years.

Paper [V] Biofuels and Market Power - the Case of Swedish District Heating Plants

The objective of paper [V] is to test for market power on the market for biofuels. Traditionally, market power has been investigated within structural models which treat the conduct of a firm or an industry is treated as unknown parameters to be estimated jointly with cost and demand parameters. One disadvantage with this approach is that restrictive assumptions concerning demand, costs, and market behavior are needed. An alternative approach is put forward by Brännlund et al. (1999), who use VAR and the Granger causality approach on Swedish price and quantity data for various paper products to test what they label 'the small open economy hypothesis'. The line of argument is that if quantities do not contribute to the explanation of future prices, the small open economy hypothesis for the Swedish forest sector is supported. In this paper we follow the same method and use Granger causality to test for market power. To achieve our objective we use VAR and a panel data set of plant specific input prices and quantities of wood chips covering a sample of Swedish district heating plants during the period 1990 to 1996. If past values of quantity contribute significantly to the determination of price, quantity is said to Granger cause price, which we will treat as a sign of market power. According to our findings this effect is present and we conclude that the investigated plants to some degree have market power in the market for wood chips.

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