ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

Welfare Effects of Price Cap Regulation in comparison with Rate of Return Regulation: A Stochastic Frontier Analysis of Efficiency Costs of Flour Factories in Addis Ababa.

BY

ZELALEM TASSEW

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfilment of the Requirements for the Degree of Master of Science in Economics.

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This is to certify that the paper prepared by ZelalemTassew with the topic entitles: Welfare Effects of Price Cap Regulation in comparison with Rate of Return Regulation: A Stochastic Frontier Analysis of Efficiency Costs of Flour Factories in Addis Ababa, and submitted in partial fulfilment of the requirement of the Degree of Master of Science (Economic Policy Analysis) and complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Adane Tufa (PhD)Signature____________________

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Acronyms

PCR	Price Cap Regulation
RRR	Rate of Return Regulation
CoS	Cost of Service
MEWITE	Merchandise Wholesale and Import Trade Enterprise
EGTE	Ethiopian Grain Trade Enterprise
CS	Consumer's Surplus
PS	Producer's Surplus
TS	Total Surplus
CPI	Consumer Price Index
RPI	Retail Price Index
X	The Factor Used to Measure Efficiency
PPPDS	Public Procurement and Property Disposal Service
RE	Random Effect
REH	Random Effect with Heterogeneity
TRE	True Random Effect
TFE	True Fixed Effect
CF	Capacity Factor
CU	Customer Unit (Number of Customers)

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Zelalem T.

Abstract

This study aims at assessing the welfare effect of Price Cap Regulation that put in order by the government to regulate and ensure price stability for basic commodities supply in the market. In order to achieve the stated objective of the study, Stochastic Frontier Analysis of Efficiency Costs model is specified using the Cobb-Douglass Specification in its stochastic form. The parameters of the stochastic frontier functions are estimated using maximum likelihood that help to analyze the welfare effects of Price Cap Regulation. The data used for the estimation includes panel of 28 wheat flour factories in Addis Ababa from the period of May 2011 to April 2015.

The major findings of the study show that Price Cap Regulation has improved the welfare of consumers as compared to the Rate of Return regulation. However, welfare distribution problem remains unsolved. The average capacity utilization of the flour mills remain as low as a quarter of their capacity and the supply of input wheat, which constitute the major cost of production of wheat flour as addressed by the government, is found to be not satisfactory.

To improve efficiency of flour mills and the corresponding consumer welfare, supply of wheat need to be improved both in quantity and frequency terms. Furthermore, welfare distribution problem need to be addressed by enforcing the incentive scheme of flour mills based on the average not on the high cost firm.

The study is made on the four year panel data of twenty eight flour factories situated in Addis Ababa. Such data helps to make comparative welfare effects in the study area, and to complement it, further research considering the regional flour mills and quality impact of price cap regulation can help to produce full effect assessment.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

The rise in the cost of basic commodities seemingly affect every household. Thiseffect in turn has cost implications to producers with the corresponding rise in labor costs. With the long gestation period to respond to the cost of living adjustments, (particularly by the government pay system) and by other employers, significantly deter social welfare.
The food - security assessment conducted by the World Food Program in Addis Ababa, for instance, found that the proportion of households consuming an adequate diet decreased from 64 to 40 percent between January to July 2008 (World Food Program 2008).

As a result regulators switch to other measures to at least lessen the cost burden from consumers. This latter advances is what the government is currently pursuing to control the prices of basic commodities in the country, among which wheat flour price control is one.

The challenge for regulators remains how to maintain welfare with the current pace of inflation and market dynamics.To further complicate the matter, government's reliance on imported wheat is conditioned on the availability of hard currency reserves and international agricultural market trends.

The recent rise in food prices proved unbearable for most. It is essential, therefore, that the governmentintervenes to contain the price trend in the country. Such interventions, however,require appropriate policies drawn from careful observation that may have effect on the price forces.

To tackle the rise in the price of commodities, the government in addition to restricting the retail price of commodities, involved in importing of commodities. According to the recent report from Ministry of Trade in reference to Fortune Newspaper (24 June 2015), Public Procurement and Property Disposal Service (PPPDS) on behalf of the Ethiopian Grain Trade Enterprise (EGTE) is procuring wheat through international tenders. The recent procurement award to two foreign companies for the purchase of 2.4 million quintals of wheat with 1.08 billionBirr shows that the cost per quintal of wheat is as high as Birr 750 even at the port of exporters' level.

In 2011/12 and 2012/13, alone 4.2 and 5.6 million quintals of wheat were imported respectively, but in 2013/14 the amount decreased to five million quintals. Out of 6.5 million quintals of planned wheat purchase for the current budget year, 2014/15, six million quintals have already been purchased (Report from Ministry of Trade 2015).

The price of domestic produce of wheat keeps rising and the wheat flour factories find it expensive to meet their capacity requirements. Instead, they mostly rely on government imported wheat. The government imports are found to be not adequate to satisfy the daily operational needs of wheat flour factories to support proper utilization of their capacities.

The government's intention is to distribute the wheat at a price of Birr 550 and claims a subsidy of Birr 250 per quintal of wheat. However, this happened to be not practical as the cost of wheat climbed to Birr 750 at sellers' delivery place a year later it has been announced (Ibid, 2015).

With these facts in place, regulatory processes that enable the efficient operation of the entire network, particularly that of the flour factories need to be in place to help in improving the welfare of consumers.

Particularly when the industry landscape is changing rapidly and inflationary movements are apparent, rate of return regulation is not in a position to produce efficiency improvements to counteract the inflation.Understandably, therefore, it is difficult for regulators at both the state and federal levels to adapt the usual policy orders ofcost of service regulation. Instead the move to adapt alternative forms of rate regulation that combine benefits for consumers with industry incentives looks promising.

With these premises, the most common forms of alternative regulation are based on a system of price caps, which imposes limits on product and service rates, as opposed to restricting the profits of carriers under the traditional rate of return regulation (RRR) framework.

The effort to substantiate the argument from earlier studies has resulted lack of empirical researches done in this area to document the reality in the country. Partly this is attributable to the relatively recent phenomenon of price cap regulation coming in to effect, with such regulation is in its four years period.

1.2. Statement of the Problem

One of the prime objectives of free market economy is to facilitate the economic environment for firms that the market remain competitive and that competitive markets warrant the efficient delivery of goods and services to their customers. When competition is absent consumers pay the higher prices. Given the demand for basic necessity remains high, the inelastic nature to price effect can deplete the consumer welfare and start to compromise for other needs.

As a result, government intervention to fill the gap and stabilize the market becomes imperative. The persistent price escalations in the basic commodities have attracted many economic researchers to investigate the price rise in relation to inflation and prescribe policy options to curb the problem. After policy measures, however, there need be some assessment of the effects of policy prescriptions and its implementations.
The upsurge of high inflation rates has been a major threat to macroeconomic stability in Ethiopia, prompting the government to take several measures to contain inflation. Thefirst measure taken by the government consisted in ceiling the retail price of selected commodities. Price capes on 18 essential commodities, including bread, rice, meat, cookingoil and sugar, were imposed in January 2011. However, most price ceilings were lifted in late May 2011. Other measures consisted in importing commodities such as grains (in particular wheat), sugar, and edible oil to stabilize local market prices.

The recently introduced price regulation scheme by the government is to limit the retail prices of basic commodities using Price Cap Regulation (PCR) has in effect for the last four years that its impact can be amenable for assessment. For consumers, capped rates mean lower and more stable prices for basic services. To investigate the impact of PCR, it would be better to study in comparison with rate of return regulation (RRR). Unlike to PCR, in the RRR system, consumers were subject to price increases if a company did not meet earning projections, or worse yet, if the company was simply inefficient.

According to Wilk (2001), financially, PCR has produced benefits for customers through rate reductions and by forcing companies to absorb the effects of inflation. By cutting the link between sales earnings and customer rates, new regulatory framework assumed to make the companies bear the risk of inflation and keeps the competitive risk on shareholders, rather than customers.

According to (Brennan, 1989; Cabral & Riordan, 1989; Vogelsang, 2002; Cowan, 2002; Vogelsang & Finsinger, 1979) view, price caps have kept consumer good and service rates low and provided a means for transitioning toward competition. Price caps have a number of key advantages over traditional rate-of-return regulation, including: Reduced regulatory lag; Predictable prices; Reduced regulatory surveillance and lower regulatory costs; Decreases in waste associated with cost-plus regulation; Increases in productivity due to earning incentives.

The introduced price cap regulation for some basic products including edible oil, sugar, and wheat flour have remained in effect for the last four years and so in order to mitigate the rising costs and to ensure consumer welfare. To evaluate the impact of these policy and guide future policy directions, empirical analysis is important. However, there are no empirical studies that address the impact of these regulations to the best of our knowledge.

This study, therefore, aims at investigating whether or not the price cap introduced shortly in our country has brought the welfare effects from wheat flour factories as compared to the rate of return regulation.

1.3. Objective of the Study

The general objective of the study is to assess the welfare effects of price cap regulation compared to the rate of return regulation.

The specific objectives of the study include the following:

- To investigate the effect of price cap regulation in terms of surplus generating potential as compared to rate of return regulation;
- To analyze the effect of regulation on welfare distribution of consumers and producers; and
- To forward some feasible suggestions and recommendations based on the findings of the study.

1.4. Significance of the Study

Although the research uses existing methodologies to study the welfare effects of PCR as compared to rate of return regulation on consumers and producers, the results can provide additional insights into the study area in the context of Ethiopia. This has particular importance since results may vary depending on specific economic circumstances and contribute to the general empirical results of the country.

In addition, the study may trigger questions that can lead to comprehensive studies in the area. It might also provide policy makers with information regarding the impact of PCR and what should be considered in future policy formulations.

1.5.Scope of the Study

The focus of this study is to investigate the policy impact on welfare of price cap regulation as compared to rate of return regulation. The price cap regulation has been initiated on eighteen widely ranging basiccommodities including rice, meat, wheat flour, edible oil, and sugar among others.

The regulation after the trial period, however, persistedon only three basic consumer goods, namely Wheat Flour (including bread), Sugar, and Edible Oil. To make theresearch more manageable both in terms of time and cost, the study focuses on the welfare effects of price cap regulation on 28 Wheat Flour Mills in Addis Ababa.

1.6.Research Design and Methodology

The researcher used Stochastic Frontier Analysis of the stochastic Cobb-Douglass production function for the estimation of efficient costs of panel of 28 flour factories. The parameters of the stochastic frontier functions are estimated using maximum likelihood method. These results of the efficient costs are further required to calculate the welfare effects of the price cap regulation compared to the bench mark, rate of return regulation that help to address the basic questions of the thesis.

The researcher specifies four models including: the basic random effect model, random effect with heterogeneity, true random effect, and fixed effect stochastic frontier models using Cobb-Douglas production function. The production function is set in its stochastic specifications that includes the error term to measure efficiency costs. The output (LHS) of the production function is multiplied by the cost (price) of output to aggregate the cost of production. Whereas, the factors of production (RHS) multiplied with their corresponding costs (prices), can help to determine the cost of production. Such specifications are dealt in detail in model specification part of thisresearch. The benchmark model is the basic random effects (RE) model, this is because not the model is best fit the data, rather the model assumes since this modelthe benchmark model is the basic random effects (RE) model. The assumption here is that the random terms v and u to be normally and half normally distributed. The inefficiency term (u) is time invariant in this model specification.

1.6.1 Sources of Data

Both primary and secondary sources of data are used for the panel study.

- Primary data was collected from 28 Flour Mills regarding Prices of capital, priceof labor, capacity utilization, and customer numbers so that the data obtained serve to smoothly fit to the model variables.
- Secondary data is collected for the study from documents and reports found at Ministry of Trade and Ethiopian Grain Trade Enterprise to learn input wheat prices, distribution levels, and regulation. The Enterprise manages the distribution of wheat to flour mills. To address the data requirement of the study, 28 wheat flour factories are included in the study. The 28 flour factories are considered in the study due to the fact that these flour factories were in operation while the price cap regulation was in effect.

1.6.2. Sample Design

There are 281 flour factories to which the government is intending to distribute the wheat at a subsidized price country wide. These factories will then sell the wheat flour for 5,000 bakeries which are identified and linked with them.In Addis Ababa, where the research is focused on, there are more than 40 flour mills in operation. However, the 28 flour mills were in operation while the price cap regulation was put in effect. Therefore, all the 28 flour mills are considered as panel data sources for the study to reflect the four years practice under the regulation.

1.6.3 Data collection Instruments

The following three data collection instruments are employed. Namely, unstructured interview, document analysis, and observation.

- Interview (Unstructured interview is employed to gain information from concerned officials about the enforcement of regulatory process).

- Document analysis: policy instruments, guidelines, acts, proclamations, reports and minutes are referred to compile the raw data used to estimate the parameters.
- Observation: to gain some insight,personal observation is used to learn about standards of packaging and distribution practices of wheat and flour.

1.6.4 Procedure for Data Collection

The necessary data are collected from time series records of the Ministry of Trade, Ethiopian Grain Trade Enterprise, and the flour factories. Data from factories were used to reflect costs of capital, labor, prices of input wheat (compiled on monthly bases and aggregated to yearly data requirements), and capacity utilization data.

1.7. Organization of the Study

Chapter one of the study deals with the proposal of the research including; Introduction, Statement of the Problem, Objectives of the Study, Significance of the Study, Scope of the Study, Research Methodology, and Organization of the study.

Chapter twopart is about the analytical framework of the study, dealing with relevant literature review covering among others: The Review of Economic Theory of Regulation, Efficiency and Effectiveness of Price Regulation, Stochastic Production Frontier Models and Technical Efficiency, the Maximum Likelihood Estimation, Welfare Effects of Price Regulation.

The third chapter is about model specification,data presentation, estimation of the efficiency costs, and interpretation of the major findings of the study.

The fourth chapter and the last part of the study is all about the conclusions and recommendations of the study.

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

2.1. ECONOMIC THEORIES OF REGULATION

2.1.1. Introduction

While reviewing the economic theories of regulation, one can note that there are two broad traditions and customs with respect to the economic theories of regulation. According to Hertog (2010) the first tradition assumes that regulators have sufficient information and enforcement powers to effectively promote the public interest. This tradition also assumes that regulators are benevolent and aim to pursue the public interest. Economic theories that proceed from these assumptions are therefore often called *'public interest theories of regulation'*. Another tradition in the economic studies of regulation proceeds from different assumptions. Regulators do not have sufficient information with respect to cost, demand, quality and other dimensions of firm behavior. They can therefore only imperfectly, if at all, promote the public interest when controlling firms or societal activities. Within this tradition, these information, monitoring and enforcement cost also apply to other economic agents, such as legislators, voters or consumers. And, more importantly, it is generally assumed that all economic agents pursue their own interest, which may or may not include elements of the public interest. Under these assumptions there is no reason to conclude that regulation will promote the public interest. The differences in objectives of economic agents and the costs involved in the interaction between them may effectively make it possible for some of the agents to pursue their own interests, perhaps at the cost of the public interest. Economic theories that proceed from these latter assumptions are therefore often called *'private interest theories of regulation'*. *These issues are reviewed in depth in the following subsections.*

2.1.2. **General Economic Theories of Regulation**

In legal and economic literature, there is no fixed definition of the term ‘regulation’. Some researchers consider and evaluate various definitions and attempt through systematization to make the term amenable to further analysis (Baldwin and Cave, 1999; Morgan and Yeung, 2007; Ogus, 2004). Others almost entirely abstain from an exact definition of regulation (Ekelund, 1998; Joskow and Noll, 1981; Spulber, 1989; Train, 1997). In order to delineate the subject and because of the limited space, a further definition of regulation is nevertheless necessary. In this research, regulation will be taken to mean the employment of legal instruments for the implementation of social-economic policy objectives. A characteristic of legal instruments is that individuals or organizations can be compelled by government to comply with prescribed behavior under penalty of sanctions. Corporations can be forced, for example, to observe certain prices, to supply certain goods, to stay out of certain markets, to apply particular techniques in the production process or to pay the legal minimum wage. Sanctions can include fines, the publicizing of violations, imprisonment, an order to make specific arrangements, an injunction against withholding certain actions, divestiture of businesses or closing down the business.

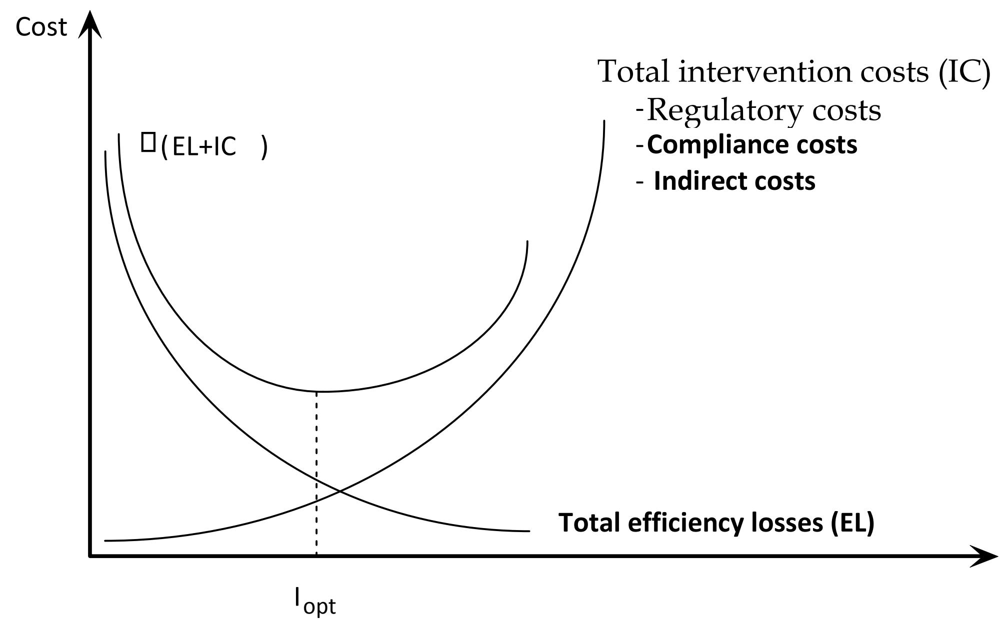
A distinction is often made between *economic and social regulation*, for example Viscusi, Vernon and Harrington (2005). Two types of economic regulations can be distinguished: structural regulation and conduct regulation (Kay and Vickers, 1990). *Structural regulation* concerns the regulation of the market structure. Examples are restrictions on entry or exit, and rules mandating firms not to supply professional services in the absence of a recognized qualification. *Conduct regulation* is used to regulate the behavior of producers and consumers in the market. Examples are price controls, the requirement to provide in all demand, the labeling of products, rules against advertising and minimum quality standards. *Economic regulation* is mainly exercised on so-called natural monopolies and market structures with imperfect or excessive competition. The aim is to counter the negative welfare effects of dominant firm behavior and to stabilize market processes. *Social regulation* comprises regulation in the area of the environment, occupational health and safety, consumer protection and labor (equal opportunities and so on). Instruments applied here include regulations dealing with the discharge of environmentally harmful substances, safety regulations in factories and workplaces, the obligation to include information on the packaging of goods or on labels, the prohibition of the supply of certain goods or services unless in the possession of a permit and banning discrimination on race, skin color, religion, sex, or nationality in the recruitment of personnel.

The economic literature distinguishes between positive and normative economic theories of regulation. The *positive* variant aims to provide economic explanations of regulation and to provide an effect-analysis of regulation. The *normative* variant investigates which type of regulation is the most efficient or optimal. The latter variant is called normative because there is usually an implicit assumption that efficient regulation would also be desirable; for the distinction between positive and normative theories, see the discussion between Blaug (1993) and Hennipman (1992). The literature here concentrates on general explanatory and predictive economic theories of regulation. In this respect two preliminary remarks are in order. First, the mainstream economic literature is implicitly or explicitly critical of the public interest theories of regulation. These theories are often thought to be 'normative theories as positive analysis' (Joskow and Noll, 1981), implying that the *evaluative* theoretical and empirical analysis of markets has been used to *explain* actual regulatory institutions in practice. The public interests theories of regulation are described as rationalizing existing regulations, while private interest theories are discussed as theories that explain existing regulation (for example Ogus, 2004). According to some other authors, there even is no such thing as public interest theories of regulation or they are a misinterpretation and have lost validity (Hantke-Domas, 2003; Häg, 1997). To have a proper discussion on the evaluation and appraisal of economic *theories* of regulation, it would be desirable to explicitly proceed from evaluation criteria that have been developed and are subject of debate in the methodological literature on the appraisal of theories (Dow, 2002; Blaug, 1992). Some of these criteria would be for example internal consistency, empirical corroboration, plausibility and more. By making the evaluation criteria explicit, the appraisal of economic theories of regulation would become more precise and explicit. The second remark pertains to the concept of regulation. A distinction is often made between legislation and regulation. Usually in legislation regulatory powers are allocated to lower level institutions or officials. The result of the use of that power by these officials or institutions is then called regulation. Within the perspective of some explanatory theories, the distinction between regulation and legislation does not always add much additional explanatory or predictive value to regulatory theories. The explanatory power of a market failure as a driving force of public interest regulation for example, does not really depend on whether decision making powers have been centralized or decentralized. From other perspectives, the distinction is important. The explanatory power of variables like rentseeking and capture may differ according to the level of regulatory decision making. According to some theories, delegation may help to prevent inefficient rent extraction by politicians (Shleifer and Vishny, 1998). According to others, that is where problems of unaccountable regulators begin (Martimort, 1999). In the remaining of this literature we will use the term regulation irrespective of its centralized or decentralized character and only introduce the distinction between regulation and legislation if this distinction is crucial for the particular hypothesis or theory in question. For a perspective on the use of the term regulation and its meaning in this respect, see Jordana and David Levi-Faur (eds.), 2004, chapter one. Other reviews of the regulatory literature are Aranson (1990), Baron (1995), Ekelund (1998), Hägg (1997), Hantke-Domas (2003), Mitchell (1991), Ogus (2004a), Joskow (2007), and Viscusi (2007).

2.1.3. Public Interest Theories of Regulation

The first group of regulation theories proceeds from the assumptions of full information, perfect enforcement and benevolent regulators. According to these theories, the regulation of firms or other economic actors contributes to the promotion of the public interest. This public interest can further be described as the best possible allocation of scarce resources for individual and collective goods and services in society. In western economies, the allocation of scarce resources is to a significant extent coordinated by the market mechanism. In developing economies, however, this may not hold. In theory, it can even be demonstrated that, under certain circumstances, the allocation of resources by means of the market mechanism is optimal (Arrow, 1985). Because these conditions do frequently not apply in practice, the allocation of resources is not optimal from a theoretical perspective and a quest for methods of improving the resource allocation arises (Bator, 1958). This situation is described as a market failure. A *marketfailure* is a situation where scarce resources are *not* put to their highest valued uses. In a market setting, these values are reflected in the prices of goods and services. A market failure thus implies a discrepancy between the price or value of an additional unit of a particular good or service and its marginal cost or resource cost. Ideally in a market, the production by a firm should expand until a situation arises where the marginal resource cost of an additional unit equals its marginal benefit or price. Equalization of prices and marginal costs characterizes an equilibrium in a competitive market. If costs are lower than the given market price, a firm will profit from a further expansion of production. If costs are higher than price, a firm will increase its profits by curtailing production until price again equals marginal cost. A market equilibrium, and more generally an equilibrium of all markets is thus a situation of an optimal allocation of scarce resources. In this situation supply equals demand and under the given circumstances can market players do no better. A great number of conditions have to be satisfied for an optimal allocation in a competitive market economy to exist, see generally Boadway and Bruce (1984).

One of the methods of achieving efficiency in the allocation of resources when a market failure is identified, is government regulation (Arrow, 1970, 1985; Shubik, 1970). In the earlier development of the public interest theories of regulation, it was assumed that a market failure was a sufficient condition to explain government regulation (Baumol, 1952). But soon the theory was criticized for its *Nirwana approach*, implying that it assumed that theoretically efficient institutions could be seen to efficiently replace or correct inefficient real world institutions (Demsetz, 1968). This criticism has led to the development of a more serious public interest theory of regulation by what has been variously referred to as the "New Haven" or "Progressive School" of Law and Economics (Ogus in Jordan and Levi-Faur, 2004, Rose-Ackerman, 1988, 1992; Noll, 1983, 1989a). In the original theory, the transaction costs and information costs of regulation were assumed to be zero. By taking account of these costs, more comprehensive public interest theories developed. It could be argued that government regulation is *comparatively* the more efficient institution to deal with a number of market failures (Whynes and Bowles, 1981). For example, with respect to the public utilities it could argued that the transaction cost of government regulation to establish fair prices and a fair rate of return are lower than the costs of unrestricted competition (Goldberg, 1979). Equivalently, it could be argued that social regulation in some cases would be a more efficient institution to deal with the pollution of the environment or with dealing with accidents in the workplace than private negotiations between affected parties could. Regulators would not be plagued by failures in the information market and they could more easily bundle information to determine the point where the marginal cost of intervention equalizes the marginal social benefits (Leland, 1979; Asch, 1988). These more serious versions of the public interest theories do not assume that regulation is perfect. They do assume the presence of a market failure that regulation is comparatively the more efficient institution and that for example deregulation takes place when more efficient institutions develop. These theories also assume that politicians act in the public interest or that the political process is efficient and that information on the costs and benefits of regulation is widely distributed and available (Noll, 1989a). The core of this basic framework is captured in the following diagram.



L*evel of intervention*

Figure 1: Optimal level of welfare loss control

Source: Noll, 1989a, 'Economic Perspectives on the Politics of Regulation'

Imagine an unregulated natural monopoly firm supplying public utility services. The firm makes supernormal profits, charges different prices to different consumer groups and does not supply services to high-cost consumers in rural areas. Economic theory predicts an inefficient allocation of resources. Without regulatory intervention these costs are at its highest at the point where the EL-curve intersects with the vertical axe (intersection not visible). Intervening in the market results in a decline of these welfare cost. The stronger the level of intervention, the lower the welfare losses in the private sector will be. The naïve public interest theory of regulation for example, would explain 'fair rate of return' regulation from the presence of the natural monopoly firm. Prices must decline and production increased until societal resources are allocated efficiently. The more complex public interest theories of regulation take the costs of regulatory intervention into account. The more a regulator intervenes in the private operation of the firm, the higher the intervention costs will be (curve IC). The regulator must have information on cost and demand facing the firm before efficient prices can be determined. There will be compliance cost for the firm in terms of time, effort and resources.

It will have to comply with procedures, adapt its administration and incur productivity losses. Once put into practice, the cost of monitoring firm behavior and enforcement of the regulations arises. It is to be expected that the firm will behave strategically and conceal or disguise any relevant information for the regulator. Furthermore, indirect costs are to be expected. The less profit the firm makes, the lower the effort in decreasing production cost or in developing new products and production technologies. Also less tangible effects are predicted. Regulatory intervention makes private investments less secure: risk premiums rise, investments decline and economic growth will slow down, etc. The regulator is aware of these costs and has several options to choose from: it could for example regulate prices or profits or a combination of both. Whichever it chooses, there will be different intervention costs and different consequences for static and dynamic efficiency. The optimal level of intervention (I_{opt}) implies trading off resources allocated to increasing levels of regulatory intervention and decreasing levels of inefficient firm behavior. Complicating the policy options further, for politicians there are alternatives to the regulation of prices, profits, service levels, etc. The legislator could also decide to franchise an exclusive right to operate the market or erect a public enterprise to maximize welfare. Again, these institutions require different cost of intervention and have different effects in terms of static and dynamic efficiency or other policy goals. Amongst others, they differ with respect to the informational requirements, the administrative costs, the burden for the private sector including the cost of errors, distributional effects, governance, accountability, risks of capture and corruption, and more. The public interest theories of regulation thus basically assume a *comparative analysis of institutions* to have taken place to efficiently allocate scarce resources in the economy. Equivalent reasoning applies to the field of *social regulation*. Imagine that lifting weight, for example a patient in a hospital or cement in the construction sector, creates back trouble or even work disability. Employees are often not very well aware of the risks they run, and even if they do they will find it difficult to deal with small risks such as 0.0001. The costs involved however, may be considerable: medical costs, lost earnings and risk of injury and pain, and consequences for relatives and friends. The inefficiency in the allocation of resources in the absence of regulation is again depicted by the curve EL. A regulator may decide on, for example, regulating maximum weights. She needs to identify the potential risk involved, how this risk varies with exposure to lower weights and different circumstances. Then the maximum allowable weight lifting must be determined. The regulator knows that increasing levels of intervention or standard setting will increase costs (curve IC). The more detailed and precise, the higher the regulatory costs. The higher the weight standard, the higher also compliance costs will be: more nurses in the hospital and increasing use of capital equipment in the construction sector. Indirect costs will also increase with the level of intervention: there will be a lower ratio of input to output and substitution between now comparatively higher priced labor and capital equipment. Not only will employment decline but also the speed of technical change. The setting of the standard lowers the incentive to seek for technologies to further prevent lifting costs below the standard. Again, the regulator is aware of these costs and has several options to choose from. It could set an output or performance standard limiting the number of incidents. It could prescribe an input standard by specifying the use of certain care technologies or machinery. Alternatively, it could set a target standard that imposes criminal liability for certain harmful consequences or it could impose process standards obligating procedures to have the firm identify the risks and deal with them. All these forms of intervention have different intervention costs and compliance costs and different effects in terms of static and dynamic efficiency or other policy goals. The optimal standard or level of intervention depicted in the diagram is I_{opt}. And again, complicating matters further, for political decision makers there are alternative institutions to regulation, such as providing the firm and the employees with information and have private law and tort liability to deal with any costs involved or, in cases of severe dangers to life and health, a prohibition to use of certain techniques, equipment or materials.

Tosummarize the discussions above, the public interest theories of regulation depart from essentially three assumptions: the prevalence of a market failure, the assumption of a 'benevolent regulator' or, alternatively, an efficient political process and the choice of efficient regulatory institutions. Starting from the allocation of scarce resources by a competitive market mechanism, *four* types of market failures can be distinguished. Discrepancies between values and resource costs can arise as a result of imperfect competition, unstable markets, missing markets or undesirable market results. *Imperfect competition* will cause prices to deviate from marginal resource cost. *Unstable markets* are characterized by dynamic inefficiencies with respect to the speed at which these markets clear or stabilize. These instabilities waste scarce resources. *Missing markets* imply the demand for socially valuable goods and services for which total value exceeds total cost but where prices or markets do not arise. And finally, even if the competitive market mechanism allocates scarce resources efficiently, the outcomes of the market processes might still considered to be unjust or *undesirable* from other social perspectives. We shall discuss these market failures in turn, assuming in first instance that the government acts as an omniscient, omnipotent and benevolent regulator (Dixit, 1996).

2.1.4. Imperfect competition

In the first place, an efficient market mechanism implies certain rules and regulations and assumes that individual property rights are established, allocated and protected and that freedom to contract exists and is enforced (Pejovich, 1979). Not only are the cost of market transactions reduced by property and contract law, also the protection of property rights and the enforcement of contract compliance is more efficiently organized collectively than individually. The freedom to contract can, however, also be used to achieve cooperation between parties opposed to efficient market operation. Agreements between producers to keep prices high and supplied quantities artificially low, will give rise to prices deviating from the marginal costs. A dominant position by one or a few firms also gives rise to prices departing from marginal costs. Anti-monopoly legislation is aimed at maintaining the efficient market operation through merger control and by prohibiting anticompetitive agreements or behavior. More importantly for this review, are the special characteristics of certain products and production processes in sectors such as the energy sector, telecommunication, transport, postal services, and water and especially for the research purpose, commodity market is included. Much of the so-called *economic regulation* relates to these sectors. In order to explain some of the market failures in these fields, we will make use of the diagram below where a simplified market situation of a typical single product firm in such a sector is depicted. The diagram shows the declining average cost curve AC of a typical firm and the market demand curve D. Marginal costs are assumed to be constant and equal to P_{mc}. The market demand curve D or average revenue (AR) intersects with the declining part of the average cost curve of the firm, which implies that average cost are minimized if the production is concentrated in one firm. If several companies with the same production technology produce the same total quantity, the unit costs of production rise. For this reason, this situation is called a *natural monopoly*. For the more precise conditions of a natural monopoly, see Baumol et al., (1982).

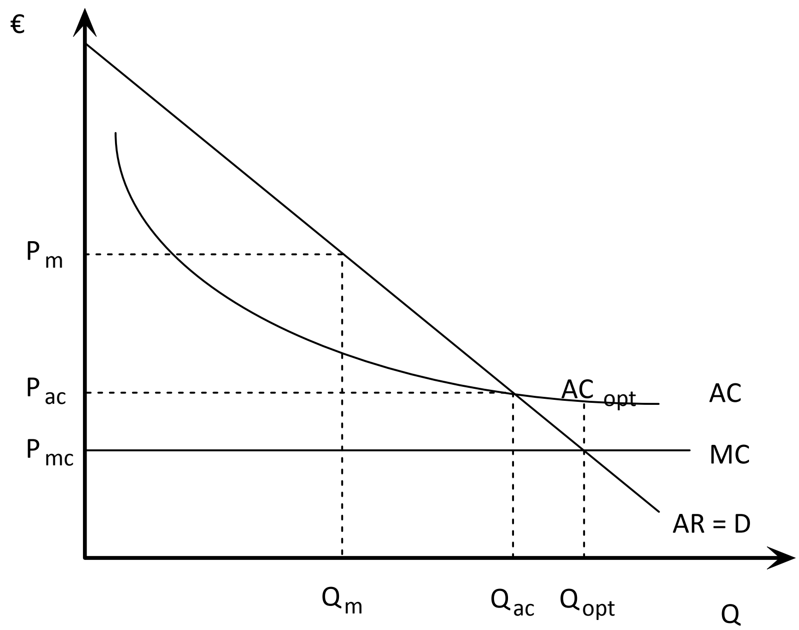


Figure 2: Natural monopoly and its tradeoffs
Source:Baumol, etal (1982), Contestable Markets and the Theory of Industry Structure, San Diego, Harcourt Brace Jovanovich.

An example of how such a situation arises is when the production process requires a great deal of sunk capital for the installment of a distribution network. You can think of a network of pipes, wires, cables or railroads to supply gas, electricity, telecommunication, television signals, or transport services respectively. In those cases, the cost per service (average costs) continues to decline as the production of goods and services increases (Baumol, 1977). In an unrestricted market, several failures will appear. First of all, a firm contemplating of entering the market will realize that entry will provoke price competition from the incumbent firm, driving prices down to marginal costs. If that is the case, the sunk costs necessary to set-up production cannot be recovered and the firm will decide not to enter. If the firm thinks it is more efficient than the incumbent firm, so-called "wars of attrition" will arise, leading to bankruptcy and waste of scarce resources. Second, if the incumbent firm is indeed a natural monopolist it will maximize profits by equalizing marginal costs and marginal revenues (P_m in the diagram). Under the usual assumptions of the inability to price discriminate and the inability to prevent arbitrage, the firm will limit production (to Q_m) and set profit maximizing prices to clear the market. As a result prices will deviate significantly from marginal costs (Train, 1997). Next, the firm knows if it has invested huge amounts of sunk capital, it will be vulnerable to expropriation by political decision makers (Newbery, 2001). Third parties will rationally expect the firm not to exit the market as long as prices are above marginal cost even though they are insufficient to recoup the fixed costs of the network. As a result of these political risks, risk premiums will rise and the firm will under-invest (Sidak and Spulber, 1998). Furthermore, entry is expected to take place, not only when these markets develop or in highly profitable parts of the market, but also in the case firms consider themselves to be more efficient than the incumbent firm. Productive inefficiency is the result and cut-throat competition will appear. For a number of these natural monopolies, history has shown these events to take place (Kahn, 1988; Priest, 1993; Vietor, 1989; 1999). Finally, from a social point of view the market outcomes will be discriminatory or unjust. Highcost consumers will not be served, consumers who cannot switch to alternative supply will pay discriminatory high profit maximizing prices and the firm will make huge profits at the cost of consumers.

To promote a more efficient and equitable allocation of scarce resources, these natural monopolies are either put under control of the state, as happened in many European countries, or highly regulated, as for example is the practice in the United States. In the former case, these firms are instructed to maximize welfare instead of profit. In the latter case, regulation consists of stopping entry and enforce price or profit rules that promote an efficient and equitable allocation of resources (Schmalensee, 1979; Braeutigam, 1989). For example, prices are set equal to average costs by means of *rate of return regulation* (price P_{ac} in the figure 2) and a price structure is determined such that the firm breaks even. Ideally, the optimal price would of course be a price according to marginal resource cost. This however, would lead to financial losses, depicted by the difference between P_{mc} and AC_{opt}. At Q_{opt} the cost per unit is AC_{opt}, while the revenues per unit are only P_{mc}, which in the diagram is about 30% too low to cover costs.

The regulator thus has to choose between the inefficiencies of subsidies or a price that covers cost, but that is not 'first best' efficient. Actual regulations taking into account limitations on information and enforcement are areas that need considerations.

2.1.5. Market instabilities

A more efficient allocation of resource may not only be accomplished by a redress of imperfectly competitive markets but also by stabilizing inherently unstable markets.

Imbalances within an economy occur at the level of separate markets and on a macro level. In separate markets, destructive or excessive competition may arise, often as a result of longterm over-capacity. The establishment of a new equilibrium may take a long time if the individual market players are in a prisoner's dilemma. For all market parties jointly, efficiency is achieved if the existing over-capacity is rationalized. For an individual producer, however, the 'sunk costs' may imply that it is rational to wait until other suppliers have withdrawn from the market. Because this consideration applies to all producers, over-capacity can persist for a considerable time. Over-capacity situations may also arise when the production capacity is adjusted to demand at peak moments or peak periods. Examples are peak loads in the rush-hour (electricity, electronic communication, busses, underground railways and trains), during the harvest in agriculture (trucks) and during the tourist high season (touring cars, aircraft). The following diagram illustrates this instability.

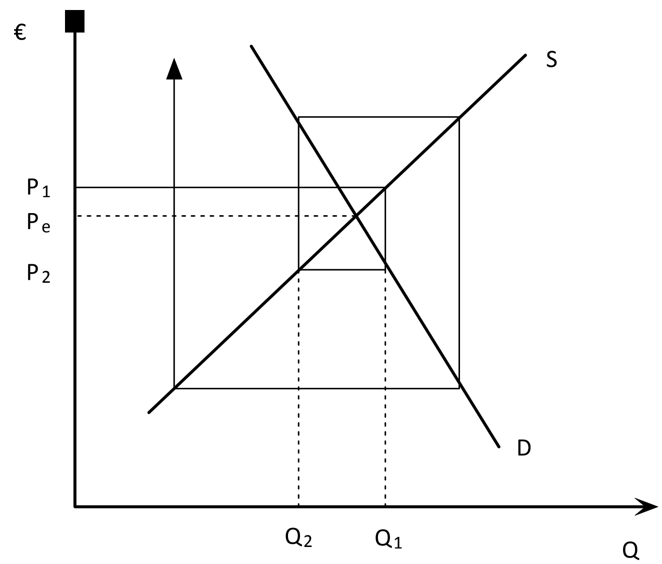


Figure 3: Dynamic inefficiency of an unstable market
Source: Breyer, Stephen G. (1982), Regulation and its Reform, Cambridge, MA, Harvard University Press, 472 p.

Assume that because of some shortage in supply in a former period, prices have risen to P_1, which is somewhat above market equilibrium price P_e. At that price, supply is Q_1. However, at that quantity, the market can only clear at price P_2. Suppliers will react to that price by supplying only Q_2 units in the next period. However, at these quantities, the market will clear only at very high prices, motivating suppliers in the next period to supply increasingly more, etc. Excessive or ruinous competition may also arise in a natural oligopoly setting. In a natural oligopoly situation productive efficiency is achieved if only a few companies supply the market. The small number of companies allows each of them to react to each other's market strategies. One of the outcomes may be a persistent price war. Effects are that prices may decline below average cost and that price dispersion is increased. Both effects create inefficiencies in the allocation of resources or in consumer decision-making. Furthermore, excessive competition may be detrimental to safety and reliability when consumers cannot observe or verify the quality of goods and services (Kahn, 1988, pp. 172-178). In the past regulatory practices assumed that situations of excessive competition applied to sectors such as air travel, passenger transport, freight or transport by water (trucks, taxis, shipping). For these sectors, business licensing restrictions were devised and the capacity was rationed, sometimes in combination with minimum price regulation. Regulatory theories however, considered the collection of excessive competition-rationales of government intervention to be ‘an empty box’ (see Breyer, 1982, pp. 29-32) and regulations might better be explained from a private interest perspective. Recently, modern regulatory theories developed several instances of structural market failures in potentially competitive sectors Telser, 1978, 1994, 1996; Button and Nijkamp, 1997). Free entry may result in too much entry if costs are sunk in the form of production facilities or marketing expenditures. The increase in competition and the resulting decrease in consumer prices may not weigh up to the increase in the resource costs that entry requires. There may as well be insufficient entry if consumers value product diversity but firms do not enter because profit opportunities decrease with increased entry (Mankiw and Whinston, 1986; Perry, 1984). Except at the level of the individual sectors, imbalances may also occur on a macroeconomic level. Market economies are characterized by a business cycle, the regular alternation of periods of increasing and declining economic activity. In the course of the business cycle, a self-sustaining process develops in the product market that is not compensated by adjustments in the labor market. This arises partly because of lack of information, long-term labor contracts and efficiency wages. Trade-cycle policies can be desirable to prevent temporary disturbances which have permanent effects. For example, specialized investments with limited alternative value in other market segments may be permanently lost in a recession. Also, structural unemployment may arise when unemployed workers lose their skill and motivation. Finally, stabilization of the business cycle may be desirable to prevent the decline of production and employment such that different social groups are unequally affected by the economic rise and fall. But of course, all these regulations have their costs that have to be compared to the benefits in terms of increases in social welfare.

Traditionally, trade-cycle policies are put into effect together with instruments of budgetary and monetary policy; for an overview of the significance of these instruments and the underlying theories, see Snowdon, Vane and Wynarczyk (2007). Because these instruments are not directed to specific sectors and can only take effect after some time, wage and price regulation have been developed in some market economies. To combat a wage-price spiral, governments have developed the legal means to freeze wages and prices for a period of within a half to one year, if necessary applicable in designated sectors (Ogus, 2004, pp. 300ff. and Breyer, 1982, pp. 60ff.). Of course, because market economies have become global these instruments, while still existing as legal powers have largely become obsolete in practice.

But for economies like ours, such promise of the long term effect market economies will not be awaited in hope. Definitely, certain regulation to bridle firm's self-interest need to be in place, as may be, the case with price regulation.

2.1.6. Missing markets

2.1.6.1. Information problems

For a number of reasons, markets may be 'missing' for some goods and services for which the utility or the 'willingness to pay' exceeds the production costs. Missing markets may be the result of information problems and transaction costs. These problems and costs justify much of the *social regulation* that efficiently aims to protect the worker, the consumer and society at large. In practice, the full information assumption of a perfectly competitive economy is rarely found. With respect to the information that is available on goods and services in a market, it is useful to make a distinction between 'search goods', for which the quality of a product can be determined prior to purchase, 'experience goods', for which quality only becomes apparent after consumption of the good and 'credence goods or trust goods', for which the quality cannot even be established after consumption (See generally, Beales et al. 1982; Armstrong, 2008; Nelson, 1970; Darby and Karni, 1973; Dulleck and Kerschbamer, 2006). Examples of each are the purchase of flowers, second-hand cars and repair firms, respectively. Consumers and workers have an interest in being informed on relevant aspects of their purchases and of their jobs, such as the safety and health dimensions. In a competitive market employers and producers also have interest in revealing the relevant characteristics of jobs and products. However, the 'information market' is characterized by market failures and these failures spill over to the market for goods and services (Hirshleifer and Riley, 1979). On the demand side, information will be searched until the marginal cost equals marginal benefit. However, since search intensifies competition, it produces external benefits for uninformed parties. As a result information is searched in suboptimal amounts from a social perspective. Furthermore, at a general level information will be undersupplied. The production of information is costly, but the dissemination is not. If competition drives prices down to marginal distribution costs, it will be difficult to cover the fixed cost of production. Also, the market will undersupply the optimal amount of information when producers are not able to fully appropriate all the revenues from their investments. Examples are the investments in the knowledge of the health and safety dimensions of chemical substances. And certainly, information will not be supplied when it is not in the interest of the sector itself to do so, as is the case in situations of collective 'bads' such as smoking hazards. When it is not possible to establish the relevant quality dimensions of particular goods or services in advance, purchasers will be prepared to pay an average price corresponding with the average expected quality. Sellers of high quality products will not be prepared to sell at that asking price, and will withdraw from the market. The end-result is that the quality of goods and services will decline, as will the price buyers are prepared to pay (Akerlof, 1970). In this process of *adverseselection*, high quality goods are driven from the market by low-quality goods. In addition, the asymmetric distribution of information can also give rise to *moralhazard* in the enforcement of contracts, which means that parties take advantage of their information lead.

Examples would be food processors (as the case in our country suggests, mixing of less expensive cereals with wheat and use of poor quality wheat to make bread flour) and lawyers who give unfounded advice.

The following diagram illustrates how valuable products or services may disappear from the market and how a market is finally missing (adapted from Pindyck and

Rubinfeld, 2001). Imagine high quality car repair firms who are offering their services (S_1^h), and drivers who cannot establish the quality of the reparations. Had they known the quality of the services supplied, they would have bought Q_1 units. Drivers however, are not informed of the quality of the firms and just know there are high and low quality firms. Visiting a repair firm, a driver expects ex ante the services supplied to be of average quality.They are willing to pay for the services according to the expected average quality, which is determined by the ratio of high and low quality firms in the market. Their actual market demand is thus not D_1^h, but D_2^h. At that price, only Q_2 units are supplied in the market, so the ratio of high and low quality firms decreases. Eventually, patients will come to learn the change of this ratio in the market and adapt their demand accordingly. The demand for high quality services shifts to D_3^h. Professional firms who supply high quality and high cost services, cannot supply these services at the lower market price and will leave the market. Now the supply of high quality services decreases to S_2^h.

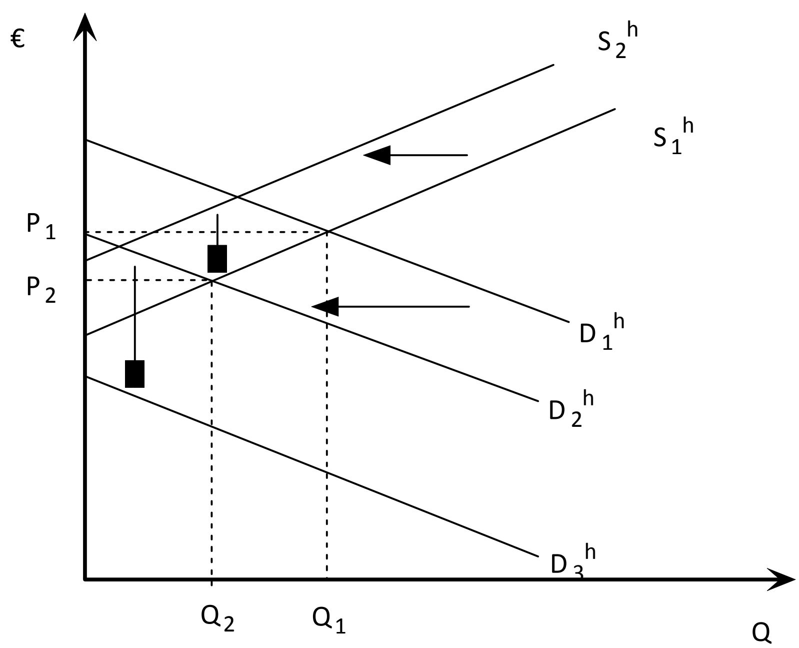


Figure 4: Adverse selection: high-quality supply disappears from the market

Source: Pindyck, Robert S. and Rubinfeld, Daniel L., (2001) Microeconomics, 5th ed., Printice Hall, Upper Saddle River, New Jersey 07457.

The final result is a missing market for high quality services, although high quality suppliers are willing to sell high quality services, which consumers are willing to buy. Of course, suppliers are interested in communicating the quality of their work, particularly if it is higher than average. For example, they will try to create a reputation on delivering high quality services. But that solution only works if consumers purchase these services regularly or if they can profit from 'hearsay'. For some experience or credence goods, this will not be the case. But even if information markets would work perfectly, some market failures would keep appearing, particularly in the fields of health and safety, but also in other markets of complex products.

In the supply of basic necessities in our country including bread, however, quality issues are not observable by customers. Instead, the availability by itself is considered as having the prerequisite quality standards. For high class customers' bread suppliers, alternative bakeries that add some additional ingredients and having some variety of cereals take advantage of the self-setting price advantage as claimed for the input use.

2.1.6.2. *Bounded rationality*

Consumers and workers are assumed to make rational, welfare maximizing choices. In this respect a distinction should be made between the rationality of the outcome and the rationality of the decision making process leading to that outcome. If consumers or workers experience limits in absorbing and evaluating information, they will adapt their preferences and their decision making processes accordingly. Given those limits, the outcome of the decision making process may be defined as 'boundedly' rational. Further research along these lines led to the development of a new branch of economics, behavioral economics which incorporates insights from psychology and sociology into economics (Dellavigna, 2009; McFadden, 1999; Rabin, 2002; Mullainathan and Thaler, 2001).

To be able to make the relevant trade-offs and to decide fully rationally, consumers and workers should be able not only to fully understand all the relevant characteristics of the products and jobs at hand, but they also must be able to understand and evaluate future developments that will have an impact on decisions that are currently taken. According to some scholars, three conditions must be met for rational behavior to occur (Poiesz, 2004). Economic subjects must be motivated to make rational decisions, they must have the capacity to make such decisions and they must have the opportunity to decide rationally. Whether or not these conditions are met will depend on a variety of circumstances such as the characteristics of the products, activities or workplaces involved and the nature of the competitive process. Products and workplaces may for example be characterized by their degree of risk involved, health risks, financial risks or other. Research has shown that consumers and workers find it hard to adequately deal with risks (Thaler, 1992; Margolis, 1996). Accidents with products or risks to life and health at work or on the road are usually *low probability events* in the order of for example 0.0001 or perhaps even one in a million. Most people will find it hard to think and act rationally on such events. Small risks are often overestimated and larger risks are underestimated. Preferences appear to be anomalous with respect to decisions concerning the future or uncertainty. Willingness to pay studies reveal that workers or consumers are willing to pay a certain amount to lower health risks with a certain percentage, but at the same time are willing to pay far larger amount to bring forth an equivalent percentage reduction toward a situation of zero risk.

The conclusion is that people are only boundedly rational and that consequently the allocation of resources driven by misguided or mistaken decisions will be inefficient (Simon, 1948; Kreps, 1998). These problems may be exacerbated if regulators act upon such preference to change the allocation of resources.

The problems of bounded rationality, adverse selection and moral hazard may explain the existence of, for example, the introduction of private or public certificates, minimum quality standards for the safety of food, toys, cars etc., licenses and other trading regulations for professional groups such as building contractors, hairdressers and plasterers, and more. By means of these rules, minimum requirements can be set on the commercial knowledge, professional skill and creditworthiness, and more so that the transaction costs decline and the information problems are reduced (Leland, 1979; Shapiro, 1986; Zerbe and Urban, 1988)). Rules relating to misleading information aim to minimize the cost of moral hazard (Beales, Craswell and Salop, 1981; Schwartz and Wilde, 1979). Because of the nature of credence or trust goods, it is difficult to set minimum quality standards precisely in those cases where the risks of moral hazard are high. In such circumstances, legally sanctioned self-regulation can combat the problems of adverse selection and moral hazard (Van den Bergh and Faure, 1991; Den Hertog, 1993). Not only do those involved have a vested interest in the maintenance of the minimum quality, they are also better able to formulate and maintain quality rules (Gehrig and Jost, 1995). If purchasers cannot establish quality levels, minimizing search costs by a ban on advertisement may even be efficient (Barzel, 1982, 1985). Problems of adverse selection and moral hazard arise particularly in insurance markets (Rothschild and Stiglitz, 1976). Insured parties have superior information available with respect to the incidence of risks but they lack information regarding the quality and independence of intermediaries. In many countries, social legislation is introduced as a reaction to these problems, and rules are established for intermediaries. It is a matter of empirical research to determine if those regulations are to be preferred above private solutions, such as developing a reputation, tort liability and self-regulation.

However, as Breyer (1993) has suggested if preferences are distorted, a vicious circle of public perceptions, parliamentary action and regulatory methods may arise. In economics revealed or stated preferences are the main explanatory device and evaluative measure of regulatory practices. Justification of regulation or the explanation of regulation from a market failure perspective becomes difficult if preferences are distorted (Adler and Posner, 2001; Sunstein, 2002).

Hence, paternalists' theories of government intervention become once more the object of debate and scientific research (Ogus, 2005; Glaeser, 2006; Thaler and Sunstein, 2008). With this condition, empirical investigation of government intervention on welfare effects worth studying.

2.1.6.3. *Externalities and public goods*

In addition to information failures, prohibitively high transaction costs may also result in missing markets. Transaction costs can impede, for example, the development of a market for the efficient use of the environmental goods. However, an inefficient allocation of resources can arise in the presence of externalities (Meade, 1973). Externalities are cost or utility effects for third parties outside the market interactions where these external effects develop. An often cited textbook example concerns the discharge of waste material by a factory such that downstream drinking water companies must incur costs of water purification. Because the private costs for the discharging manufacturer differ from the social costs, production will be increased further than would be desirable from the point of view of efficient allocation of resources. According to the Coase theorem, an efficient allocation of resources can nonetheless result from a process of negotiation in the case of clearly defined property rights and in the absence of transaction costs (Coase, 1960). However, information cost, bargaining cost or enforcement cost may prevent efficient solutions. Negotiation costs can be prohibitively high if several parties are involved in the negotiating process or if elements of strategic behavior are present (Veljanovski, 1982a).

Markets may also be missing with goods and services having public goods characteristics (Samuelson, 1954). For the supplier of such goods it is difficult to exclude others from consumption who fail to pay for the good (non-excludability).

For the focus of this research, however, discussion of such topic is not dealt in detail. The researcher included the topic at least to comprehend the theoretical foundation of regulation from the point of view of externalities and public goods.

2.1.7. Undesirable market results

According to the public interest theories, regulation can be explained not only by imperfect competition, unstable market processes and missing markets, but also by the need to prevent or correct undesirable market results. In a competitive market economy, participants in the economic process are rewarded according to their marginal productivity contribution. This result of the market process may be undesirable for economic and other reasons. In the first place it is possible that a redistribution has large incentive effects (Stiglitz, 1994, p. 47 ff). In the second place it is possible that an efficient redistribution will increase the general level of economic welfare when dilemma's such as the prisoner's dilemma impede voluntary transfers (Hochman and Rogers, 1969, 1970). An efficient redistribution might also take place if the marginal utility of income diminishes and satisfaction capacities do not differ widely among people. However, in economics it is conventional to assume the unfeasibility of cardinal measurement of utility and interpersonal utility comparison, so that this last form of efficient redistribution cannot theoretically be justified from an economic point of view

(Robbins, 1932).

In the third place, it can be argued that bounded rationality offers a number of explanations to correct market outcomes from the point of view of efficiency: real preferences are not adequately reflected in market behavior and values or their formation is the result of distorting contexts (Sunstein, 1997). Redistributive policies on behalf of drug addicts or other disadvantaged groups often recognizes that people do not 'prefer' to become disadvantaged in this way. Furthermore, it has widely been established that consumers have social preferences and care about the inequality of market outcomes (Dellavigna, 2009).

The correction of undesirable market results can finally also be considered desirable for other than economic reasons, such as considerations of justice, paternalistic motives or ethical principles (Ogus, 2005). In that case, tradeoffs may arise between, for example, economic efficiency and equality: the incentive effects of redistribution may result in a decline in the level of individual utility (Okun, 1975). Public interest theories are most often applied by economists to explain regulation as an aim for economic efficiency (Joskow and Noll, 1981, p. 36). In other cases, public interest theories are interpreted more broadly and regulation is predicted to correct inefficient or inequitable market practices (Posner, 1974). According to this last view, regulation might be said to aim for a socially efficient use of scarce resources as opposed to an economically efficient allocation of resources, where economically is interpreted in a narrow way. However, according to some other views, a complete efficiency analysis should be able to include principles and values like corrective justice (Kaplov and Shavell, 2002; Zerbe, 2001), as long as these values and principles consume scarce resources. Examples of laws and rules intended to prevent or ameliorate undesirable market results are a legal minimum wage, maximum rents, cross-subsidies in postal delivery, telephone calls and passenger transport, rules enhancing the accessibility of health care, rules guaranteeing an income in the event of sickness, unemployment, disablement, old-age, 'reasonable rate of return regulation, and more. *From the above discussions, regulation as a tool to correct inequitable market practices warrant the effort put to this study.*

2.2. Is regulation efficient and effective?

In the first place, the regulation theory assumes that government regulation is effective and can be implemented without great cost (Posner, 1974). So precisely the transaction costs and information costs, which underlie market failure, are assumed to be absent in the case of government regulation. This assumption has been criticized in both empirical and theoretical research. *Theoreticalresearch*, the theory of the second best, has demonstrated that the partial aim for efficient allocation does not make the economy as a whole more efficient if unavoidable inefficiencies persist elsewhere in the economy (Ng, 1990). Unavoidable inefficiencies such as dominance in product markets or taxation distort the allocation in the economy at large. Not only is the good concerned produced in insufficient quantities, but also too many resources are devoted to the production of other goods and services in the economy.

Accurate predictions on how rules will work, cannot be made if regulations changes the behavior of regulates and the structures in which they operate. Furthermore, the changes in the original situation by rules and regulations will be anticipated by rational actors (Kydland and Presscott, 1977; Boorsma, 1990). Optimal policies would thus become inconsistent. One effect is the preference for uniform and fixed rules rather than discretion for regulators, but other inefficiencies would then result from the heterogeneity of sectors, regions or firms (Kaplov, 1992, 1995; Latin, 1985). But of course the information to devise optimal policies and regulations is not available nor is enforcement perfect (Sappington and Stiglitz, 1987a, 1987b; Viscusi and Zeckhauser, 1979). The results are inefficient rules, imperfect enforcement and incentives for firms and consumers to behave inefficiently (for a criticism of some of this research, Kelman, 1988). Examples are inefficient safety standards set by regulators, the selection of inefficient combinations of production factors by firms (Averch-Johnson effect) and the inefficient planning of investment projects (Viscusi, 1985; Baumol and Klevorick, 1970; Sweeney, 1981, and more generally on the interaction between firms and regulators: Laffont and Tirole, 1993). Theoretical research into the efficiency and effectiveness of government regulation gradually developed into theories of non-market failures equivalent to the theories of market failures (Wolf, 1987, 1993; Tullock, Seldon and Brady, 2002). These theories point to non-market failures such as:

- The lack of information on marginal benefit of regulatory agency activity and the consequential lack of incentives to equate marginal cost with marginal benefit;
- the lack of output valuation or indicators and the consequential lack of incentives to minimize cost or to end the regulatory activity;
- the lack of a market for regulatory control analogues to the market for corporate control, with its consequential failure to discipline managers;
- the inequalities in the distribution of the agency benefits as a result of capture or bargaining;

- the unavoidability of unintended effects, unexpected side-effects and even adverse effects of regulation.

The exaggeration in some parts of the literature on the supposedly inefficiencies of government regulation led Wittman to argue that political markets were in effect efficient (Wittman, 1989, 1995; and criticizing this position, Lott, 1997; Rowley, 1997).

2.3. Testing the public interest theories of regulation

Public interest theories usually assume that regulation aims to establish economic efficiency. Interpreted in this way, these theories are unable to explain why on occasion other objectives such as procedural fairness or redistribution are aimed for at the expense of economic efficiency (Joskow and Noll, 1981, p. 36). On the other hand, when it is assumed that regulation pursues social efficiency, another problem is encountered. Where there is conflict between efficiency and equity, it is impossible for at least two reasons to establish the social efficiency of regulation (Sen, 1979a, 1979b). Such conflicts may arise when regulators mandate for example universal service obligations for public utilities, cross-subsidies for certain consumer groups, the prohibition to use price discrimination, minimum wage legislation or rent control, and more generally the protection of disadvantaged groups. Firstly, in such situations the evaluation of social efficiency is difficult because evaluation standards of levels or dimensions of justice are not available. No agreement exists regarding the definition of justice in concrete situations (Dworkin, 1981). Secondly, the establishment of social efficiency of regulation requires that economic efficiency and justice be weighed against each other. A theoretically justified and practically usable scale of values that this calls for is not available (Ng, 1985). The absence of generally applicable standards of justice and the lack of insight into the relationship between justice and efficiency renders empirical testing of public interest theories as explanatory theories of regulation impossible. A key problem of the public interest theory is that the evaluating, normative theory of economic welfare is being used as a positive explanatory theory of regulation (Joskow and Noll, 1981). Empirical work of testing the public interest theories relative to the private interest theories has concentrated for the larger part on the effectiveness and not the efficiency of regulations: are prices lower, is price discrimination absent, is there a decrease in costs, did pollution decline, is influence of interest group detectable, etc. Examples include Jakee and Allen (1998), Kroszner and Strahan (1999), Tanguay et al (2004).

Having discussed the foundations to government regulations with the guiding principles and criticisms, let's turn to exploring the different kinds of price regulation options that are compatible with the research thesis.

2.4. Price Regulation

2.4.1. The Underlying Theory

Regulators and other policy makers have certain goals for their countries, including near-universal availability of service, affordable prices, and quality service.

It is generally known that fully informed regulators do not exist in reality. In most of the casesthe regulated firm has more information about its costs and other factors and accordingly, theregulated firm may use its information advantage strategically in the regulatory process toincrease its profits or to pursue other managerial goals, to the disadvantage of consumers, Kopsakangas-Savolainen, M. and Svento, R. (2008).

Many regulatory agencies have put lot of effort to reduce this information asymmetry.Theoretical research on regulation (especially incentive regulation) has also evolved and it hasprovided new information to regulators (see e.g. Laffont (1994), Laffont and Tirole (1986)and (1993), Armstrong, Cowan and Vickers (1994) and Armstrong and Sappington (2004)).Because the regulator has less information than the firms the regulated firms have strategicadvantage. Generally any firm would like to convince the regulator that it is a "higher cost"firm than it actually is. By behaving like this the firm believes that the regulator sets higherprices (which increases firms' profits and removes welfare from consumers to the regulatedfirms).

2.4.2. Different Regulation Regimes

2.4.2.1. Rate of Return Regulation

Rate of return regulation has emerged in the U.S.A in the 19th century to limit the profits of franchise monopolies (Newbery, 1999, p. 38). It consists in letting the firm freely choose its inputs, outputs, and even prices, provided that its return on capital be fair, but below some specified level. Prices can thus increase to ensure that costs are covered. This direct link between changes in costs and changes in prices fully insures the firm against adverse shocks, and strongly weakens the firm's incentives to pursue cost efficiency. In practice, regulators tend to set prices at average historical costs, so as to ensure the adequate rate of return. These prices are revised upward when costs increase, or when demand conditions worsen (ibid, p.39).

A simple equation evolves from the RRR model: INCREASED PRICES + INCREASEDINEFFICIENCY = HIGHER COST FOR THE CONSUMER.

By reverting to RRR, states would eliminate the progress made under PCR that have adjusted to today's advances in technology.

To summarize the discussions on rate of return, we could raise three main points. Firstly, rate of return regulation involves thesetting of allowed prices or revenues that are explicitly designed to just recover costs, includinga fair rate of return on necessary investments in fixed assets. Reflecting this, there is under rateof return regulation a direct relationship between changes in costs and changes in prices suchthat legitimate increases in the former cause increases in the latter. Second, the more accuratelythe regime can calibrate earnings to costs, the weaker are the incentives for the regulated firm toreduce costs. More specifically, the greater the extent to which any excess profits are refunded toconsumers, the lower the gain to the firm from effecting improvements that could otherwiseenhance its earnings. Finally, the weak incentive properties of rate of return regulation havebeen well understood for many decades.

2.4.2.2. Price-Cap Regulation

Becoming more efficient is precisely one of the most important objectives of privately run enterprises (Vickers and Yarrow, 1988; Bishop, Kay and Mayer (eds.), 1995). On the other hand if practices are found to be on the other way and to guarantee certain outcomes, regulation of businesses takes its own posture.To this effect a new system of regulation was developed, originally based on the ideas of Professor Littlechild (Bartle, 2003; Beesley and Littlechild, 1989; Rees and Vickers, 1995). In the UK, legislation on privatized utilities system determines that regulation should be such that utilities ensure adequate quantity and quality of supply, that competition is promoted, that efficiency and economy is promoted and that interests of consumers are protected. To accomplish these goals, *price-cap regulation* was instituted (Armstrong, Cowan and Vickers, 1997). Utility prices were determined according to the formulae RPI – X, where RPI stands for the retail price-index and X for the productivity increases of the employed production factors. If for example inflation rises with 5% and productivity increases yearly with 3%, then regulated firms are allowed to maximally increase their prices according to the cost increase, which is 2%. Procedurally, to regulate a firm, a financial model of the firm will be devised and consultation documents published on the internet so that interested parties can react. After this period of consultation the regulator decides, among others, on the price-caps which are either accepted by the regulated firm or contested by appealing to the courts. The entire procedure takes about one to two years, but the decisions on the price formulae and thus the X-factor will remain in place for about five years. This means that, if a firm succeeds in lowering its costs more than the productivity increases reflected by the X-factor, its profits will rise equivalently at given prices. Schematically, the X-factor is determined as follows (adapted from Baldwin and Cave, 1999, pp. 229-231):

Output
and price

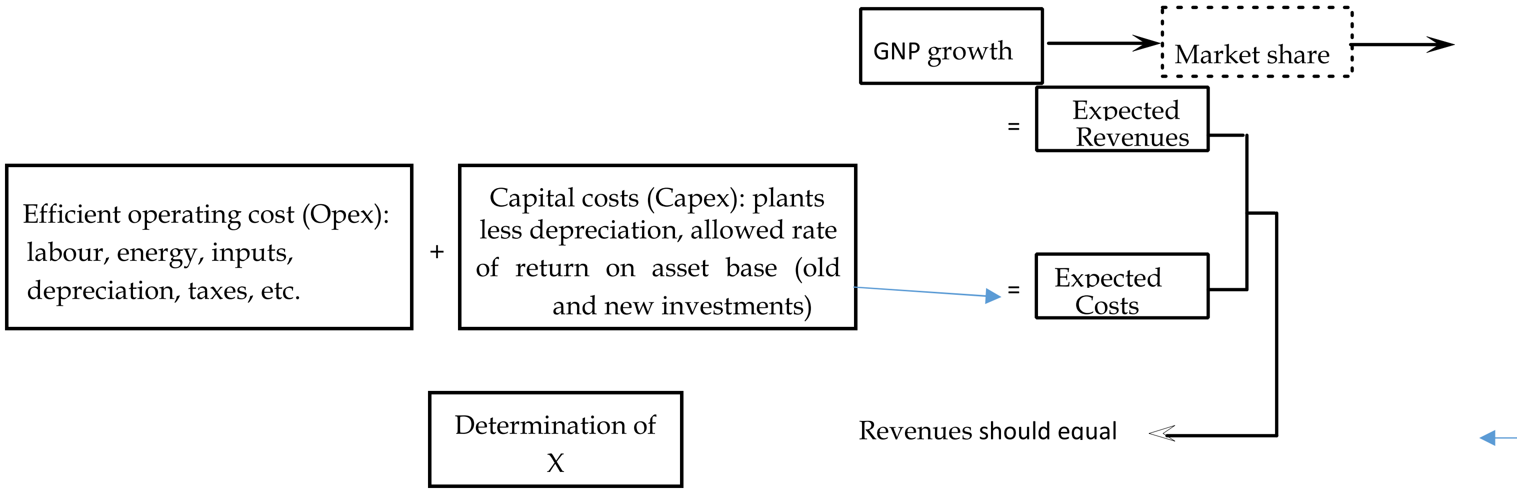


Figure 5: Price-Cap Regulation or how to determine X
Source: Baldwin, Robert E. and Cave, Martin (1999), Understanding Regulation: Theory, Strategy and Practice, Oxford, Oxford University Press.

The X-factor determined at the price-review thus reflects the unanticipated efficiency savings of the past, forecasted efficiency savings, desired quality improvements, a desirable 'glide path' adapting prices to costs, and more. Price-cap regulation differs in the following ways from rate of return regulation (Beesley and Littlechild, 1989; Newbery, 1998; Sappington and Weisman, 1996; Crew and Kleindorfer, 1996; Baron, 1995, Vogelsang, 2002). Unlike rate of return regulation, price-cap regulation is particularly focused on motivating managerial efforts and investments in decreasing operating costs. For this reason it is also called incentive regulation. Also, price-cap regulation proceeds from projected efficient cost. Regulators determine these projected costs on the basis of efficiency studies, comparative analysis with other firms (yardstick competition, see below) or from general productivity trends. Because price-cap regulation is only applied to the monopoly part of the firm and not to the competitive parts, where competition is expected to discipline the firm, this type of regulation is administratively less cumbersome compared to rate of return regulation. The price-cap furthermore concerns a 'basket' of prices which means that the structure of prices is for the most part determined by the managers of the firm. They will set prices to maximize profits which often also contributes to efficiency. Also, regulators have more flexibility and discretion compared to US-regulators: there are more degrees of freedom in setting X than in determining the rate of return. Finally, the length of time between the formal price reviews is four to five years, unlike rate of return regulation where rate cases might take place each year, for example in times of inflation. This could mean that firms earn excess profits for a period of up to five years.

There are also a number of obvious drawbacks from this type of incentive regulation. If it is difficult to observe quality, and quality requires spending resources, the firm may be motivated to decrease costs by decreasing quality, thus improving its profits (Elliot, 2006; Sappington, 2005). The firm might thus invest less in maintenance, reliability, frequency, and the like. In practice, regulators have sometimes included an extra factor in the formulae to motivate the managers to reach certain quality levels. Prices are allowed to increase more when those levels have been reached. Also, the regulator will gradually come to learn the firm's realized costs. It may be tempting for regulators not to proceed from projected efficient cost, but from what they have learned the firm can accomplish. But if they do so, the firm will anticipate this and will not be motivated or behave strategically in putting effort to minimize costs. At the end of the regulation period, the managers for example will postpone investments in efficiency. Of course, regulators should also be committed not 'to claw back' any excess profits the firm has acquired by maximizing the difference between its revenues and costs. Again, if they do, they would undermine the motivation of the firm's managers to maximize profits and decrease costs. Finally, price-cap regulation is best suited as an incentive regulation to promote the cost efficiency of firms. But if the primary goal is to have more investments, for example to renew the sewerage network or to install a fiber optics network, is not obvious that price regulation is the best instrument to deal with such issues. Investments are more commonly thought to be motivated by profits rather than by prices.

The comparison makes clear that price-cap regulation and rate of return regulation are actually two polar forms of regulation (Laffont and Tirole, 1993; Newbery, 1998; Cowan, 2006; Joskow, 2008). Regulators trade off the objectives of cost efficiency and profit extraction. The regulator does not know the firm's cost and its potential, nor is the level and composition of the firm's demand fully known by the regulator. The regulator thus faces a dilemma: it can take away all the firm's profit but then the managers have no incentive to reduce the operating cost. And furthermore, in order to induce the firm to produce, it has to set a high allowable revenue anyway. But to motivate efforts in cost efficiency, the regulator also needs to let the firm keep some of its profits. Regulators have tried to escape this dilemma by narrowing their information disadvantages. For example they have used benchmarking, yardstick competition and bidding processes to become better informed about the cost opportunities the firm actually has. There appears to be a *general economic problem of regulation* (Newbery, 1998). The regulator has to determine the allowable revenue for the firm. This can be specified as:

$P = bP^i + (1\text{-}b)\ C$, where P^i is a price independent of the firm's average cost, C.If b is zero, the allowable price or revenue is equal to the firm's cost, which compares to rate of return regulation. The firm is thus allowed to cover its cost but no more and it has no incentives to reduce its costs. If b is 1, the formulae reduces to the allowed price being equal to a fixed price, which corresponds to price-cap regulation. The firm is allowed to keep all of its profits. The term b is the *incentive 'power'* of the regulatory scheme, it is at its highest if b = 1. For example, assume the firm's unit cost are €10. The regulator sets the incentive power to zero and let the allowable revenue to be only equal to the firm's cost of €10. Alternatively, the regulator could set the incentive power term at for example 0.7. Let us assume that initially the average cost are equal to the projected efficient cost, P^i. At the efficient cost of €10, the firm can still recover its costs because the allowable revenue is also €10 = (0.7x10 + 0.3x10). However, let us now assume that the firm can reduce its costs by better operating procedures to €9 per unit. The *projected* efficient cost are still €10 but the actual costs to the firm have decreased to €9. Allowable revenue for the firm now falls to €9.70 = (0.7x10) + (0.3x9). The firm is rewarded for its managerial efforts to reduce its cost by an additional profit of €0.70 per unit. The consumer benefit of these efforts is €0.30. Of course, given the objectives of the regulator to extract profit and to minimize cost, such a scheme is only efficient if these cost reductions are truly the result of managerial effort and not the result of some exogenous decrease in input prices (see generally Lyon, 1996; Mayer and Vickers, 1996; Hawdon et al., 2007).

A potential drawback to price cap regulation, however, derives from the fact that incentives for cost reduction may lead to degradation of service quality (Sheshinski, 1976; Sappington, 2003, 2005; Weisman, 2005). Indeed, under a price cap, the firm may be able to increase profit by reducing costs without regard to service quality, particularly if it is difficult for consumers to directly discern delivered service quality levels.

The empirical evidence regarding service quality degradation under price cap regulation is mixed. Armstrong, Cowan, and Vickers (1994) find evidence of reduced service quality for British Telecom in the mid- to late-1980s. Tardiff and Taylor (1993), however, find no evidence of degraded service quality for the former Bell companies. Alexander (2001) cites evidence of reduced service quality for Ameritech, and OFTA (2004) notes evidence of telecommunications service quality problems in Hong Kong. It is interesting that Sappington (2003) finds evidence that under price cap regulation, some aspects of telecommunications service quality have improved while others have apparently degraded.

When it comes to Ethiopia, though documented studies in the area is lacking, there is a general consensus that price cap regulation has brought somehow predictability in prices coupled with the slashed target market prices of basic goods for the consumers to better afford, the general quality level, however, remained poor.

2.4.2.3. *The Optimal Incentive Scheme*

In the Laffont-Tirole (1986) model the firm chooses output and effort and after the costs are realized and observed, the planner rewards the firm according to the two observables, output and costs. Equivalently, the planner can ask the firm to reveal its true productivity parameter. Laffont and Tirole show that it is possible to construct such an incentive scheme that it induces the firm to tell the truth such that the level of effort is voluntarily optimally chosen by the firm. The incentive scheme is linear in costs and can be written as $T(\beta,C) = s^*(\beta) + K(\beta)[C^*(\beta) - C]$, where T is net transfer to the firm, s^* is ex ante reward, C^* is ex ante cost, C is realized costs, β is the productivity parameter and $K^*(\beta)=\psi\,[e^*(\beta)]q^*(\beta)$, where q^* is optimal output, e^* is optimal effort level and ψ' is marginal disutility of effort. Hence the reward depends on the announcement of the β and the ex post costs.

2.5. Stochastic production frontier models and technical efficiency

To begin with the discussion of production frontier models, the initial work comes from Aigner and Chu (1968) who were the first researchers to estimate a deterministic frontier production function using Cobb-Douglas production function. They argued that, within a given industry, firms might differ from each other in their production processes, due to certain technical parameters in the industry, due to differences in scales of operation or due to organizational structures. Under this assumption, they considered a Cobb - Douglas production function, with an empirical frontier production model such as:

$$q_{it} \le f(\mathbf{x}_{it}) \qquad (1)$$

This equation defines a production relationship between inputs, $\mathbf{x}$, and output q_{it}, in which for any given $\mathbf{x}$, the observed value of q_{it} must be less or equal to $f(\mathbf{x}_{it})$. Since the theoretical production function is an ideal (the frontier of efficient production), any non - zero disturbance is considered to be the result of inefficiency.

In the decade of 1970, deterministic production frontier model was extended by Afriat (1972), and more systematically by Aigner et al. (1977) and Meeusen and van den Broeck (1977). Based on the literature commencing with theoretical work by Debreu (1951) and Farrell (1957), Aigner et al. (1977) and Meeusen and van den Broeck (1977) extended the deterministic frontier approach in order to account not only for technical inefficiency, but also for any measurement errors or any statistical noise[1]. They developed a statistically and theoretically sound method for measuring efficiency, different is the sense that it allows random events to contribute to variations in producer output. Aigner et al. (1977) and Meeusen and van den Broeck (1977) proposed, almost simultaneously, but independently, a formulation within which observed deviations from the production function could arise from two sources: a) productive inefficiency, that would necessarily be negative, and b) effects specific to the firm, that could be of either sign. The model is In order to incorporate this feature, there is need to introduce another random variable representing any statistical noise or measurement errors. In order to capture this, the stochastic model includes a composite error term that sums a two-sided error term, measuring all effects outside the firm's control, and a one-sided, non-negative error term, measuring technical inefficiency. The resulting frontier is presented in terms of a general production function, known as a stochastic production frontier

$$\ln q_{it} = \mathbf{x}_{it} + v_{it} - u_{it} \qquad (2)$$

Where the observed response q_{it} is a scalar output, $\mathbf{x}_{it}$ is a vector of m inputs, β (as in equation 3 below) is a vector of the unknown technology parameters, $f(\mathbf{x}_{it})$ is the production frontier. As described in Coelli et al. (2005), in this case, a Cobb Douglas stochastic frontier model takes the form:

$$\ln qit = \beta_0 + \beta_1 \ln x_{it} + v_{it} - u_i t \qquad (3)$$

[1] Since the introduction of stochastic frontier analysis, it has been widely accepted that frontier models provide a number of advantages over non-frontier models (see, e.g., Forsund et al., 1980 and Bravo-Ureta and Pinherio, 1993). The economic literature on efficiency and stochastic frontier analysis has been rather extensive with numerous studies. To name just a few, there are inuential research papers by Forsund et al. (1980) and Greene (1993, 1997) , Bauer (1990), Battese (1992), Schmidt (1985), Cornwell and Schmidt (1996), Kalirajan and Shand (1999), and Murillo-Zamorano (2004), as well as book-length approaches, including Coelli et al. (1995), Coelli et al. (1998), Kumbhakar and Lovell (2000) and Fried et al (2008).

or

$$q_i t = \exp(\ \beta_0 + \beta_1 \ln xit + vit\ -\ \ u_{it}) \qquad (4)$$

or

$$q_i t = \exp(\beta_0 + \beta_1 \ln x_i t)\ \ x\ \ \exp(v_{it})\ \ x \qquad \exp(-\ u_{it}) \qquad (5)$$

where,

1. $\exp(\beta_0 + \beta_1 \ln x_{it})$: deterministic component
2. $\exp(v_{it})$: noise
3. $\exp(-u_{it})$: inefficiency

The model equation can be rewritten as:

$$q_{it} = f(\mathbf{x}_{it}\beta\ )\ x\ \exp(v_{it}\text{-}u_{it}); u_i \quad \geq 0 \qquad (6)$$

where u_i represents the shortfall of output from the frontier.

The composite error structure is:

$$\varepsilon it = v_{it}\text{-}u_{it} \qquad (7)$$

The stochastic econometric approach enables to attempt to distinguish the effects of noise and inefficiency, thereby providing the basis for statistical inference. The model is such that the possible production q_{it} is limited above by the stochastic quantity $f(x_{it,}\beta)$ x $\exp(v_{it})$. The noise component v_{it} is assumed to be independently and identically distributed (i.i.d.), symmetric, and distributed indepedently of u_{it}. The combined error termε_{it} = v_{it} -u_{it} is therefore asymmetric since $u_{it} \geq 0$. Providing estimates of producer - specic technical efficiency, which is the ultimate objective of the estimation process in addition to obtaining estimates of the production technology parameters β in $f(x_{it,}\beta)$, requires an extraction of separate estimates of statistical noise v_i and technical inefficiency u_{it} form the estimates of ε_{it} for each producer. Therefore, the distributional assumptions of the inefficiency term are required to estimate the technical inefficiency of each producer.

In order to dene technical efficiency within the stochastic frontier framework, let us consider the above production function:

$$q_{it} = f(\mathbf{x}_{it}\beta) + \varepsilon_{it} \qquad (8)$$

Under the assumption for the error term and ensuring that observed output lies below the stochastic frontier, the production function becomes:

$$q_{it} \leq f(\mathbf{x}_{it}\beta) \times \exp(v_{it}) \qquad (9)$$

Consequently, we have:

$$TE_{it} = \frac{observed\ output}{potential\ \max imum\ output} =$$

$$= \frac{f(x_{it}\beta) \times \exp(v_{it}) \times \exp(u_{it})}{\exp(xit\beta)}$$

$$= \exp(-u_{it}); 0 \leq TE_{it} \leq 1 \qquad (10)$$

Which will ensure that the observed output lies below the frontier. As stated above, following the inclusion of the second random error, the stochastic frontier model asserts that the composite error term of the function is made up of two independent components: a) of a two sided random term, v_{it}, and b) by a one sided positive error term u_{it}. The component v_{it} represents factors that cannot be controlled by production units, measurement errors, and left-out explanatory variables. On the other hand, the component u_{it} represents the shortfall from the production frontier due to inefficiency, which may be the result of cultural factors, such as attitude toward work; climatic factors, such as summers, or traditions, such as religious holidays.

Aigner et al. (1977) assumed that the stochastic error terms v_{it} are independent and identically distributed (i.i.d.) normal random variables with mean zero and constant variance σ^2_v:

$$(v_{it}) \sim iidN(0, \sigma_v^2) \qquad (11)$$

Which denotes that the errors v_{it} are independently and identically distributed normal random variables with zero means and variances ${}^2{}_v$, and

$$(u_{it}) \sim iidN(0, \sigma_u^2) \qquad (12)$$

Which denotes that the errors u_{it} are independently and identically distributed normal random variables with zero means and variances σ^2_u.

The model assumes that each v_{it} is distributed independently of each u_{it} and that both errors are uncorrected with the explanatory variables in x_i. In addition, it is assumed that:

1. $E(v_{it}) = 0$ (zero mean)
2. $E(v_i^2) = \sigma^2_v$ (homoskedastic)
3. $E(v_{it}v_{jt}) = 0$, for all $I \neq j$ (uncorrelated)
4. $E(u^2_i)$ = constant (homoskedastic)
5. $E(u_i u_j) = 0$, for all $i \neq j$ (uncorrelated)

2.6. Stochastic Frontier Model Estimation using the Maximum Likelihood Estimation Method

Since early, Aigner et al. (1977) first estimated the unknown parameters of the stochastic frontier model using the method of maximum likelihood (*M.L.*) method followed also widely in later decades by Greene (1982) and Coelli (1995), among others. Maximum likelihood (*M.L.*) estimation is a popular statistical method used for fitting a mathematical model to real world data. The concept of maximum likelihood (*M.L.*) estimation is based on the idea that a particular sample of observations is more likely to have been generated from some distributions than from others. Consequently, the maximum likelihood estimate of an unknown parameter is defined to be the value of the parameter that maximizes the probability (or likelihood) of randomly drawing a particular sample of observations.

In order to use the maximum likelihood principle to estimate the parameters of the production frontier function model, we make the assumption that the errors are normally distributed. This assumption is combined with the assumptions expressed above[2]:

1. $E(v_i) = 0$ (zero mean)
2. $E(v_i^2) = \sigma^2$ (homoskedastic)
3. $E(v_i v_j) = 0$, for all $i \neq j$ (uncorrelated).

[2] For a detailed analysis, see Coelli et al. (2005)

Aigner et al. (1977) focused on the implicit assumption that the likelihood of inefficient behavior monotonically decreases for increasing levels of inefficiency. They parameterized the log likelihood function for the half normal model in terms of the variance parameters:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \quad (13)$$

Where σ^2 is a measure of the total variance of the combined error term

$$\varepsilon_{it} = v_{it} - u_{it} \qquad (14)$$

and

$$\lambda^2 = \sigma_u^2 / \sigma_v^2 \geq 0. \quad (15)$$

If $\lambda = 0$;there are no technical inefficiency effects and all deviations from the frontier are due to noise.

Following is the discussion of welfare assessment of price regulations having their bases on the discussions made above of the models in stochastic frontier analysis (efficiency modeling) of Cobb-Douglass production function.

2.7. Welfare Effects of Price Regulations

2.7.1. Bergson-Samuelson social welfare function

Bergson (1938), introduced the *social welfare function*. The objective is "to state in precise form the value judgments required for the derivation of the conditions of maximum economic welfare" set out by earlier writers, including Marshalland Pigou, (1873); Paretoand Barone (1935); and Lerner (1934). The function was real-valued and differentiable. It was specified to describe the society as a whole. Arguments of the function included the quantities of different commodities produced and consumed and of resources used in producing different commodities, including labor. Necessary general conditions are that at the maximum value of the function:

- The marginal "dollar's worth" of welfare is equal for each individual and for each commodity

- The marginal "diswelfare" of each "dollar's worth" of labor is equal for each commodity produced of each labor supplier
- The marginal "dollar" cost of each unit of resources is equal to the marginal value productivity for each commodity.

Auxiliary specifications enable comparison of different social states by each member of society in preference satisfaction. These help define *Pareto efficiency*, which holds if all alternatives have been exhausted to put at least one person in a more preferred position with no one put in a less preferred position. Bergson described an "economic welfare increase" (later called a *Pareto improvement*) as at least one individual moving to a more preferred position with everyone else indifferent. The social welfare function could then be specified in a *substantively* individualistic sense to derive Pareto efficiency (optimality). Samuelson, (1947) notes that Bergson's function "could derive Pareto optimality conditions as *necessary* but not sufficient for defining interpersonal normative equity." Still, Pareto efficiency could also characterize *one* dimension of a particular social welfare function with distribution of commodities among individuals characterizing *another* dimension. As Bergson noted, a welfare improvement from the social welfare function could come from the "position of some individuals" improving at the expense of others. That social welfare function could then be described as characterizing an equity dimension.
Samuelson (1947, p. 221)stressed the flexibility of the social welfare function to characterize *any* one ethical belief, Pareto-bound or not, consistent with:

- A complete and transitive ranking (an ethically "better", "worse", or "indifferent" ranking) of all social alternatives, and
- One set out of an infinity of welfare indices and cardinal indicators to characterize the belief.

He also presented a lucid verbal and mathematical exposition of the social welfare function (1947, pp. 219-49) with minimal use of Lagrangean multipliers and without the difficult notation of differentials used by Bergson throughout. As Samuelson (1983) notes, Bergson clarified how production and consumption efficiency conditions are distinct from the interpersonal ethical values of the social welfare function.

Samuelson further sharpened that distinction by specifying the *Welfare function* and the *Possibility function* (1947, pp. 243-49). Each has arguments with the set of utility functions for everyone in the society. Each can (and commonly does) incorporate Pareto efficiency. The Possibility function also depends on technology and resource restraints. It is written in implicit form, reflecting the *feasible* locus of utility combinations imposed by the restraints and allowed by Pareto efficiency. At a given point on the Possibility function, if the utility of all but one person is determined, the remaining person's utility is determined. The Welfare function ranks different hypothetical *sets* of utility for everyone in the society from ethically lowest on up (with ties permitted), that is, it makes interpersonal comparisons of utility. Welfare maximization then consists of maximizing the Welfare function subject to the Possibility function as a constraint.

The same welfare maximizationconditions emerge as in Bergson's analysis.

2.7.2. Arrow social welfare function (constitution)

Arrow, (1963) generalizes the analysis. Along earlier lines, his version of a social welfare function, also called a 'constitution', maps a set of individual orderings (ordinal utilityfunctions) for everyone in the society to a social ordering, a rule for ranking alternative social states (say passing an enforceable law or not, ceteris paribus). Arrow finds that nothing of behavioral significance is lost by dropping the requirement of social orderings that are *real-valued* (and thus cardinal) in favor of orderings, which are merely *complete* and *transitive*, such as a standard indifference-curve map. The earlier analysis mapped any set of individual orderings to *one* social ordering, whatever it was. This social ordering selected the top-ranked *feasible* alternative from the economic environment as to resource constraints. Arrow proposed to examine mapping different sets of individual orderings to possibly different social orderings. Here the social ordering would depend on the set of individual orderings, rather than being *imposed* (invariant to them). Stunningly (relative to a course of theory from Adam Smith and

Jeremy Bentham on), Arrow proved the *General Possibility Theorem* that it is impossible to have a social welfare function that satisfies a certain set of "apparently reasonable" conditions.

To summarize, the two welfare functions show that the socially optimum welfare be maintained at the point where the marginal reallocation of welfare results in no harm on the other. Their approach to welfare maximization, however, based on different assumptions. ***Bergson-Samuelson social welfare function*** *takes the production function (Cobb Douglass production function) with technological element and the input resources constraint to maximize welfare. Whereas, the* ***Arrow social welfare function*** *considers individual consumer's utility ordering to explain the social welfare by using indifference curves and resource constraints. As individuals are building blocks of society, it seems logical to extend the individual preferences to the society.*

For this research, the Bergson-Samuelson welfare function helps to synchronize the frontier and production function with welfare analysis and the Arrow Social welfare function to analyze the producer's and consumer's surplus to compare the welfare effects of price cap and rate of return regulation regimes.

2.8 Empirical Researches on Price Regulation

Though there is no empirical researches found on price regulation within Ethiopian context, the research intothe effectiveness and efficiency of government regulation from other country's work can be summarized as follows,for a general overview of the effects of economic regulation, see Joskow and Rose (1989):

The research into economic regulation was started with the famous article by Stigler and Friedland (1962), 'What can regulators regulate', about the effects of *price regulation on electricity producers*. In this paper, they showed that regulation did not lower rates, it had an insignificant effect on profits and that price discrimination was not significantly reduced. This paper started an entirely different way of thinking about government regulation.

An earlier synthesis of this type of empirical research showed firstly that the influence of regulation on natural monopolies was slight if not non-existent (Jordan, 1972). In the second place, it appeared that regulating potentially competing sectors such as air traffic and freight resulted in an increase in prices and a restricted number of competitors.

Empirical research further demonstrates that regulation prescribed an inefficient price structure in which mainly certain consumer groups received cross subsidies (Posner, 1971).

Later research into the effects of economic *deregulation* demonstrated furthermore that mainly consumers, but to some extent even also producers, derived a benefit on balance from less government regulation (Winston, 1993, 1998). Often it were employees who benefitted from regulation. Deregulation increased welfare by 7-9% of GNP and employment increased as well.

Social regulation appeared to keep costs and benefits more or less in balance (Hahn and Hird, 1991) although there is also empirical evidence suggesting that much social regulation is poorly targeted or is over-stringent (Sunstein, 1990; Hahn, 1996; Baldwin, 1990; Wilson, 1984).

Research also suggested that about one third of the productivity slowdown in a decade resulted from the cost of social regulation (Gray, 1987). A qualifying remark can be made pertaining to economic and social regulation, that it is often difficult if at all possible to quantify many of the benefits. For example, it is difficult to put a value on the distributional effects of cross-subsidies or the preservation of a variety of life forms, or to take account of the preferences of future generations.

Studies conducted on the effect of different price regulations on welfare in electric distribution utilities by Kopsakangas, Savolainen, andSvento (2009), has found that the general welfare improvement due to regulation is not significant. However, the effect of specific price regulation can be comparable and there is improvement of welfare in some price regimes than others.

A recent but important empirical literature has investigated the relationshipbetween efficiency and incentive mechanisms. Wolak (1994), in a pioneer paper,shows that the regulation of some utilities in California is more likely tocorrespond to a context of asymmetric information than of perfect information.

Dalen and Gomez-Lobo (1996) develop a model including both an efficiencyparameter and a cost reduction effort variable that enter the cost function butare not directly observable by the regulator.Using this model, they recover the distribution of efficiency measures for transit operators in Norway.

Finally, there are arguments for assuming that even competition legislation is sometimes misused as an instrument of monopolization (Baumol and Ordover, 1985; McChesney and Shughart II, 1995).

According to Joskow, P.L. and Noll, R. (1981) in their study of public regulation they concluded that economic regulation has important direct and indirect effects on the costs of production and the quality of service. Regulatory influences on input choices, X-inefficiency, and technological change tend to increase costs. Regulation also alters the quality and variety of services, although these effects often are difficult to quantify. It tends to increase service quality through non-price competition when regulated prices in structurally competitive industries are above competitive levels. Regulation may lower service quality when its intention is to keep prices below their market-clearing levels.

Although the performance of regulated firms is sensitive to prevailing economic conditions, regulatory structures are quite impervious to exogenous economic forces. Regulatory systems tend to respond only to profound changes in the economic and political environment.

Our understanding of the effects of economic regulation has advanced considerably over the last twenty five years, but many questions remain unresolved. The profound changes in both regulatory institutions and economic conditions during the past decade provide a valuable opportunity to carefully analyze the effects of these changes. A number of recent studies have measured early responses to regulatory reforms. In some cases, however, these may be observing transition behavior, rather than a steady-state response to a new regulatory environment. Further analysis of the behavior and performance of industries that have experienced major changes in regulation will be invaluable in discerning permanent impacts.

Chambers and Collins (2016) study about how regulation affect consumer prices. They documented consumer spending patterns by income group and find that the lowest-income households spend a larger fraction of their income in areas that are more heavily regulated. The opposite is true of the wealthiest households; they allocate more of their spending to goods and services that are subject to fewer regulations. Their estimates of the effect of increased regulations on price levels suggest a positive and statistically significant relationship. A 10 percent increase in regulations is associated with a 0.687 percent increase in prices. This increase is particularly concerning for low-income households, which face higher levels of overall inflation than high-income households. Their analysis of price volatility also suggests that low-income households also face higher price volatility.

Given these empirical evidences on price regulation, this study is not meant to refute the results, rather it tries to see the comparative welfare effects of price regulation in two price regimes – price cap and rate of return regulation within the wheat flour factories in Addis.

CHAPTER THREE

Model Specificationand Estimation for the Efficiency Costs

The model specification and estimation for the efficiency costs are discussed in the literature part of the research paper. The research focuses on two price regimes and specified as follows:

3.1. Rate of return / Cost of service regulation

The Rate of return (ROR) or cost of service regulation is the traditional approach to regulate monopolies and in its purest form, the rate of return is fixed to the costs. This means that the producer or distributor does not face the risk connected to input prices or other risks related to the costs (see e.g. Liston (1993)).

Disadvantages connected to this regulation scheme (just to remark the most obvious ones) are that it does not give incentive to produce efficiently and if the allowed rate of return on capital is higher than the cost of capital an input bias (called the Averch-Johnson effect, *see appendix D*) follows.

Formally the rate of return regulation for firm i can be written as:

$$\mathbf{P_{i,t} = (1 + r)\, C_{i,t-1},} \qquad \mathbf{(1)}$$

Where P is the allowed price at period t, r is the allowed rate of return, and C is realized costs at period t-1.

To summarize, the main reservation against this approach is clearly that it does not provide incentives for cost savings and efficiency improvements to have a better welfare effect. It may also easily lead to over investments. For comparative purposes, the researcher has included the rate of return (cost of service) regulationmodel.

3.2. Price cap regulation

The price cap regulation essentially decouples the profits of the regulated utility from its costs by setting a price ceiling. This method is also referred to as the "RPI – X" model. In this model the price cap for each year is set based on the Retail Price Index and an efficiency factor X. Hence prices remain fixed for the rate period and the producer or distributer is allowed to keep the achieved cost savings. Formally the price ceiling for firm i is set according to the following equation:

$$\mathbf{P_{i,t} = P_{i,t-1} * (RPI - X_i) +/- Z_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

According to the equation above the price ceiling P_t for each year is calculated based on the previous year´s price ceiling P_{t-1} adjusted by RPI minus the efficiency factor X. The efficiency factor X is set by the regulator. In practice the price ceiling may be adjusted using a correction factor Z. This correction factor accounts for the effect of exogenous extraordinary events affecting the production costs.

The potential problems associated with the practical implementation of price cap regulation are connected to the price review procedure, to the commitment of regulating authority, to the quality and to the rules how to determine the X parameter (see e.g. Joskow (2006) and Jamasb and Pollitt (2001)).

3.3. Stochastic Frontier model specifications

The researcher uses Stochastic Frontier Analysis for the estimation of efficient costs which is needed in order to calculate the welfare effects of the price cap in comparison with rate of return regulation.

The basic Stochastic Frontier Model specification based on the Cobb-Douglass Production Function in its stochastic form can be given by:

$$\mathbf{Y = \beta_1 X_{2i}^{\beta 2} X_{3i}^{\beta 3} e^{ui}}$$

The cost function can be formulated from the above function by multiplying the physical quantities of the left and right hand side of the equation by their corresponding costs.

Where, Y is output; X_2 labor input; X_3 is capital input; $u_i$is stochastic disturbance term; and e is base of natural logarithm.Here four modifications of thebasic random and fixed stochastic frontier models are estimated using Cobb-Douglas specifications. In the following models (3-6) it is assumed that the deterministic cost frontier takes the log-linear Cobb-Douglas form and linear homogeneity of cost frontier is attained through dividing all prices by input wheat price.

In each model, total annual costs per quintal of flour (C) is explained by:

- Distributed quintals of flour (y),
- Capacity factor (CF),
- Number of customers (CU),and
- Labor and capital prices (P_L, P_K).

The first of the estimated models which accounts heterogeneity (observed) is the RE model extended by the inclusion of a heterogeneity component into the mean of the distribution of $u_{i,}$ and referred to as the REH model.

Model TRE (True Random Effect model) is the random parameter version of the RE model. Now, however, the inefficiency term (u) is time variant. In the TRE model a firm specific random constant term is used. This model specification is what Greene (2005a) calls the true random effects model.

Last model estimated is the True fixed effect model (TFE) proposed by Greene (2005a).

The estimated model specifications are:

RE model

$$\ln C_{it} = a + \beta y \ln y_{it} + \beta_{CF} \ln CF_{it} + \beta_{CU} \ln CU_{it} + \beta_l \ln P_{Lit} + \beta_k \ln P_{Kit} + \beta_t t + v_{it} + u_i \quad (3)$$

REH model

$$\ln C_{it} = a + \beta y \ln y_{it} + \beta_{CU} \ln CU_{it} + \beta_l \ln P_{Lit} + \beta_k \ln P_{Kit} + \beta_t t + v_{it} + u_i \quad (4)$$

$$v_{it} = N(0, \sigma^2 v),\ u_i = N^+(\mu_i, \sigma^2),$$

$$\mu_i = \delta_0 + \delta_1 \ln CF_{it}$$

TRE model

$$\ln C_{it} = (a + w_i) + \beta y \ln y_{it} + \beta_{CF} \ln CF_{it} + \beta_{CU} \ln CU_{it} + \beta_l \ln P_{Lit} + \beta_k \ln P_{Kit} + \beta_t t + v_{it} + u_{it} \quad (5)$$

$$w_i \sim N(0, \delta^2)$$

TFE model

$$\ln C_{it} = a + \beta y \ln y_{it} + \beta_{CF} \ln CF_{it} + \beta_{CU} \ln CU_{it} + \beta_l \ln P_{Lit} + \beta_k \ln P_{Kit} + \beta_t t + v_{it} + u_{it} \quad (6)$$

All models are estimated by maximum likelihood. Since there is no closed form solution exists for the TRE model it is estimated using a grid for w. After a choice for w is made the model is estimated using maximum likelihood. The global optimum is the one with the highest likelihood over the w grid and t is included in the model to see the technical progress over time (technology).

3.4. The Data

The data used for this study consists of a panel of 28 wheat mills that process and distribute wheat flour in Addis Ababa.

It covers the 4-year period from 2011 to first quarter of 2015. The data, which is unbalanced panel data, is collected for the research from the Ministry of Trade, Ethiopian Grain Trade Enterprise, and the panel of 28 factories. Factories that prepare wheat flour and use for their own bakery are also included in this study. The relative size (in terms of capacity) of the flour factories varies significantly which is one of the reasons that explain why significant variations in costs exist (*refer table 1below for the descriptive statistics*).

The researcher used constant Birr prices by converting all money values to the year 2011 by using the retail price index and calculations are made by taking in to account the following points:

- Costs (C) are expressed as average costs calculated as total annual costs per quintal of wheat flour delivered. This includes the delivery to the network (bakeries, cake makers etc,) and delivery to the final customers, supplying to their own baking plants. The costs of losses are excluded because of the lack of reliable data (this is also the reason for the strong correlation, close to 1:1 between input wheat and output wheat flour, i.e., while flour is to be extracted from the raw wheat there is some weight loss in the process at least to the byproducts).

- Annual output (y) is measured in Quintals and as can be seen from Table 1 it varies quite significantly since the range runs from very small flour factories to the relative large factories that operate in Addis Ababa.

- Annual labor price (P_l)per quintalof wheat flouris calculated by dividing total annual labor cost by the average number of employees (both direct and associated indirect labor) and this in turn linked with the annual quintals of flour produced.

- The capital price (P_k)is calculated by dividing the annual capital expenditures to the value of capital stock, (P_k = Annual Capital Expenditure/Value of Capital Stock). Total capital expenditure is calculated as residual costs (the capital costs incurred and capitalized over the period) and when this total expenditure is prorated over the life of the machines, with the consideration of productive efficiency, yields the respective year's capital expenditure. Whereas, the capital stock is approximated by adding annual depreciation expenses andthe year's share of repair and maintenance costs, and deducting estimated recoveries for the year.

- The price of input wheat (p_w)is in most cases computational.[1] This is particularly the case when the flour factories receives part of its delivered wheat directly from the government agency and purchases only part of its total input wheat. For the objectivity of this study and incomplete data reasons, the factory's wheat purchase from the open market is excluded.
- Capacity Factor (CF) is the ratio of the average wheat flour supplied during a designated period to the integrated capacity of the factory in that period, in quintals.[2] Simply, the capacity factor is the actual amount of quintals of wheat flour delivered on a system in a designated period of time as opposed to the total possible quintals of wheat flour that could have been delivered on a system in a designated period of time if the factory operates at its full capacity.

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1 The input price is computed when flour factory purchases only part of its delivered wheat flour. The calculations are based on the market place payment, payment to other wheat suppliers than the government quotas based on companies' network and on the relative share of the received wheat and delivered flour. It is important to correct the input wheat price when only part of the delivered flours' wheat is purchased. Otherwise it distorts the cost structure of these companies. As a matter of fact, whatever the cost of the additional wheat purchased to utilize the factory's capacity, the final flour price, however, remain the same.

The input wheat (Pw) is used to determine the overall cost of producing one quintal of wheat flour. Since Pw is linearly explained by the output (Y), it is dropped from the subsequent regression.

2 Factories are generally interested in increasing capacity factors on their systems. A high capacity factor indicates high usage of the system's equipment and is a measure of efficiency. High capacity factor customers are normally very desirable from a factory's point of view. Using a year as the designated period, the capacity factor is calculated by dividing the quintals of wheat flour delivered during the year by the capacity for the year times the total number of working days during the year (taking 300working days a year). Since the division of year by year results in a ratio, multiplying this by the number of working days give better capacity factor indication.

3.5. Descriptive Statistics

Table 1 below, summarizes the results of the descriptive statistics of the 28 flour factories and discussions using the mean values of the variables are made following the table.

Table 1 Descriptive statistics (112 observations)

	Mean	Standard Deviation	Minimum	Maximum
Average annual Costs (C) per Quintal of wheat flour (Birr)	824.65	854.76	166.06	4895.19
Annual Av. output (y) in quintals	53113.39	64642.46	10,000	420000
Number of Customers (CU)	630	705	120	4,800
Capacity Factor (CF)[3]	0.245	0.41	0.02	0.33
Annual labour Price (pl) per Quintal	8.32	11.20	1.70	71.60
Capital price (pk)per quintal	15.18	19.09	2.92	122.38
Price of input wheat (p_w) per quintal	807.71	837.83	162.57	4801.05

Source: Own computation

3 Except CF in the RE model in absolute terms.

Table 1 gives the summary of descriptive statistics of the variables used in this research. From the table, we can learn that the average annual **cost** of producing one quintal of wheat flour is Birr 824.65. The annual average output from the sampled factories is 53113.39 quintals with the capacity utilization rate close to 25% or (0.245). On average there are 630 customers (mostly bakeries) that are supplied with the wheat flour. The labor cost and capital cost to produce one quintal of wheat flour is Birr 8.32 and 15.18 respectively, with the capital cost close to double that of the labor cost. The price of input wheat is found to be Birr 807.71. As compared to the input wheat, the average total cost of other factors (including labor & capital) to produce one quintal of wheat flour contribute less to the cost build up. This is partly due to the cost structure of flour factories, where by plants are acquired in good financial and investment encouraging terms whereas the input wheat price keeps increasing. Whereas, the range between the minimum and maximum cost of producing a quintal of wheat flour is wider due to the existence of significant variation in the relative size (in terms of capacity) of the flour factories.

3.6. Estimation for the Efficient Costs

The estimation of efficient costs are made with the cost parameters of the Stochastic Frontier Analysis models specified using Cobb –Douglass production function.

In Table 2 results for the estimations are presented. The explained variable is average annual cost per quintal in 2011 Birr.

Table 2. Cost frontier parameters of models 3 – 6

	RE		**REH**		**TRE**		**TFE**	
	Coeff.	***Std.er***	***Coeff***	***Std.er***	***Coeff.***	***Std.er***	***Coeff.***	***Std.er***
Constant	2.226	1.128	7.75	1.14	6.925	1.230	16.356	4.239
lny	-.376	.293	-.544	.303	-.554	.230	-.348	.446
lnCU	.006	.126	.050	.136	.076	.134	.206	.208
lnCF[4]	-.010	.085	-.163	.086	-.147	.089	-.043	.107
lnpl	.013	.152	.206	.169	.233	.167	.300	.256
lnpk	.007	.435	.069	.321	.185	.326	.003	.455
T	-.0422	.0263	-.0516	.0257	-.0461	.0259	-7.91e-07	1.90e-06
Log likelihood	435		142		263		466	

[4] In the model REH refers to the third equation in model (4).

Table 2 shows both price effects (P_k and P_l) have positive signs in all model specifications and the capital price effect is larger in the TRE model than other models. The sign of output (y) estimator is negative, which is expected since the explained variable is total costs per quintal. As the distributed wheat flour quintals increases, the unit costs decrease up to the point of minimum efficient scale. Also the sign of the time estimate is negative. The negative sign of time variable indicates that there has been technological development and/efficiency improvements which has the effect of decreasing the costs of producing one quintal of wheat flour.

It is also notable that in the basic random effects model (RE), the constant term is considerably smaller than the corresponding averages from the REH specification. This being the case that the basic RE model estimates the initial points of the average cost of producing wheat flour in the frontier, closer points to the vertical cost axis compared to the extended RE model. The estimate of CF is significantly smaller in REH model than in other specifications. This indicates in absolute terms, |-0.163|, the possibility of efficiency improvements under such model is higher. In other words, the possibility of decline in inefficiency is as high rate as 0.163, as the figure is already negative, while production (capacity utilization) increases by additional units, the corresponding efficiency will be improved by the rate of 16.3%.

3.7. Statistics of Inefficiency Scores

The Statistics of Inefficiency Scores represent the percentage deviation from a minimum level that would have been incurred if the company had operated as best-practice (or cost efficient) given our data set.

The statistics of inefficiency scores are summarized in table 3 below.

Table 3. Statistics of inefficiency scores

	RE	REH	TRE	TFE
Minimum	.0404	.0359	.0429	.0743

Maximum	.9544	.9508	.7523	.7523
Mean	.8735	.8700	.5318	.5318
Std.Dev. of $E[u_i \mid \varepsilon_i]$	.3072	.2724	.3070	.0528
σ (v)	.2207	.2197	.2208	.2208
σ (u)	.0958	.150	.096	.7636
λ	.434	.683	.435	.458

These basic statistics clearly show that the models REH, TRE and TFE capture the firm specific heterogeneity into the cost frontier allowing the inefficiency distribution move to the left. Another clear observation is that TFE produces clearly different inefficiency scores than either the basic RE model or the random parameterized versions of the RE model (REH and TRE). The difference among basic RE model inefficiency scores and those which TFE model produces can be explained by the clearly different model assumptions. (However, TRE model's inefficiency scores are close estimates to TFE model though not as TFE does). First difference is the assumption of time varying inefficiency. Both RE and REH models assume constant inefficiency over time. The second difference is that in TFE correlation between firm specific effects and explanatory variables is allowed. This is not the case for the basic RE model. Third clear difference is that in the basic RE model, any unobserved firm-specific differences are interpreted as inefficiency. Given that in flour factories, a considerable part of the unobserved heterogeneity is related to supply of wheat input (as the open market for wheat is not captured) and the procurement performance of wheat is very likely beyond the firm's own control, the inefficiency estimates can be overestimated in RE models. All these three distinguishing assumptions among TFE and RE models can be observed from the inefficiency estimates. It is notable that the variance of the frontier in TFE model is rather a little bit highest (.22) which may show that the model does not produce robust estimates for the frontier but captures firm specific fixed effects that can better explain the data. This can be also attributable to the rather short panel of the data or insufficient number of observations.

When comparing among the random and its versions, the basic random effect model to the random parameterized versions of RE model, one observation to note is that mean inefficiency estimates clearly diminish. This can be explained by the fact that in the random parameterized models, unobserved heterogeneity is not appearing as inefficiency. The inefficiency scores among TFE and random parameterized versions of the RE model differs somewhat. The maximum and the mean inefficiency scores are clearly smaller in TFE model except with that of TRE model. The mean of inefficiency is higher in RE model than in the model of TFE. However, the mean of inefficiency is clearly the same between the TFE model and the random parameterized version of the RE model, which is the TRE model.

The variance parameter of the underlying distribution of u_i, σ_u, is estimated as .10 in basic random effects model (RE). In the REH model,the randomized TRE model, and the TFE model, the counterparts are .102, .096, and .76 respectively. This points out that some of the variation in the inefficiency in the TFE model can be explained as heterogeneity. Based on this notification, we can expect the estimated inefficiencies to diminish with time and in effect efficiency improves. Accordingly, the true fixed effects model (model TFE in this case) fits the data best (see hausman fixed test statistics in appendix C).

3.8. Welfare effects

The effects of the changes in regulation schemes with respect to the welfare are calculated by using the empirical cost inefficiency information (in determining the size of the efficiency gains). In the calculations, the researcher has assumed constant elasticity of demand over the data periods,as there is no significant income and substitution effects take place and the elasticity value to be taken as a single unique figure for each modelwithin the range of -0.76 to -0.10 values as determined as the respective variances. For these demand elasticity, reference is made to TFE's and RE's coefficients of inefficiency scores respectively (with the assumption that demand is not at least greater than supply that initiated the price regulation).The overall welfare change is calculated as the sum of the change in consumer and producer surplus. The changes in consumer and producer surpluses can be specified as follows.

The change in consumer surplus can be written as the line integral.

$$\Delta CS = \int_{P_C}^{P_N} D^{-1}(Q)\, dQ, \ldots\ldots\ldots (7)$$

Where P_C is the price under rate of return (cost of service regulation), P_N is the new price under the price cap regulation, D^{-1} is the constant elasticity inverse demand function obtained from the inefficiency scores, and Q is distributed total wheat flour in quintals.

The corresponding change in producer's surplus is:

$$\Delta PS = (P_{Ni}Q_{Ni} - C(Q_{Ni})) - (P_{Ci}Q_{Ci} - C(Q_{Ci})) \ldots\ldots\ldots\ldots (8)$$

Therefore, the change of total surplus is:

$$\Delta CS + \Delta PS = \int_{P_C}^{P_N} D^{-1}(Q)\, dQ + [(P_{Ni}Q_{Ni} - C(Q_{Ni})) - (P_{Ci}Q_{Ci} - C(Q_{Ci}))] \ldots..(9)$$

Where, the new volume Q_N is the supply and demand equilibrating quantity at the new price P_N. This assumption can be made because real time demand and supply must always equal each other that there will no stock put aside from flour (and in turn bread) distributionto consumer.

Based on the regulatory schemes, the researcher is able to calculate the total welfare changes using firm specific results on efficiency improvement potentials of the models. The results for all four stochastic frontier Analysis (SFA) model types (see equations 3-6) are presented in Table 4.The details of the calculations of surpluses in the two price regimes are put under annex E and F.

Table4. Change in welfare (CS + PS = TS)*, RRR/ Cost of service regulation as benchmark, per customer/ firm*

SFA model	Price cap*			Rate of Return**		
	ΔCS	**ΔPS**	**ΔTS**	**ΔCS**	**ΔPS**	**ΔTS**

RE	-508 89059 88551	-508 88869 88361
REH	-356 78436 78080	-4087891178503
TRE	-455 77772 77317	-54177962 77421
TFE	-108 79024 78916	-124 7891178787

** 10% for r in the Rate of Return regulation is used [$P_{i,t} = (1+r)\,C_{i,t-1}$]. The assumption is 8% RPI +2% miscellaneous as cost of capital considering the Averch-Johnson effect for rate of return regulation.*
***5%, which is 8% for RPI less 3% efficiency gain or value of X parameter [$P_{i,t} = P_{i,t-1} * (RPI - X_i) + /-Z_i$]*
(See also appendices E & F, for the details of Consumer's and Producer's Surplus calculations)

From the table, we can see that Price Cap for the subsequent years is computed using 5% increment to the cost of producing one quintal of wheat flour after compensating the 8% inflation rate with 3% gain in efficiency. Whereas, Rate of Return is calculated by taking 10% as the cost of capital (*r*) to produce one quintal of wheat flour in the subsequent years of the study period.

The result shows that there is some savings (surplus) to consumers under Price Cap Regulation compared to Rate of Return Regulation. This is due to the fact that the price per quintal of wheat flour for price cap is calculated and set to be ETB 907 whereas the equivalent price for rate of return is found to be ETB 1017 (see appendix E & F for details). There is definitely some efficiency gains to account for the better change in consumer surplus (ΔCS) under price cap regulation. The negative change in consumer surplus is due to the fact that the line integration is made with price cap and rate of return rates, ETB 907 and ETB 1017 rates respectively. As the price tag of rate of return is higher than the price tag of the price cap, the integration of the smaller to the larger results in negative values. In effect it results in the reduction of the overall costs to consumers' welfare better than rate of return. In other words, in aggregate,with 5% margin of the price cap regulation out performs the 10% margin of rate of return regulation even for the producers who take advantage of higher prices.

Consistent with the theory, there is no significant improvement in welfare due to price regulation. However, changing the regulatory schemefrom rate of return (cost of service) to price cap regulation regime presented above results in a significant welfare improvement.

However, there is clear difference how different regulation schemes divide welfare to producers and consumers. In the price cap regulation producer surplus increase if the efficient levels of the firms costs are determined by using the values of random effects (RE) model. If the possibilities of the efficiency improvements are determined according to the REH, TRE models, however, producer surplus clearly decreases. Once again, the producer surplus gets better in TFE model. The consumer surplus smoothly increases from RE towards TFE. TFE model shows better efficiency improvements as compared to the two extensions of the RE models (namely REH, and TRE models). Consequently the efficient cost of the highest type C* is quite high, i.e. from the panel of twenty eight factories some are found to have high cost of production, needs more time than the four years period to get into some sufficient production level to minimize the overall costs.

The higher cost raises the average level of the allowed price and hence removes the welfare from the consumers to the producers. This result is even clearer in the case of price cap regulation as firms are allowed to set the price equal to the efficient cost of the highest type cost firm, as the study considers the high cost firm as the benchmark for price limitation. The overall welfare improvement is better in price cap regulation than simple cost of service based regulation. If the regulator is interested only in maximizing total welfare it should choose the RE model. However, if the regulator is interested more on consumer welfare and wishes to see lower overall prices, it should set the regulation in accordance with efficiency improvements integrating with incentive schemes.

CHAPTER FOUR
Conclusions and Recommendations

4.1. Conclusions

The study tried to address whether it is possible to improve social welfare by changing the regulation scheme on basic consumption item of wheat flour (bread) by introducing price cap regulation or not. A great deal of theoretical research has been conducted concerning different regulation methods but the connections of the regulation theory to the real regulatory processeshave been problematic. In this study, the researcher has combined the theory of price cap regulation schemes to the firm specific cost information of flour mills which distribute wheat flour to bakeries and use for own baking plants.

The welfare effect in TFE model, coupled with Price Cap Regulation integrates efficiency improvements with incentive schemes than that of the Cost of Service regulation scheme.The overall welfare is found to be higher in price cap regulation compared to rate of return regulation.

Wheat input constitutes the major share of the total input costs. And the wheat supply inadequacies have highly contributed to the low level capacity utilization rate of flour factories, which is found to be 25%. The model does not incorporate the wheat supply from the open market rather it is accounted only to the government's supplyof wheat.

The results of the study also shows that there are some improvements in efficiency over the four years period. The efficiency improvements can be attested by the results of comparative welfare effects and the negatively correlated capacity factor to the flour producing costs. There is also some technological gains that impacted efficiency to improve with the time variable shows negative correlation with the average cost of flour production. The results clearly support the theory of Price Cap Regulation and changing the regulation method from rate of return pricing to price cap regulation considerably improves social welfare.

The results of the study found to be consistent with the theory that price cap regulation minimizes the problem of moral hazard. In other words the incentive scheme helps to improve efficiency. However, in price cap regulation the problem of adverse selection remains unsolved. The benchmarking of the high cost firm by regulators lets the efficiency efforts in some way guaranteed up to the high cost firm.

According to the theory from the literature, the menu of contracts regulation should solve both the moral hazard and adverse selection problems. Welfare can be significantly improved by moving from the pure cost based regulation to the price cap regulation.

Notable is that the total welfare is positive and significant in all model specifications. However, there are significant differences among regulation schemes on how improved welfare is distributed to consumers and producers.

4.2. Recommendations

With the input wheat cost takes much of the cost share of producing wheat flour, the inadequate supply of wheat to flour factories further causes the factories to run at lower level of their capacity which is found to be 25%. There should be efficiency improvement concerns that can focus on wheat supply improvements both from import and domestic supply. This may take the form of increasing the quantity and frequency of government imports, to take advantage of bulk purchases and to fill the safety stock requirements until the next order arrives. Domestic wheat market stabilization within the open market and distribution network synchronization to properly handle stocks should be considered in order for the flour factories to get wheat supply and distribute wheat flour in competitive price.

To complement the regulatory process, price cap regulation should be accompanied by welfare distribution concerns. To boost the consumer welfare, the incentive to increase efficiency of production processes should take in to consideration that of the average not the high cost firm benchmark.

Furthermore, integrating supervisory exercises with and among the stakeholders should be in place to guarantee quality and meeting standard package measurements.

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Appendices

Appendix A.Descriptive statistics

```
. xtsum c y cf cu pl pk pw
```

Variable		Mean	Std. Dev.	Min	Max	Observations
c	overall	4.38e+07	4.54e+07	8820000	2.60e+08	N = 112
	between		4.25e+07	8966425	2.38e+08	n = 28
	within		1.76e+07	-8825216	2.02e+08	T = 4
y	overall	53113.39	64642.46	10000	420000	N = 112
	between		64813.3	12250	362500	n = 28
	within		9561.299	-9386.607	110613.4	T = 4
cf	overall	13013.88	21787.18	1000	162319	N = 112
	between		20907.35	2735	113797	n = 28
	within		7026.934	-28283.13	61535.88	T = 4
cu	overall	630	705.111	120	4800	N = 112
	between		696.8641	187.5	4000	n = 28
	within		157.1204	-170	1430	T = 4
pl	overall	441818.8	594771	90000	3803000	N = 112
	between		591280.1	97702.5	3276500	n = 28
	within		116573.5	-434181.2	968318.8	T = 4
pk	overall	806095	1013809	155000	6500000	N = 112
	between		1015567	183650	5675000	n = 28
	within		155909	131095	1631095	T = 4
pw	overall	4.29e+07	4.45e+07	8634500	2.55e+08	N = 112
	between		4.16e+07	8778000	2.33e+08	n = 28
	within		1.72e+07	-8640768	1.97e+08	T = 4

Note: *- The overall annual average total cost is meant for the annual average quintals of wheat produced. So dividing the cost by the output yields the average annual total cost of a quintal of wheat flour. The same approach holds true to the rest of the variables.*

Appendix B. Regression results of the specified models.

```
. use "C:\Documents and Settings\user\Desktop\zeleregression\zelenewdata.dta", clear

. xtreg  lnc lny lncf lncu lnpl lnpk  year,re

Random-effects GLS regression                   Number of obs      =       112
Group variable: newid                           Number of groups   =        28

R-sq:  within  = 0.0404                         Obs per group: min =         4
       between = 0.9544                                        avg =       4.0
       overall = 0.8735                                        max =         4

                                                Wald chi2(6)       =    482.08
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |   .3273442   .3231561     1.01   0.311    -.3060302    .9607186
        lncf |  -.1240885   .0885595    -1.40   0.161    -.2976619     .049485
        lncu |   .2417239   .1620758     1.49   0.136    -.0759389    .5593867
        lnpl |   .3359433   .1752525     1.92   0.055    -.0075453    .6794319
        lnpk |    .143244   .3228147     0.44   0.657    -.4894613    .7759492
        year |  -.0461533   .0258986    -1.78   0.075    -.0969137     .004607
       _cons |   100.2236   52.36692     1.91   0.056    -2.413631    202.8609
-------------+----------------------------------------------------------------
     sigma_u |  .09589719
     sigma_e |  .22075561
         rho |  .15874989   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. xtreg  lnc lny lncu lnpl lnpk  year,re

Random-effects GLS regression                   Number of obs      =       112
Group variable: newid                           Number of groups   =        28

R-sq:  within  = 0.0359                         Obs per group: min =         4
       between = 0.9508                                        avg =       4.0
       overall = 0.8700                                        max =         4

                                                Wald chi2(5)       =    454.67
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |   .2903832   .3244911     0.89   0.371    -.3456076     .926374
        lncu |   .2419883   .1644374     1.47   0.141     -.080303    .5642797
        lnpl |   .3278584   .1776126     1.85   0.065    -.0202558    .6759726
        lnpk |   .0406253   .3170117     0.13   0.898    -.5807062    .6619568
        year |  -.0516096    .025747    -2.00   0.045    -.1020728   -.0011464
       _cons |   111.9455   51.99048     2.15   0.031     10.04605     213.845
-------------+----------------------------------------------------------------
     sigma_u |  .10193942
     sigma_e |  .21966328
         rho |  .17719998   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. xtreg  lnc lny lncf lncu lnpl lnpk  year,fe

Fixed-effects (within) regression               Number of obs      =       112
Group variable: newid                           Number of groups   =        28

R-sq:  within  = 0.0798                         Obs per group: min =         4
       between = 0.8962                                        avg =       4.0
       overall = 0.6494                                        max =         4

                                                F(6,78)            =      1.13
corr(u_i, Xb)  = -0.8918                        Prob > F           =    0.3546

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |  -.4351673   .4656616    -0.93   0.353    -1.362228    .4918937
        lncf |   -.050539   .1077167    -0.47   0.640    -.2649865    .1639084
        lncu |   .1085764   .2534374     0.43   0.670    -.3959788    .6131316
        lnpl |    .192326   .3024269     0.64   0.527    -.4097597    .7944118
        lnpk |    .005079   .4563463     0.01   0.991    -.9034367    .9135947
        year |   .0365858   .0539087     0.68   0.499    -.0707382    .1439098
       _cons |  -54.41359   104.2909    -0.52   0.603    -262.0407    153.2136
-------------+----------------------------------------------------------------
     sigma_u |  .76358678
     sigma_e |  .22075561
         rho |  .92286609   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(27, 78) =     1.80             Prob > F = 0.0234
```

```
. xtreg  lnc lny  lncf lncu lnpl lnpk lnpw year,re
note: lnpw omitted because of collinearity

Random-effects GLS regression                   Number of obs      =       112
Group variable: newid                           Number of groups   =        28

R-sq:  within  = 0.0404                         Obs per group: min =         4
       between = 0.9544                                        avg =       4.0
       overall = 0.8735                                        max =         4

                                                Wald chi2(6)       =    482.08
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |   .3273442   .3231561     1.01   0.311    -.3060302    .9607186
        lncf |  -.1240885   .0885595    -1.40   0.161    -.2976619     .049485
        lncu |   .2417239   .1620758     1.49   0.136    -.0759389    .5593867
        lnpl |   .3359433   .1752525     1.92   0.055    -.0075453    .6794319
        lnpk |    .143244   .3228147     0.44   0.657    -.4894613    .7759492
        lnpw |          0  (omitted)
        year |  -.0461533   .0258986    -1.78   0.075    -.0969137     .004607
       _cons |   100.2236   52.36692     1.91   0.056    -2.413631    202.8609
-------------+----------------------------------------------------------------
     sigma_u |  .09589719
     sigma_e |  .22075561
         rho |  .15874989   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. xtreg  lnc lny  lncu lnpl lnpk lnpw year,re
note: lnpw omitted because of collinearity

Random-effects GLS regression                   Number of obs      =       112
Group variable: newid                           Number of groups   =        28

R-sq:  within  = 0.0359                         Obs per group: min =         4
       between = 0.9508                                        avg =       4.0
       overall = 0.8700                                        max =         4

                                                Wald chi2(5)       =    454.67
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |   .2903832   .3244911     0.89   0.371    -.3456076     .926374
        lncu |   .2419883   .1644374     1.47   0.141     -.080303    .5642797
        lnpl |   .3278584   .1776126     1.85   0.065    -.0202558    .6759726
        lnpk |   .0406253   .3170117     0.13   0.898    -.5807062    .6619568
        lnpw |          0  (omitted)
        year |  -.0516096    .025747    -2.00   0.045    -.1020728   -.0011464
       _cons |   111.9455   51.99048     2.15   0.031     10.04605     213.845
-------------+----------------------------------------------------------------
     sigma_u |  .10193942
     sigma_e |  .21966328
         rho |  .17719998   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. xtreg  lnc lny lncf lncu lnpl lnpk lnpw year,fe

Fixed-effects (within) regression               Number of obs      =       112
Group variable: newid                           Number of groups   =        28

R-sq:  within  = 1.0000                         Obs per group: min =         4
       between = 1.0000                                        avg =       4.0
       overall = 1.0000                                        max =         4

                                                F(7,77)            =  9.84e+09
corr(u_i, Xb)  = -0.8457                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         lnc |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lny |   .0000224   .0000164     1.36   0.177    -.0000103    .0000551
        lncf |  -2.90e-06   3.78e-06    -0.77   0.445    -.0000104    4.63e-06
        lncu |  -.0000111   8.90e-06    -1.25   0.216    -.0000288    6.61e-06
        lnpl |  -.0000173   .0000106    -1.63   0.108    -.0000385    3.88e-06
        lnpk |   .0000209    .000016     1.31   0.195    -.0000109    .0000528
        lnpw |   .9999972   3.97e-06  2.5e+05   0.000     .9999893    1.000005
        year |  -7.91e-07   1.90e-06    -0.42   0.678    -4.57e-06    2.98e-06
       _cons |   .0226536   .0036641     6.18   0.000     .0153575    .0299497
-------------+----------------------------------------------------------------
     sigma_u |  .00001319
     sigma_e |  7.742e-06
         rho |  .74365784   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(27, 77) =     2.20              Prob > F = 0.0039
```

Appendix C. Basic Models Test

```
. hausman fixed

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed          .           Difference          S.E.
-------------+----------------------------------------------------------------
         lny |   -.348042     .5540903        -.9021324        .3301737
        lncu |   .2060038     .0760784         .1299254        .1589058
        lncf |  -.0453187    -.1466083         .1012896        .0601821
        lnpl |   .3005012     .2326136         .0678876        .1939963
        lnpk |   .0029802     .1846954        -.1817151        .3175697
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        9.01
                Prob>chi2 =      0.1085
```

Appendix: D, the Averch-Johnson Rate of Return Regulation

The Averch-Johnson effect of overcapitalization under rate of return (ROR) regulation can be shown using a mathematical model. This presentation follows the work of Takayama, (1969)" on **Behavior of the Firm under Regulatory Constraint".**

A monopoly's production function is

Equation 1

$Q = f(L,K)$,

where Q is output, L is units of labor, and K is capital stock. Its profit is

Equation 2

$\pi = p(Q)Q - wL - uK = R(L,K) - wL - uK$,

where $p(Q)$ is the inverse demand curve, w is the wage rate, u is the user cost of capital, and $R(L,K)$ is the revenue function $R(L,K) = p(f(L,K))f(L,K)$.

Suppose the board decides the fair rate of return is v, so that, using Equation 2,

Equation 3

$$\frac{\pi}{p_k K} = \frac{R(L,K) - wL - uK}{p_k K} \leq v.$$

We can rewrite this constraint as,

Equation 4

$$\frac{R(L,K) - wL}{p_k K} \leq v + \frac{u}{p_k} \equiv s.$$

That is, this type of regulation requires that revenues left over after covering labor expenses per unit of capital cannot exceed s, where s is the cost of capital divided by p_k plus the fair rate of return. If v were less than 0, then the firm would not produce. We assume in the following that $v > 0$, so that $s > u/p_k$. [It is not necessary for v to be positive. If $v = 0$, $\pi = 0$ and the firm covers costs because the user cost already incorporates a normal rate of return to capital. If $v = 0$, this solution resembles that of Ramsey pricing in which price equals average cost.]

The regulated firm's objective is to maximize profits, Equation 2, subject to the rate of return restriction implied by Equation 4. The firm's optimal behavior is determined by finding the saddlepoint of the Lagrangian

Equation 5

$R(L,K) - wL - uK - \lambda[R(L,K) - wL - sp_k K]$, Where λ is the Lagrangian multiplier, and the term in brackets is obtained by multiplying Equation 4 through by $p_k K$ and rearranging terms.

If the L and K at the saddlepoint of Equation 5 are positive, and the constraint binds, then the Kuhn-Tucker-Lagrange conditions,

Equation 6

$R_L = w$,

Equation 7

$R_K = u - ((sp_k - u)/(1 - \lambda))\lambda$,

Equation 8

$R - wL - sp_k K = 0$,

Equation 9

$\lambda > 0$,

Determine the values of L, K, and λ. Equation 6 says that the value of the marginal revenue product of labor equals the wage. Equation 7 equates the value of the marginal revenue product of capital to the cost of capital plus an adjustment factor that depends on the fair rate of return ($v = s - u/p_k$) and the Lagrangian multiplier. Equation 8 is the rewritten constraint, Equation 4.

If the constraint does not bind ($\lambda = 0$), Equations 6 and 7 are the usual profit-maximizing equations of the unregulated monopoly:

Equation 6'

$R_L = w$

Equation 7'

$R_K = u$.

That is, the value of the marginal revenue product of labor equals the wage, and the value of the marginal revenue product of capital equals the per-unit user cost of capital. The nonconstrained ROR, then, is

Equation 10

$s_0 = \quad R_0 - wL_0 \quad .$

$$\overline{}$$
$$K_0$$

For the ROR constraint to matter, s_0 must exceed s, which, by assumption, exceeds u/p_k.

Takayama (1969) shows that L and K are continuous functions of s. Differentiating Equation 8 with respect to s, we obtain

Equation 11

$$\frac{dL}{ds}(R_L - w) + \frac{dK}{ds}(R_K - sp_k) = p_k K.$$

Evaluating at $s = s_0$ (the unconstrained, profit-maximizing rate of return) and substituting using Equations 6 and 7, this equation may be rewritten as

Equation 12

$$\frac{dK}{ds} = \frac{p_k K_0}{u - s_0 p_k} < 0,$$

Because$s_0 > u/p_k$. Thus, introducing an active fair-rate-of-return constraint (that is, lowering s from s_0) must increase capital, which is the Averch-Johnson effect.

Appendix: E

How the Consumer's and Producer's Surplus is Computed under Price Cap Regulation usingthe results of the inefficiency statistics

The Elasticity of Demand, in absolute terms, for each model is given below:

RE=0.1

REH=0.15

TRE=0.11

TFE=0.76

Price Cap Regulation equation is given by, $\mathbf{P_{i,t} = P_{i,t-1} * (RPI - X_i) +/- Z_i}$

To determine surplus under RE, first we need to calculate the inverse demand (Q_D^{-1}) from the price equationas follows:

Q_D = a-bP;

/ED/ = b*P/Q

b= -ED/ (P/Q)

b= 0.1(53113/824.65)

b = 6.4

Q_D = a-bP

a = Q_D + bP

= 53113+(6.4*824)

= 58424

Q_D = 58424-6.4*P

P= 9129-1/6.4(Q_D)

To determine surplus under REH, first we need to calculate the inverse demand (Q_D^{-1}) from the price equationas follows:

b= 0.15(53113/824.65)

b= 9.66

QD = a-bP

a= QD+bP

a = 53113+(9.66(824.65)

a = 61079

Q_D = a-bP

Q_D = 61079-(9.66*824.65)

Q_D = 61079-9.66P

P=6323-1/9.66 QD

To determine surplus under TRE, first we need to calculate the inverse demand (Q_D^{-1}) from the price equationas follows:

b=0.11/(53113/824.65)

b =7

a = Q_D +bP

a = Q_D + bP

a = 53113+(7*824.65)

a = 58886

Q_D = 58886-7P

P = 8412-1/7(Q_D)

To determine surplus under TFE, first we need to calculate the inverse demand (Q_D^{-1}) from the price equationas follows:

$b = 0.76(53113/824.65)$

$b = 49$

$a = Q_D + bP$

$a = 53113+(49*824.65)$

$a = 93521$

$Q_D = 93521-49P$

P= 1909-1/49(QD)

Computation for ΔCS for Price Cap Regulation of RE model is as follow:

In reference to the model specification of computing consumer surplus (CS) in section/chapter four of the study, the model is given as:

$$\Delta CS = \int_{P_C}^{P_N} D^{-1}(Q)\, dQ$$; by taking the inverse demand function of RE model,

$$\Delta CS = [9129Q - 1/12.8Q^2]_{1017}^{866}$$

$\Delta CS = -2,352,589$

Number of Customers =630

$\Delta CS = -2,352,589/630$

$\Delta CS = -3,734$

Clarification on how $P_C = 907$

$\mathbf{P_{i,\,t} = (1 + r)\, C_{I,\, t-1}}$

Given r = 10%

$\mathbf{P_{i,\,t} = (1 + 0.1)\, 824.65}$

$= 907$

$\mathbf{P = 9129 - (1/6.4)(Q_D)}$

P = 9129-(1/6.4)(53113)

P = 924.65

$\mathbf{P_{i,\,t} = (1 + 0.1)\, 924.65}$

= 1017

To calculate Producer's surplus for RE

$\Delta PS = (P_{Ni} Q_{Ni} - C(Q_{Ni})) - (P_{Ci} Q_{Ci} - C(Q_{Ci}))$

Assumption:

- Only 5% margin to adjust the price to reflect the cost of inflation. Given that CPI (or RPI) is one digit and specifically it is 8% and efficiency gains is 3%, so 8%less 3% equals 5%.
- Producers' benefit the difference between cost of production and selling price. In this case therefore, Pc is taken to be the average annual total cost of producing one quintal of flour wheat (equal to Birr 824.65).

So, Price Cap = P_{Ni} + 5% inflation cost over efficiency.

P_{Ni}=[9129–(1/6.4) (53113)] + [5%(9129–(1/6.4)(53113))]

P_{Ni} = 871.60

$\Delta PS = (P_{Ni}Q_{Ni} - C\ (Q_{Ni})) - (P_{Ci}Q_{Ci} - C\ (Q_{Ci}))$

$\Delta PS = [(P_{Ni} - C)\ (Q_{Ni})] - [(P_{Ci\ -}\ C)\ (Q_{Ci})]$

ΔPS = [(871.60 - 824.65) (53113)] - [(824.65 - 824.65) (53113)]

ΔPS = 2,493,655

Number of Companies=28; So, ΔPS = 2,493,655/28 =89,059

The Rest models are computed in the same way by taking each model's price function!

As the highest price is found to be Birr 871.50, it should be taken as the market price standard for the Price Cap Regulation.

Appendix F:

How the Consumer's and Producer's Surplus is Computed under Rate of Return Regulation usingthe results of the inefficiency statistics.

From the calculations of inverse demand function of Appendix A, we find the inverse demand function of each model as follows:

For RE model's (Q_D^{-1}) is given by,

P= 9129-1/6.4(Q$_D$)

For REH model's (Q_D^{-1}) is given by,

P=6323-1/9.66 QD

For TRE model's (Q_D^{-1}) is given by,

P = 8412-1/7(Q$_D$)

For TFE model's (Q_D^{-1}) is given by,

P= 1909-1/49(QD)

Rate of Return Regulation is given by, $P_{i,t} = (1 + r)\, C_{i,t-1}$

Computation for ΔCS for Rate of Return (Cost of Service) Regulation of RE model is as follow:

In reference to the model specification of computing consumer surplus (CS) in section four of our estimation part in the study, the model is given as:

$\Delta CS = \int_{P_C}^{P_N} D^{-1}(Q)\, dQ$; by taking the inverse demand function of RE model,

$\Delta CS = [9129Q - (1/12.8)(Q)^2]_{907}^{871.5}$

$\Delta CS = -320{,}147$

Number of Customers =630

$\Delta CS = -320{,}147/630$

$\Delta CS = -508$

Clarification on how $P_C = 907$. The model specification of Rate of Return is given by

$P_{i,t} = (1 + r)\, C_{I,t-1};$ given r = 10% for the sake of cost of capital that take in to inflation.

$P_{i,t} = (1+r)\, C_{i,t-1}$

= (1.1) (824.65)

$= 907$

Whereas, P under Price cap will be;

$P_{i,t} = P_{i,t-1} * (RPI - X_i) + /- Z_i$

$P = 9129-(1/6.4)(Q_D)$

$P = 9129-(1/6.4)(53113)$

$P = 830$

$P_{i,t} = P_{i,t-1} * (RPI - X_i)$

$P_{i,t} = 830 * (1.08 - 0.03) = 871.50$, by taking the inflation level of 8% (as RPI is taken to be CPI for this case) and productivity level of 3%.

To calculate Producer's surplus for RE

$\Delta PS = (P_{Ni} Q_{Ni} - C(Q_{Ni})) - (P_{Ci} Q_{Ci} - C(Q_{Ci}))$

Assumption:

- Only 5% margin to adjust the price to reflect the cost of inflation. Given that CPI (or RPI) is one digit and specifically it is 8% and efficiency gains is 3%, so 8%less 3% equals 5%. (Remark, the inflation index based on the data sources)
- Producers' benefit the difference between cost of production and selling price. In this case therefore, Pc is taken to be the average annual total cost of producing one quintal of flour wheat (which is equal to Birr 824.65).

So, Price Cap = P_{Ni} + 5% inflation cost over efficiency.

$P_{Ni} = [9129 - (1/6.4)(53113)] + [5\%(9129 - (1/6.4)(53113))]$

$P_{Ni} = 871.50$

$\Delta PS = (P_{Ni} Q_{Ni} - C(Q_{Ni})) - (P_{Ci} Q_{Ci} - C(Q_{Ci}))$

$\Delta PS = [(P_{Ni} - C)(Q_{Ni})] - [(P_{Ci} - C)(Q_{Ci})]$

$\Delta PS = [(871.50 - 824.65)(53113)] - [(824.65 - 824.65)(53113)]$

$\Delta PS = 2{,}488{,}344$

Since the number of Companies is equal to 28; PS = 2,488,344/28 =88,869

REH, TRE, and TFE models follow the same approach with the price function already set.