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Financial Sustainability of Public Higher Education Institutions in Uzbekistan

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Declaration of Authenticity & Copyright

This thesis is the result of the author's original research. It has been composed by the author and not been previously submitted for examination which has led to the award of a degree.

Signed: _____

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Abstract

Since the early years of independence in 1991, a central topic of higher education in Uzbekistan has been how to fill the gap left by the reduced government funding at public Higher Education Institutions (HEIs). The majority of the Uzbek universities, as in many other countries, have responded to the decline in public allocations through charging significantly increased tuition fees. Therefore, the revenue structure of public HEIs has changed from full government funding to mostly tuition funding over the last decade. The main aim of this study is to examine the impact of this shift in the institutional revenue structure on behaviour and efficient resource utilisation of public HEIs in Uzbekistan. For these purposes, this study begins with analysing the contemporary outlook of Uzbek education sector, particularly administrative and financing structures and reforms of the higher education. A comprehensive comparison between the higher education system of Uzbekistan and the rest of the Central Asian Republics (CARs) is also provided in this thesis. To the best of my knowledge, this thesis is the first study which scrutinises the higher education systems of the entire CARs.

Utilising resource dependence theory (RDT), this study empirically investigates whether or not increased institutional reliance on tuition fees as a main source of revenue has augmented the share of institutional expenditures dedicated to educational activities at public HEIs in Uzbekistan over the period 2000-2013. Drawing on a 14-year panel of university-level data and employing an instrumental variable approach that acknowledges the potential endogeneity of institutional tuition revenue, the author finds that the institutional expenditures for educational expenses are considerably increased as institutions became more dependent on tuition revenue for their financially sustainable operation. This finding is

consistent with the predictions of RDT. Robustness of the empirical findings is also tested utilising several diagnostic models.

In this study, a stochastic cost frontier analysis is used in order to examine whether the institutional fiscal resources obtained mostly from tuition have been utilised efficiently or inefficiently at public HEIs in Uzbekistan during the period of 2000 to 2013. The Battese and Coelli (1995) method is applied to measure the influences of institution, staff and student characteristics on cost efficiency of the universities. According to mean efficiency scores that the Uzbek universities are not remarkably cost efficient in producing education and research outputs, although the significant improvements in the efficiency followed throughout the sample period. Interestingly, findings also reveal that public HEIs with a greater share of public funding are less cost efficient relative to those institutions with a smaller share of public funding.

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Chapter 1: INTRODUCTION AND OVERVIEW

1.1 Background

In the aftermath of the recent financial crisis, many countries had to considerably reduce their spending on public service sectors, such as health, transportation, education and tourism, in order to balance their budgets (Johnstone and Marcucci, 2010). Education was often among the sectors that lost out as a result of such public cuts (Albrecht and Ziderman, 1995; Sanyal and Johnstone, 2011). Higher education institutions have been struggling to find sufficient financial resources for conducting basic teaching and research activities due to the decline in government allocations (Barr, 2009; Sam, 2011). In some countries, the process of reforming the HEIs, to make them less dependent on government funding, had already been ongoing by giving more financial autonomy to their public HEIs for obtaining funds from external/private sources (Johnstone, 2004; Salmi and Hauptman, 2006; Sanyal and Johnstone, 2011). These reforms also included increasing demands on public sector institutions to improve the efficient utilization of available resources and to operate at the optimal level of efficiency (Johnes and Johnes, 2013).

Many public HEIs used this newly 'granted' financial autonomy to introduce or dramatically increase tuition and other user charges (Barr, 2010; Muscio et al., 2013). Most of the previous studies on consequences of increased tuition and other user charges have largely focused on their impact on behaviours of students (Canning at. al, 2007; Johnstone and Marcucci, 2010; Paulsen and Smart, 2001; Psacharpoulos and Partinos, 2004; Sam, 2011; Tilak, 2004). Over the recent years, however, understanding the behaviours of state HEIs has been a subject of

research by many scholars of economics, education and public administration. Compared to other bureaucracies, these institutions usually enjoy much greater autonomy and their incomes are a mixture of both private and public financing. In most countries, public universities are state-owned and heavily financed from government purse, while non-for-profit and private universities usually generate their revenues from tuition and other user fees. Nevertheless, Winston (1999) described the public HEIs as "part church and part car dealer" (p. 31).

In the recent years, many public universities have also started to rely more on tuition income for their survival due to insufficient government funding (Chernoshtan and Griciva, 2013; Jaramillo and Melonio, 2011; Van deuren, 2012). This shift in income structures of public HEIs from government to tuition financing, to some extent, made those institutions more dependent on students who are paying for their education (Fowles, 2013). Whereas, universities which obtain large proportion of their operational revenues from contracting out research or private donations become heavily beholden to these clients or donors which are providing 'critical' financial resources (Bozeman and Gaughan, 2007).

This form of resource dependency relationships between institutions and external stakeholders have been investigated by many researchers using different organisational theories, such as contingency, resource dependence, network organisation and institutional isomorphism theories (Austin and Jones, 2015). Most of the researchers found that the theory of resource dependence to be the most suitable theory in explaining the behavioural consequences of organisations within such relationships (Neinhuser, 2008; Pfeffer and Salancik, 2003). Accordingly, this PhD research will also utilise the RDT to investigate whether or not the public HEIs in Uzbekistan changed their behaviours when their main source of income shifted from full government to mostly tuition financing.

The education system of Uzbekistan inherited, at the point of independence in 1991, was fully funded and strictly controlled by the government via the Cabinet of Ministers of Uzbekistan (CMUZB). All of the HEIs were fully state-funded and higher education was absolutely free for every student. This level of funding to higher education was not sustainable considering the fact that over 60 per cent of Uzbekistan's population in 1991 was under the age of 15 (Majidov et. al, 2010). By 1995, the Uzbek government was struggling to finance its education sector, particularly the higher education sector, due to the increased enrolment and reduction in the country's export revenues caused by sharp drop in the commodity prices.

Between 2000 and 2013, the share of government funding allocated to public HEIs reduced by 21 per cent (MFUZB, 2013). This reduction was a part of a wider reform program of higher education carried out by the Uzbek government with the aim of making it more financially sustainable in the long run in order to meet increasing demand (Majidov et. al, 2010). After implementation of the first phase of the reforms, the total number of public HEIs increased from 57 in 1995 to 64 in 2013, and the total number of full time equivalent student enrolments more than doubled during the period of 2000 to 2013 (MFUZB, 2013).

In 1996, the Uzbek government decided to introduce tuition fees for the first time and the average tuition prices were increased by over 10 times at the public universities since that year (MFUZB, 2013). As a result of these changes, the main source of income of the public universities shifted from government to tuition funding throughout the last decade. Therefore, it is reasonable to expect that Uzbek HEIs have become more resource dependent on students and their parents for their continued operation and survival in this decade. Utilising resource dependence theory, the first empirical part of this study investigates whether or not this increase in tuition revenue has led to proportional increase in institutional expenditures

dedicated to the activities that are more consistent with the preferences of the students paying these tuition fees at public HEIs in Uzbekistan.

Numerous studies have found that simply introducing or increasing tuition fees at public HEIs was not always sufficient to fill the gap left by the reduced government funding (Erkoc, 2013; Horne and Hu, 2008; Johnes and Johnes, 2013). These scholars argue that public higher education establishments should always seek to utilise their resources more efficiently and perform at the best level of cost efficiency in order to achieve financially sustainable development. Besides, some other studies have discovered that public HEIs with a greater share of income from tuition were less cost efficient relative to public institutions with a smaller share of tuition revenue but with a greater share of public funding (Robst, 2001; Sav, 2012). In addition to the increased tuition charges, policy-makers in public higher education need to increase awareness concerning efficient usage of institutional resources.

Over the last decade, productivity and efficiency topics have received considerable attention by policy-makers and administrative bodies of universities in many countries, especially in high-income countries. In light of this, many scholars have tried to analyse whether HEIs are utilising their resources productively and efficiently (Agasisti, 2016; Agasisti and Johnes; 2015; Johnes, and Johnes, 2013; Katharaki and Katharakis, 2010; Kempkes and Pohl, 2010; Kuo ad Ho, 2008; Leitner et. al, 2007; Salerno, 2003; Sav, 2012; Worthington and Lee, 2008). Having benefited from the studies evaluating the efficiency performance of universities, administrators within governmental institutions and HEIs began to reorient their financing choices (Erkoc, 2013).

Similar to any other forms of organisations, measuring resource efficiency of universities often involves conducting specific analytical procedures that rely on fundamental assumptions of microeconomic theory. One of the key assumptions of the theory is that the

goal of a typical entity is to produce maximum amount of outputs through utilising given inputs with minimum cost. Within the framework of free market rules, the microeconomic concept supposes that entities direct input and output efficiently with the objective of minimising total cost or earning maximum revenue/profit (Farrell (1957). For many years, organisational efficiency has been evaluated by estimating distance to productivity frontier, cost frontier, revenue frontier or profit frontier (Kumbhakar and Lovell, 2000). Chapter 5 includes in depth description of the efficiency frontiers and differences between those various frontiers.

The second empirical part of this study is dedicated to investigating the cost efficiency of public HEIs in Uzbekistan. Since any public organisation's objective is to minimise cost, the distance between these Uzbek institutions' actual costs and minimum attainable cost levels is measured by utilising the cost frontier efficiency model. The numbers of research papers, which examine the economic efficiency level of public universities, have noticeably increased in the frontier analysis literature over the last decade (Agasisti and Johnes, 2015). Some of the main driving forces behind this proliferation could be the evident reduction in government allocations to public HEIs as well as increased institutional costs.

These financial challenges stimulated administrative bodies of many universities and governmental institutions to be more attentive about efficient utilisation of institutional fiscal resources. Consequently, most of the studies on economic efficiency are served as recommendation papers to the policymakers in higher education and administrative bodies of universities (Agasisti and Salerno, 2007). Findings of the analyses conducted in this thesis could also have policy-making implications to the CMUZB and Ministry of Higher and Secondary Specialized Education of Uzbekistan (MHSSE).

1.2 Objectives

This thesis has following main objectives which are analysed and discussed chapter by chapter throughout this study:

- To analyse the recent financial performance and challenges of education sector, particularly higher education sector of Uzbekistan;
- A comprehensive comparison between the higher education system (HES) of Uzbekistan and the rest of the Republics in Central Asia;
- To evaluate and explain the impact of the shift in institutional income structure from full government to mostly tuition funding on behaviours of public HEIs in Uzbekistan. Particularly, to empirically investigate whether or not increased institutional reliance on tuition fees as a main source of revenue has augmented the share of institutional expenditures dedicated to educational expenses at public HEIs.
- To examine whether the institutional fiscal resources obtained mostly from tuition revenue have been utilised efficiently or inefficiently at public HEIs in Uzbekistan. Another goal of this study is to determine whether public HEIs with a greater decline in the share of public funding improved the cost efficiency relative to public institutions with a smaller reduction in the share from public financing.
- Based on findings of the empirical analysis, this study aims to offer policy-orientated discussions and recommendations to administrative bodies of CMUZB, MHSSE and public HEIs in Uzbekistan.

1.3 Reasons to develop the study and expected contributions

This PhD thesis is expected to be the first comprehensive study which scrutinises entire education system of Uzbekistan and compares the higher education system of Uzbekistan with the rest of CARs in the context of reforms, administrative structure and financial performance. Therefore, this study will be beneficial for legislators and researchers concerned with higher education in CARs to carry out further empirical analyses and policy investigations for making informed policy choices in improving the higher education sectors of CARs.

The published empirical works on RDT based on higher education so far concentrated on institutions in the US, the UK, Canada and Taiwan only. To the best of the author's knowledge, in the case of low and middle income countries, there are no theoretical or empirical studies that specifically focus on the behaviours of public HEIs by utilising RDT. Chapter 4 contributes to the existing literature by testing the predictions of RDT through empirically investigating the changes in behaviours of the Uzbek HEIs during the period when the government funding became scarce. Moreover, this study offers an empirical model which is developed in order to test the relationship between institutional dependence on tuition fees as a main source of revenue and institutional expenditures for education. This model can be also applied to conduct resource dependence investigations in cases of public HEIs in other countries.

The empirical analysis in Chapter 6 is expected to be the first cost frontier and efficiency study that applies parametric efficiency estimation approach to public HEIs in one of the low- and middle-income countries. This chapter also contributes to the existing literature by analysing the cost efficiencies of different groups of public HEIs in Uzbekistan classified by the percentage of their revenue received from government. This investigation aims to answer

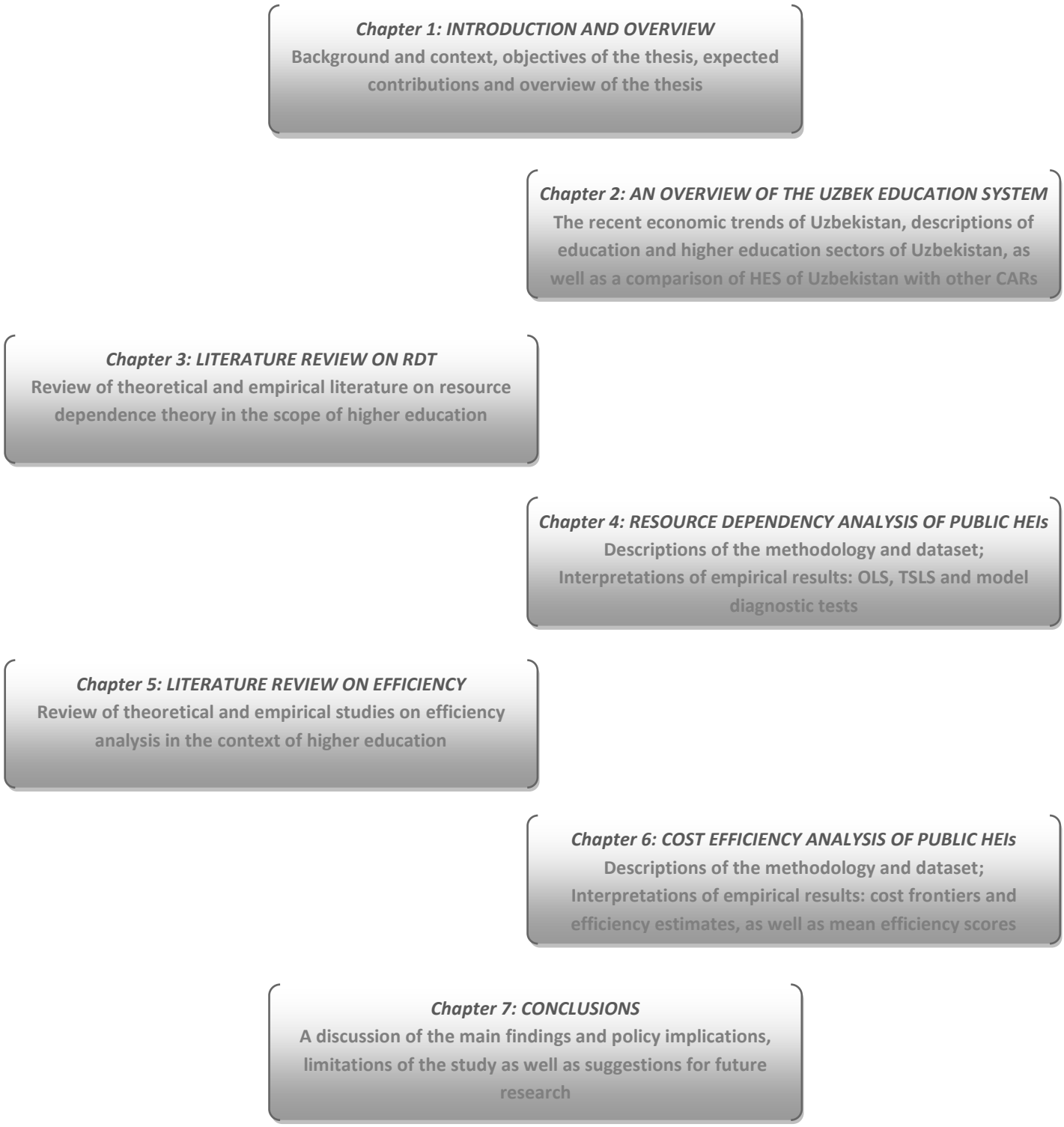
for the following critical question; whether the public HEIs with a greater share from government allocations improved efficiency more relative to institutions with a smaller share of government allocations over the period of 2000-2013. Consequently, findings on cost efficiency of the universities would offer additional insights to the existing literature in the efficiency of HEIs.

Another significant contribution of this thesis is the construction of the unique database employed in this study. This database contains most forms of financial data on almost entire public HEIs operating in Uzbekistan alongside with institutional characteristics, student numbers, completions and staffing related data, as well as durations of various academic programs. Based on this database, two separate datasets are constructed and implemented during the empirical analyses in Chapters 4 and 6. Introduction parts of these chapters describe exact contributions of each dataset on each empirical study. Furthermore, the database is broadly used for analysing and describing the education sector, particularly higher education sector of Uzbekistan in Chapter 2. This database can be also used by researchers as well as administrative bodies of the governmental institutions for further evaluation of the higher education sector in Uzbekistan.

Finally, another main reason for developing this study is the importance of the policy implications part of this research for scholars and decision makers concerned with the Uzbek higher education system. Since there is no similar empirical research available which could offer policy discussions and recommendations, the policy-orientated implications in this study is expected to be valuable for making future policy decisions about the HES of Uzbekistan.

1.4 Overview of the thesis

The figure below aims to demonstrate more in detail how the current thesis runs from chapter to chapter.



This thesis consists of seven chapters including this introduction chapter, and the remainder of the study is structured as follows:

Chapter 2 provides information on the education system of Uzbekistan including an overview of its higher education system through relying mostly on previously unpublished data obtained from the Ministry of Finance of Uzbekistan (MFUZB). Particularly, it examines the contemporary outlook of the Uzbek higher education system regarding reforms, administrative structure and finance. In this chapter, a comprehensive comparison between the higher education system of Uzbekistan and the rest of the Central Asian Republics is also provided. A main goal of this chapter is to offer an opportunity for policy-makers and researchers to conduct policy investigations which could help administrative bodies of the governmental institutions and public HEIs in CARs to make informed policy choices in improving their higher education systems.

Chapter 3 extensively discusses the consequences of increased resource dependence on tuition funding through reviewing related theories, concepts and recent empirical studies. The chapter consists of two key sections: the first main part reviews theories of organisation and environment; while the second main part is dedicated to the discussion of empirical studies which review several key researchers' investigations, estimations and methodological contributions on evaluating and explaining behaviours of universities using RDT. The identified gaps in the literature along with the contributions to be made by this thesis are outlined in the summary part of this chapter.

Chapter 4 investigates whether or not the increased institutional reliance on tuition fees as a main source of revenue has augmented the share of institutional expenditures dedicated to educational activities at public HEIs in Uzbekistan over the period 2000-2013. This chapter first presents an empirical model and dataset, including descriptions of key variables and

instrumental variables as well as summary statistics. Afterwards, the interpretation of empirical findings that discusses both the parameters of OLS and TSLS estimations is revealed. Results of the model diagnostic tests are discussed at the end of the chapter.

Chapter 5 reviews the concepts of productivity and efficiency in the context of higher education, as well as the development history of stochastic frontier and data envelopment approaches are provided. This chapter also provides a wide coverage of recent empirical literature on technical, economic, scale and scope efficiency of public HEIs in the case of various countries. The identified gaps in the literature along with the contributions to be made by this thesis are outlined in the summary section of this chapter.

Chapter 6 evaluates the cost efficiency of public HEIs in Uzbekistan for the period 2000-2013. The descriptions of the model, dataset and selected variables are presented in Section 6.2. The next section of this chapter deals with the interpretations of the results derived from stochastic cost frontier analysis (SCFA) estimations which implement the method of Battese and Coelli (1995) to measure cost inefficiency of public HEIs through accounting for the potential influences of institution, staff and student characteristics. At the end of this section, mean inefficiency scores and re-estimated government funding effects are exposed.

Chapter 7 is the important part of this study as it presents a discussion of the empirical findings and policy implications. Furthermore, this final chapter explains the limitations of the current study and provides some suggestions for future research.

Chapter 2: AN OVERVIEW OF THE UZBEK EDUCATION SYSTEM

2.1 Introduction

Uzbekistan was established in the early 1920s as a part of a 'national delimitation' and as one of the Soviet Socialistic Republics, every aspect of the life in the country was strictly controlled by the Soviet government. The Republic of Uzbekistan became independent on September 1, 1991 and established itself as a parliamentary democracy. The country is located in the heart of Central Asia and is a doubly landlocked country surrounded by other Central Asian countries: Tajikistan on the Southeast, Turkmenistan on the South, Kyrgyzstan on the Northeast and Kazakhstan on the North and Northwest. Uzbekistan consists of twelve provinces and the Autonomous Republic of Karakalpakstan. The city of Tashkent is the capital of Uzbekistan. The Republic of Karakalpakistan and the twelve provinces are subdivided into 163 districts and 80 municipalities. The oasis towns of Khiva, Bukhara, Samarkand and Tashkent mark the famous "Silk Road" over which caravans delivered the products of Europe to exchange for those of Asia.

According to the State Committee on Statistics of Uzbekistan (2013), its population exceeded 30 million in 2013 and increased by 1.4 per cent since early 2011. Currently, more than 36 per cent of the population in Uzbekistan live in urban areas and the rest live in densely populated rural communities. Uzbekistan is one of the largest cotton producing and exporting countries in the world (sixth largest cotton producer and fifth largest exporter) as well as having large deposits of gold, uranium, natural gas and various commodities (The World Bank, 2014).

This chapter is dedicated to presenting a descriptive overview of the Uzbek education system, including the higher education system in context of reforms, administrative structure and finance. In this chapter, a comprehensive comparison between the higher education system of Uzbekistan and the rest of the Central Asian countries is also provided. Thus, this chapter is expected to be the first study which scrutinises the higher education systems of the entire CARs using most recent available data. Several publicly available sources, such as the ADB Evaluation Study, the EC Tempus, the World Data, and the State Committee on Statistics of Uzbekistan, are frequently utilised in this chapter. However, this chapter draws mostly on previously unpublished data obtained from the MFUZB. A main goal of this chapter is to offer an opportunity for policy-makers and researchers to conduct policy-oriented investigations which could help administrative bodies of the governmental institutions in the CARs to make informed policy choices in improving their higher education systems.

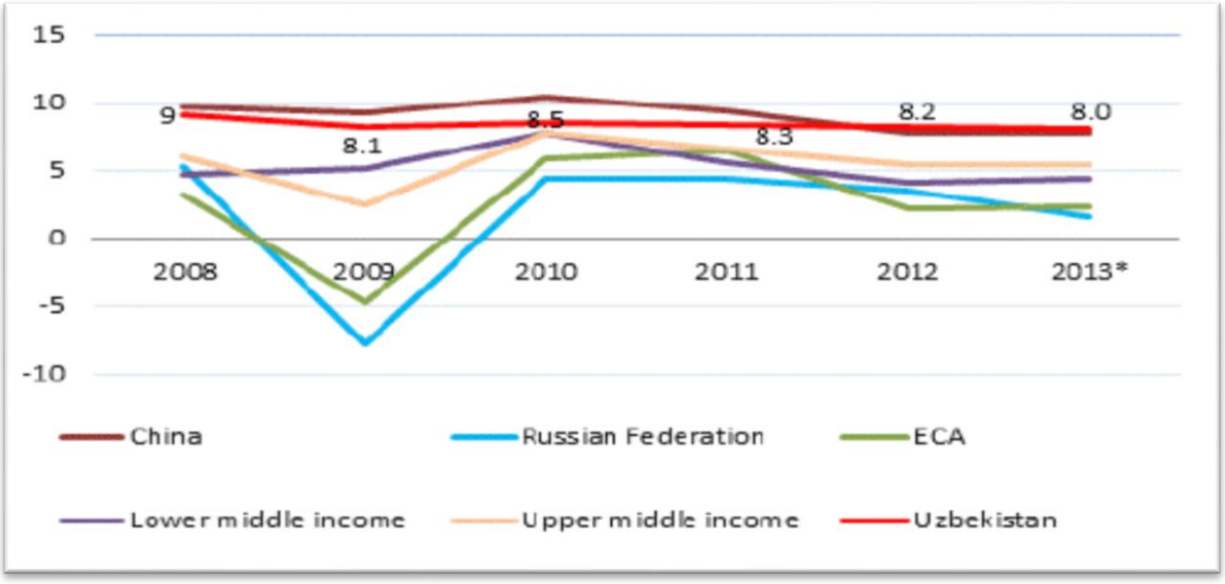
After this brief introductory section, Section 2.2 describes the recent changes in the economy of the country and discusses the education system after the independence, including the recent education reforms, the main forms of education, and financing of the education system. A descriptive overview of the Uzbek higher education system along with the government failure to allocate adequate financial resources to the higher education is discussed in Section 2.3. Section 2.4 is dedicated to a comparison of higher education systems of Uzbekistan with the rest of the CARs. Finally, a summary of the chapter follows in Section 2.5.

2.2 The Economy and Education System

2.2.1 Recent economic performance of the country

According to the World Bank (2014) assessment, Uzbekistan is a lower-middle income country with a small-sized economy. During Soviet times, the economy of all Central Asian countries was regulated by the central government in Moscow. Without Soviet support, Uzbekistan's economy experienced a major decline during its period of transition to a market economy. During the recent decade, however, Uzbekistan's economy continued to perform strongly. For example, real gross domestic products (GDP) growth averaged 8.3 per cent per year between 2008 and 2013 (see Figure 2.1). That made Uzbekistan's economy one of the fastest rising economies among the middle-income countries and among the CARs over the recent years.

Figure 2.1: GDP growth in Uzbekistan, its key trade partners, ECA, Lower- and Upper-Middle income countries (in per cent)

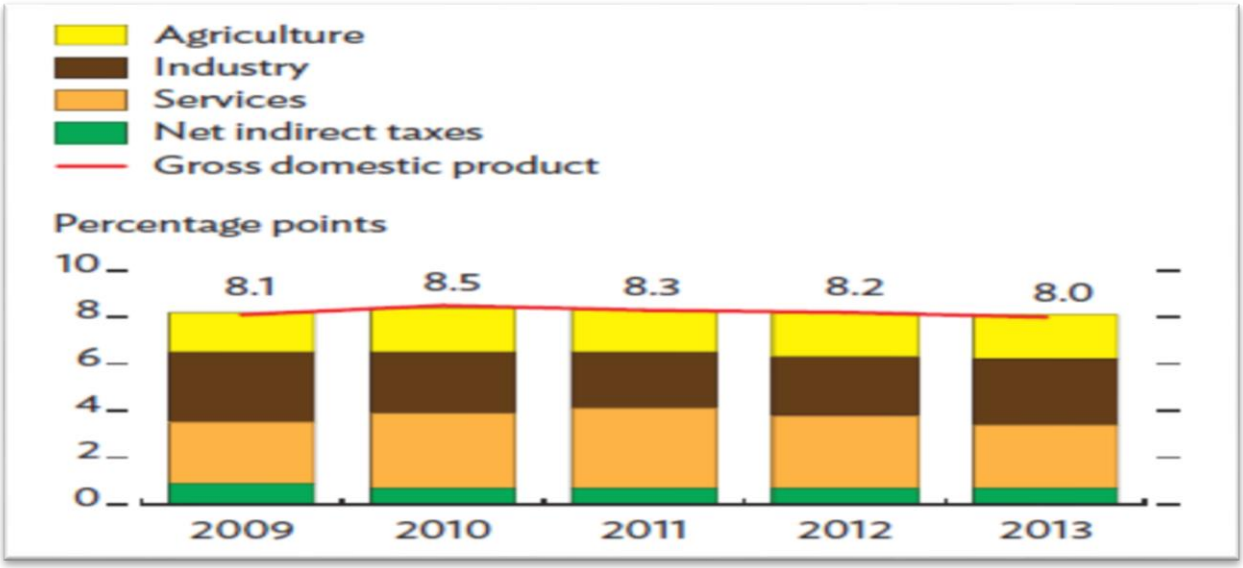


Source: Asian Development Bank (2014)

The economy of Uzbekistan is primarily services-based, since services sector accounts for approximately 48 per cent of the GDP and the employs 35 per cent of population. Industry and manufacturing together account for more than 32 per cent of GDP and employ 19.5 per

cent of the workforce. Finally, agriculture accounts for 19 per cent of GDP and employs 38.5 per cent of the population. However, the core contributor to the economic growth was industry including construction, which increased by 8 per cent in 2012 and by 9 per cent in 2013. At the same time, services decreased from 10.4 per cent to 8.8 per cent (ADB, 2014).

Figure 2.2: The main contributors to growth: agriculture, industry, services, net indirect taxes and GDP

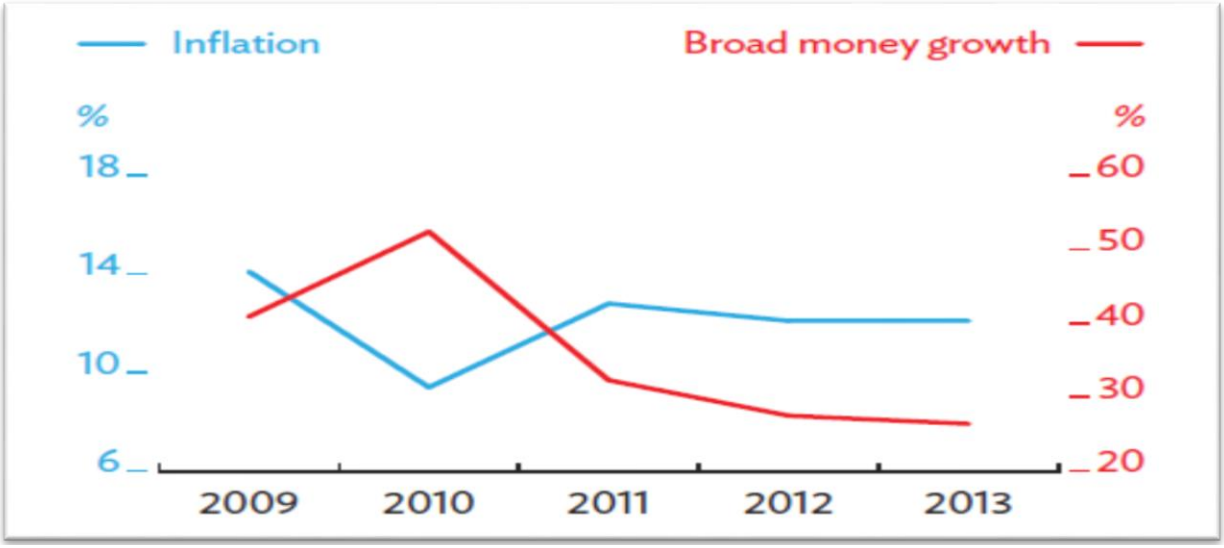


Source: State Committee on Statistics, (2013), ADB estimates

In industry, the continuing innovation and modernization program backed by significant public investment and recovering external demand, increased the production of construction materials, textiles, machinery and foodstuffs. However, services posted considerable growth as retail trade, finance, telecommunications and catering all recorded double-digit raises. The ongoing housing marking boom increased construction growth to more than 16 per cent in 2013 from 11 per cent in 2012. Despite favourable weather conditions and record harvest of the main cereal and vegetable crops, agriculture expanded by less than 6.8 per cent in 2013 compared to 7 per cent in 2012 (see Figure 2.2). The foreign direct investment (FDI) decreased from 3.6 per cent of GDP in 2011 to more than 1.5 per cent of GDP in 2012 and 2013 (The World Bank, 2014).

According to the report published by the International Monetary Fund that inflation rate was 6.8 per cent in 2013 which was below the target range (7-9 per cent) set by the Central Bank of Uzbekistan (see Figure 2.3). Despite wage and pension increases, inflation was held in check by ongoing global food price deflation, lower import costs and the Central Bank's sterilization of excess liquidity. At the end of 2013, the main Central Bank rate was reduced from 12 to 10 per cent, signalling lower inflation expectations for 2014. Moreover, unemployment rate slightly decreased to 4.8 per cent in 2013 from 5 per cent in 2011 (Ministry of Labour of Uzbekistan, 2014).

Figure 2.3: Inflation and broad money growth

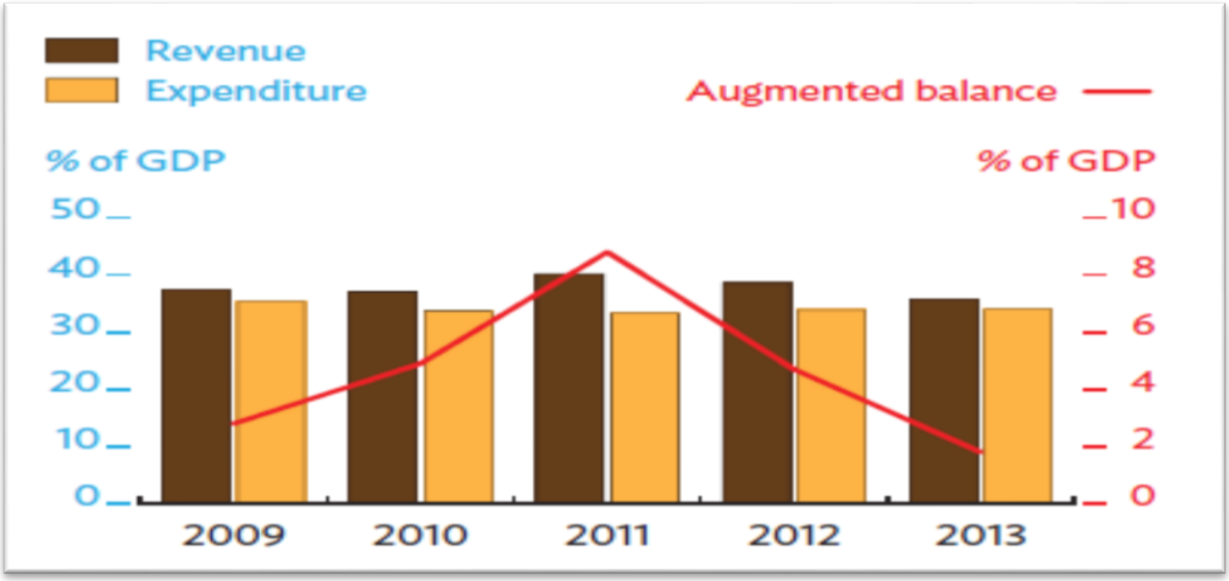


Source: International Monetary Fund, ADB estimation (ADB, 2014)

Lower demand for Uzbekistan's exports and lower commodity prices have led the government to take action to support the domestic economy. In 2013, the government increased the current spending on health, education and public sector wages as well as capital expenditure. After the tax cuts for small and medium sized enterprises as well as individual entrepreneurs in industry and service sectors, the tax revenue declined along with lower projected "Funds for Reconstruction and Development (FRD)" budget. Moreover, higher public current and capital spending resulted in a smaller budget surplus of 0.3 per cent of

GDP in 2013, that is estimated having narrowed to 1.7 per cent of GDP in 2013 from the 8.2 per cent in 2011 (see Figure 2.4).

Figure 2.4: The government revenue and expenditure as well as augmented budget



Note: Augmented budget includes the FRD

Source: International Monetary Fund, ADB estimates (ADB, 2014)

According to the figure above, the government's budget revenue (including the FRD's estimated revenue) decreased insignificantly from 39 per cent of GDP in 2011 to 36 per cent in 2013. Increased government expenditures (including the FRD's estimated expenditures), especially for health and education, assisted to insignificantly increase budget spendings from 33.8 per cent of GDP in 2012 to 34 per cent in 2013. In other words, public capital expenditure grew from 4.2 per cent of GDP in 2012 to 4.5 per cent of GDP in 2013. Public spendings on health increased from 3 per cent of GDP in 2012 to 3.2 per cent in 2013, whereas the government expenditures on education were sustained at about 8 per cent of GDP in 2013 as in the preceding year (The World Bank, 2014).

2.2.2 Education reforms

The education system before independence was completely different that Uzbekistan had to virtually start everything from anew and address a whole range of issues on policy,

governance, planning and management of education. The need to improve teaching skills, tools and techniques; upgrade the curriculum; and provide with adequate resources was also transparent. Therefore, the new government introduced the Law on Education in July 1992 in order to provide the legal basis for the sector and to set off the most urgent reforms needed to adapt the education system. The following reforms have been introduced in the education sector over the last two decades:

- In 1997, the Law on Education was revised to more explicitly advocate for the children's right to education and protection as well as to affirm a commitment to provide free compulsory education for all residents of the country in public schools. The law also addresses "the right of workers to individual leave for training purposes, the financial autonomy of institutions including the possibility to conclude contracts with companies and the right to establish private pre-primary schools" (UNESCO-IBE, 2011).
- The government adopted the National Programme for Personal Training (NPPT) project at the end of August 1997. According to the government authorities, the NPPT provides a consistent framework for the reform being launched and further directs the educational development of the country well into the 21st century. The main function of the NPPT is the development of a unified and continuous instruction and training programs as well as the mandate for the government to provide 12 years of compulsory education based on a "4+5+3" pattern.[1]
- The National Programme on School Education Development (NPSED) for the period 2004-2009, with the aim of improving the quality of education, was adopted in 2004. According to a recent report of UNICEF (2010), successes of NPSED consist of:

[1] 4 years - primary education; 5 years - junior secondary education; and 3 years - senior secondary education

- ❖ the construction of more than 350 new schools and the renovation of approximately 8,150 existing schools (83 per cent of all schools within the country);
- ❖ improved the state educational standards and curricula;
- ❖ the strengthening of staff in-service training and their salaries;
- ❖ modern laboratory equipment, teaching aids, and textbooks provided to all schools that enclosed by the programme; and
- ❖ the development of sport curriculums as well as improvements of sports equipment and playing fields in schools.

- ➢ The Child-Friendly School Project introduced in 2006 with the purpose of improving the efficiency and quality of basic education in areas facing improvement challenges. The project brings in new instruction technologies, also tools for monitoring and assessing teacher performance and the active participation of parents of children in schools.
- ➢ In 2008, the National Program on Improving Quality and Efficiency of Education was introduced, covering main public priorities for 2008-2012.
- ➢ Resolution of the CMUZB of (30/09/2008) – addresses issues such as child labour as well as domestic violence against pupils and children with disabilities.

As a result of these reforms, the system of continuous education consists of following educational establishments providing instructional services (NHDR, 2011):

Pre-school instruction – delivered by both public and private pre-school educational establishments; General secondary education - mainly by public schools and by an insignificant number of private schools on a fee basis; Secondary special and vocational education – by public vocational colleges and academic lyceums which provide free

education services; Higher education - by public institutes and universities, providing free and a fee based education; Postgraduate education - by academies, institutes, universities and business schools; and increasing the level of professional skills and personnel education - at institutions, universities, business schools and specialised institutions for upgrading professional skills.

2.2.3 Structure of general education

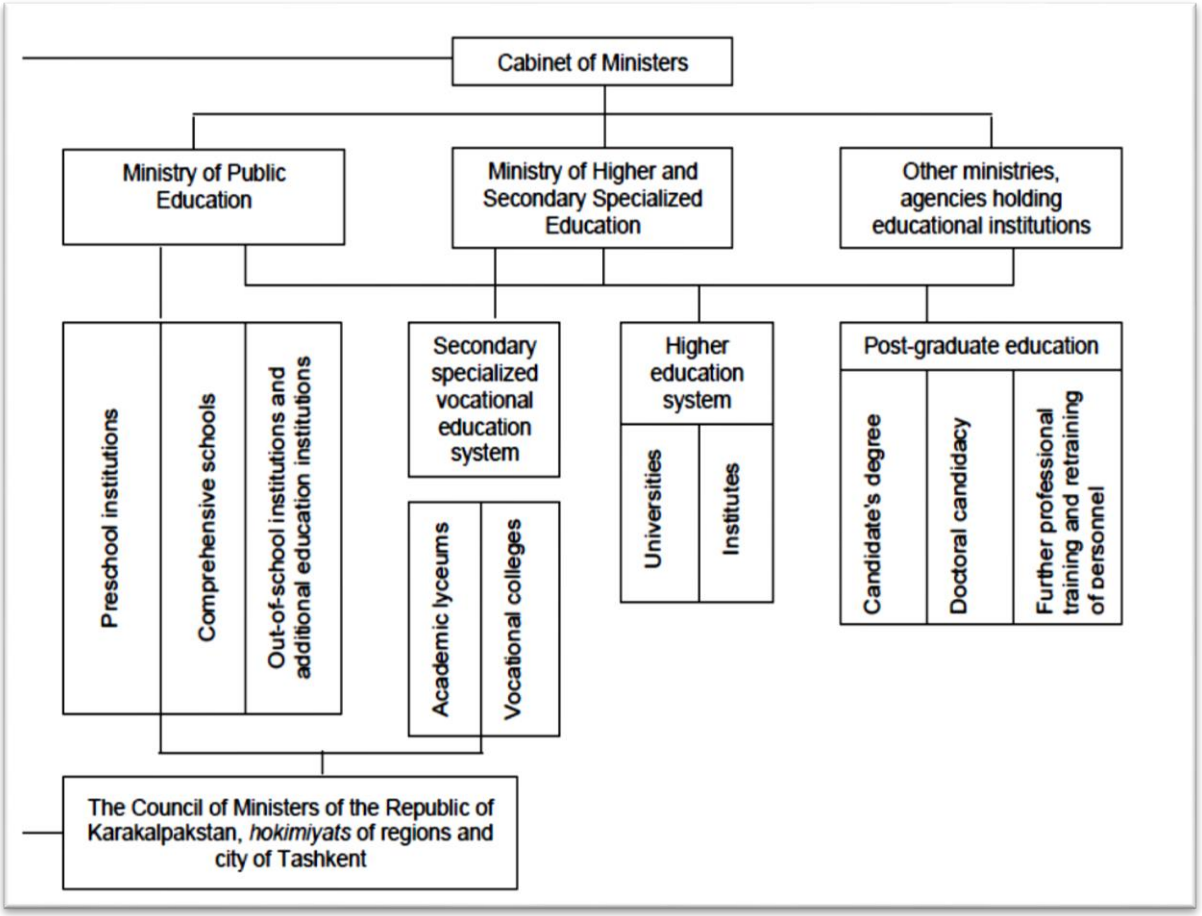
Since the early years of independence, the government has placed a high priority on education, particularly on providing free general education for all citizens of Uzbekistan and on modernising the education system as well as on improving the quality of education services to promote citizen's access to income-generating opportunities. Due to these changes in the education system, the total literacy rate of 15–24 year olds was quite high, on average, 99.91 per cent between 2000 and 2012, including the literacy rate of young males 99.87 per cent and of young females 99.94 per cent (Index Mundi, 2013).

All stages of education exist in the country and the compulsory education consists of 12 years: four years - primary education (levels 1-4); five years - junior secondary education (levels 5-9); and three years - senior secondary education (levels 10-12). In addition, higher education in Uzbekistan contains bachelors (undergraduate) programs of four years and two years for masters (postgraduate) programs, also doctorate programs of 3-6 years (recently updated to the Ph.D.).

Several governmental institutions are responsible for the management of the education sector in Uzbekistan, as in other Central Asian countries (see Figure 2.5). The Social Sector Department of the CMUZB is primarily responsible for introducing quality standards and education policies. Basic-education schools are administrated by the Ministry of Public Education (MPE). This ministry executes the educational policy, sets standards and programs in general education such as textbook, curriculum and teacher development through the

departments of education of the *oblasts* and *regions* (districts). The Ministry of Higher and Secondary Specialised Education manages secondary specialised vocational education, including vocational colleges, academic lyceums, specialised institutions and universities.

Figure 2.5: The structure of the education system management in Uzbekistan



Source: ADB Evaluation Study, 2010

Specialist training institutes are administered by other ministries, such as agriculture, communication, railway, tourism, and water resources, but under the authority of both MPE and MHSSE. Several programmes dedicated to professional trainings and increasing the level of academic staff's professional knowledge are regulated by the Ministry of Labour and Social Security. At the end of the general and specialised secondary education cycles, the State Testing Centre of Uzbekistan prepares and controls tests to assess students' qualifications for the higher levels of education. Moreover, the daily administration of

general education is the responsibility of the Province and District Education Boards (ADB Evaluation Study, 2010).

2.2.4 Overview of the main types of education

Pre-school education - the first stage of the continuous education system is this type of instruction in Uzbekistan. The pre-school education is provided to children until they are aged 6-7 at public and private kindergartens or within the family. The main targets of pre-school education are to prepare children for general secondary education as well as to develop their individual abilities and talents (Statistical Bulletin, 2005). The content of the institution and educational process in pre-school educational establishments are usually evaluated by the Basic National Program. For their activities, pre-school educational establishments have a right either to select any instructional program from the set of programmes approved by the MPE or to elaborate their own instructions based on the model which must be approved by that ministry.

The numbers of children enrolled have considerably decreased after 2000, due to declines in public subsidies provided to support children at pre-school education institutions. Thus, the number of children enrolled in such establishments has reduced from 6,000 in 2000 to 5700 in 2013 (SCS, 2013). However, the numbers of pre-school educational establishments have not changed remarkably. During the period 2000-2013, more than 9,700 public-owned pre-school education institutions have been operating in the country.

General secondary education - is compulsory and absolutely free for all citizens of Uzbekistan. It is divided into primary education (from 1st to 4th levels), and secondary education (from 5th to 9th levels). Education at the 10th and 11th levels has completely shifted to secondary special vocational education institutions at the end of 2009. Though, secondary education consisted of seven years from 5th to 11th level before 2009. The accessibility of general secondary education is assured not only by the fact that school

education is free, but also by the opportunity to study in one's native language. Nevertheless, the suitable location and a sufficient amount of schools are also important for improving accessibility.

Table 2.1: Trends in number of schools and schoolchildren in 2000/01-2012/13

	2000/2001			2012/2013		
	Total	Including:		Total	Including	
		urban	rural		urban	rural
Number of school	9,726	2,065	7,661	9,800	2,100	7,700
Number of pupils (in thousand)	6,018	1,923	4,095	5,710	1,808	3,902
Proportion of schools with more than one shift (%)	73.6	76.1	72.7	72.6	73.8	72

Source: State Committee on Statistics (2013)

In the academic year of 2012-2013, the total number of day schools was about 9,800, including 7,700 in rural regions and 2,100 in urban regions. At the same time, the total number of pupils was approximately 5,710,000 (in 2000/2001, 6,017,600 pupils), including 3,902,000 (4,095,000) in rural areas and 1,808,000 (1,923,000) in urban areas (SCS, 2013). The reduction in the number of school children can be related to the transition of general secondary education (10-11 grades) to secondary specialised vocational education. Moreover, the percentage of pupils attending school in different shifts has only decreased from 74 per cent in 2000 down to 73 per cent in 2013. On the contrary, the total number of day schools has not recently reduced but has grown slightly.

There is still a lack of teachers, particularly in rural schools. According to the National Human Development Report Team, schools were short for a total of 1,455 teachers of foreign languages and over 550 teachers of mathematics at the beginning of the school year of 2012/2013. Nowadays, more than 142,000 (32 per cent) school teachers do not have a higher education degree, and the primary school teachers are mostly educated at colleges rather than at institutions of higher education. Therefore, teachers with a higher education make up less

than 66 per cent for rural schools and less than 76 per cent for schools located in the cities (MFUZB, 2013).

Over the recent years, an improved system of training and upgrading qualifications of the teachers for all school subjects have been settled and provided at 22 public establishments of higher education. Most of these institutions have created the necessary conditions for training and disseminating the best practice as well as for applying the lessons learned.

Secondary specialised vocational education is compulsory and an independent element in the overall system of continuous education. In other words, secondary specialised vocational education is provided on full-time bases and became compulsory for all secondary general school graduates at the end of 2009. All of the graduated students have the right to select the route of their further studies - whether at a vocational college or an academic lyceum. Vocational colleges and academic lyceums offer a secondary specialised vocational education with which students can go on to higher education for further study or join the labour market in accordance with their learned knowledge and profession.

According to the data provided by SCS (2013), the total number of secondary specialised institutions was 1055 in 2013, including 953 vocational colleges and 99 academic lyceums. Nowadays, this type of educational establishments serve over 2,150 thousand students, out of which 2,044 thousand students enrolled in 953 vocational colleges and 106 thousand students enrolled in 99 academic lyceums. In addition, more than 63 thousand vocational training staff and teachers work in the system of secondary special vocational education, out of which 57,550 (92 per cent) have a higher education degree and 5,450 (8 per cent) of them hold a secondary special education. Among them, 103 (0.2 per cent) are doctors of sciences and 875 (1.4 per cent) are candidates of sciences.

Between 1998 and 2006, the full amount of public investment on the facilities and infrastructure of the secondary specialised vocational education network was: for construction and reconstruction - more than 981 billion Som; for teaching materials - 11.4 billion Som; and for provision of equipment and computers - 78.5 billion Som. In addition, 113 million USD from foreign investment has been allocated to this type of education during the same period of time (MFUZB, 2013).

There are many problems with the employment of graduates of secondary special education institutions in Uzbekistan, as in the other Central Asian countries, because of a shortage of vacancies in the labour market. Such as, 60 per cent of total college graduates found a work in 2013 but only 50 per cent of them found a job based on their professions. Over 80 thousand college graduates or 34 per cent could not manage to find a job in that year. However, only 12 per cent of academic lyceum graduates found a job in 2013 and more than 60 per cent of graduates enrolled in public HEIs in the same year, but the remaining 28 per cent could not find a workplace (SCS, 2014).

Higher education provision is based on the "National Vocational Training Program" and on the Laws of the Republic of Uzbekistan "On Education". As the president of Uzbekistan, Islom Abduganiyevich Karimov, stated that the main objective of higher education is to provide with the specialized training of qualified and competitive personnel meeting the modern requirements of employers. The president also remarked that graduates have to be able to independently work in their chosen areas of professions in order to contribute to the technical, scientific, economic, cultural or social development of the country.

As in many Ex-Soviet Union countries, there are two main professional training stages in the higher education sector in Uzbekistan: the four years of basic higher education or bachelor's - which provides the fundamental and applied knowledge in the area of professional education;

as well as the two years of master - which delivers both fundamental and applied knowledge in the selected area of specialisation. However, bachelor and master programs at medical institutes of higher education in Uzbekistan consist of seven and three academic years, respectively (see Appendix A).

For bachelor's programs - prospective students are admitted to institutions of higher education through entrance state-tests. However, entry to the master's courses is on a competitive basis upon completion of a bachelor's program. All the public HEIs deliver professional education which is financed by the government grants but also on a fee basis which is usually paid by students or their parents (NHDR, 2011). The higher education system of Uzbekistan is discussed in more detail in the next section of this chapter.

2.2.5 Financing of education

During the last decade, total public expenditure on education as a percentage of GDP has been relatively higher in Uzbekistan compared to the rest of the republics in Central Asia (see Figure 2.12 for a comparison). The total expenditure on education in Uzbekistan has continuously gone over 10 per cent of GDP and reached 12 per cent between the period 2010 and 2013, which was the highest percentage in the sub-region and region (MFUZB, 2013).

Table 2.2: Total expenditure on education (as percentage of GDP)

Source of Financing	*2000*	*2002*	*2004*	*2006*	*2008*	*2010*	*2011*	*2012*	*2013*
Government expenditures	9.6	9.1	8.5	8.8	8.6	8.9	9.2	8.9	9.1
Extra-budgetary expenditures	1.1	2.6	2.2	2	2.1	3.1	2.8	3.1	2.9
Total	10.7	11.7	10.7	10.8	10.7	12	12	12	12

Source: MFUZB (2013)

According to Table 2.2 and Table 2.15, Uzbekistan's total expenditure on education as percentage of GDP exceeds the other Central Asian countries. Moreover, this level of educational expenditure in Uzbekistan significantly exceeds even the average of OECD

countries which was around 5.5 per cent between 2005 and 2013 (OECD, 2015). This high weighting of expenditure for education in Uzbekistan can be explained by several objective reasons. First, it is linked to the high attention of the Uzbek government to reduce poverty, to develop the economy of the country as well as to the dynamic development and foundational magnitude of the education sector for development of human capital. Second, there is another reason for the high proportion. As in many lower-middle income countries, the GDP per capita is not very high in Uzbekistan; therefore, it would not be plausible idea to compare this country's budget with those of the high-income countries.

In accordance with the NPPT and the NPSED projects, a large share of public resources was directed to the education sector because of significant investments made in the new educational establishment buildings and the provision of equipment to the educational institutions. Considerable financial resources of the government were also allocated to the construction, reconstruction and provision of modern technologies to basic schools. Moreover, the introducing of these two national large-scale projects has effected in changing the composition of public expenditures to various education levels.

Table 2.3: Government expenditure on education by sectors (as percentage of GDP)

	2000	*2002*	*2004*	*2006*	*2010*	*2011*	*2012*	*2013*
All levels of education	9.6	9.1	8.5	8.8	8.9	9.2	8.9	9.1
including:								
Pre-school	1.03	1.18	1	0.9	1.18	1.08	1	0.9
Basic education	3.59	3.81	3.8	4.6	4.21	4.71	4.43	4.75
Secondary special and vocational education	3.93	2.98	2.8	2.3	2.55	2.43	2.49	2.46
Higher education	0.48	0.45	0.44	0.4	0.42	0.41	0.42	0.42
Other education institutions	0.57	0.58	0.42	0.5	0.46	0.48	0.47	0.48
Training and upgrading the level of teachers	0.05	0.06	0.06	0.1	0.08	0.09	0.09	0.09

Source: MFUZB (2013)

According to Table 2.3, the Uzbek government has spent a substantially high amount (expressed as a share of GDP) for basic and secondary education. On the other hand, very

small portions of public expenditure have allocated for higher education, for other education institutions and for upgrading the level of teaching staff between the period 2000 and 2013 (MFUZB, 2013).

If one relies on a recent report published by the World Bank (2014) to compare the expenditure level of Uzbekistan to other nations over the period 2005-2013, Uzbekistan has spent more than five times as much for every student in Secondary Specialised Vocational Education as the OECD average for upper secondary education. Around three times as much as the OECD average for higher education. Nevertheless, the government allocated one-third less than the OECD average share of GDP for each pupil in general education and less than half as much for each pupil in primary education.

In Uzbekistan, operational expenditure categorises in the following way: salaries and social charges, office supplies, stipends, food, learning materials, reconstruction and maintenance (NHDR, 2011). Between 1990 and 1995, the aggressive reduction in the real wage rates of teachers led to outflow of teachers, shrinking in education quality and lack of motivations for postgraduate students to work as a part-time teacher. To solve these issues, the government decided to dramatically increase wages of teachers after 2000. However, this expansion was not enough to stimulate the performance of teachers, since the absolute monthly average wages of teachers reached only between 60 - 70 per cent of the monthly average throughout the country and 40 - 50 per cent of its level in industry. Moreover, the dramatic increase of all citizens' wages resulted in increasing the share of staff wages at educational establishments in the total current budget from 54 per cent in 2000 to 76 per cent in 2012 (MFUZB, 2013).

This increase in average wages, however, has not been accompanied by a sufficient raise in the budget allocation for operational spending in education. The consequence was a considerable disproportion and insufficient funds allocation to the current maintenance of the

all education sectors. Particularly, the insufficiency of financial resources for current expenditures resulted to an accelerated depreciation of newly built or reconstructed buildings of the educational establishments (NHDR, 2011). Moreover, school equipment are not repaired, new teaching aids are not bought and public utilities are not paid in time and fully, due to the insufficiency of public funding. As Brunner and Tillett (2007) suggest that all these factors have led to the reduced quality of education at public schools and HEIs.

Over the last ten years, more than hundred new public educational institutions have been established in Uzbekistan, which require extra financial resources to maintain. Therefore, Uzbek government has serious problems in trying to solve together the issues of capital construction, increasing the salaries of academic staff, covering institutional daily expenditures and equipping newly opened schools (MFUZB, 2013). Furthermore, the budgeting system works based on the incremental principle that takes its starting point the allocation of previous year, the consequence of which is an inefficient distribution of financial resources between educational establishments.

Recognising these challenges, the government of Uzbekistan has undertaken a number of measures in order to decrease budget expenditure needs and diversify the sources of funding (Brunner and Tillett, 2007):

- decentralising the responsibility of managing and funding majority primary and secondary education projects from central to oblast governments;
- encouraging the educational establishments to acquire additional funds, such as fees paid by students and their parents as well as endowments from local communities and residence. All institutions, that offer specialised secondary and higher education, charge tuition fees for students with entry scores below the threshold;

- allowing educational establishments to supplement budgetary income through renting out "unused" or “unneeded” buildings and laboratory equipment, as well as providing extracurricular training programs and introducing rental-based provision of textbooks;

Early in the transition, educational establishments allowed to spend extra-budgetary funds to develop the material and technical bases of the establishments, implement IT projects and involve personnel through providing bonuses. Since early 2003, the extra-budgetary financing activities have not been severely controlled by the government. Therefore, public educational institutions could generate and utilise extra-budgetary funds without detailed reporting on their usage and management.

From the beginning of 2004, all agencies and ministries which are managing the education sectors have to report to the ministry of finance on exact sources of their income and use of extra-budgetary funds (NHDR, 2011). More specifically, the educational establishments have to submit quarterly reports to their ministries then the ministries submit these reports to the MFUZB with the purpose of informing them about expenditure and management of additional sources of funding. However, incomes are immediately transferred to the central budget of the country if the non-targeted expenditure of income is disclosed.

2.2.6 External assistance to the education sector

Supplementing the government budget and private sources of revenue, the development assistance by foreign financial institutions and donors plays a key role in subsidising the Uzbekistan's education sector. The first figure below represents the external funding dedicated to the education sector as a form of loans, credits and grants. The second figure shows the external assistance by types of sponsor.

Figure 2.6: External assistance to the education sector by types of funding for 2006-2013 (in USD)

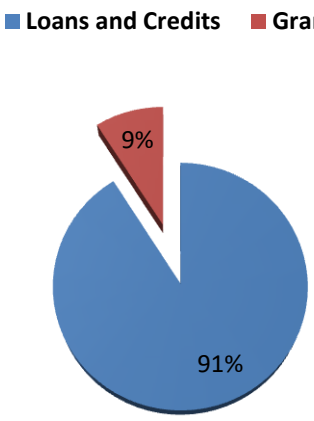
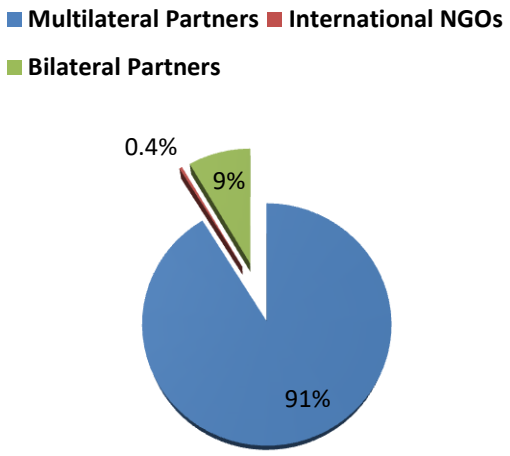


Figure 2.7: External assistance by donor types (in USD)



Source: MFUZB (2013)

Over the period of 2006 to 2013, more than 120 funding projects have been implemented with allocations totalling approximately 1 billion US Dollars (SCS, 2013). During this period, over 90 per cent of external subsidies were provided as credits and loans, and only 9 per cent as grants. Multilateral donors directed more than 91 per cent (or 952 million USD) of the assistance, 8.5 per cent (87 million USD) was allocated by bilateral donors and only 4.1 million USD was provided by international non-governmental organisations.

In 2013, the external-assistance was diversified between the sub-sectors of education as following ways: 1.4 per cent for pre-school and primary schooling; 73 per cent for secondary schooling; 10.2 per cent for vocational, technical and management education and training; 4.2 per cent for higher education; 0.3 per cent for informal education (including the literature and basic education) and 10.7 per cent to sector policy and planning. Table 2.4 shows that the greatest amount of development assistance was allocated to the secondary schooling, but the informal education received the smallest share of the external-assistance in 2013.

Table 2.4: A distribution of development assistance by educational sub-sectors in 2013

Sub sectors of the education sector	Amount in USD (thousand)	Percentage
Sector policy and planning	111,214	10.7
Pre-school and primary schooling	15,033	1.4
Secondary schooling	764,772	73
Higher education	43,738	4.2
Vocational, technical and managerial education and training	106,499	10.2
Informal education	3,034	0.3

Source: Author's calculations, based on data from MFUZB (2013)

More than twenty philanthropic organisations have allocated assistances for the improvement of the Uzbek education sector over the period of 2006 to 2013. The Japanese Bank for International Cooperation (62 per cent) was the leading agency in committing funds into the Uzbek education sector. The next biggest collaborator is the Asian Development Bank (25 per cent). Third and fourth are the Government of Japan (3 per cent) and the Government of India (2 per cent), respectively. The rest of the committed agencies were UNICEF (2 per cent) and other contributors with the share of over one per cent (NHDR, 2011).

2.3 The System of Higher Education

2.3.1 Reforms in the higher education

The first phase of reforms in the higher education is entitled "The Restructuring Stage" and it was implemented between the years 1991 and 1995. The main areas of reforms in higher education system during that period were prioritisation of university education, specialisation of HEIs and localisation of higher education (NHDR, 2011). In order to prioritise university education, several new public universities were established after the independence achieved in 1991. These newly established HEIs those located in the capital city (Tashkent) of Uzbekistan were Tashkent State Technical University, Tashkent State University of Economics, Tashkent Islamic University and the University of World Economy and Diplomacy. Several state institutions were also established in Bukhara, Andijan, Gulistan, Namangan, Karshi, Fergana and Urgench regions. The status of university was also honoured to the Tashkent Agriculture Institute and Tashkent Institute of Foreign Languages after 2005.

From one large institute (Tashkent Polytechnic Institute) two more HEIs (Tashkent Chemical Technological Institute and the Tashkent Architectural-Construction Institute) were established in order to specialise the higher education institutions (NHDR, 2011). The Tashkent State Institute of Oriental Studies merged off from Tashkent State University to become an independent university. Public universities, 75 per cent of which situated in several large cities (mostly in Tashkent), were opened in almost all regions of the country to overcome a skew in the location of institutions of higher education. Every institution of higher education had a precise task for restructuring the forms and content of instructions based on the new status introduced.

In October 1997, the Presidential decree entitled "Fundamental Reforms in Education and Personnel Training System" settled a three stage NPPT project:

The first stage (1997-2001): legal, personnel, scientific and methodological, financial and material basis for the reforming and developing the education system has been introduced. The main priorities of this stage were the followings: (1) switching to a two-stage system of higher education consisting of four years of bachelor's and two-year master's programs; (2) switching to a new system of financing that allocates funding from public budget in the form of government grants for the limited amount of students who achieve the top scores in the entrance tests, as well as introducing private funding in the form of admitting students on a contractual basis. (3) Transition to a new system of entrance examinations; admitting students on the basis of entrance tests instead of the elderly oral and written examinations.

The second stage (2001-2005): it is targeted to full-scale implementation of the NPPT, with changes and modifications based on the socio-economic conditions and labour-market. This stage of the reform is especially aimed to overall improvement of education quality and upgrading of academic staff.

The third stage (2005 and onwards): further development and improvement of personnel training of pedagogical staff based on the obtained experience and analysis.

According to UNDP (2011) report, more than a half billion USD was allocated from the state budget and extra-budgetary funds to establish the NPPT and the school education development programs.[2]

3.3.2 Structure of higher education

Prior to independence, there were 42 public HEIs in the country. Such as, 3 state universities, 9 engineering and technical, 14 pedagogical and language, 3 agricultural, 3 cultural and arts, 7 medical and pharmaceutical institutions. Also one physical, cooperative, and sports HEIs

[2] There are two main sources of funding for every public HEI in Uzbekistan: state-budget funds (public funds allocated to HEIs) and extra-or off-budget funds (tuition revenues).

were operated in the country (SCS, 2013). The two third of HEIs of the republic were located in four big cities: Tashkent (19), Andijan (4), Bukhara (3) and Samarkand (5). Teaching and curricula programs on the subjects educated at the HEIs of the country were approved by the Centre-Moscow and it was not allowed to make any modification without taking into account the regional requirements.

Since the implementation of the reforms, the number of higher educational establishments has significantly increased from 46 in 1990 to 64 in 2013 of which 41 institutes, 21 universities and 2 academies (SCS, 2014). The academy is the most prestigious one and it mainly offers postgraduate programs and scientific research in its respective subject fields. Most of the universities are generic institutions of higher education, which taught both bachelor and postgraduate programs in different subject fields. Therefore, institutes and academies differ from universities in educating narrower scientific programs.

The higher education sector in Uzbekistan is mainly managed and financed by the MHSSE. This ministry is the main coordinating and methodological body in higher education which implements severe rules for the recognition of new developed curricula based on the public education standards. There are 34 HEIs, including 14 universities and 20 institutes accountable to the MHSSE. However, highly specialised public HEIs are administered by other ministries, for example, the MPE has five pedagogical institutes, the Ministry of Public Health - six, the Ministry of Culture - five, and the Ministry of Agriculture - four (SCS, 2013). These days six international universities are operating in the country, such as: Westminster International University in Tashkent, Singapore Institute of Management in Tashkent, Turin Polytechnic University in Tashkent, the Russian University of Oil and Gas named after Gubkin, branches of the Moscow State University named after M.V. Lomonosov

and of the Russian Academy named after Plekhanov. However, there is no private institution of higher education in Uzbekistan yet.

The Uzbek HEIs offer higher educational training in the following fields: 16 in the areas of transport, construction, industry and communication; 4 in agriculture; 7 in economics and law; 6 in medicine; 27 offer professional training in the field of education; and 4 in other sectors. All these HEIs can have learning and training centres, branches, specialised colleges, training subdivisions of complementary vocational education, postgraduate and doctoral schools, scientific and research laboratories, and other structural subdivisions. In addition to the HEIs by sectors, the distribution of institutions associated with ministries and agencies is illustrated in the table below.

Table 2.5: The number of HEIs by sector as well as by ministries and agencies

By Sector	**Number of HEIs**			**By Ministry or Agency**	**Number of HEIs**		
	2000	2006	2012		2000	2006	2012
Total	*61*	*62*	*64*	*Total*	*61*	*62*	*64*
including, Industry	11	11	11	Navoiy metallurgical plant	0	1	1
Construction	1	1	1	Uzbek Railways	1	1	1
Transport	2	2	3	Uzbek telecommunications agency	1	1	2
Communications	1	1	1	Ministry of public health	7	6	6
Agriculture	4	4	4	MHSSE	34	33	34
Economy	3	6	6	Ministry of Foreign Affairs	1	1	1
Law	1	1	1	MPE	5	5	5
Health	7	6	6	Ministry of culture and sport affairs	5	5	5
Sport and recreation activities	1	1	1	CMUZB	1	1	1
Education	27	26	27	Ministry of Justice	1	1	1
Arts and cinema	3	3	3	Ministry of agriculture and water management	4	4	4
				State tax committee	0	1	1
				Fine arts academy	1	1	1

Source: State Committee on Statistics (2013)

The management structure of all Uzbek HEIs relies on the number of students, teaching staff, public budget and off-budget funds. All properties of public HEIs belong to the government.

Public higher education establishments are permitted to manage their land plots, such as they are allowed to acquire and freely manage incomes received from commercial activities and property renting as well as from individuals and legal entities as a form of donations (EC Tempus, 2010). Furthermore, each HEI has the scientific boards to consider major operational issues, but the general frameworks are defined by regulations approved by the MHSSE. Moreover, the Board of Trustees is an advisory body of a HEI and its main goal is to direct and control institutional activities in order to improve the quality of education. The Board of Trustees consist of representatives of local state bodies, financial and science institutes, mass media, public associations and organisations regardless of ownership type (Mirkurbanov, Anoshkina and Danilova, 2009).

2.3.3 Number of students and tuition fees

In many countries, there are two most common methods of entrants to institutions of higher education: limited access and unlimited access (NHDR, 2011). Most of the governments utilise limited access approach on either a centralised or decentralised basis (NHDR, 2011). Factors which affect the choice are the amount of funds available, the resource capacity of HEIs and the results of entrance tests. For example, at public institutions of higher education in Japan, South Korea and China have relatively high entrance examination criteria. According to the experience of these countries, this approach brings a very high quality of education at HEIs since it permits for the selecting of the well prepared and most gifted prospective students (NHDR, 2011).

Under the decentralised system, every HEI based on their available resources determine the admission quota. While under the centralised system, the admission quota is posted by the various ministries or governmental institutions (STC, 2013). Uzbekistan's HEIs operate under the centralised system, and the CMUZB takes responsibility for determining the admission quota to public institutions every academic year after consulting with each HEI. Detailed

information about admission quotas by HEIs and fields of education can be found through broachers, advertisements and events held at academic lyceums and vocational collages.

A limited access to higher education is related to the fact that a tuition fee is charged and the amount of that fee plays a crucial role in many Central Asian countries. Nowadays, overall 250,500 students are studying at the Uzbek HEIs, out of them 236,800 at the bachelor's level and 13,100 at the master's level (see Table 2.6). More than 70 per cent of students study on a fee basis at the bachelor's level and 80 per cent study on a fee basis at the master's level. The total number of full-time based students at public HEIs has increased by over 100,000 - since 2000, at the bachelor's level 75 per cent and at the master's level over 30 per cent students were taught. Between 2000 and 2013, the total number of full-time enrolled students has increased by over a third and more than twice full-time students of HEIs graduated in 2013 relative to 2000.

Table 2.6: Total number of enrolled, admitted and graduated full-time students by the level of study (in thousands)

	2000	2002	2004	2006	2008	2010	2012	2013
Total Number of Students	183.6	232.2	263.6	286.3	275.0	274.1	252.3	250.5
Bachelor's	179.6	223.5	253.2	273.7	257.6	258.5	237.3	236.8
Master's	4	8.7	10.4	12.6	14.1	12.0	13.2	13.1
Admission in HEIs	44.7	54.6	59.3	61.1	64.4	63.5	62.7	64.5
Bachelor's	41.9	50.6	54.2	55.4	57.6	56.5	55.9	55
Master's	2.8	4	5.4	5.7	54.8	5.722	5.8	6.2
Graduates of HEIs	31.6	39.8	52.8	60.7	63.6	69.5	61.1	61.4

Source: MFUZB (2013)

The public HEIs enrol students every year on the basis of government subsidised scholarships and quotas for fee paying students. The State Test Committee of Uzbekistan conducts annual entrance examinations for the bachelor's programs; prospective students with lower scores are enrolled as self-funded students but within the boundaries of given quota, while applicants

with higher scores are granted with government sponsored scholarships. In the same vein, entrance examinations for the master programs follow the same procedure; applicants with lower results can be admitted as contract-based students and quotas for contract-based students in line with the relevant Cabinet of Ministers Resolution.

Table 2.7: State-granted and tuition fee paid students by the level of study

	2012			2013		
	Overall Full-Time Students	**Bachelor**	**Master**	**Overall Full-Time Students**	**Bachelor**	**Master**
Total Number of Students	252,344	237,304	15,040	250,542	236,856	13,113
State-granted	82,997	79,318	3,679	81,885	78,649	3,236
Self-funded	169,347	157,986	11,361	168,657	158,207	10,450
Admission in HEIs	62,734	55,974	6,760	61,468	54,985	7,341
State-granted	21,220	19,350	1,870	20,592	19,010	1,582
Self-funded	41,514	36,624	4,890	40,876	35,975	4,901
Graduates of HEI	61,104	53,942	7,162	61,474	55,046	6,428
State-granted	20,754	18,928	1,826	20,309	18,757	1,552
Self-funded	40,350	35,014	5,336	41,165	36,289	4,876

Source: MFUZB (2013)

Since 2000, the government has gradually increased an amount of annual tuition fees for all areas of training at the both bachelor and master programs in order to compensate the reduced public budgetary funds channelled to education, particularly to higher education. Consequently, as Table 2.8 reveals that tuition fees were remarkably high when compared to average salaries of citizens of Uzbekistan. For example, an average annual tuition price for the bachelor programs was 2110 in the academic year 2012/2013, but an average annual wage of one Uzbek citizen was 1,976USD in the same year.[3]

[3] Average annual salary: 4,350,972UZS / 2202.2USD (exchange rate at the rate of CB of Uzbekistan) = 1,976USD; Source: http://www.mehnat.uz/site/salary

Table 2.8: Growing rates of average annual tuition fees for the bachelor programs at public HEIs in Uzbekistan from 2005/2006 to 2013/2014

Year	Average price in UZB Sums (in thousands)	Exchange rate 1 USD=UZS (at the rate of CB)	Average price (in USD)	Growth rate
2005/2006 1st September	507	1,133	447	
2006/2007 1st September	578	1,229	470	1.051
2007/2008 1st September	656	1,272	516	1.097
2008/2009 1st September	1075	1,321	814	1.577
2008/2009 1st March	1237	1,408	878	1.079
2009/2010 1st September	1640	1,495	1097	1.249
2009/2010 1st March	1970	1,540	1279	1.166
2010/2011 1st September	2668	1,615	1653	1.292
2011/2012 1st September	3202	1,737	1843	1.116
2011/2012 1st March	3676	1,828	2011	1.091
2012/2013 1st September	4056	1,922	2111	1.049
2012/2013 1st March	4462	2,021	2208	1.046
2013/2014 1st September	6790	2,202	3084	1.552

Source: Author's calculations, based on data from MFUZB (2013)

Table 2.9: Annual tuition fees for bachelor's and master's programs by areas of training

Area of training	2005/2006		2013/2014	
	USD at the rate of CB on 01/09/05 (Bachelors FT)	USD at the rate of CB on 01/09/05 (Masters FT)	USD at the rate of CB on 01/09/13 (Bachelors FT)	USD at the rate of CB on 01/09/13 (Masters FT)
Training of Teaching Staff & Pedagogies	362	414	2276	2484
Art	480	528	2672	3168
Humanities	376	414	2696	2484
Turkic Languages	451	497	-	-
Social Sciences	394	434	2276	2604
Journalism	435	479	2474	2874
Business and Management (economics)	504	554	2276	3324
International Economic Relations	569	627	3340	3762
Law	594	653	3340	3918
Natural Sciences	395	435	2276	2610
Engineering	406	472	2474	2874

Source: Author's calculations, based on data from MFUZB (2013)

The State Enrolment Commission of Uzbekistan is responsible for setting tuition prices, and these tuition charges vary by levels and types of education as it is represented in Table 2.9. The tuition fee for a bachelor student studying on a contract-basis varied from 2276 USD to 3340 USD in 2013/2014 and for a postgraduate student varied from 2484 USD to 3918 USD

in the same academic year. However, the both types of professional program, on average, were six times more expensive in the academic year 2013/2014 relative to the academic year 2005/2006. Moreover, according to Table 2.9, the most expensive bachelor and master programs by fields of study were the International Economic Relations and Law throughout the 8 eight academic period. However, the cheapest field of study was TTS&P for the both level of programs during the same academic years.

Full-time students who enrolled on the basis of government-grants were provided with institutional stipends, until 2001. In 17th October 2001, a new procedure was first implemented in order to provide all students with a monthly stipend, whether they are educating on a government-grant basis or on a tuition fee basis (NHDR, 2011). This procedure was established to ensure social protection of students and to provide students with an opportunity to have a monthly income for their daily expenses. However, the main objective of introducing this institutional stipend is to reward students who are showing an excellent performance. For example, a student with better final exam results may receive higher amount of monthly stipends relative to other students who are not performing well. At the public HEIs in Uzbekistan, three levels of institutional stipends exist which are paid based on whether student scores are "excellent" - 153 USD in 2013; "good" - 114.6 USD in 2013; or "satisfactory" - 76.4 USD in 2013 (MFUZB, 2013). [4]

3.3.4 Academic staff and salary issues

The following categories of academic staff exist at the public HEIs of Uzbekistan in these years: Lecturer, Senior Lecturer, Associate Professor, Professor and Head of Department. A diploma of higher education (Master - "Magistr") is required in order to get a position of Lecturer or Senior Lecturer. For being eligible for a competition for a position of Associate Professor - a diploma of "Fanlar Doctori" (Doctor of Sciences) or the scientific title of

[4] Exchange rate at the rate of CB of Uzbekistan (2013): 1USD=2,021.2UZS

"Docent"; for a position of Professor - a diploma of "Fanlar Doctori" or the scientific title of Professor; for a position of Head of Department - a diploma of "Fanlar doctori" is required (EC Tempus, 2010).

With the purpose of encouraging and increasing responsibility among academic teachers for the performance and results of their work, a mechanism for rating academic staff was introduced in the early 2000s. The intention is that lecturers and professors are required to upgrade their qualifications on a compulsory and differentiated basis, receive certification and have their results assessed. Therefore, academic staffs of all public HEIs need to take short training and upgrading courses in every five years (ADB Evaluation Study, 2010). Moreover, the President's fund "Istedod" (means talent) was established with the objective of allocating state support for upgrading qualifications of teachers in all public HEIs. By the end of 2010, more than 3000 teaching staff had received short training courses and had improved their qualifications (NHDR, 2011).

According to the information provided by the MFUZB (2013), currently the total number of academic staff in the entire public HEIs in the Republic is over 22,500. Approximately 45 per cent of the teaching personnel have scientific degrees, as well as there are 1,800 professors and doctors of sciences (8 per cent), 7,875 assistance professors and candidates of science (35 per cent), 12,825 lecturers (57 per cent). Furthermore, number of teachers and professors per institution of higher education, on average, increased from 302 in 2000 to 395 in 2012 as it is revealed by the table below. In academic year 2009/2010, over 40 academic personnel from foreign countries were also providing their educational services at public HEIs in Uzbekistan (EC Tempus, 2010). Unfortunately, data on the number of foreign academic staff at public universities were not available for the other academic years.

Table 2.10: Average number of academic personnel per HEI

	2002	2004	2006	2008	2010	2012
Number of teachers and professors per HEI	349	360	377	379	380	395
Out of them						
Doctors of Science	23	23	24	25	27	29
Candidates of Science	113	113	103	110	116	111
With Master degree	214	224	250	244	237	255

Source: Author's calculations, based on data from State Committee on Statistics (2013)

One of the most common and important methods to increase the quality of education is to allocate sufficient financial resources to the expenses of academic staff (EC Tempus, 2010). According to Table 2.11, academic personnel are poorly paid at the Uzbek HEIs and the differences between low and high level of positions' salaries are not significant. This process devalues academic degrees and titles. Therefore, junior staff may not be motivated continuing further professional education and this may discourage them from going to postgraduate programs.

Other factors which serve as an intellectual foundation for quality education are research and publishing activities. However, the government allocates financial resources which do not even cover expenses to prepare books or manuscripts (Brunner and Tillett, 2007). If the government does not begin reviewing the current funding system for scientific activities, this current low level of public funding may eventually demolish any motives of academic staff for publication of methodological, scientific and educational studies.

Table 2.11: Monthly average salary of academic personnel

Teaching Positions	Monthly Average Salary in USD		
	2005-2006	2009-2010	2013-2014
Head of Department	62-65	372-390	682-715
Professor	59-62	354-372	649-682
Associate Professor	53-56	318-336	583-616
Senior Teacher	48-50	288-300	528-550
Assistant	42-45	252-270	462-495

Source: Author's calculations, based on data from MFUZB (2013) and the CB of Uzbekistan (2013)

2.3.5 Financing of higher education

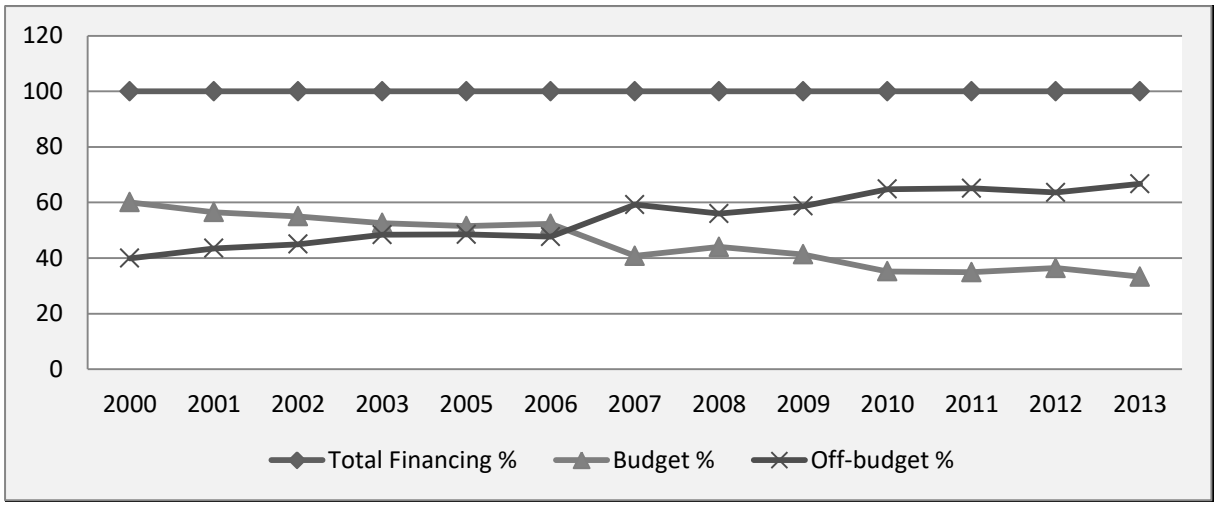
The higher education system is mainly funded from the state budget at three levels: local, regional and central (ADB Evaluation Study, 2011). Institutions of higher education, teacher training institutions and affiliated academic lyceums in the Republic are financed from the central budget. The budget expenditure is calculated based on the student quotas, the costs of government grants for students, fixed assets, equipment and buildings. To evaluate the salary of higher education staff a 9/1 students and a teacher ratio has been used since 1996, but in practice it differs depending on the field of study (EC Tempus, 2010).

According to the Decree of the CMUZB (1997), before starting of every academic year – all public HEIs make budget bids based on the basis of the last year's allocations to the institutions, which are submitted to and then evaluated by the ministries and agencies. These ministries and agencies aggregate the total budget and thereafter submit to the MFUZB, where a judgement about the total is made and return to those ministries and agencies which then redistribute the final figures between the HEIs (Mirkurbanov, Anoshkina and Danilova, 2009). Furthermore, extra-budgetary funds make up more than half of overall expenditures on the higher education system of Uzbekistan in these days. Main reasons of this situation can be seen the continually raising the number of contract-paid students and the prices of their education (EC Tempus, 2010). The extra-budget funds of Uzbek HEIs are usually generated from the following sources: tuition and other fees, renting the properties and provision of short-term training programs by academic staff of HEIs (MFUZB, 2013).

According to the Resolution of the CMUZB (2001), extra-budget funds which obtained from tuition charges and other private activities do not reduce the amount of funding from the public budget. These extra revenues can be spent for operational expenditures of HEIs, but all financial activities have to be reported to their ministries. For example, the Tashkent Medicine Academy reports about the allocations of its extra-budget funds to the Ministry of

Health. Particularly, the extra-budget funds can be spent for further developments of the facilities and infrastructure of universities (NHDR, 2011). According to Figure 2.8, the amount of extra/off-budget funding has considerably increased relative to the state-budget funding at Uzbek HEIs during the period 2007-2013.

Figure 2.8: The state-budget and off-budget funding of HEIs in 2000-2013



Source: MFUZB (2013)

If we rely on the data exposed by the figure above, the off-budget funding rose by over 27 per cent in 2013 compared to 2000. In 2013, the off-budget funds were twice higher than the state-budget funds due to extensively increased tuition fees. It is important to remark that a share of institutional revenue derived from tuition payments has consisted more than 90 per cent of total off-budget revenue at public HEIs – since 2007. Accordingly, shares of institutional revenue from research activities and public services were lower than 10 percent during that period (MFUZB, 2013). In addition, the ratio of state-budget/off-budget financing of higher education has reduced by 1.01 between 2000 and 2013 (see Table 2.12), which implies the increased share of extra-budget financing at Uzbek universities.

Table 2.12: Ratio of state budget and extra-budget financing of HEIs as well as financial indicators of higher education expenditures as share of GDP

Indicators	2000	2002	2004	2006	2008	2010	2012	2013
Total Financing %	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Including:								
State-budget %	60.1	55.0	53.1	52.3	44	35.2	36.4	33.3
Off-budget %	39.9	45.0	46.9	47.7	56	64.8	63.6	66.7
State-budget financing / extra-budget financing, index	1.51	1.22	1.13	1.10	0.79	0.54	0.57	0.50

Source: Author's calculations, based on data from MFUZB (2013)

After introducing the new system of funding for the public-financed HEIs, it was believed that public HEIs capacity for a more flexible and efficient use of off-budget resources would be increased. However, significant changes in the situation have not been followed due to predefined prioritization of the use of funds and established restrictions by the CMUZB. Whereas, most of the state-funds are utilised to satisfying accounts payable and expenditures for improving infrastructures of institutions.

Table 2.13: Trends of expenditure per student

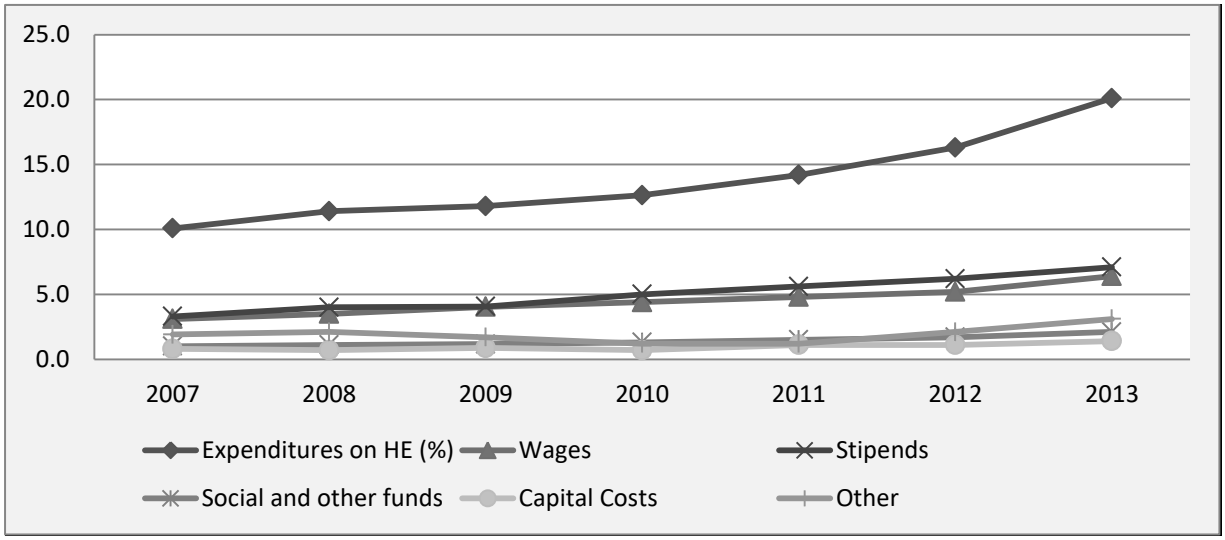
Indicators	Monetary unit	2000/2001	2003/2004	2007/2008	2011/2012	2012/2013
Total expenditure per student	*UZS('000)*	*125.8*	*126.3*	*109.1*	*109.1*	*112.3*
	US dollars	*531.7*	*533.8*	*461.1*	*461.1*	*474.6*
State-budget expenditure per student on scholarship	UZS('000)	153.5	171.4	172.1	184.8	197.8
	US dollars	661.5	724.4	727.4	781.1	836
Extra-budget expenditure per student on a fee-based contract	UZS('000)	92.3	96.7	73.7	70.7	72.3
	US dollars	390.1	408.7	311.5	298.8	305.6

Source: MFUZB (2013)

Table 2.13 illustrates that the total expenditure per student has insignificantly changed between the period 2000 and 2013. A slight trend towards an increase in public expenditure per student is witnessed during the annual adjustment for inflation of teachers' wages and

students' scholarships. A decline in the off-budgetary expenditure per student may be a result of the fact that in 2003, the adjustment for inflation of the tuition fee contracts amount was not made (EC Tempus, 2010). In 2013, with respect to the state-budget funding per student and payment per student on a fee-based contract, the amount of the state expenditure reduced from 50 to 25 per cent depending on the academic performance of a student. This residual amount per student does not meet even the minimal needs of the Uzbek HEIs (EC Tempus, 2010).

Figure 2.9: Expenditures on higher education in percentage (between 2007 and 2013)



Source: MFUZB (2013)

The data obtained from the MFUZB (2013) suggest that expenditures on higher education have increased by 10 per cent from 2007 to 2013. Accordingly, the amount of funds which need to be allocated to the several institutional expenditures, such as wages, stipends, social and other funds, capital costs and other expenses, have also increased year by year. Huge portions of the governmental funds were dedicated to paying stipends of students and salaries of academic staff over the period of 2007 to 2013. Whereas, relatively less amount of funds have been allocated to capital costs and other expenses during the same period. However, this increased expenditure to higher education was sufficient neither to expand the number of academic staff nor to improve financially sustainable operation of the HEIs.

According to the Resolution of the CMUZB (1991), the policy document - "improved mechanisms of financing of state-funded institutions initiated new financing arrangements" - was established in 1991 and it contains the following guidelines (Brunner and Tillett, 2007):

- "Broader independence and strengthened responsibility of managers of state-financed institutions for more efficient, effective, and targeted use of budget funds as well as for strengthening of budget discipline;
- Simplified of financing mechanism for state-financed institutions and broader opportunities for funds management to maximise their efficiency;
- Introduction of new financing arrangements through one-line allocation;
- Combined budget financing with increased production and sales by HEIs operation;
- Incentives for higher education staff (to improve their performance and increase motivation)" (p. 176).

In Uzbekistan, all public HEIs are allowed to acquire extra funds from the following private sources:

- Outstanding public funds from the prior fiscal year;
- Incomes earned from HEIs' production and sales of goods;
- 50 per cent of income earned from leasing of unused university properties, while another half goes to the local government budget;
- Financial sponsorships from individuals and legal entities.

All sponsorship moneys received from legal entities and individuals are spent for increasing technical and material resources of HEIs, if it is not specified by a sponsor. Revenues acquired from leasing public property can only be used for improving of learning and instruction procedures. According to the financing regulations, all public HEIs are exempted

from paying state taxes and from responsibilities on incomes acquired from off-budget sources (Mirkurbanov, Anoshkina and Danilova, 2009).

The tax exemptions implemented under current legislation have several implications. First of all, HEIs as budget organisations are exempt from land fees and property taxes regardless of their extra-budgetary activities. Secondly, all public HEIs have a tax privileges for some operations, such as research & development and paid educational services. Finally, all universities can be exempted from revenue tax charged for several extra-budgetary operations if the revenue is reinvested in HEIs (EC Tempus, 2010).

To the best of my knowledge, nowadays, there are three main issues that concern the financing of public institutions of higher education in Uzbekistan:

(1) Insufficient public financing of HEIs' expenses;
(2) Insufficient financial incentives for academic staff;
(3) Lack of independence granted to HEIs in administrating their extra-budgetary incomes.

Administrative bodies of the governmental institutions should seriously consider these funding challenges at public HEIs, perhaps, through introducing new reforms in the higher education system.

2.3.6 Role of higher education in research and innovation

At most of the institutions of higher education in many countries, the two important components of knowledge production and dissemination are the teaching and scientific research (Johnstone and Marcucci, 2010). In Uzbekistan, every public HEI identifies independently its scientific research areas based on the priorities of contemporary science, requests from branches of industry, institutional material and technical capacities, and national program requirements. Majority academic personnel are involved in scientific

research which is a vital component of staff assessments and qualifications. On average, around 200-400 academic hours are spent by teaching staff on scientific research in each academic year (SCS, 2013). Research activities which are required to be carried out during the academic hours consist of writing papers and theses, improvement of learning materials and literature, as well as execution of scientific and methodological works.

Table 2.14: Dissemination of scientific personnel by ministries in 2013/2014

Ministries	Number of professors and teachers	Share (%)	Including :			
			Doctor of Sciences, Professor	Candidate of Sciences	Aspirant	"Doctorant"
MHSSE	13346	62	954	4758	1230	98
Ministry of Agriculture and Water Management (MAWM)	1153	5	87	509	166	16
Ministry of Health (MOH)	3002	14	421	1038	231	14
MPE	1656	8	49	404	41	5
Ministry of Sport and Culture Affairs (MSCA)	652	3	31	153	43	0
Other ministries and agencies	1658	8	130	524	158	2
Total	21467	100	1672	7386	1869	135

Source: State Committee on Statistics (2013)

Highly-qualified senior staff, necessary research and production equipment and facilities are normally required for the scientific research and development. Scientific human resources, those are doctors and candidates of sciences, are mainly employed by the public HEIs. According to Table 2.14, the MHSSE employed twice more academic staff (with 62 percent of share) compared to all other ministries in the Republic in the recent academic year. The table also shows that most of the academic personnel of these ministries have Candidates of Science degrees (total - 7386), and only few have the Doctorant degrees (total - 135). The MSCA has not employed any Doctorant academic staff during the same academic year.

According to the State Committee on Statistics of Uzbekistan (2013), the main sources of funding for research activities at public HEIs are: (1) government funding within the regulations of the National Scientific and Technical Program (NSTP) and National Program for Fundamental Research (NPFR); and (2) off-budget funding, such as:

- Advisory and consulting services;
- Contract-based research;
- Leasing of scientific inventories and equipment;
- Conducting research for government bodies, local governments or commercial entities;
- Sale of patents and licenses;
- Technical and scientific assistance for small and medium businesses;
- Organisation of paid scientific conferences and workshops;
- Audit;
- Other forms of innovative activities which are not prohibited by the legislation of the Republic of Uzbekistan.

The government funds for research activities of HEIs are allocated by competition-basis only (NHDR, 2011). Between 2010 and 2012, a total of 5 billion USD was granted for public universities' research by the NSTP, NPFR and National Innovation Program (NIP) of the Science and Technology Centre under the CMUZB (SCS, 2013). A distribution of the government grants for research activities by ministries and agencies is shown in Table 2.15. As the table below exposes, public HEIs under the MHSSE have received the greatest share of research grants, over 77 per cent, during the years 2010-2012. In the same period, the lowest share of the grants was allocated to institutions of the MOH.

Table 2.15: Allocation of scientific research grants by ministries and agencies between 2010 and 2012

Name of Ministries	In USD	In percentage
MHSSE	3,738,501	77
MPE	382,979	8
Ministry of Agriculture and Water Management (MAWM)	338,925	7
Ministry of Health (MOH)	80,692	2
Other ministries and agencies	312,616	6

Source: State Committee on Statistics (2013)

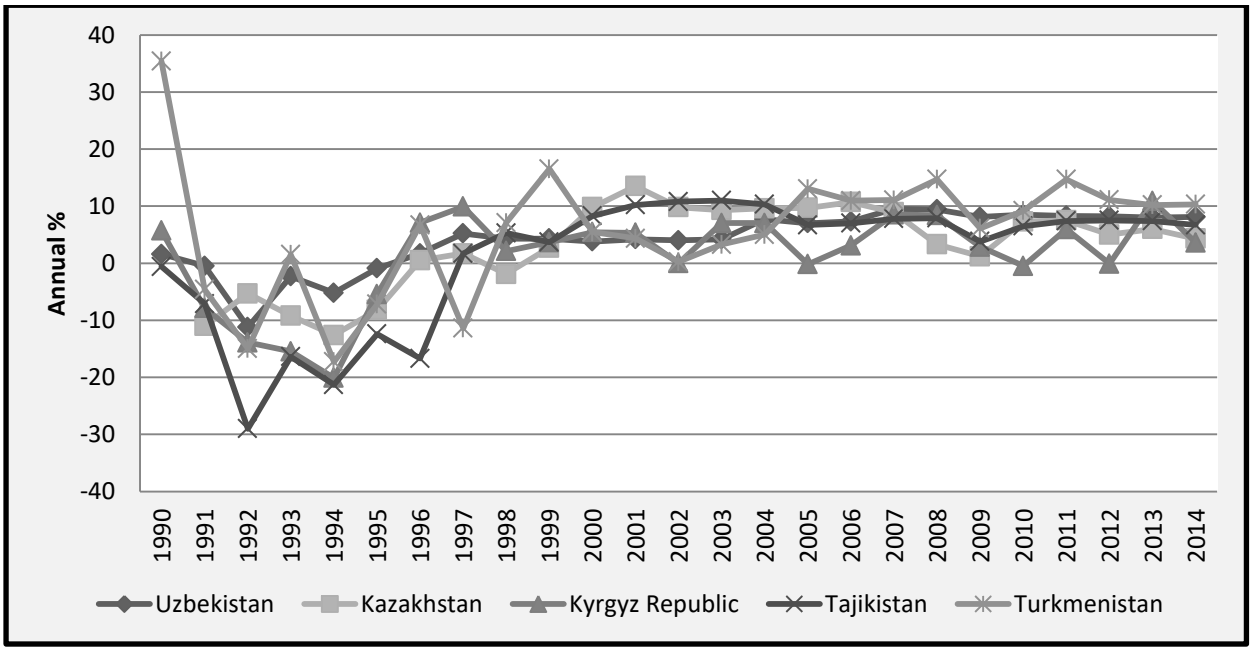
In these years, there are two central issues which concern higher education on scientific research in Uzbekistan. First, poor technical and material facilities for carrying out scientific research, and second, an insufficient state-funding for conducting scientific research (EC Tempus, 2010). Hevertheless, if the government (1) assists to integrate the scientific research capacity of HEIs with the Scientific Research Institutes of the National Academy of Science of the Republic of Uzbekistan and (2) gives sufficient autonomy to HEIs to diversify sources of funding for scientific research, then those two issues can be solved in the future.

2.4 Comparative Analysis with Higher Education Systems of other CARs

2.4.1 Recent growth performance

After Soviet Union collapsed in 1990, the independent republics have experienced social, political and economic challenges which they were weakly prepared to meet (Brunner and Tillett, 2007). Obviously, there were no longer allocations of financial resources from the Central-Moscow to the governments of the "newly" independent countries for running social programs, such as housing, health care and education, nor subsidies for higher education, training and research. According to the EC Tempus report published in 2011, the collapse of the Soviet Union had a more severe influence on the economy of the Central Asian countries – Uzbekistan, Kazakhstan, the Kyrgyz Republic, Tajikistan and Turkmenistan – compared to other former Soviet Republics. Perhaps for this reason, the economy of these five countries is not noticeably improved between 1990 and 2014 which can be seen from their GDP growth rate. Accordingly, Figure 2.10 represents annual percentage growth rate of GDP at market price based on constant local currency.

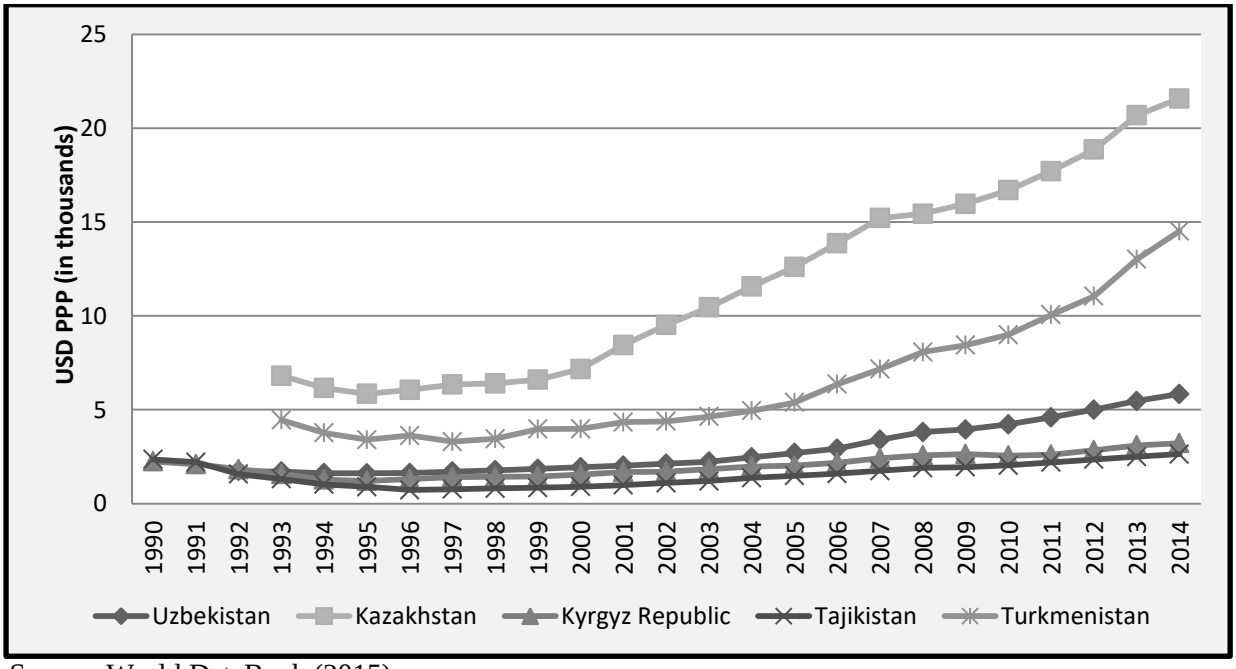
Figure 2.10: GDP growth (by percentage)



Source: World DataBank (2015)

All CARs have experienced two growth phases – recession and growth – over the period of 1990 to 2001. However, GDP growth rate of all these countries were stably fluctuated and ranged between 0 and 15 – since 2001. In the recent years, it seems that almost all the CARs, except Turkmenistan, have recovered satisfactorily to reach and exceed their 1991 GDP value. Moreover, another indicator which represents economic performance and financial stability of the countries is the Gross National Income (GNI) per capita. The figure below exposes GNI per capita, which were converted to international dollars utilising purchasing power parity rates, for Uzbekistan, Kazakhstan and Turkmenistan from 1993 to 2014 and for the Kyrgyz Republic and Tajikistan after 1990 when their series commences. According to the GNI per capita indicator, residents of Kazakhstan and Turkmenistan have received relatively higher salaries compared to their counterparts. These findings suggest that the economy of these two Republics have rapidly recovered after the collapse of the Soviet Union.

Figure 2.11: GNI per capita (USD, PPP)

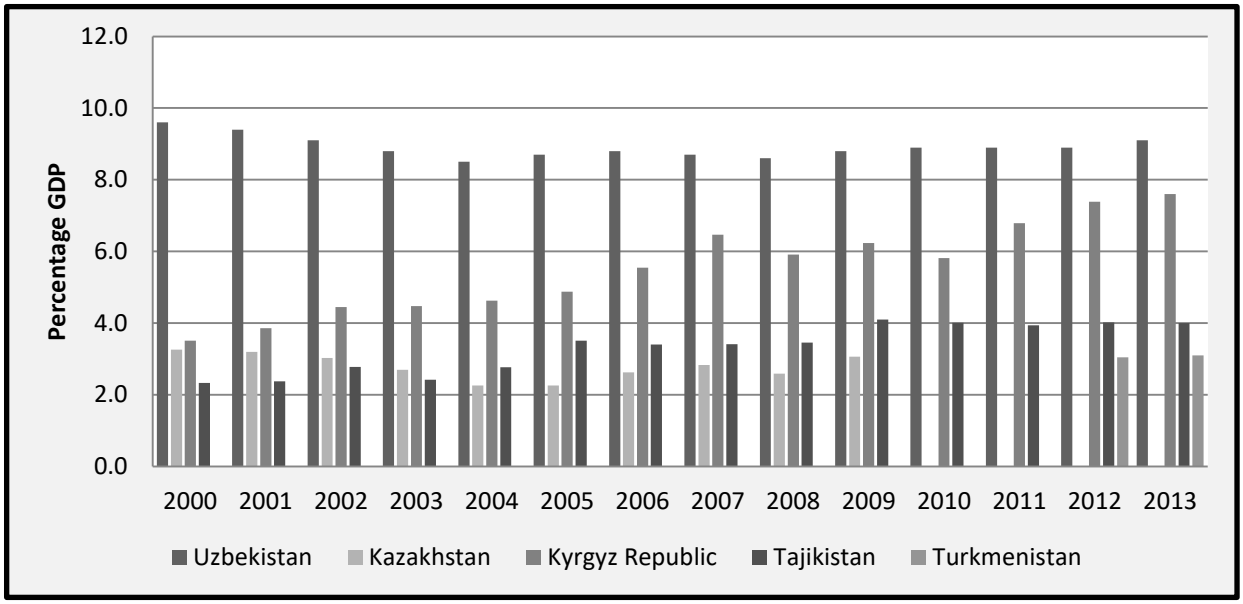


Source: World DataBank (2015)

2.4.2 Public expenditure on education and higher education

Despite the satisfactory economic performances of Kazakhstan[5] and Turkmenistan[6], their public expenditures on education as a percentage of GDP have not remarkably increased after 1991. Over the period of 2000 to 2013, educational expenditures in the rest of the CARs have slowly increased and stabilised with the exception of the Kyrgyz Republic. Figure 2.12 displays that Uzbekistan reached around 9 per cent, the Kyrgyz Republic more than 7.5 per cent, and Tajikistan less than 4 per cent public expenditure on education in 2013. It can be concluded that Uzbekistan has considerable superiority over other republics of Central Asia in financing education sector. Then the Kyrgyz Republic is dominating. Since the early 2000, Uzbekistan and the Kyrgyz Republic have been allocated, on average, 8.9 per cent and 5.5 per cent of their public spending on education, respectively.

Figure 2.12: Government expenditure on education (as % of GDP)



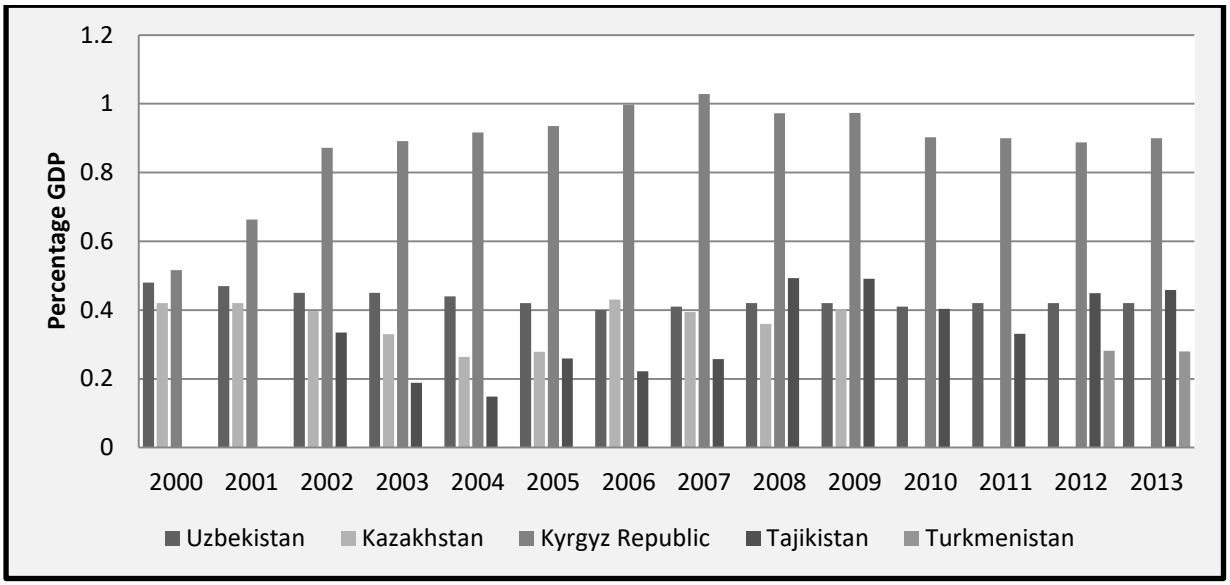
Source: World DataBank (2015) and MFUZB (2013)

Figure 2.13 exposes the public expenditure on higher education in all countries of Central Asia as a percentage of GDP for the period 2000-2013. In these years, the Kyrgyz Republic

[5] The data are available only for the period 2000-2009
[6] The data are available only for the period 2012-2013

allocated, on average, more than 0.9 per cent of the government expenditure on higher education out of 5.5 per cent that was dedicated to entire education sector. With the highest public educational budget among the CARs, Uzbekistan has directed a very small portion – only one twentieth – of educational expenditure on higher education during 2000-2013. Similarly, Kazakhstan has allocated, on average, 0.4 per cent of its public spending on higher education,[7] but this makes only one seventh part of public expenditure on entire education sector. Finally, Tajikistan has dedicated the one tenth share of its education expenditure on higher education - since 2002.

Figure 2.13: Government expenditure on higher education (as % of GDP)



Source: World DataBank (2015) and MFUZB (2013)

2.4.3 Number of HEIs, students and academic personnel

Since independence, the number of higher educational establishments has been steadily increased in the entire CARs except in Kazakhstan, even the government expenditures on higher education were the lowest priority relative to other education sectors for the all Ex-Soviet Union countries. Table 2.16 describes that Kazakhstan has several times more institutions of higher education compared to other CARs. In Kazakhstan, the number of

[7] The data were available only for years from 2000 to 2009.

public HEIs was almost six times less than private ones in 2000 and two times less in 2011. A country with the lowest number of HEIs was Turkmenistan among the CARs during the period 2000-2011. According to the EC Tempus (2010) report, there is no private domestic institution of higher education in Uzbekistan, Tajikistan and Turkmenistan yet. However, on average, Uzbekistan has had the highest amount of public HEIs compared to the rest of the CARs with 62 state HEIs - since 2000. In the next places Kazakhstan with 48, Tajikistan with 33, the Kyrgyz Republic with 32 and Turkmenistan with 15 public HEIs. Nevertheless, private higher education establishments seem to have greater scope in Kazakhstan, and almost one of the third of the entire HEIs were private in the Kyrgyz Republic over the same period.

Table 2.16: Number of higher education establishments in the CARs

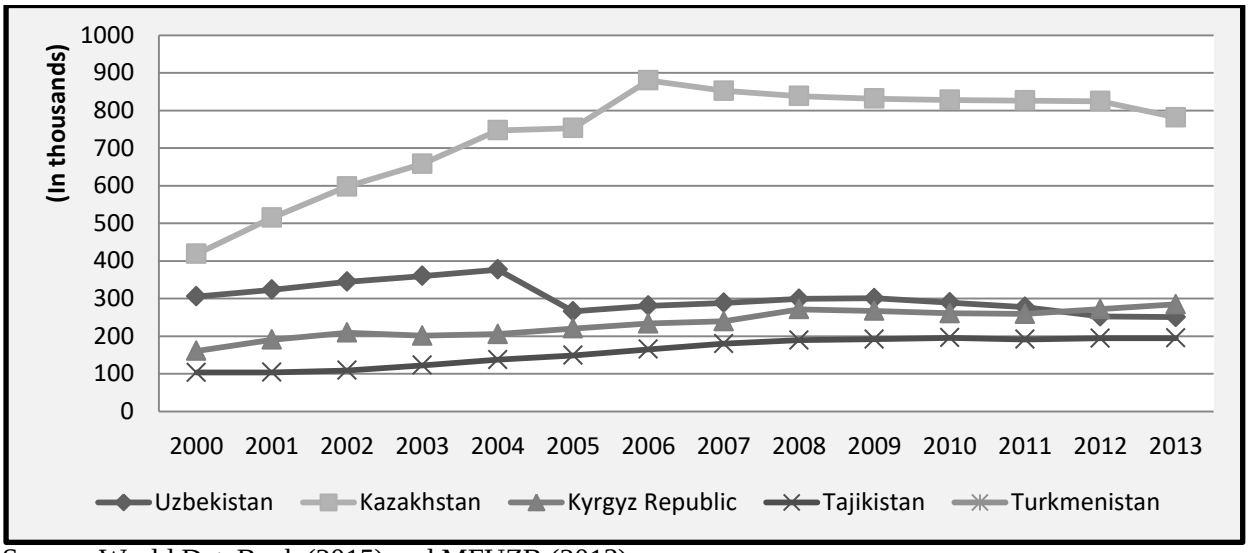
	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Average*
Uzbekistan	**61**	**61**	**61**	**61**	**61**	**62**	**62**	**62**	**62**	**63**	**64**	**64**	**62**
Kazakhstan	**171**	**170**	**185**	**177**	**180**	**181**	**181**	**178**	**150**	**150**	**147**	**144**	**168**
Public	25	24	59	50	46	51	51	52	52	51	55	55	48
Private	146	146	126	127	134	130	130	126	98	99	92	89	120
Kyrgyz Republic	**43**	**45**	**48**	**46**	**47**	**49**	**49**	**48**	**49**	**50**	**50**	**50**	**48**
Public	30	30	32	31	31	33	32	32	34	34	34	34	32
Private	13	15	16	15	16	16	17	16	15	16	16	16	16
Tajikistan	**29**	**29**	**30**	**31**	**33**	**38**	**38**	**35**	**36**	**33**	**33**	**31**	**33**
Turkmenistan	**11**	**10**	**12**	**12**	**18**	**19**	**19**	**14**	**17**	**17**	**17**	**18**	**15**

Source: EC Tempus (2010) and MFUZB (2013)

The total number of students enrolled (both sexes) in all programs was the highest for Kazakhstan and it was increased approximately from 418500 to 879000 during the period of 2000 to 2013. While the enrolment rate at public HEIs of Tajikistan was the lowest one relative to their counterparts. However, Figure 2.15 reveals that Uzbekistan has the lowest enrolment per 100,000 inhabitants in higher education which ranged between 986 and 1462 over the period 2000-2011. Enrolment in higher education per 100,000 inhabitants was

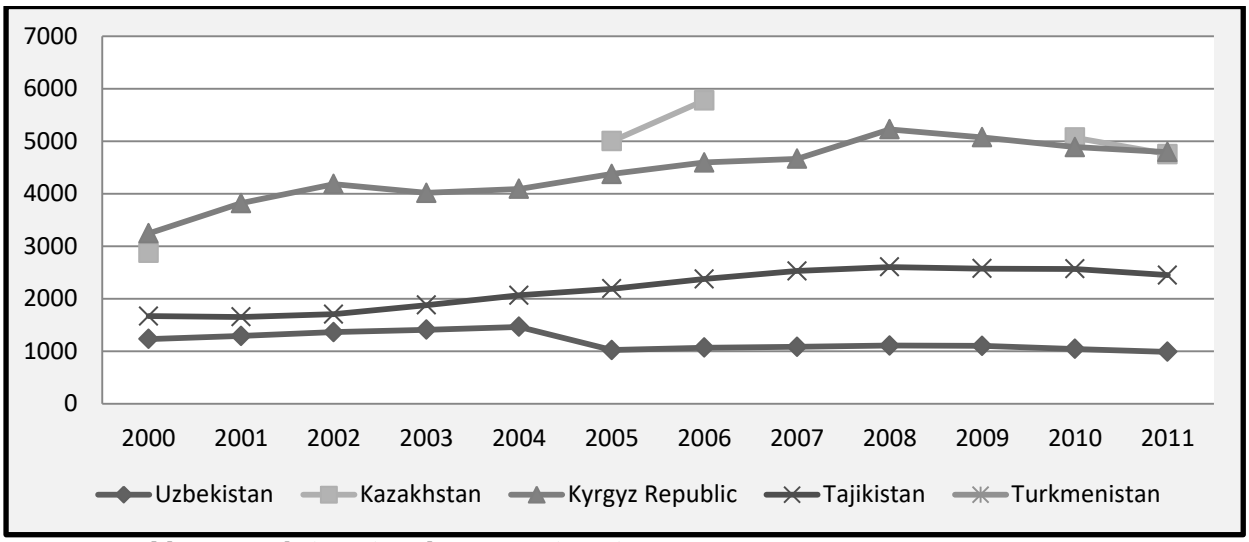
superior in Kazakhstan and in the Kyrgyz Republic compared to Tajikistan and Uzbekistan. The data for Turkmenistan were not available for any period.

Figure 2.14: Enrolment in higher education (all programs and both sexes)



Source: World DataBank (2015) and MFUZB (2013)
Note: Due to lack of data for all CARs, the enrolments in higher education by study programs (e.g., bachelor and master) and by status (e.g., government grants or tuition fee contracts) were not included

Figure 2.15: Enrolment in higher education per 100,000 inhabitants (both sexes)



Source: World DataBank (2015) and MFUZB (2013)
Note: The data for Kazakhstan are available only for the years: 2000, 2005, 2006, 2010 and 2011

Since the collapse of Soviet Union, the higher education sector of Kazakhstan has always been dominated in terms of the number of higher educational establishments and the amount of students attending to these institutions. Through relying on the education statistic of

enrolment in higher education per 100,000 inhabitants, it can be concluded that access to higher education were better in Kazakhstan and the Kyrgyz Republic relative to the other Central Asian countries.

Table 2.17: Number of academic staff per HEI

	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Average*
Uzbekistan	279	264	284	303	320	323	372	377	387	378	361	360	**334**
Kazakhstan	183	-	-	-	-	-	276	-	-	-	353	370	**295**
Kyrgyz Republic	195	221	218	248	248	272	275	281	363	342	350	341	**280**
Tajikistan	275	289	288	292	285	263	306	307	316	348	400	425	**316**
Turkmenistan	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Author's calculations, based on data from the World DataBank (2015) and MFUZB (2013)
Note: The data for Kazakhstan are available only for the years: 2000, 2006, 2010 and 2011; Data are not available for Turkmenistan.

Table 2.18: Number of students per HEI

	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Average*
Uzbekistan	5007	5299	5649	5897	6179	4290	4530	4654	4823	4774	4519	4335	**4996**
Kazakhstan	2447	3028	3230	3718	4151	4161	4860	4786	5588	5541	5631	5736	**4406**
Kyrgyz Republic	3737	4234	4359	4372	4366	4499	4765	4987	5541	5340	5212	5177	**4716**
Tajikistan	3557	3582	3633	3955	4165	3918	4346	5135	5262	5806	5930	6168	**4621**
Turkmenistan	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Author's calculations, based on data from the World DataBank (2015) and MFUZB (2013)

The number of academic staff[8] in institutions of higher education is one of the indicators that can represent a size of institutions and higher education system of many countries. Table 2.17 reveals that on average, public HEIs in Uzbekistan have utilised more human resources than any other the CARs over the years 2000 and 2011. Such as, on average, 334 teachers per HEI have been employed in Uzbekistan, 316 teachers per HEI in Tajikistan, 295 and 280 academic personnel per HEI in Kazakhstan and the Kyrgyz Republic respectively. Moreover,

[8] Includes both full- and part-time teachers in higher education

Table 2.18 shows that the Uzbek HEIs have had the highest amount of students per institution during the period of 2000 to 2011. The lowest score belongs to Kazakhstan where only, on average, 4400 students educated in each HEI. Although this CAR owned the greatest amount of HEIs (on average 168) and students in higher education (on average 728660) between the years 2000 and 2011. Moreover, Uzbek HEIs educated greater amount of students through employing greater number of teachers compared to the higher education establishments in the other Central Asian countries.

Table 2.19: Students and teacher ratio

	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Average*
Uzbekistan	18	20	20	19	19	13	12	12	12	13	13	12	**15**
Kazakhstan	13	-	-	-	-	-	18	-	-	-	16	15	**16**
Kyrgyz Republic	19	19	20	18	18	17	17	18	15	16	15	15	**17**
Tajikistan	13	12	13	14	15	15	14	17	17	17	15	15	**15**
Turkmenistan	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Author's calculations, based on data from the World DataBank (2015) and MFUZB (2013)
Note: Data on higher education teachers by their qualifications (senior teachers, associate professors or professors) and by status (full- or part-time) are not available

Having superiority on the number of academic staff per HEI or on the amount of students per institution should not lead to assume that quality of education is good or satisfactory at public HEIs in Uzbekistan. Furthermore, one of the many factors which are very often utilised to measure quality of education is the students/teacher ratio. In 2000, this indicator was quite high for the Kyrgyz Republic (19 students per academic staff) and for Uzbekistan (18 students per academic staff). However, the ratio declined significantly from 19 to 13 students per teacher in Uzbekistan at the end of 2004; also it started to considerably decrease for the Kyrgyz Republic in 2007. For Tajikistan, the ratio of students and teacher has slightly increased from 13 in 2000 to 15 in 2011, while data for Turkmenistan are not available for any period.

2.4.4 Tuition fees, personnel salaries and expenditures for research

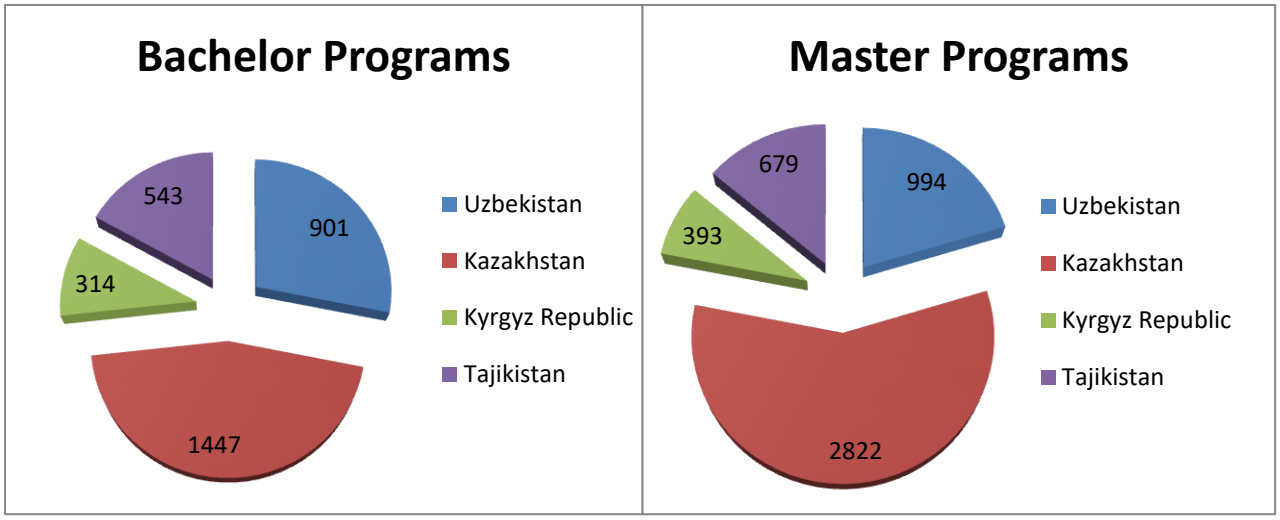
There has been followed a shift in higher education financing from governments to individuals and household in most of the countries worldwide (Barr, 2009). Tuition income is one of the main financial resources of the Central Asian HEIs in these days (Brunner and Tillett, 2007). However, majority of the universities in Kazakhstan and the Kyrgyz Republic still receive governmental block grants for their research or capita expenses. Normally, tuition charges are evaluated in two following methods, (1) by public authorities based on a formula and (2) by the HEIs according to their costs or institutional based formula (Albrecht and Ziderman, 1995). In case of the CARs, except Uzbekistan, there is no information regarding which government applies which one of these methods for fee settings.

In the all five countries of Central Asia, limited numbers of government scholarships are awarded to students on merit bases (EC Tempus, 2010). This form of scholarship usually covers full tuition fee (as in Uzbekistan and Tajikistan) or provides partial tuition support (as in Kazakhstan). Moreover, once the overall quantity of government supported students is determined then either the Ministry of Education or the HEIs themselves can specify the amount of fee-based students they wish to admit and set out the price of tuition they willing to charge (Brunner and Tillett, 2007).

A major share of institutional revenue is derived from tuition fees paid by students or their parents at most of the public HEIs in CARs. Depending on profession and program being followed, the tuition prices vary between the Republics and between public and private HEIs as well as within institutions. Figure 2.16 reveals that compared to students in other CARs, Kazakh students paid the highest tuition fees ranged, on average, from 1447 Euro for bachelor's program and 2822 Euro for master's programs in 2010. According to the EC Tempus (2010) report that on average, 80 per cent of institutions' revenue derived from external activities (principally as fees) in Kazakhstan. While, students of Uzbek universities

paid, on average, 50 per cent higher tuition fees compared to Tajik students and twice more than students of the Kyrgyz Republic in the both levels of study.

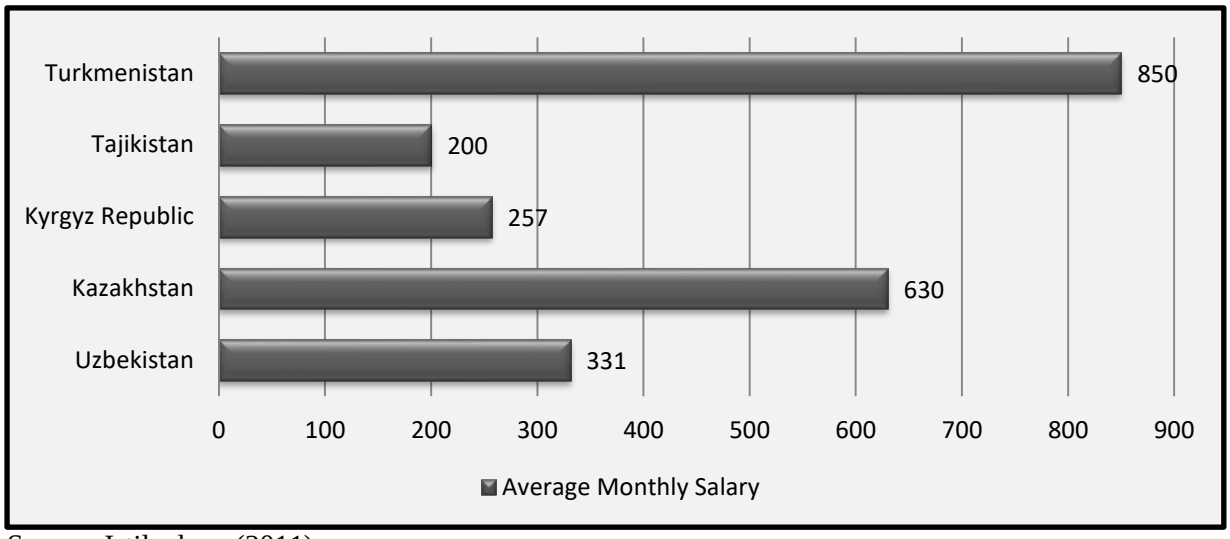
Figure 2.16: Average annual tuition fees (in Euro) for bachelor's and master's programs at public HEIs in the CARs (2010)



Source: Author's calculations, based on data from EC Tempus (2010) and MFUZB (2013)
Note: The data are available only for public HEIs and for the year 2010.

For most of the public HEIs in the CARs, revenues from tuition have become crucial for their survival and a huge share of the universities' operational expenses have been covered through tuition incomes over the last decade. The most important current and capital cost for many universities in the CARs is the academic personnel. According to the NHDR (2011) report, salaries of university teachers are calculated to be around 62 per cent in Uzbekistan, 58 per cent in the Kyrgyz Republic and 40 per cent in Kazakhstan of total institutional budget in 2010. In Tajikistan, wage expenses reduced from 70 to less than 50 per cent in order to allocate more funds on much needed maintenance and repairs. As Figure 2.17 shows that an average monthly salary of a university teacher is estimated to be approximately 630 USD in Kazakhstan, 330 USD in Uzbekistan, 257 USD in the Kyrgyz Republic, 200 USD in Tajikistan and a surprisingly high level in Turkmenistan (850 USD) in 2010.

Figure 2.17: Average monthly wages (in USD) of academic staff at HEIs in the CARs (2010)



Source: Istileulova (2011)

At the most HEIs in the CARs, scientific research activities are mainly financed from the government budgets, but public expenditures on research and development (R&D) activities are significantly low in these countries. Shares of other sources of income, such as contributions of donors and sponsors as well as institutional own financial sources, in financing R&D are also very low (EC Tempus, 2010). According to the European Commission recent report, Kazakhstan has directed greater source of funds to R&D activities relative to their Central Asian counterparts between the period 2000 and 2010 (EC Tempus, 2010). During the same years, Kazakhstan's R&D expenditure improved by 9.6 times, whereas the Republic's GDP enlarged by 13 times. Therefore, the R&D expenditure as a percentage of GDP reduced from 0.36 to 0.26 per cent.

In the Kyrgyz Republic, a share of scientific research expenses in GDP has been noticeably decreased between 1991 and 2010. The percentage of R&D expenditure to GDP ratio was 0.7 per cent in 1991, but reduced to 0.3 between 1992 and 1997 and to less than 0.2 per cent of GDP from the period 1998 to 2005. In Tajikistan, the government funding of scientific research and sciences was 0.13 per cent of GDP in 2005 and the greater share of this fund was allocated to fundamental sciences managed by the Academy of Sciences of Tajikistan. In

case of Uzbekistan, scientific research has become one of the important components of human capital production at public HEIs during the recent five years. A total of 5 billion USD was granted to public HEIs' research activities by the Science and Technological Centre under the CMUZB over the period of 2010 to 2012 (SCS, 2013). However, a share of the Uzbekistan public expenditure on research and development activities as a percentage of GDP is uncertain.

2.5 Summary

The detailed analysis of the Uzbek higher education system and factors that determine its development expose that (1) insufficient financial resources have been allocated to public HEIs from the government budget, (2) inflows of limited local and foreign investments to the public HEIs, (3) insufficient financial autonomy of the public HEIs and (4) a lack of competition between institutions for clients. The Uzbek universities do not have to compete for students who are "buyers" of educational services, therefore there is a lack of incentives by universities to strength their financial performance and to improve the quality of education. Moreover, financial and institutional restrictions imposed by the CMUZB prevent the creation of incentive for building capacities, as well as extensive state regulation of higher education inhibits the appropriate responses to new problems and challenges.

After independence, tuition fees for higher education were introduced in all of the Republics of Central Asia and it has been greatly increased since then. Therefore, a huge share of institutional income has been generated from off-budgetary sources, particularly from tuition charges. At the same time, the allocations of the state financial resources to public HEIs have considerably reduced in most of the CARs. The institutional funds were usually spent for the main institutional expenditures, such as personnel salaries, student stipends, administrative expenses and refurbishments. Since a fee-based education established, most of the HEIs in the CARs including public HEIs in Uzbekistan have become strongly dependent on funds derived from tuition charges. Therefore, Uzbek HEIs that generate an extensive portion of their income from tuition should devote most of their funds to improve the quality of education and to other student related activities. At the same time, the governments of the all CARs need to consider increasing the share of fiscal resources allocated for conducting scientific research and innovative programmes at their HEIs.

According to the data provided by the MFUZB (2013), efficiency in utilisation of institutional resources is significantly low throughout the higher education system in Uzbekistan. The response of administrators at public HEIs focused on maintaining the existing teachers and other institutional staff, when the public expenditure on higher education reduced and enrolment rate increased by several times. As a result, students/teacher ratio and academic staff workloads have notably decreased at all levels of the education system. Since the late 2000s, institutional expenditures on personnel salary have considerably increased parallel with the number of teaching staff at HEIs. Therefore, it would be a reasonable to expect the inefficient utilisation of resources at the Uzbek HEIs during the recent decade.

Chapter 3: LITERATURE REVIEW ON RDT IN THE CONTEXT OF HIGHER EDUCATION

3.1. Introduction

Over the recent decades, competing demands on public funds have grown more intense as most of the governments around the world face difficulties in delivering more and better public services, including agriculture, housing, health care, transportation and the full range of education (Johnstone and Marcucci, 2010). In this context, higher education is often far from utmost importance for public financing in most of the countries, particularly in low and middle income countries (Sanyal and Johnstone, 2011). The recent report of The World Bank (2014) asserts that a share of public funds directed to HEIs budget have been considerably reduced in many countries and this can be seen as one of the main reasons why many public universities turn out to be financially unsustainable in the last two decades.

Majority of the public HEIs sought to fill the gap left by the reduced public financing through generating private sources of funding, such as introducing or increasing tuition and other user fees; commercialising of research; providing consulting services; offering training and seminars for industries; trading activities; and other private uses of institutional facilities and staff (Johnstone, 2004). According to Salmi and Hauptman (2006), however, the most common response for the decreased public allocations were to mobilise more resources principally by imposing or increasing tuition fees as a way of rising cost-sharing.

The recent empirical studies reveal that, however, the increased reliance on private sources of income has some unintended consequences to institutions of higher education (Coupet, 2013;

Fowles, 2013; Nienhuser, 2008). Most of the studies revealed that institutions focus more on instructional activities by increasing expenditure to educational and other related expenses – in the case of increased tuition income reliance, but, when institutions generate a greatest portion of their revenue from contracting out research and private donations, they become more dependent on these clients and private donors (Fowles, 2013).

This chapter extensively discusses the consequences of increased resource dependence on tuition funding through reviewing related theories, concepts and recent empirical studies. The chapter consists of two key sections: the first main part reviews theories of organisation and environment; as well as the second main part is dedicated to discussing of empirical studies which reviews several key researchers' investigations, estimations and methodological contributions on evaluating and explaining behaviours of universities using RDT. A summary of the chapter follows in the last section.

3.2 Review of Theoretical Literature

In this section, the changing behaviours and structures of HEIs are explained using some organisational theories, particularly using RDT. In the late 1970s, three imperative theories which focus on organisations and their environments (which usually consist of other organisations) began to emerge. These theories are institutional theory (Meyer and Rowan, 1977), population ecology theory (Hannan and Freeman, 1977) and resource dependence theory (Pfeffer and Salancik, 1978). All these theories are developed based on adaptation and open system theories (Gumport and Sporn, 1999). Institutional theory helps to explain that organisations are social institutions with expectations, norms and rules - imposing constraints on organisations and shaping their behaviours and structures (Austin and Jones, 2015). Population ecology theory is the study which focuses mainly on the dynamics of organisational populations, and "on birth and mortality of organisations within the population" (Hannan and Freeman, 1989). RDT primarily seeks to understand the changes in organisational behaviours and structures when organisations collaborate with their environment (Neinhuser, 2008).

These three theories have much in common, but there are also several noteworthy differences between them. In their one of the recent publications, Pfeffer and Slancik (2003) highlighted the specific distinctions between institutional and resource dependence theories by stating that "institutional theory tended to emphasise social rules, expectations, norms and values as the source of pressures on organisations to conform, rather than the patterns of transactions and exchanges that formed the focus for resource dependence" (p. 15). Furthermore, issues of interests and power which are prominent in resource dependence theory are largely neglected by institutional theory (Meyer and Rowan, 1977).

Population ecology, as the theory of resource dependence, stresses the necessity of the environment for understanding organisations (Hannan and Freeman, 1989). According to Pfeffer and Slancik (2003), population ecology theory differs from RDT mainly in three perspectives. Firstly, the population ecology does not acknowledge the possibility of organisations changing their environments but a theory of resource dependence does. Secondly, resource dependence offers more options and possibility of organisational adjustment in response to environmental forces, while in population ecology, conversely, differential choice via birth and death procedure constitutes the primary way in which institution populations alter. Thirdly, population ecology does not say anything regarding organisational decisions (e.g., decision to merge of organisations and selecting boards of directors), whereas resource dependence focuses specifically on organisational decisions.

Possibly most of the behavioural consequences of organisations that are reviewed in the literature can be best explained and analysed under the scope of RDT (Austin and Jones, 2015; Hannan and Freeman, 1989; Neinhuser, 2008; Pfeffer and Salancik, 2003). This theory aims to describe inter-organisational relations involving a several organisations and the dependence which occurs between them. Many researchers have been contributed for the development of this theory through their comprehensive studies. The first ideas on resource dependence approach are revealed by Zald (1970) and Wamsley and Zald (1973), but the same idea can be observed in Thompsan's (1967) power-dependence model. The most noteworthy development of the RDT has been contributed by Pfeffer and Salancik in 1978 and 2003.

Originally, RDT formulated by Jeffrey Pfeffer and Gerald Salancik in their largely cited book - entitled: "The External Control of Organisations: A Resource Dependence Perspective" in 1978. This theory emphasizes that control over resource allocation is an important power

source in organisations and the core of this theory is that "the behaviours of organisations will respond to demand made by external organisations upon whose resources they are heavily dependent" (Pfeffer and Salancik, 1978; p. 39). These scholars propose three factors which are 'critical' in describing the dependence of one institution on a second institution: (1) "the importance of resource and the extent to which the institution requires it for continued operation and survival; (2) the extent of discretion over the allocation and use of a resource possessed by the other institution; (3) the extent to which there are few alternatives or concentration of resource control" (p. 45). Within this frame, the power of an organisation is interpreted as a measure of the extent to which it can govern responses and decrease its dependencies on external resources.

Since many years, this theory has been a principal and influential theory for explaining environment and organisation interactions, in that RDT can well exposes the impact of the external environment on organisational behaviours (Austin and Jones, 2015). These researchers remark that the environmental relation is based on concept that organisations cannot always sufficiently-support their-self and need engage in interchanges with their external environment for being alive. Whereas, Nienhuser (2008) precisely describes the fundamental assumption of this theory by stating that "dependence on 'critical' resources impact the behaviours of organizations and that organisational decisions, thus behaviours can be interpreted relying on the particular dependency condition" (p. 4).

In the context of higher education, public institutions in many countries are publicly owned and operated, or governmentally funded. Therefore, it is plausible to expect that governments are in the position of exerting influence on public HEIs through the allocation of subsidies (Tolbert, 1985). Financing mechanisms are the main governing method that governments or ministries demand greater accountability from their HEIs; therefore, institutions are expected

to fulfil government financing requirements and expectations (Austin and Jones, 2015). Nowadays, the state and local governments as well as accrediting agencies are the most powerful agents in the higher education sector. Public HEIs are mainly dependent on these external state-authorities' allocations for their continuously operation and survival. However, governments have considerably reduced allocation of financial resources to public HEIs in many countries over the last three decades (Sanyal and Johnstone, 2011). Most of the universities may not be willing to or able to perform in a manner as a government demands, due to the decline in public funding.

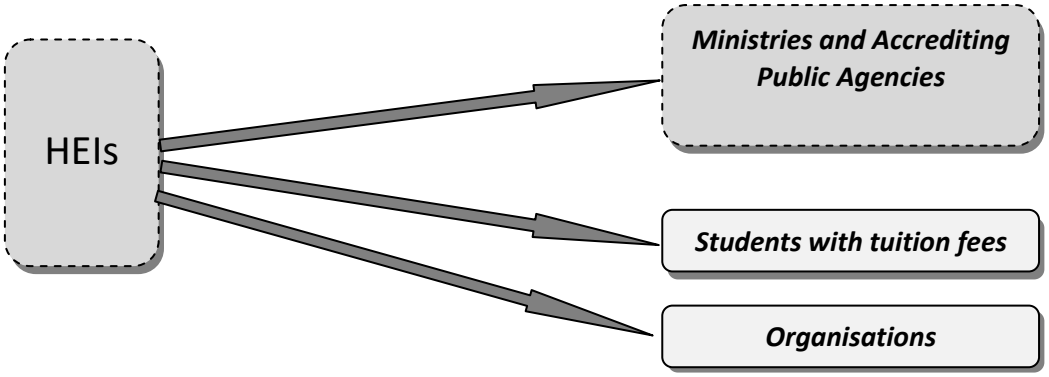
It is extensively discussed and explained by the prior studies of Pfeffer and Salanick that theory of resource dependence has some of its consequences: "(a) organizational behaviour is a consequence of influences; and (b) organisations who are dependent on the continued success of another organisation may build behavioural dependencies with them" (p. 45). Thereby, they can be interpreted as: in the case of (a), an organisation is less powerful if it is more dependent on external resources; and in the case of (b), one of the key elements to decrease environmental pressures is a mitigation of resource dependency (Pfeffer and Salanick, 2003).

The explanations of Pfeffer and Salanick become more relevant in the context of HEIs after Slaughter and Leslie (1997) extended RDT by suggesting that a publicly funded university that facing the reducing public allocations seek to find other opportunities to diversify its funding base. In other words, this insufficiently funded HEI may enter into new dependency relationships with other principals in order to decrease dependency on government subsidies. These new principals can be organisations contracting out research and students who paying tuition fees as described in Figure 3.1. Austin and Jones (2015) also suggest that mitigating the dependency on only one resource provider (e.g., a government) minimizes the

vulnerability of a HEI to access the resources. Besides, these authors note that dependence power can be reduced when a university also has resources which become more essential for a government.

This new resource dependency relationship between HEIs and the external resource providers are comprehensively discussed through Wang's (2001) studies. The scholar emphasises that institutions of higher education function within a multi stakeholder environment and they respond to the demands of institutions, students, parents, governments and legislation. Due to the declines in government funding, majority of the public HEIs begun to generate the main fraction of their income from students by providing teaching services and from enterprises by providing research and consulting services (Wang 2001). Therefore, students and other purchasers of academic services become clients who make a significant influence on revenue streams of HEIs.

Figure 3.1: Resource dependency relationships between HEIs and other principals



The several influential researchers in the education field, such as Albrecht and Ziderman (1995); Barr (2010); Johnstone and Marcucci (2010); Psacharopoulos (1986); Rena (2010), remarked that reduction in government allocations, increasing costs, the needs to meet expanded social expectations and build better management systems compel public HEIs to offer private services which are normally consisted of tuition-based education, consulting

services, applied research contracts, short ad hoc vocational oriented courses, university-industry linkages and business activities. The joint study by Psacharopulos and Partinos (2004) suggests that the welcoming atmosphere should be created for the involvement of the private sector to improve efficiency in the entire education system and to mitigate the resource dependency of institutions on public subsidies.

Until very recently, public universities were not allowed to acquire private incomes in most of the low and lower-middle income countries (Sam, 2011). Public HEIs are still heavily financed through the government purse by taxpayers' money in most of the public higher education systems. However, Levy (2008) states that if a country seeks to improve financial condition of its HEIs, then this improvement needs to be supported through involving external financial resources. This scholar also argues that external sources of funding are not substitutes for government financing, rather, external funds are a very important factor in the development of institutions beyond the basic expenditures.

In most of the high-income countries, a significant share of financial resources are directed by external stakeholders to both public and private HEIs, in the form of tuition fees, research contracts, endowments and grants (Barr, 2009). Usually, the external stakeholder's demand drives many activities of universities, faculties and staff (Fowles, 2013). Competitiveness among HEIs is high for acquiring greater level of funding, therefore HEIs need to provide students and enterprises with high-quality teaching and research activities (Barr, 2009). For these reasons, a strong relationship between an institution and external stakeholders is being seen as crucial in many high-income countries and this requires a structural modification in the role of public HEIs within the countrywide innovation system (European Commission, 2009).

The charging of tuition and other user fees provide some of the much necessitated financial resources for these HEIs and shift some of the burden of instruction funding to students (Sam, 2011). Psacharopoulos and Partinos (2004) propose the two common methods of increasing user charges for higher education. The first method is to reduce student allowances – this may be the most appropriate method in countries where both tuition-free education and stipends are available for students. The second method is to charge for services – after decreasing allowances, authorities need to start charging for tuition to recover at least some part of the costs of students' education. Barr (2009) also supported the idea of imposing a maximum level of tuition and other fees. This scholar states that the rates of education charges need to be high enough to yield additional funds and to mitigate resource dependency of universities on public authorities.

All these alternative sources of funding may offset the reducing government allocations to a huge extent. Although RDT argues that providers of these external resources can have some incentive and power to change institutional behaviours, strategies and structures. For example, a HEI focuses more on instructional activities by increasing its expenditure on educational and other related expenses – in the case of increased tuition income reliance. However, if a HEI generates its greatest share of revenue from contracting out research or from private donations, then this institution is more likely to prioritize preferences of these clients or private donors (Fowles, 2013).

Institutional efforts to reduce environmental dependence

In the existing literature, there are several strategies which are broadly used by administrative bodies of universities to reduce their environmental dependence. Pfeffer and Salancik (1978) propose five strategies which can be beneficial for institutions of higher education to mitigate their environmental resource dependence:

1) Mergers – RDT theorises that if two or more organisations decide to merge in order to diversify operations, then this integration may alleviate dependence on the other organisations upon which they are dependent (Pfeffer and Salancik 1978). In the context of higher education, universities usually engage in mergers to decrease educational expenditures and to increase diversity of resources.

2) Joint ventures – prior studies by Coupet (2013) reveal that several institutions were successful in alleviating the dependency on government funding through joint ventures. Therefore, the joint partnerships of the public authorities and institutions of higher education can be instruments for both relationships with civic and government sectors and technology transfer agreements with entrepreneurs which emphasise the innovation that HEIs bring to these areas.

3) Board of directors – institutional directors or trustees need to manage and track dependencies more closely when fiscal resources are scarce and critical. Hillman et al. (2009) propose four functions of board members in organisations, including in HEIs: (1) advice and counsel; (2) legitimacy; (3) access to channels of information between the organisation and the environment; and (4) preferential access to resources. The extent to which a HEI can secure critical resources from its external environment depends on the effectiveness and quality of the management, particularly its leaders.

4) Political action – this is another method of mitigating organisations resource dependence on their external environment, which is more extensively discussed by Pfeffer and Salancik (1978) in RDT context. These scholars interpreted this action by asserting that organisations seek to impact the policy environment with the purpose of creating suitable conditions. For public HEIs, considering their heavily resource dependency on policy environments for operation and survival – this can arguably be the best strategy.

5) Executive Succession – Pfeffer and Salancik (1978) propose the four models by considering the role of executive leaderships in the scope of RDT: "(1) the environmental context, with its contingencies, uncertainties and interdependencies, influences the distribution of power and control within the organisation; (2) the distribution of power and control within the organisation affects the tenure and selection of major organisational administrators; (3) organisational policies and structures are results of decisions affected by the distribution of power and control; and (4) administrators who control organisational activities affect those activities and resultant structures" (p. 228). In the context of higher education, an institution may mitigate its environmental dependence through selecting leaders (e.g., administrators) who can better able to equate the behaviour of the institution with the resource environment (Coupet, 2013).

3.3 Review of Empirical Studies

This section summarises the several key researchers' empirical contribution on the development of RDT which represents the changing behaviours of universities when they become more dependent on external funding for survival. Previous empirical studies corroborate that RDT is broadly used to explain organisational behaviours, structures and strategies (Baker and Aldrich, 2003; Fowles, 2013; Proven, Beyer and Kruytbosch, 1980; Saidel, 1991; Tolbert, 1985). These empirical works utilise this theory mainly for three purposes: to test this theory itself; to expose the behaviour of a focal institution based on its dependencies; or to explain patterns of exchange and dependency linkages (Kontamaki, 2009). Nienhuser (2008) argues that "it is not possible to test such a complex theory like RDT in its entirety because it consists of many hypotheses" (p.18). However, this section is dedicated to reviewing recent empirical studies which investigate to what extent the RDT is able to evaluate behaviours of HEIs and which test how realistic the assumptions of this theory are.

RDT is becoming a very popular among many researchers to explain the behaviour of organisations and to examine organisations dependency on other organisations' resources. One of the first studies that analysis the resource dependence of one organisation on another was conducted by Proven, Beyer and Kruytbosch in 1980. The scholars investigated the relationship between non-profit organisations and their 'umbrella' organisations funding. In agreement with the assumptions of RDT, they concluded that "power over an individual organisation is larger the more resources it controls" (p. 18).

Empirical findings of Saidel (1991) are also consistent with the assumption of RDT. Through conducting a survey of 80 non-profit and 73 public organisations, the researcher finds a relationship between the importance of governed resources and the impact of the organisation

governing those resources. Baker and Aldrich (2003) examine how organisation founders respond to the dependency on workers who possess qualifications as critical resources. The scholars find two patterns of human resource politics which assert the assumption of RDT: "for one, employers create alternatives for "irreplaceable" staff by recruiting further suitable staff and thus reducing their dependency. On the other hand, they make such powerful staff dependent on the organization by better fringe benefits and other financial sources of motivation" (p. 21).

Over the last three decades the most of the conceptual and empirical studies on the RDT, which examine the relationships between organisations and external environments, have been extensively conducted by many researchers (Boyd, 2006; Casciaro and Piskorski, 2005; Davis and Cobb, 2010; Freel, 2000; Frooman, 1999; Hillman, Shropshire and Cannella, 2007; Ozcan and Eisenhardt, 2009). Since the main objective of this section is to review the relevant empirical contributions on the development of RDT in the context of higher education, the empirical studies which utilise this theory to examine resource dependence of HEIs will be discussed from now on.

Over the last several years, many HEIs become heavily dependent on 'critical' resources provided by external stakeholders and these resources can be public grants, funding from industry contracts, private funding and tuition payments (Nienhuser, 2008). In the context of higher education, the first substantial and influential work on evaluating the RDT and its assumptions belongs to Tolbert (1985). The scholar applies RDT to explore the administrative structures of HEIs and study samples contained 167 public and 114 private American HEIs which were randomly selected. Pamela Tolbert measures institutional resource dependence using the share of four main sources of funding to the total revenues of HEIs. The four revenue sources are: government allocations, public grants and contracts;

grants and gifts from private organisations; and self-earned funds such as endowments and tuition income.

The scholar assumes that the "magnitude of dependence would predict the number of administrative offices and positions associated with the management of the funds" (Tolbert, 1985; p. 3). The institutional total revenues from four primary sources of funding are used as independent variables, and as two dependent variables, the number of public-funding offices reported and the number of private-subsidising offices reported, are selected. The scholar finds that dependence on private sources of funding is a robust predictor of administrative differentiation.

In one of his empirical studies, Wayne (2003) uses RDT in the context of higher education in order to examine commercial determinants of prosperous university technology transfer. The research focuses on the influences of various external resources on the technology transfer performance of American research universities. The study is based on 109 research universities which were participating in the Association of University Technology Managers' surveys from 1997 to 2000. The five explanatory variables (such as federal R&D funding, industry R&D funding, state level venture capital, regional level venture capital and university type) and three dependent variables (such as licensing revenue, number of licenses and start-up companies) are utilised in the estimation process.

Findings reveal that the federal R&D financing is the best reliable predictor of the three dependent variables. Therefore, Wayne (2003) concludes that "the RDT serves as a useful framework for exploring environmental influences on commercial outputs of university technology transfers, such as university type with regard to commercial outputs of university technology transfer" (p. 109). The result also suggests that the universities are not only

generating significant grant income through providing more research services but they are also reducing their dependence on public appropriations.

The first empirical contribution on testing RDT in terms of a comparison of the changing behaviour of HEIs and senior academic managements when seeking external-incomes to survive is presented by Slaughter and Leslie (1997). The authors employed the data of universities in Australia, Canada, the UK and the US. Furthermore, Pilbeam (2012) utilises this theory to explain the role of pro-vice chancellors (PVCs) in the interactions between 16 UK universities and resource environment. A web link for the questionnaire and a covering letter showing the aims of the study was send to the 16 PVCs responsible for teaching and 16 PVCs responsible for research at the UK universities. The main findings show that PVCs responsible for research have had a cohesive relationship between each other, while those PVCs responsible for teaching have had no significant relationship.

Empirical study of Chen (2001) is also contributed to the development of RDT through evaluating the performance of the University Fund system in Taiwan. For this purpose, questionnaires and interviews were conducted from administrators of the five pioneer universities. The scholar found that the Taiwanese universities are paying more attention on professional management training, operation management, and perception adjustment, but less attention on administrative management. Regarding the operation management; operation concentrates less on managing existing resources but more on acquiring financial resources, and cares more about internal and external interactions. Jeff Chen also suggests that the Taiwanese universities should redesign their organisational managements and structures by taking into account the needs of stakeholders.

Utilising resource dependence theory, Santos (2007) investigates the internal distributions of resources at public research universities of America. Findings reveal that bachelors educating

activities have the lowest return in the engineering and the physical sciences than in the social sciences, and teaching is frequently used to cross-subsidize research activities in these fields. One of the recent empirical studies which utilises RDT in the context of higher education belongs to Jacob Fowles. The scholar examines the relationship between institutional dependence on net tuition funds as a main source of income and institutional expenditures for instruction and related activities at 419 four-year public HEIs in the US. Using 11-year panel of university-level data, the instrumental variables model is implemented by admitting the potential endogeneity of institutional revenue pattern. A main independent variable is the share of total operating revenues derived from net tuition and the dependent variable in this estimation is the share of total institutional expenditures for education and related expenses.

In this study, three instrumental variables are implemented using the prior literature studies. First, the two dummy variables are included through following the empirical strategy used by Aghion et al. (2010). These dummy variables are interpreted by Fowles (2013) as; "the first is set to one if either of the two senators from the state in which an institution is located is a new appointment to the Senate Allocations Committee during a given academic year, zero otherwise. The second is coded identically but captures House Allocations Committee membership" (p. 7). Third, a variable that contains the inflation-adjusted rate of return of the S&P 500 stock market index for every academic year is involved. This variable is aimed to expose exogenous changes in the income streams supplied by HEI investments.

Results of the estimations reveal that institutional expenditures are highly sensitive to changes in revenue patterns at the American HEIs. However, one of the main drawbacks of Fowles's (2013) study is that the obvious and critical question of – whether or not the increased institutional expenditures for education and related expenses increased graduation rates or educational outcomes – left unanswered. However, another recently published study

that is delivered by Coupet (2013), to some extent, fills the gap left by Fowles (2013). Jason Coupet examines the impact of total operational expenditures on graduation rates in Black and other universities by calculating the production function of a subset of a 6-year panel of four-year American institutions. A Chow test is used in order to find structural differences in production functions of 152 Black and 3086 other institutions.

Instructional, academic support, student service and institutional support expenditures (all divided by the full-time enrolment) are used as independent variables, while institutional graduation rates as a dependent variable. The analysis finds noteworthy structural differences, e.g., at Black institutions - the administrative expenditures have a significantly negative influence on graduation rates. For this reason, Coupet (2013) suggests to reduce the administrative costs or to alleviate the negative impact of these costs on student outcomes through mitigating resource dependence. The analysis also shows that the institutional support expenditures are significantly and negatively linked to student outcomes at Black universities, but insignificantly related to graduation rates of other HEIs.

3.4 Summary

This chapter revealed the several theoretical and empirical contributions on the development of resource dependence theory. From the currently existing literature, it was found that most of the universities have responded to the reduced public allocations by shifting educational and other related costs from public to beneficiaries of these services. Section 3.2 represented the development of RDT and its capability to explain the institutional behaviours which are shaped by the availability of private sources of funding upon which HEIs rely for survival. Section 3.3 focused on summarising empirical works which investigate, evaluate and methodologically contribute for examining the RDT and its assumptions in the scope of higher education.

After reviewing the existing theoretical and empirical studies on RDT, the author concludes that there are a very few empirical contributions which explicitly extend and test this theory in the context of higher education. Moreover, to the best of my knowledge, majority of the empirical works on the theory of resource dependence have been conducted in the case of public HEIs in the United States of America, the United Kingdom, Canada and Taiwan only.

Chapter 4: RESOURCE DEPENDENCY ANALYSIS OF PUBLIC HEIs

4.1 Introduction

After reviewing the existing literature in the previous chapter, we came to the conclusion that there are a very limited number of theoretical and empirical studies which analyse the changes in HEIs' behaviours and structures when institutions collaborate with their environment. The literature on these issues is rather scarce. Previous research studies corroborate that RDT is broadly utilised to explain organisational behaviours, processes and structures. In other words, majority of the empirical works are dedicated to examine and describe a resource dependence of private and public banks as well as other financial institutions (e.g., Boyd 2006; Davis and Cobb 2010; Freel 2000; Ozcan and Eisenhardt 2009). In the context of higher education, a wide coverage of the recent empirical literature on RDT has been conducted in the case of public universities in the US and in few other high-income countries. In the case of low and middle income countries, however, there is no any study that specifically focuses on the resource dependence of HEIs or on the changing behaviours of institutions after government funding become scarce.

This chapter contributes to the existing literature by examining the changes in behaviours of Uzbek HEIs when their income structure shifted from full government financing to mostly tuition funding. In other words, utilising RDT the current chapter investigates whether or not increased institutional reliance on tuition fees as a main source of revenue has augmented the institutional expenditures dedicated to educational activities at public HEIs in Uzbekistan over the period of 2000 to 2013. Based on theoretical discussions, the author conducted an

empirical model which examines the relationship between institutional expenditure and revenue patterns by taking into account the potential influences of other time-varying factors.

The rest of the chapter is structured as follows. The next section mainly discusses the methodology and data, including descriptions of key variables and instrumental variables as well as summary statistics. Section 4.3 presents the interpretation of empirical findings that discusses both the parameters of OLS and TSLS estimations. In that section, instrumental variables approach is utilised in order to acknowledge the potential endogeneity of tuition revenue variable. Moreover, robustness of the empirical findings is tested employing several diagnostic models at the end of this section. Finally, Section 4.4 summarises the chapter.

4.2 Methodology and Data

4.2.1 The higher education production function

Since the many years, whether looking at public or not-for-profit organisations, many scholars have interested in improving systematic models and methods which help to understand performance and behaviour of an organisation (Baker and Aldrich, 2003; Fowles, 2013; Kontamaki, 2009; Nienhuser, 2008; Proven, Beyer and Kruytbosch, 1980; Saidel, 1991; Tolbert, 1985). As suggested by Hopkins (1990) the production function shows a powerful organisational heuristic for achieving this task and the production function shows the process by mean of which an institution transforms inputs (typically labour and capital) into outputs. To the best of my knowledge, however, only a very few empirical investigations have been conducted on implementation of the production function approach in public higher education context. This is leaving many empirical queries about the nature of the links between institutional inputs, outputs and outcomes unanswered.

The lack of scholarly attention to the institutional input and output relationships can be explained by the context of the general lack of agreement with respect to the applicable framework for understanding the behaviour of public HEIs (Fowles, 2013). As it is extensively discussed in the "Literature Review" chapter, however, RDT presents an alternative framework to understand organisational behaviour which is not focused only internal dynamics of the organisations but also on the external environment of organisations with a particular focus on the suppliers of resources upon which the organisation relays for survival. In the literature, it is well understood and defined that public HEIs are multi-product institutions that serve a varied clientele. For example, Tuckman and Chang (1990) listed several major stakeholders within higher education including internal stakeholders like administrators of faculties and universities as well as external stakeholders such as state

funding agencies, state legislatures, students, private industries and philanthropic institutions. Although each of those stakeholders has its own set of preferences and these preferences can often overlap.

Given the variety of preferences held by these diverse stakeholders, a critical question arises that how do institutions of higher education make decision on which of these demands to follow and to what extent to pursue them. The theory of resource dependence gives a straightforward explanation how HEIs balance the competing demands by linking them to resources (Coupet, 2013; Fowles, 2013; Santos, 2007; Slaughter and Leslie, 1997; Tolbert, 1985). In other words, this theory postulates that most of the HEIs prioritise the preferences of those stakeholders who provide critical resources upon which the institutions rely for their financially sustainable operation.

Over the last two decades, the Uzbek HEIs have considerably increased their share of tuition revenue in order to fill the gap left by the government funding. As these public HEIs become more dependent on tuition payments as income sources, the RDT proposes that it is reasonable to expect these institutions to produce outputs which are more consistent with the demands of the students who are paying these tuition fees. By applying this notion to the current context, the author constructs following straightforward research hypothesis which is subject to empirical test: *a resource dependence perspective suggests that increased institutional revenues generated mostly from tuition payments lead to an increased share of institutional expenditures dedicated to education and other student related activities at public HEIs in Uzbekistan.*

According to the findings in Chapter 2,[9] the Uzbek higher education system has traditionally been regulated by the central government. This has been particularly obvious in the area of finance and managerial issues, also it extends to the pattern of education provision across HEIs. Since the mid-2000s, there has been a reform that was aimed to introduce a high degree of autonomy to the HEIs. Since then, all public HEIs have been allocated a total budget by MFUZB and institutions have had autonomy to determine how this budget should be spent. Public HEIs are free to set their own tuition charges, but within a maximum cap which is determined by CMUZB. The administrators of HEIs can freely decide about the use of tuition revenues, but their ministries should be reported about the management of the private funds in addition to the public funds. Sources of finance at the Uzbek HEIs are now much more heterogeneous compared to the previous decade, with more than 60 per cent of total revenue coming from private sources in 2013 (MFUZB, 2013). Thus, this enhanced autonomy has encouraged institutions to pay heed to the financial performance and cost efficiency of their operations. The public HEIs in Uzbekistan remain very similar in their status and mission, in spite of the increased autonomy.

4.2.2 Empirical model

Based on the theoretical discussions, the following empirical model is estimated to investigate the relationship between institutional expenditure and revenue patterns:

$$SHEE_{it} = \beta SHTR_{it} + \delta TVC_{it} + \gamma time + \mu_i + \varepsilon_{it} \qquad (4.1)$$

Where, *i* and *t* are the institutions and time respectively.

[9] See pages 44-49, for the more detailed information on the higher education financing and institutional framework.

$SHEE_{it}$ – captures the share of total institutional expenditures dedicated to education expenses for *i* institutions and *t* years;

$SHTR_{it}$ – captures the share of institutional revenues derived from tuition payments for *i* institutions and *t* years;

TVC_{it} – is a vector of time-varying institutional-level controls;

time – is a linear time trend which is included to capture the effect of common changes impacting all HEIs over time.

μ_i – denotes the institution-specific fixed effects; and ε – denotes the idiosyncratic error term.

4.2.3 Description of the key variables

The dependent variable

The dependent variable in this analysis is the share of total institutional expenditures for educational activities which captures the amount of institutional spending on instruction, student services, as well as the spending on maintaining of the library and classroom facilities. Thus, $SHEE_{it}$ measure includes both current expenditures and capital expenditures in the form of depreciation. However, the main part of $SHEE_{it}$ goes to the salaries paid to academic and administrative staff to maintain the provision of education as well as financial support to students for assisting them with monthly stipends.[10] In other words, this variable captures the share of institutional expenditures occurring in the regions most possibly to have tangible and direct benefit to students or those regions of spending most reconcilable with the demands of students. The share of educational expenditures was calculated by simply dividing the education and other student related expenses by the total institutional expenditure.

[10] At Uzbek public HEIs, all students receive institutional stipends based on their previous semester's grades (Index Mundi, 2013).

The main independent variable

The key explanatory variable in this equation strategy captures the extent to which a HEI depend on tuition as a source of revenue ($SHTR_{it}$). This variable is calculated as the tuition share of total operating incomes, and the total operating incomes consist of tuition revenue; government allocations and grants; private gifts and contracts; and revenue generated from services and sales of educational products.

Control variables

Several time-varying variables are also included into the model in order to control for their potential impacts on the dependent variable in the interest. Since the control variables in addition to the ($SHTR_{it}$) may also have effects on the ($SHEE_{it}$), they need to be held constant to test the pure effect of the main independent variable on the dependent variable.

The first time-varying institutional-level control variable in the model is *institutional size* (SIZE) which is measured as total institutional full-time equivalent student enrolment. This variable is included into the model to account for potential economies of scale in the provision of instruction. For example, institutions which care only about quantity but not quality may have incentive to decrease their educational expenses by increasing number of FTE student enrolments while keeping number of academic staff constant. The second control variable is the *price of tuition and mandatory fees* (TP) which is included due to expectations of very different expenditure patterns depending on tuition charges. For example, if tuition price functions as a market signal of institutional quality, then institutions with higher tuition prices may provide a better quality education and experience to their students which may yield greater educational expenditures. Moreover, in order to account for potential nonlinearities in the relationships between TP and SIZE and expenditures that the quadrates of these variables are included to the model.

The next controlled variable is the *duration of postgraduate programs* (measured as *study weeks*) which is include to control for the fact that all else equal. Undergraduate programs are relatively cheaper than postgraduate education at every institution of higher education in Uzbekistan (Index Mundi, 2013). However, some scholars frequently argue that this greater cost in the provision of postgraduate education can be partially offset by economies of scope in postgraduate and undergraduate education (Albrecht and Ziderman, 1995; Koshal and Koshal, 1999; and Barr, 2009). The *number of staff* is also included to the model as an independent variable which comprises the total number of academic and administrative staff at public HEIs. The reason of including this variable can be explained that a huge share of institutional expenditure allocates to staff salaries at all HEI in Uzbekistan (MFUZB, 2013). Therefore, if these institutions decide to increase the number of staff in order to reduce a ratio of student and staff with the aim to increase quality of education, then those institutions with greater number of personnel are more likely to have greater educational expenditures. Although institutions with smaller number of, but with better qualified and experienced,[11] academic staff may still have an objective to deliver high quality educational services yielding higher instructional expenditures. Lastly, a simple linear *time trend* is included to capture the impact of common changes affecting all HEIs over time.

Instrumental variables

One of the main challenges in this empirical study is the potential endogeneity of the tuition share of total institutional revenues ($SHTR_{it}$). Therefore, it is reasonable to suspect that $SHTR_{it}$ may be simultaneously determined with the share of total institutional expenditures for educational expenses ($SHEE_{it}$). In other words, it is often the case that the universities would strategically define both their tuition revenue and expenditure patterns

[11] By "better qualified and experienced academic staff", we mean the academic staff with doctoral or professor degrees and the administrative staff with longer working experience.

simultaneously.[12] This endogeneity cannot be ignored in the empirical analysis of the Eq. (4.1). Otherwise, this equation would result in biased estimates of the statistical coefficients between the dependent variable and the independent variables. One of the potential methods to solve the problem of an endogenous independent variable is to use the instrumental variable (IV) approach. In order to use the IV(s) with the endogenous variable ($SHTR_{it}$), at least one observable variable (Z_{it}) will be required which is not already captured by Eq. (4.1). Also, Z_{it} must satisfy two following conditions as stated by Wooldridge, 2002:

First condition is that Z_{it} must not be correlated with the error term:

$$\text{Instrument exogeneity: } Cov(Z_{it}, \varepsilon_{it}) = 0$$

In fact, it is not usually easy to test this condition because of unavailability of unbiased estimator for (ε_{it}).

Second condition requires the partial or strong relationship between (Z_{it}) and the endogenous variable ($SHTR_{it}$). In other words, Z_{it} must have no direct influence on $SHEE_{it}$ but must have direct influence on $SHTR_{it}$:

$$\text{Instrument relevance: } Cov(Z_{it}, SHTR_{it}) \neq 0$$

With the aim to satisfy these two conditions, particularly the latter one, as well as to account for this potential endogeneity of $SHTR_{it}$, two instrumental variables are used in this study. We expect these IVs are at least partially correlated with the endogenous variable ($SHTR_{it}$) while uncorrelated with the dependent variable ($SHEE_{it}$) and the error term (ε_{it}).

In this empirical strategy, the first IV ($\theta_1 Z_{it}$) is the inflation-adjusted "*Development Fund*" for each of the academic years given in the analysis. According to the Decree introduced by

[12] Simultaneity arises when at least one of the independent variables is determined simultaneously along with the dependent variable of interest (Wooldridge, 2002).

the CMUZB in 1997, each HEI must devote their five per cent of overall income to this fund's budget at the beginning of every academic year.[13] However, if any of the Uzbek institutions seek extra funding to finance its institutional expenses, then the CMUZB returns the HEI an amount of money which is negotiated between the CMUZB and the institution. It is important to note that all public HEIs, to some extent, rely on "Development Fund" returns to finance institutional activities. Therefore, it is plausible to suspect that exogenous changes in the returns generated by "Development Fund" should have a direct impact on relative institutional revenue patterns ($SHTR_{it}$), but should not have a direct impact on ($SHEE_{it}$).

The second IV ($\theta_2 Z_{it}$) is the dummy variable, *additional admission allowance,* which captures the number of additional students enrolled as a tuition-fee basis at the public universities in each academic year. The Uzbek institutions may receive this allowance during the first month of academic semester (in September) if demands to study at these institutions from matriculants are too high. This is a responsibility of the CMUZB to decide either to allocate or not to allocate extra admission quotas to HEIs. As such, I set to one if the HEIs received this allowance, zero otherwise. If a university receives this allowance, then this HEI generates extra revenue, since every additionally enrolled student has to pay a full instruction fee. According to the report of CMUZB, the funds from additional admission allowance have to be allocated for improving infrastructure of the HEIs, such as constructing new campuses as well as purchasing new technologies and furniture (NHDRT, 2011).

[13] Decree of the CMUZB (1997). "On State Educational Standards", No. 341

4.2.4 Description of the dataset

This study utilises various institutional-level data which were collected mainly from one single source through working closely with several administrative personnel of the MFUZB.[14] The financial data used for this study are mainly derived from Annual Financial Report of the each public HEI in Uzbekistan which is originally conducted by the Main Department for Financing Social Sphere and Science under the MFUZB. Using these Annual Financial Reports of public HEIs, the author constructed a panel dataset which is used in this study. This dataset contains variables on institutional main revenue sources such as tuition revenues, government allocations, income from private activities and incomes from "Development Fund", as well as on various forms of institutional expenditures including expenditures to education for the universe of the public HEIs in Uzbekistan covering the years from 2000 to 2013.

Table 4.1: Interpretations and sources of the key variables

Variables/ Abbreviation	Explanation	Data Source	Variables/ Abbreviation	Explanation	Data Source
SHEE *(in percentages)*	The share of total institutional expenditure dedicated to educational expenditures	Ministry of Finance of Uzbekistan (2013)	***NumStaff*** *(in numbers)*	Total number of academic and administrative staff	Ministry of Finance of Uzbekistan (2013)
SHTR *(in percentages)*	The share of institutional revenue derived from tuition fees	Ministry of Finance of Uzbekistan (2013)	***DurPP*** *(in weeks)*	The share of education weeks offered at the postgraduate level	Official web-site of the MHSSE of Uzbekistan (2014)
Size *(in numbers)*	Total institutional full-time equivalent student enrolment	Ministry of Finance of Uzbekistan (2013)	***DevFund*** *(in UZB Soms)*	"Development Fund" allocated by the CMUZB	Ministry of Finance of Uzbekistan (2013)
TP *(in UZB Soms)*	Tuition and mandatory fees	Ministry of Finance of Uzbekistan (2013)	***DumAdAdm*** *(zero and one)*	Dummy variable: Allowance for admissions of additional students	Ministry of Finance of Uzbekistan (2013)

Source: Appendix B

[14] The author has visited to the MFUZB during the period of 29/07/2013 to 31/08/2013 in order to collect all the necessary data for this empirical analysis. A confirmation letter from this ministry can be found from the Appendix B, but an original copy is available from the author upon request.

The dataset also contains several variables on institutional characteristics, such as number of FTE student enrolments, admissions, graduation rate, staffing and tuition prices for each institutions of higher education for the period of 2000 to 2013. These forms of data are retrieved from authorized documents which are prepared by the Main Department for Financing Social Sphere and Science under the MFUZB. Finally, the data for the duration of postgraduate programs are collected from the official web-site of the MHSSE for the years 2000-2013. This variable is measured as the share of study weeks offered at the postgraduate level. Brief descriptions and sources of those mentioned data are revealed in Table 4.1.

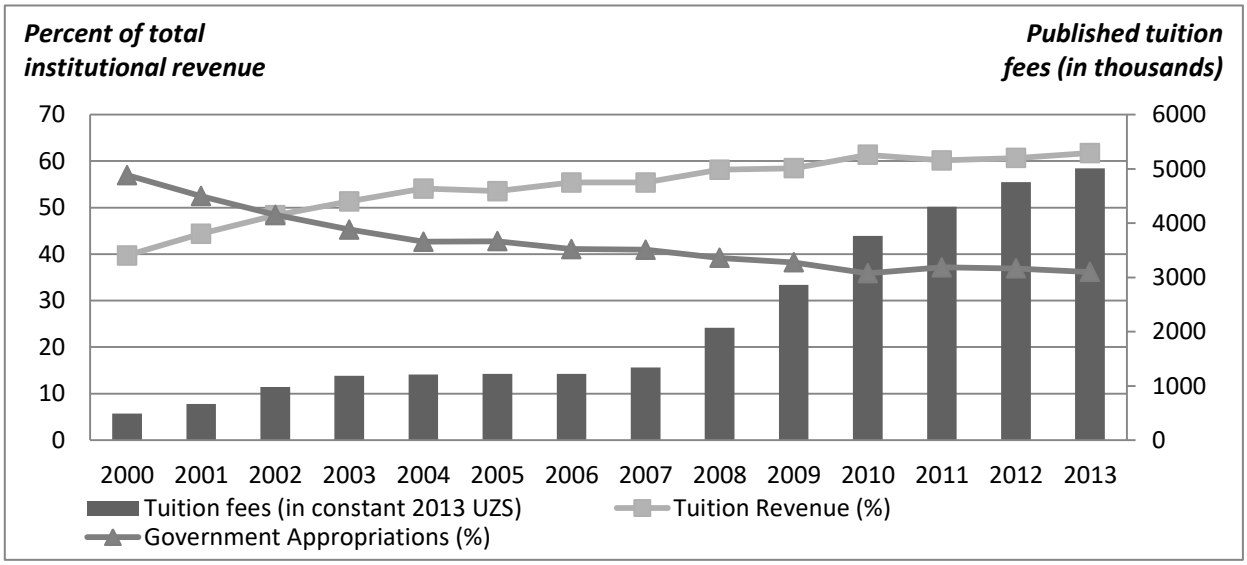
All financial data are used as real UZB Soms during the analysis and estimation processes. For this purpose, the entire financial data were transformed from nominal Uzbek Soms to real Uzbek Soms using the Consumer Price Index (CPI) of Uzbekistan for each of the academic years. The CPI is a measure of the inflation rate of a basket of goods and services purchased by households (Bryan and Cecchetti, 1993), and the data are available from IMF World Economic Outlook Database. Although the outcomes considerably unchanged by adjusting by the GDP-deflator of Uzbekistan.[15]

4.2.5 Summary statistics

The analytic sample utilised in this empirical study captures almost entire public HEIs in Uzbekistan from the years 2000 to 2013 for which complete data were available. The final sample comprises 857 institution-year observations demonstrating 62 public institutions of higher education, each of which is observed for an average of 13.8 years. Figure 4.1 illustrates the evaluation of institutional revenue patterns for all 62 public HEIs in Uzbekistan, figured against the considerably increasing tuition prices over the 14 years.

[15] Results can be found from the Appendix F: Robustness Checks

Figure 4.1: Revenue patterns at the public HEIs in Uzbekistan from 2000 to 2013



Source: MFUZB (2013), author's calculations

The figure above exposes that the reduced allocations from government after 2002 have been offset by an increased reliance on tuition revenue. These increased tuition revenue has been derived mostly in part through raises in tuition charges, although most of the public HEIs considerably increased the number of contract-based student enrolments (see Table 4.2) over the sample period. The average institutional FTE enrolments and tuition prices at the Uzbek HEIs for the period 2000-2013 are displayed in the table below.

Descriptive statistics for the share of total institutional expenditures dedicated to education expenses, the share of institutional revenue derived from tuition, institutional FTE enrolment and the tuition prices are provided for the HEIs included in the sample over the period 2000-2013 appear in Table 4.2.[16] This table also captures the annual CPI scalar that was used to transform nominal Uzbek Soms to real Uzbek Soms.

[16] Appendix D contains a figure which provides graphic representations of 62 institutions' expenditure (SHEE) and revenue (SHTR) trends for the years between 2000 and 2013.

Table 4.2: Selected institutional characteristics

Year	Per cent of total institutional expenditures dedicated to education (%)	Per cent of institutional revenue derived from tuition (%)	Full-time equivalent enrolment	Tuition price (in constant 2013 UZS)	Consumer Price Index scalar
2000	72.79	39.70	1,559	487,763	0.1860
2001	73.70	44.38	1,864	666,843	0.2366
2002	72.77	48.35	2,037	978,795	0.3012
2003	71.80	51.33	2,167	1,188,452	0.3361
2004	79.08	54.09	2,497	1,209,043	0.3582
2005	80.57	53.54	2,741	1,221,981	0.3942
2006	79.25	55.39	3,387	1,223,445	0.4503
2007	82.92	55.39	3,799	1,338,272	0.5056
2008	82.79	58.14	4,256	2,071,708	0.5700
2009	85.57	58.46	4,648	2,859,238	0.6503
2010	85.93	61.36	3,935	3,765,462	0.7113
2011	75.63	60.13	3,671	4,299,449	0.8025
2012	83.07	60.66	3,763	4,753,797	0.8992
2013	86.61	61.71	3,683	5,010,595	1.0000

Source: MFUZB (2013), CB of Uzbekistan and IMF World Economic (2015), author's calculations

As the table above illustrates that the per cent of institutional tuition revenue has increased consistently over the sample period, while the per cent of total institutional expenditures dedicated to education expenses has considerably increased as well. This signifies that the growth in the share of tuition revenue yield to the increased share of educational expenditures at public HEIs in Uzbekistan. Table 4.2 also represents that on average, the number of full time enrolled students and the amount of tuition prices have remarkably increased by year. The peak of FTE enrolment took place in 2009, while the public HEIs charged the highest tuition fees in the last year of the sample. Furthermore, Table E1 represents the mean, the standard deviation, the minimum and the maximum values of all variables those are utilised during the empirical estimations. This table can be found from the Appendix E.

4.3 Empirical Results

The next two sub-sections are dedicated to the interpretation of empirical findings derived by applying the Ordinary Least Squares (OLS) and the Two Stage Least Squares (TSLS) methods. Finally, Sub-Section 4.3.3 reveals several tests those are conducted in order to diagnose TSLS findings.

4.3.1 Ordinary least squares results

This sub-section is dedicated to the interpretation of OLS estimation results. The standard regression findings are reported in Table 4.3 with four different specifications. The outcome of this table shows mixed results for the beta coefficients of the regressions. Some variables have positive coefficients while others have negative coefficients. The four specifications differentiate in the following way. Specification 1 shows only findings of simple OLS estimation (neither institutional effect is controlled nor time trend is included). Specification 2 captures the time trend in order to account for unexpected events or variation which may have influence on the dependent variable, while this specification does not include institutional fixed effect.

Specification 3 includes institutional fixed effect only that captures the influence of time-invariant characteristics of HEIs such as location, status and mission. The impact of these individual characteristics, however, cannot be uniquely identified. The main insight here is that any changes in the educational expenditures must be due to effects other than those institutional fixed effects (Stock and Watson, 2003). Therefore, the coefficients revealed are not artefact of the confounding influence of those time-invariant variables in the last two specifications. Finally, Specification 4 includes both institutional fixed effect and time trend. Moreover, all the specification results include cluster-robust standard errors in order to account for arbitrary forms of intra-group correlation and heteroscedasticity.

Table 4.3: OLS estimation results with the dependent variable: share of institutional expenditures dedicated to educational activities ($SHEE_{it}$)

VARIABLES	Spec.1	Spec.2	Spec.3	Spec.4
SHTR	0.083	0.098*	0.095	0.115*
	(0.064)	(0.066)	(0.077)	(0.084)
TP	2.96e-08*	5.03e-08***	3.61e-08*	5.19e-08***
	(1.54e-08)	(1.56e-08)	(1.96e-08)	(1.66e-08)
TPSQ	-1.86e-15	-3.64e-15*	-2.77e-15	-3.90e-15*
	(2.06e-15)	(1.91e-15)	(2.57e-15)	(2.23e-15)
SIZE	-1.67e-05***	-1.48e-05**	-2.48e-05***	-2.17e-05***
	(6.45e-06)	(6.67e-06)	(7.06e-06)	(7.70e-06)
SIZESQ	1.26e-09***	1.14e-09***	1.70e-09***	1.44e-09***
	(3.89e-10)	(4.04e-10)	(4.17e-10)	(4.72e-10)
DURPP	0.0002	0.0002	0.0002	0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
NUMSTAFF	2.34e-05	2.81e-05	2.70e-05	4.11e-05
	(2.39e-05)	(2.44e-05)	(3.12e-05)	(3.38e-05)
YEAR		-0.005*		-0.005
		(0.002)		(0.003)
Institutional fixed effects	*NO*	*NO*	*YES*	*YES*
Observations	*857*	*857*	*857*	*857*
Number of HEIs	*62*	*62*	*62*	*62*

Cluster-robust standard errors in parentheses
* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

The table above reveals that many of the explanatory variables can have significant, either positive or negative, influence on the dependent variable in the interest. Since both the dependent and main independent variables are measured as percentages, the coefficient on the tuition share factor can be understood as an elasticity of a Cobb-Douglas function that measures the responsiveness of institutional expenditures to changes in institutional revenues. The first specification of Table 4.3 shows that a one percentage point increase in the main explanatory variable that is the tuition share yields a 0.08 percentage point increase in the share of institutional expenditures allocated to educational expenses, holding all other regressors constant. However, the percentage of ($SHEE_{it}$) is increased and the coefficient becomes statistically significant when the time trend is included to the model in Specification 2. Additionally, the accounting for institutional fixed effects led to decreased and

insignificant coefficient of the main independent variable ($SHTR_{it}$) in Specification 3. In the fourth specification, ($SHTR_{it}$)'s coefficient of 0.12 suggests that HEIs are quite inelastic. In other words, large changes in tuition revenue leads proportionally smaller changes in institutional expenditures dedicated to education expenses.

Rest of the explanatory variables, TPSQ and SIZE, have negative values as well as TPSQ, SIZE and SIZESQ have significant coefficients when both of the institutional fixed effect and time trend are not included to the model. Most of the variables still have significant correlation coefficients when the time trend is accounted for in Specification 2. However, only three explanatory variables, TP, SIZE and SIZESQ, remained statistically significant when the effects of institutional time-invariant characteristics are included in Specification 3. In Specification 4, the influences of entire exogenous variables, except DURPP and NUMSTAFF, become statistically significant after the institutional fixed effects and time trend factor are included to the model. This finding suggests that the changes in duration of academic period and in quantity of personnel do not have impacts on the share of institutional expenditures allocated to educational activities at the Uzbek HEIs.

The magnitude of the linear time trend is negative and significant in the second specification only, indicating an overall reduction in the share of institutional expenditures dedicated to education expenses over the period 2000-2013. That means the Uzbek institutions of higher education have tended to allocate a smaller share of total expenditures for educational activities during the period under consideration. However, the coefficient of time trend is negative and statistically insignificant in the last specification. This outcome leads to a conclusion that the expenditures for educational activities are not varying because of time, but other factors.

4.3.2 Two stage least squares results

If one makes a decision by relying on the OLS estimation outcomes, then the endogeneity of $SHTR_{it}$ would be ignored in the Eq. (4.1). This would result in biased estimates of the relationship between the explanatory variables and the dependent variable in the interest. In this study, the two instrumental variables are utilised to solve this potential endogeneity of the main independent variable by applying the TSLS estimator that is originally developed by Theil (1953). According to Wooldridge (2002), the TSLS technique is one of the efficient ways to combine multiple instruments. Table 4.4 exposes the TSLS results with four different specifications. Specification 1 reveals that TSLS outcomes which were estimated without accounting for institutional fixed effects and linear time trend. Specification 2 includes time trend only, but Specification 3 drops linear time trend while includes institutional fixed effects. Both of the institutional fixed effects and time trend are captured in Specification 4 in order to expose the net effect of the predictors on ($SHEE_{it}$). All of the TSLS estimations utilise the robust standard errors clustered on institutions.

Findings of the first and second specifications reveal that all of the variables have statistically significant coefficients when the institutional fixed effect is not included into the models. The TSLS estimations show that the magnitudes of several exogenous variables (TP and TPSQ) become statistically insignificant when institutional fixed effects are accounted for in the last two specifications. Moreover, the variable of tuition revenue share shows negative but highly significant coefficients in the first two specifications. However, Table 4.4 shows that the values of the $SHTR_{it}$ become a positive and remarkably high when potential effects of institutional time-invariant characteristics are accounted for. The coefficients of this main explanatory variable are statistically significant at 1% level in the all specification phases.

Table 4.4: TSLS estimation results with the dependent variable: share of institutional expenditures dedicated to educational activities ($SHEE_{it}$)

VARIABLES	Spec.1	Spec.2	Spec.3	Spec.4
SHTR	-0.740***	-0.779***	0.525**	0.829***
	(0.265)	(0.263)	(0.249)	(0.342)
TP	1.12e-07***	1.04e-07***	-2.68e-08	5.70e-09
	(3.56e-08)	(2.96e-08)	(3.87e-08)	(2.56e-08)
TPSQ	-1.05e-14**	-9.76e-15***	4.29e-15	3.32e-15
	(4.34e-15)	(3.72e-15)	(4.58e-15)	(3.97e-15)
SIZE	0.00005***	0.00005***	-0.00004***	-0.00003***
	(0.00002)	(0.00002)	(8.31e-06)	(7.41e-06)
SIZESQ	-2.32e-09**	-2.44e-09**	2.61e-09***	2.01e-09***
	(1.06e-09)	(1.05e-09)	(6.03e-10)	(5.07e-10)
DURPP	0.0012***	0.0013***	-0.00002	0.0001*
	(0.0004)	(0.0004)	(0.0002)	(0.0002)
NUMSTAFF	-0.00006***	-0.00006***	0.00003*	0.0001***
	(0.00002)	(0.00002)	(0.00002)	(0.00003)
YEAR		0.003		0.020**
		(0.005)		(0.008)
Institutional fixed effects	*NO*	*NO*	*YES*	*YES*
Observations	*857*	*857*	*857*	*857*
Number of HEIs	*62*	*62*	*62*	*62*

Cluster-robust standard errors in parentheses
* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

The last specification of TSLS results reveal that, on average, a one percentage point increase in the share of institutional revenue generated from tuition yields a 0.83 percentage point growth in the share of institutional expenditures dedicated to education expenses, holding all other variables constant. In general, these findings are more consistent with findings of Fowles (2013) and Titus (2006a, b) regarding the relationships between institutional revenue patterns and student outcomes. These scholars conclude that if the American HEIs change their revenue structures from government funding to student tuition dollars, then these institutions are more like to shift their expenditure patterns to more greatly emphasized activities which most consistent with the preferences of this particular customer group.

When the both institutional fixed effects and linear time trend are captured, the fourth specification of the OLS results exposes that estimated coefficient of ($SHTR_{it}$) is over seven

times smaller than one that estimated utilising TSLS model which is not simply a point of econometric significance. The estimated coefficients can be interpreted as an elasticity that measures the responsiveness of the institutional expenditures to changes in institutional revenue. The OLS coefficient of 0.12 percentage suggests that Uzbek HEIs are fairly inelastic, which means the large changes in the share of tuition revenue cause proportionally smaller changes in the share of expenditures allocated to education expenses. Conversely, the TSLS results reveal a much stronger institutional response to changing revenue structure by confirming that Uzbek institutions are quite elastic in this respect.

Regarding institutional characteristics, when both the institutional time-invariant variables and linear time trend are included, some remarkable differences emerge in institutional expenditures. A straightforward effect is observed for FTE student enrolments; institutional size is negatively correlated to the share of institutional expenditures dedicated to education activities across all institutions. Thus, all else equal, the educational expenditures ($SHEE_{it}$) decrease by -0.003 percentage if institutional FTE enrolments increase by a one student. This finding can be explained by the economies of scale in the provision of education at the public HEIs in Uzbekistan. Perhaps, the Uzbek universities were trying to decrease the total institutional costs by increasing students/teacher ratio over the sample period. The coefficient on the duration of postgraduate program shows that institutions with longer postgraduate course provision spend more on educational activities. This outcome is not surprising given the increased institutional expenditure associated with postgraduate instructions. This finding is in line with the recent study of Fowles (2013), who found that the American public HEIs with a greater graduate share of total instructional hours spend more on education and related expenses.

Specifications 4 also exposes, all else equal, the dependent variable increases by 0.01 percentage point as number of personnel increases by a one employee at 1% significance

level. This finding suggests that institutions with greater number of academic and administrative staff spend more on educational expenses. One plausible explanation for this finding can be wages of staff; a huge share of institutional expenditures goes for paying staff salary at all the public HEIs in Uzbekistan. Therefore, it is reasonable to expect that increased number of academic or administrative personnel is more likely to lead the increased share of institutional expenditures dedicated to educational activities. For example, institutions that care more about a quality of education may decide to decrease a student/staff ratio by increasing a quantity of academic staff or by hiring "better" qualified and experienced senior academics[17] those normally demand relatively higher salaries than less experienced and lower qualified teachers. Both of these methods may yield to the increased institutional costs.

The coefficient of linear time trend reveals positive and insignificant magnitude in the second specification, but it shows significant coefficient in the last specification. While plausible explanation for this outcome can be driven by the recent increased attention that improving quality of curricula and opening new faculties which specialised to information technologies have received from the CMUZB. Perhaps, public universities are responding to that pressure through dedicating the increased institutional expenditures to activities intended to promote these objectives.

4.3.3 Model diagnostic tests

Once the instrumental variable techniques are utilised, as suggested by Wooldridge (2002), it is a very important to conduct tests for exogeneity and for the validity of the over-identifying restrictions. Therefore, this sub-section starts with interpreting results of first-stage regression in the TSLS procedure. Then it proceeds with a discussion of tests for exogeneity and validity of the external instruments

[17] E.g., an academic staff who has a PhD degree from a subject field he/she is supposed to teach.

First-stage results - the influence of the instrument(s) on the endogenous variable(s) is a necessary diagnostic check for IV examinations. A valid IV cannot explain variations in the dependent variable without a relationship between the instrumental and endogenous variables, and a valid instrument is biased in the direction of OLS if a significant correlation between the IV and endogenous variable does not exist (Murray, 2010). In the first-stage equation, the coefficients of IVs should have the expected sign and significance. Therefore, coefficients of "Development Fund" and dummy "additional admission allowance" variables are expected to have statistically significant influence on the share of total operating revenue derived from tuition in the table below.

Table 4.5: First-stage results with the dependent variable: share of institutional revenue derived from tuition $(SHTR_{it})$

VARIABLES	Spec.1	Spec.2	Spec.3	Spec.4
TP	1.13e-07***	5.81e-08***	1.46e-07***	7.00e-08***
	(1.40e-08)	(2.15e-08)	(1.13e-08)	(1.41e-08)
TPSQ	-1.39e-14***	-8.84e-15***	-1.54e-14***	-9.71e-15***
	(2.23e-15)	(2.68e-15)	(1.78e-15)	(1.84e-15)
SIZE	0.0001***	0.0001***	0.00003***	0.00001**
	(6.03e-06)	(6.14e-06)	(5.52e-06)	(5.76e-06)
SIZESQ	-3.91e-09***	-3.87e-09***	-1.58e-09***	-4.23e-10
	(4.68e-10)	(4.66e-10)	(4.35e-10)	(4.70e-10)
DURPP	0.001***	0.001***	0.0004**	0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
NUMSTAFF	-0.0001***	-0.0001***	-0.00002	-0.0001***
	(0.00001)	(0.00001)	(0.00002)	(0.00002)
DevFund	*1.32e-11****	*1.42e-11****	*7.96e-12****	*7.55e-12****
	(3.44e-12)	*(3.43e-12)*	*(2.68e-12)*	*(2.60e-12)*
DumAdAdm	*0.023**	*0.018**	*0.029****	*0.017**
	(0.015)	*(0.015)*	*(0.010)*	*(0.009)*
YEAR		0.011***		0.020***
		(0.003)		(0.003)
Institutional fixed effects	*NO*	*NO*	*YES*	*YES*
Observations	*857*	*857*	*857*	*857*
Number of HEIs	*62*	*62*	*62*	*62*

Cluster-robust standard errors in parentheses

* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

The coefficients of "Development Fund" have positive and statistically significant influence on $SHTR_{it}$ at 1% level in the all specifications. The second instrumental variable, DumAdAdm, shows a positive correlation on the endogenous variable at 10% significance level in the all specifications except third. In Specification 3, a correlation between the main independent factor and DumAdAdm is statistically significant at 1% level. Consequently, both of the IVs are showing positive and statistically significant correlations with the endogenous variable when institutional fixed effects and linear time trend are accounted for. Nevertheless, these external IVs are subject to validity tests which will be carried out after presenting results of the Durbin-Wu-Hausman heteroscedasticity-robust endogeneity test.

Testing for exogeneity - one of the main reasons for implementing the TSLS estimator was the suspension that the key independent variable ($SHTR_{it}$) is endogenous. If this endogeneity is in fact not a problem, the TSLS estimator will be consistent (provided that the instruments are relevant and valid) but inefficient due to higher variance than for OLS estimator. In other words, if ($\mathrm{SHTR_{it}}$) is in fact exogenous, then OLS and 2SLS estimators should differentiate only with sampling error but they should not reveal considerably different outcomes (Wooldridge, 2002). Accordingly, it is beneficial and a very important to examine the null hypothesis that $\mathrm{SHTR_{it}}$ is exogenous (that $E[\mathrm{SHTR_{it}}\varepsilon_{\mathrm{it}}] = 0;\ p = 0$) by testing for a statistically significant difference between the OLS and TSLS estimators of β. For this purpose, the Durbin-Wu-Hausman[18] test is used in this diagnostic test and findings are presented in Table 4.6.

A finding of the endogeneity test reveals that the Durbin-Wu-Hausman test strongly rejects the null of exogeneity of the suspected endogenous variable, suggesting the treatment of the main exogenous variable as endogenously determined.

[18] Hausman (1978) proposed a test for exogeneity based on a comparison of the OLS and TSLS estimators of β.

TSLS first-stage regressions summary - reported in Table 4.6 presents results of under-identification and weak-identification tests. The Angrist and Pischke chi-squaresd test of under-identification suggests rejecting the null hypothesis that the endogenous variable is unidentified. The Kleibergen-Paap rk LM statistic is also applied in order to conduct the test of under-identification that also suggests rejecting the null. Critical values for the Angrist-Pischke F-statistics are not available. Therefore, the Stock and Yogo (2002) critical values should be applied, or the Staiger and Stock (1997) rule-of-thumb that the F-statistic should be equal or greater than 10 can be used here. The Angrist-Pischke F-statistic is higher than the basic threshold (11.6 > 10) which suggests rejecting the null hypothesis that the utilised instruments are weak. Since the cluster-robust standard errors are used, the Klibergen-Paap Wald rk F-statistic is also appropriate test for weak-identification analysis. Using critical value of Stock et al. (2002), F-statistic of 15.9 indicates that IV estimates retain 10% of OLS bias, suggesting to reject the null hypothesis of weak-identification.

Table 4.6: Model diagnostic tests

Tests of endogeneity			
Durbin-Wu-Hausman chi-squaresd statistic	8.35	*p=0.004*	Reject Ho
Durbin-Wu-Hausman F-statistic	7.73	*p=0.006*	
Under-identification			
Angrist-Pischke first stage chi-squaresd statistic	13.25	*p=0.000*	Reject Ho
Kleibergen-Paap rk LM chi-squaresd statistic	11.71	*p=0.003*	Reject Ho
Weak-identification			
Angrist-Pischke first stage F-statistic	11.61	*p=0.000*	Reject Ho
Kleibergen-Paap Wald rk F-statistic	15.88		Reject Ho
Over-identification			
Hansen J-statistic	1.39	*p=0.24*	Do not Reject Ho

Note: Institutional fixed effects and linear time trend are included and cluster-robust standard errors are reported. Test statistics: Number of clusters-62; Observations-857; Endogenous regressor-1; Excluded instruments-2.

Validity of instruments - a decision to instrument the share of institutional revenue derived from tuition with the "Development Fund" and dummy "additional admission allowance" variables requires careful consideration to instruments validity. As such, it is important to test for validity of over-identifying restrictions when the number of instruments exceed from the number of endogenous variable. This study utilises the two IVs and only one the endogenous variable as it was noted earlier. In this diagnostic part, the Hansen J-statistic is employed since the cluster-robust standard errors are applied in the TSLS estimation procedures.

The over-identification test suggests that IVs are not correlated with the error term of the second stage across all models. Therefore, I test the null hypothesis that the instrument sets are valid and the model is correctly specified (Hayashi, 2000). A rejection arise doubt on the validity of the instruments. However, Table 4.6 exposes that Hansen J-statistic fails to reject the null hypothesis. This means, the IVs those were employed during the TSLS estimations are valid and simultaneously uncorrelated with the error term of Eq. (4.1), thus the instruments are correctly excluded from the estimated equation.

4.4 Summary

This chapter analysed the shifting revenue structures of the Uzbek HEIs from fully government funding to mostly tuition funding during the period 2000 and 2013. The empirical estimations revealed that public HEIs have been mainly financed through tuition income and a small share of the total institutional revenue has been obtained from government allocations. The chapter also examined the changing behaviours of the public institutions when they become more dependent on revenues from tuition. The results of TSLS estimations suggest that the Uzbek universities have significantly changed their behaviours through paying more attention to finance educational and other student related activities when these institutions' income structure shifted from public financing to tuition financing. These findings are in the line with the RDT, thus we do not reject the research hypothesis: a resource dependence perspective suggests that increased institutional revenues generated mostly from tuition payments lead to an increased share of institutional expenditures dedicated to education and other student related activities at public HEIs in Uzbekistan.

Robustness of these empirical findings was tested utilising the several diagnostic models. The main results revealed that the IVs applied during the TSLS estimations are valid and they simultaneously uncorrelated with the error term. Unfortunately, this chapter cannot answer the critical question of whether or not the increased share of institutional revenues generated from tuition have been actually associated with improved institutional efficiently throughout the sample period. For this reason, the next empirical chapter is dedicated to analysing the recent financial performance and cost efficiency of the Uzbek HEIs.

Chapter 5: LITERATURE REVIEW ON EFFICIENCY IN THE CONTEXT OF HIGHER EDUCATION

5.1. Introduction

The recent report by The World Bank (2014) asserts that a share of public funds directed to institutions of higher education budget have been considerably reduced in many countries and this can be seen as one of the main reasons why many public universities turned out to be financially unsustainable over the last several years. The most common response for the reduced public funding is to obtain more resources from the increased tuition and other user fees. Numerous studies have found that simply introducing or increasing tuition fees at public HEIs was not always sufficient to fill the gap left by the reduced government funding (Barr, 2009; Erkoc, 2013; Horne and Hu, 2008). Therefore, many researchers suggest that public higher education establishments should always seek to utilise their resources more efficiently and perform at the best level of cost efficiency in order to achieve financial sustainability.

Throughout the last two decades, productivity and efficiency topics have received considerable attention by policy-makers and administrative bodies of universities in many countries, especially in high-income countries. In light of this, many scholars have tried to analyse whether HEIs are utilising their resources productively and efficiently (e.g. Agasisti, 2016; Agasisti and Johnes; 2015; Johnes, and Johnes, 2013; Katharaki and Katharakis, 2010; Kempkes and Pohl, 2010; Kuo ad Ho, 2008; Leitner et. al, 2007; Salerno, 2003; Sav, 2012; Worthington and Lee, 2008; etc.). Having benefited from the studies evaluating the efficiency performance of universities, administrators within governmental institutions and HEIs began to reorient their financing choices.

This chapter consists of two main sections: “Review of Theoretical Literature” and “Review of Empirical Studies”. The first main section explains the concepts of productivity and efficiency in the context of higher education, as well as the development history of stochastic frontier and data envelopment approaches are reviewed. The second key section provides a wide coverage of recent empirical literature on technical, economic, scale and scope efficiency of public HEIs in various countries, mostly in high income countries. Lastly, a summary of the chapter follows in the final section.

5.2 Review of Theoretical Literature

Productivity and efficiency topics have received considerable attention among many scholars of higher education and administrators of public HEIs over the many years (Erkoc, 2013; Horne and Hu, 2008; Kumbhakar and Lovell, 2000; Kuo and Ho, 2008; Paulsen and Smart, 2001; Robst, 2001; Salerno, 2003; Sav, 2012; Sullivan et al., 2012). Considerably reducing public subsidies and continuously increasing costs in higher education can be the main reasons for the following obvious questions to emerge: whether or not institutional fiscal resources are efficiently utilised at HEIs; and are they operating at the best level of cost efficiency? These types of critical and fundamental questions are becoming the main motivation for many policymakers to measure productivity and efficiency of universities (Johnes and Johnes, 2013). Nowadays, the productivity and efficiency concepts are central to interpretations of the quality, cost and financial sustainability of HEIs.

5.2.1 Productivity in higher education

Functions of productivity in the context of higher education will be briefly reviewed first, before turning to the discussions of various efficiencies that are commonly applied in the evaluation of universities' performance. For any organisation, productivity can be interpreted as simply the ratio of output produced to physical inputs used (Salerno, 2003). In the literature, various productivity measures have been employed to assess the efficiency and performance of different industries and organisations. However, two most common productivity measures are single-factor productivity (e.g., labour productivity – the ratio of output per labour-hour) and multifactor productivity which uses multiple inputs to produce multiple outputs (Sullivan et al., 2012). In the case of institutions of higher education, a single-input can be defined as the number of students matriculated and a single-output can be determined as the number of graduated students.

The various forms of input and output which are frequently employed in the context of higher education are summarised in the table below:

Table 5.1 Types of input and output in higher education

Inputs	***Outputs***
New students matriculating	Student enrolment in courses
Total number of academic staff	Undergraduate degrees awarded
Total number of non-academic staff	Postgraduate degrees awarded
Academic staff salary	Research awards, articles and citations
Non-academic staff salary	Services rendered to the general public
Faculty and student time and effort	
Expenditure on administration, library and comp. facilities	
Building and equipment	
Endowments	

Source: Adapted from Paulsen and Smart (2001)

Many scholars emphasise that inputs can be measured not only in physical quantities but they can also be expressed by costs (Sullivan et al., 2012). For example, an input measure could be expenditures for educational activities and an output could be defined by the quantity of graduated students. In this case, the productivity measure becomes faculty spending per student (Paulsen and Smart, 2001). Salerno (2003) also claims that "if one identifies and ranks this cost-based productivity measure, that ranking assesses the cost efficiency of each institution relative to the others being evaluated" (p. 8).

Utilising the single-input and single-output productivity measures, however, might not be an appropriate method for explaining the overall productivity of a university which normally utilises multiple inputs to produce multiple outputs (Paulsen and Smart, 2001). In the context of HEIs, Sullivan et al. (2012) suggest to employ the multifactor productivity by stressing that institutions are typically multi-product organisations, producing different forms of research, educational programs, entertainment and public services using different educational

inputs, such as government funds, private funds, number of academic/non-academic staff, faculty time and effort, buildings and equipment. However, these scholars also remark that the multifactor productivity is the one of the main factors which creates complexities during estimation of institutional productivity.

Since the comparisons of the relative value of degrees and research outputs are extremely difficult, it is not easy to develop accounting structures which capture the full value of the outputs in both private and public HEIs (Sullivan et al., 2012). Moreover, according to Salerno's (2003) critics on the productivity measure that “in sum, productivity measures are nothing more than rank-free indicators of the rate at which inputs are translated into outputs” (p. 8). However, how about the efficiency measure; does it has the same limitations as productivity has; and what is the difference between efficiency and productivity?

5.2.2 Efficiency in higher education

According to Salerno (2003), efficiency can be understood as the index used to rank various productivity values if one were to measure productivity estimates for a set of institutions and strive to find the most (least) productivity unit. Carlo Salerno also interprets the differences between efficiency and productivity by stating that "productivity is a value assigned to the rate at which inputs are converted into outputs and efficiency is a ranking of different values” (Salerno 2003; p. 8). Cowan (1985) explains efficiency as the ratio of output to input. Whereas, Aubyn et al., (2008) state that "efficiency is essentially a comparison between inputs used in a certain activity and produced outputs" (p. 5). In general, different organisations and industries have different motivations which lead them to seek to be efficient (Johnes and Johnes, 2013). Efficiency is a prerequisite of survival in industries characterised by strong competition, also efficiency is important to ensure that goals of the organisations can be maximised (Johnes, 2006). In the context of higher education, if

institutions are funded by a government or external stakeholders' purses, then these HEIs have a responsibility to the government or/and external stakeholders to ensure that these financial resources are utilised efficiently or are being spent wisely (Izadi, 2002).

In the existing theoretical and empirical studies, the various forms of efficiency have been identified and implemented, such as: 1) technical efficiency; 2) allocative efficiency; 3) exchange efficiency; 4) efficiency of scale; 5) dynamic efficiency; 6) social efficiency; 7) productive efficiency; 8) Pareto efficiency; 9) distributive efficiency; and 10) price efficiency (Kosor, 2013; McMahon, 1983; Pettinger, 2010). In addition, Nicholson (1995) defined and utilised (11) industry efficiency in order to measure the extent to which inputs are allocated efficiently between firms. According to the studies of many researchers, including Katharaki and Katharakis (2010), Kipesha and Msigwa (2013) and Salerno (2003), there are four types of efficiency which are most frequently utilised in the scope of higher education; such as technical, allocative, overall and scale efficiencies.

In the efficiency estimation, Farrell (1957) first puts forward two components as fundamentals of efficiency consisting of technical and allocative. According to Koopmans (1951) and Debreu-Farrell (1957) formal definitions, technical efficiency of an institution (e.g., institution A) is measured as:

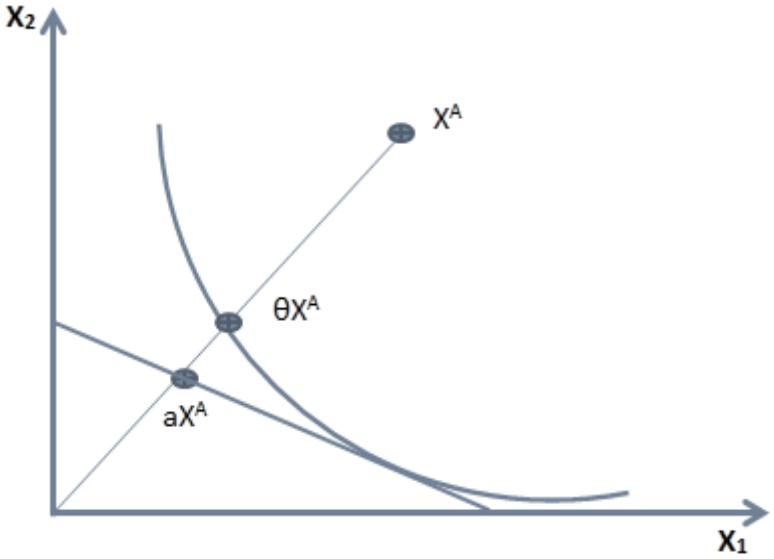
$$TE = \frac{\theta X^A}{X^A}$$

Where θX^A denotes the combination of technically efficient quantities of inputs and X^A represents the observed input levels, as it shown in Figure 5.1.

According to Figure 5.1, allocative efficiency for the institution A is measured as:

$$AE = \frac{\alpha X^A}{\theta X^A}$$

Figure 5.1 Technical and allocative inefficiency

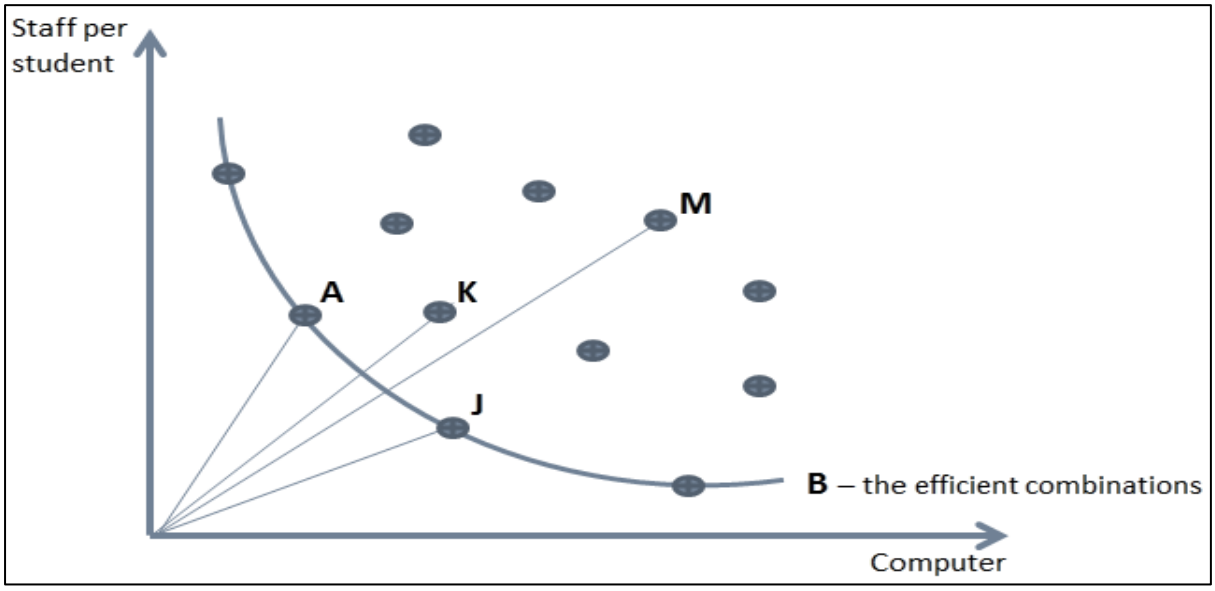


Where, x_1 and x_2 are inputs, aX^A represents the mixture of inputs those have the lowest costs given the output and technology, and θX^A denotes the combination of technically efficient quantities of inputs. The strictly convex curve is an isoquant for a given level of output and the straight line reflects the ratio of input prices (an isocost line).

The first type of efficiency that is very often used in the context of higher education is *technical efficiency* – denotes the optimum physical combination of the resources (factor-input) to produce some educational outcomes (Worthington, 2001). A HEI can be technically efficient if it produces the maximum output (e.g., the number of graduate students) using the given amount of inputs (e.g., the number of academic staff), or the ability of an institution to minimise input utilisation in the production of a given output vector (Kumbhakar and Lovell, 2000). Contrary, a university would be inefficient if it used too many academic staff than was necessary to 'produce' graduate students (Kipesha and Msigwa, 2013). Carlo Salerno also states that "technical efficiency is a measure of the extent to which an institution efficiently allocates the physical inputs at its disposal for a given level of output" (Salerno, 2003; p. 8).

The definition of technical efficiency can be more precisely explained using Figure 5.2 which is adopted from Salerno (2003). The two axes describe the two inputs (number of staff and number of computers) utilised per student to produce the output (education). The figure also shows the institutions (A, K, M, and J) with different enrolment size. By fitting a line through the institutions which are using the minimum quantity of inputs per output, one can identify the frontier from which efficiency or inefficiency of other institutions can be estimated (this is shown by line B). Institutions are technical inefficient if they are not lying on line B, e.g., institutions K and M are not efficient since they are using more staff per student and computers per student than institutions A and J.

Figure 5.2 Technical efficiency



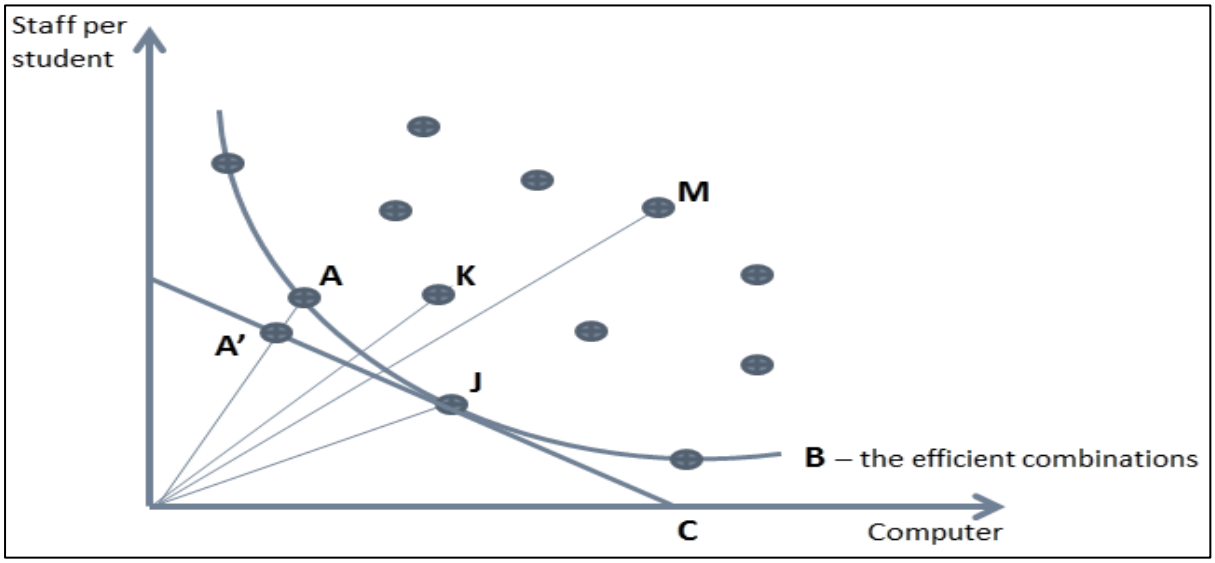
Source: Salerno (2003)

The second efficiency measure is *allocative efficiency* – concerned with producing outputs by utilising the lowest cost inputs (Pettinger, 2010). In other words, "the input combination should be selected appropriately on the basis of their prices" (Kumbhakar and Lovell, 2000). In institutions of higher education, the allocative efficiency measures the extent to which inefficiency occurs due to utilising the wrong mixture of resources given what they cost to purchase (Katharaki and Katharakis, 2010). Using the example adopted from Salerno (2003),

Figure 5.3 has been created by reproducing Figure 5.2. The isocost line (C) is included which shows the rate at which the two inputs can be traded off in the market. Therefore, it characterises the various input combinations which can be bought from a fixed budget.

According to Koopmans (1951), "the best practising mixture of inputs concerning the prices is the interaction point of isoquant and isocost curves where technically feasible production units are produced at the lowest cost." In the previous efficiency figure, institutions A and J are regarded as technically efficient. However, the institution A becomes allocatively inefficient after costs are considered, because it is not operating at the isocost line. The amount of inefficiency can be measured by the distance between A and A' in Figure 5.3. Although the institution A could increase the quantity of computers and decrease the amount of staff in order to achieve overall efficiency.

Figure 5.3 Allocative and overall efficiency



Source: Salerno (2003)

The third form of efficiency is *overall or economic efficiency* – jointly considers allocative and technical efficiency. Once again, Figure 5.3 can be helpful for explaining the overall efficiency of HEIs. Since institution J is laying on both the isocost (C) and isoquant (B) lines, it can be regarded as allocatively and technically efficient; therefore institution J is overall

efficient. In contrast, institutions K and M are both technically and allocativelly inefficient which means they are overall inefficient. Furthermore, one can measure *economic efficiency* (e.g., cost, revenue or profit efficiency) of institutions through adding information of the input and output prices along with one of the following behavioural objectives: cost minimisation, revenue maximisation or profit maximisation. For example, if a behavioural objective of cost minimisation is appropriate for public universities then the cost efficiency is required to be estimated.

The cost, revenue and profit efficiencies are estimated by means of evaluating the distance to a particular frontier, such as, cost frontier, revenue frontier, and profit frontier. Kumbhakar and Lovell (2000) suggest that "these three frontiers describe the best that can be achieved economically, and so they provide standards against which the economic performance of producers can be measured" (p. 33). Cost frontier efficiency models estimate the distance between actual cost and minimum attainable cost level; Revenue frontier models measure the distance between each institution's actual revenue and maximum achievable revenue, while profit frontier gauges the distance between actual profit level and maximum achievable profit of the institutions (Kumbhakar and Lovell, 2000). The cost frontier model entails information on input prices for the estimation while revenue frontier model requires output prices. Also, the profit frontier entails to integrate both input and output prices.

The fourth form of efficiency is *scale efficiency* – this happens when an organisation produces an output on the lowest point of its long-run average cost (Pettinger, 2010). The scale efficiency is frequently employed in studies on higher education. Several previous studies of higher education on efficiency and productivity have often sought to evaluate the extent at which institutions are working at increasing or decreasing returns to scale which

also serve to define the optimal size of universities (Abbot et al., 2003; Katharaki and Katharakis, 2010; Kipesha and Msigwa, 2013; Paulsen and Smart, 2001).

In the context of the scale efficiency, economic theory proposes that, in the long run, competitive universities keep adjusting their scale size to the level that universities operate at constant returns to scale (Paulsen and Smart, 2001). If institutions are not operating at constant returns to scale, then they have scale inefficiency. It can be said that institutions are operating at constant returns to scale, if a doubling all inputs result in a doubling of the output at these HEIs (Cohn at al., 1989). These scholars also remarked that "if doubling the inputs results in a less than equal increase in output then the institution is said to be operating at decreasing returns to scale. On the other hand, if scaling up inputs entails a greater than equal increase in output then it is said to be operating at increasing returns to scale" (Cohn at al., 1989; p. 11).

5.2.3 Approaches for measuring efficiency

The existing efficiency studies that focused on measuring the relative efficiency of HEIs can be divided into two main groups:[19] those which used parametric estimators such as stochastic frontier analysis (SFA) (Johnes and Johnes, 2013; Robst, 2001; Sav, 2012) and those which used non-parametric estimators such as data envelopment analysis (DEA) (Abbot and Doucouliagos, 2003; Johnes, 2006; Wolszczak and Parteka, 2011; Worthington and Lee, 2008). The development of the SFA approach is mostly attributed to the studies of Aigner et al. (1977) and Jondrow et al. (1982). The roots of DEA date back to the seminal paper by Farrell (1957), but through their influential work Charnes, Cooper and Rhodes (1978) contributed to the development of DEA approach. Since the recent decade, the literature of SFA and DEA is voluminous and expanding rapidly (Daghbashyan, 2011). In the context of

[19] In the next section, recent empirical studies which applied both of these efficiency measuring approaches will be presented.

higher education, SFA is well recognized in the literature as an econometric technique to estimate costs, but DEA is a well-known method which compares institutions to the minimum cost institution (Robst, 2001).

Both of these frontier methodologies aim to measure and characterise concepts of efficiency, but they are fundamentally dissimilar in their development and underlining assumptions. Therefore, each possesses its own advantages and disadvantages (Robst, 2001). Nowadays, the main strengths and weaknesses of estimating efficiency by using these approaches are well recognised. However, Salerno (2003) argues that "the advantages to using either method tend to rectify the disadvantages in the other" (p. 13). Onwards, a more comprehensive comparison of SFA and DEA - including their strengths and weaknesses over each other - will be outlined more in detail. Moreover, reasons for preferring the econometric approach over the mathematical programming approach for cost efficiency estimations of the Uzbek HEIs will also be discussed.

Management scientists usually prefer to examine efficiency of institutions using DEA approach due to its several major advantages. Since efficiency assessments in data envelopment estimations are constructed on the behaviour of other institutions, the DEA does not require to draw assumptions about the distributional form of the error terms and efficiency a priori. In addition, due to the non-parametric nature of DEA, there is no need to pre-define or impose a priory any functional form which mitigates the risk of imposing wrong assumptions on the model. Finally, DEA allows measuring how cost efficiency of institutions can be influenced by multiple expenditure categories, while SFA approach cannot jointly assess the impact of independent variables on multiple expenditures.

At the same time, scholars who suggest applying SFA in order to measure efficiency of institutions repeatedly cite two main shortcomings of DEA approach. 1) Sensitivity to data

errors.[20] Since DEA is non-parametric and is a deterministic approach, it does not account for the possibility of random errors in the data. However, random errors may cause considerable problem through affecting to the shape of the frontier and evaluated efficiency of institutions. Furthermore, the possibility of random variations across universities is too great to ignore when the sample contains the large number of HEIs. 2) DEA estimates not absolute, but relative, efficiency. The shape of the best practice frontier can be altered and efficiency scores of organisations can be distorted because of outliers in the data.

In stochastic frontier evaluations, neither of these concerns can cause significant problem. Therefore, SFA approach can easily handle random noise (e.g., caused by measurement error) through statistical inference on the estimated parameters. In the case of absolute versus relative efficiency, the stochastic frontier estimates are much less sensitive to variations in a single data point because SFA characterises the behaviour of the "average institutions". Salerno (2003) suggests that "as the frontier reflects the average firm after efficiency is taken into account, what is left is a hypothetically absolutely efficient frontier" (p. 22). Whereas, the major limitations of SFA technique are availability of only a single-valued dependent variable (e.g., total expenditure) and the necessity of assumptions about the nature of efficiency.

For the empirical analysis in Chapter 6, SFA approach is preferred after carefully analysing data on the hands (availability of data) as well as due to its superiority over DEA in terms of the possibility to account for random noise and make an absolute estimate of efficiency.

[20] Using DEA, several researchers (Erkoc, 2013; Mettas at al., 2001) have found that estimated efficiency scores can be extremely sensitive to data errors.

5.3 Review of Empirical Studies

The efficient utilisation of resources become a central topic for many managers and administrators of public HEIs, as public subsidies to universities have been decreased over the last two-three decades (Kipesha and Msigwa, 2013). Since the first decade of the 21th century, extensive empirical studies have been undertaken in order to measure efficiency in utilisation of resources at public universities in various countries. Throughout this section, empirical contributions of several scholars on measuring the technical, allocative, scale and economic efficiency of HEIs are extensively discussed. Based on the research techniques implemented, previous empirical studies on the efficiency of HEIs have been divided into two different types: those which use econometric approach such as SFA and those which implement mathematical programming approach such as DEA. Accordingly, this section first reviews recent and frequently cited empirical studies which applied SFA approach, then those studies which used DEA (these empirical contributions are summarised in Table 5.2).

5.3.1 Studies which utilised SFA

Robst (2001) implements SFA approach to investigate cost efficiency of public institutions of higher education in the US. The scholar's main concern was to analyse whether HEIs with a greater reduction in the share of income from public appropriations improved efficiency relative to HEIs with a smaller reduction in the share from public appropriations. The cross-sectional data is employed to evaluate differences between institutions, and the time-series data to analyse changes within institutions. The panel data is retrieved from Integrated Postsecondary Education Data System for four academic years, 1991-1995, and OLS, MLE and SFE methods are also used step by step. After the estimations, John Robst concludes that public HEIs in America with greater public funds are more efficient than institutions with smaller public funds. This finding looks to controvert with the conventional wisdom,

suggesting that the share of public allocations does not have any integration with efficiency performance of institutions. This paper also exhibits that majority of the HEIs' public shares of revenue are reduced, but HEIs with smaller government share declines increased efficiency more than HEIs with greater public share declines.

In one of the empirical studies on efficiency of American HEIs, Sav (2012) uses the parametric estimation with a purpose of evaluating the operating cost efficiencies of 257 public and 297 private non-profit institutions. The author utilises a panel data for four academic years from 2005-06 through 20008-09. The maximum likelihood estimation is used for both public and private HEIs under two efficiency models: first model with environmental/external factors directly affecting institution cost and second model with environmental/external factors as determinants of institution inefficiency. Findings suggest that private HEIs are less cost efficient when environment factors impact cost frontiers, however, public HEIs are less cost efficient when environmental factors are determinants of inefficiency. Findings also show that the reduced government funding decreased the cost efficiency of public universities but improved efficiency among private universities.

One of the first influential studies that use SFA approach belongs to Johnes (1996), who constructs a quadratic multi-product cost function for UK universities. The preferred specification applies to estimate ray economies of scale, product-specific economies of scale and economies of scope for the academic year 1989-90. The scholar also evaluates the average incremental cost of outputs, such as the undergraduate student load, the number of postgraduates and research activity. As Geraint Johnes stated, this study represents a methodological advance on earlier works in three respects. "First, the results obtained by ordinary least squares (OLS) estimation are compared with corresponding results using the more appropriate method of stochastic frontier analysis. Second, a theoretical framework is

provided which allows estimation of scale and scope economies not only at out-turn levels of output but at an equilibrium output vector defined by societal preferences. Third, a disaggregation of outputs by broad subject area is employed" (Johnes, 1996; p. 557). The findings reveal that the maximum likelihood estimates of all coefficients except constant term are not changed at four significant digits, compared to the OLS results. This leaves the estimates of ray and product-specific economies of scale as well as average incremental cost unaffected by the change in estimate method, although the estimates of economies of scope are rather changed.

Izadi et al. (2002) contribute to the efficiency literature by measuring the technical efficiency of 99 British universities. The primary objective of their study was to reveal measures of scale and scope economies as well as to deliver information on the technical efficiency of every university in the given sample. After using the necessary analytical methods, the scholars find that the UK HEIs are utilising their resources inefficiently. That means significant inefficiency remains in the UK higher education system. In this study, no suggestion is shown as to how remedy the inefficiencies and what were their causes. The scholars also conclude that economies of scale for post-graduate teaching and research outputs exist in British universities, while there are not economies of scope.

In another study in which SFA is used to evaluate cost efficiency of English and Welsh HEIs, Stevens (2001) finds that on average universities are operating inefficiently. It is important to note that one of the first incentives to account for quality of outputs came from Stevens' (2001) analysis. Stevens employed average A-level scores and the percentage of students receiving firsts and upper-seconds degrees in secondary school to account for education quality, but to account for research output he simply implemented research income. Results of the estimations expose that imposing tuition charges seems to be influential for less

efficient universities than higher efficient ones to acknowledge their cost structures. Moreover, Erkoc (2013) remarks this study has a unique feature in the sense that "Stevens' (2001) paper remains the first research modelling inefficiency levels of HEIs as a function of their student and staff characteristics" (p. 4).

In examining performances of HEIs, most of the recent studies suggested that the efficiency scores may suffer from the presence of time-invariant (or unobservable) effects which lead to biased estimation of efficiency values. For example, students' or researchers' innate ability may be a main determinant of their individual academic achievement and thus account for an important share of the heterogeneity in data when evaluating the efficiency of the HEI in which they are working or studying (Agasisti et al., 2015). The most recent studies in stochastic frontier analysis have increased the volume of empirical evaluations which allow for unobserved heterogeneity using random parameter and latent class models.[21] The former offers greater allowance for heterogeneity than the latter. The random parameter stochastic frontier model was already used for empirical analyses in UK by Johnes and Johnes (2009), in Spain by Johnes and Salas-Velasco (2007), and in Italy by Agasisti and Johnes (2010), as well as Johnes and Johnes (2013) applied the latent class model for analysing the cost efficiency of HEIs in UK. A very recent study by Agasisti and Johnes (2015) utilised both random parameter and latent class models in the case of the United States. "The idea behind these studies is that colleges tend to be different, and so they each face a cost function that is distinct" (Agasisti and Johnes, 2015; p. 65). Therefore, a separate cost function is estimated for each university.

[21] The latent class approach splits observations on the basis of maximum likelihood into several classes and evaluates distinct parameter vectors for each of the classes. Usually, a number of classes are prescribed by the researcher (Agasisti and Johnes, 2015). The random parameter model is basically similar to the latent class model in that there are as many latent classes as there are observations.

Tsionas (2002) and Greene (2005) have first developed random parameter formulations of the stochastic frontier model using panel data technique. That is, Greene (2005) systematically investigated various ways to incorporate heterogeneity and the results show that different models produce quite different outcomes. More specifically, this scholar assessed various extensions of the stochastic frontier which account for unmeasured heterogeneity and decision making unit inefficiency. An application of these methods to the estimation of HEIs' efficiencies is discussed in Johnes and Johnes (2009). Using the random parameter stochastic frontier model that has become recently available to estimate frontier cost functions for HEIs, these authors evaluated average efficiency scores of English HEIs for the period 2000-2003. Estimations on average incremental costs as well as on returns to scale and scope presented very similar results with the existing literature.

In one of their influential studies, Johnes and Johnes (2013) evaluate the average cost efficiency of English universities utilising random parameter stochastic frontier and latent class models which allow to fully accommodate both the heterogeneity across HEIs and the presence of technical inefficiencies. A main result of the paper shows that variation in efficiency scores across universities is seriously decreased. As the scholars remark, this reduction may be due to the data which are highly aggregated and failed to capture the detail of how and why efficiency scores vary. In one of their recently published papers, Agasisti and Johnes (2015) made first attempt to apply latent class and random parameter models for evaluating costs, returns to scale and scope, as well as efficiency in the context of a framework which allows for the heterogeneity of HEIs in America. Results from random parameter approach are compared to the results from the traditional frontier model and latent class models. The paper explores the usefulness of latent class models, and the findings suggest that American HEIs are heterogeneous. The authors also analysed if the efficiency estimations were correlated with ratings included in the existing rankings of HEI quality.

Johnes and Salas-Velasco (2007) contributed to the literature by evaluating a random parametric stochastic frontier cost function for the Spanish HEIs in 1998, 2000, 2002 and 2004 to form a panel. Findings suggest that all institutions in the sample achieved high levels of efficiency. An addition, the estimated returns to scale and scope effects were significantly high which imply that global cost savings could be done by a reallocation of activity across HEIs. According to the outcomes of average incremental costs, the cost of producing master students is higher relative to that of producing bachelor students in all subject areas. The average incremental cost of research is high, showing that a euro of extra research financing adds 7 Euros to total expenditures. Using a random parameters stochastic frontier model, Agasisti and Johnes (2010) evaluate the cost efficiency of 57 public universities in Italy for the period 2001-2004. The authors suggested that this model yields very beneficial information on inter-institutional variation in cost structure and technical efficiency. Findings reveal that the examined technical efficiency is high with a mean efficiency score of 81 per cent. Based on cost efficiency values, the scholars concluded that "average costs are in line with studies of university costs conducted in other countries" (p. 5). Moreover, returns to scale and scope are estimated and findings show that the returns are ubiquitously reducing which have clear policy implications.

Since the last two decades, several empirical studies have started to emerge which are dedicated to measuring economic efficiency of HEIs in Australia. To the best of my knowledge, however, most of the scholars preferred to employ non-parametric approaches relative to parametric for assessing efficiency of the Australian HEIs. Through utilising the SFA approach, Horne and Hu (2008) investigate the cost efficiency of 36 Australian universities for seven academic years, from 1995 to 2002. A main result of their analysis shows that the Australian universities have not operated efficiently relative to each other, as measured by cost efficiency. Although the five years before this investigation, Abbot and

Doucouliagos (2003) discovered the different outcomes using non-parametric techniques that will be discussed in the DEA part of this sub-section.

Over the recent decade, several scholars have also started to investigate efficiency of universities in high-income countries, other than the US, the UK and Australia. Daghbashyan (2011) investigates the cost efficiency of 30 public and private HEIs in Sweden by implementing SFA method. Pooled and panel data approaches are used in order to estimate the average cost efficiency of Swedish HEIs in the period 2001-2005. Three groups of variables are also included to the inefficiency model to examine the inefficiency determinants: the first, HEIs specific factors – such as load per teaching/research staff and institution size are found to have negative impacts on the overall efficiency in pooled data models and they are not significant in panel data model. The second, staff characteristics do not have a significant influence on the overall efficiency of HEIs. This finding suggests that those HEIs employing more academics have greater efficiency and their personnel contribute more to the institutions' performance in terms of cost efficiency. The third, student characteristics (e.g., age and quality of students) are found to have no effect on the cost efficiency. Nevertheless, students with a foreign background are found to raise the cost of HEIs and therefore cost inefficiency. The main conclusion from those results is that the Swedish HEIs vary in their cost efficiency, though their average score is relatively high and they do perform differently. However, it would be useful if the scholar defined the driving forces behind this variation.

One of the first empirical studies, which investigate economic efficiency of Turkish HEIs through utilising the efficiency measuring techniques, is developed by Erkoc (2013). The author examines cost frontier and efficiencies of more than 50 public HEIs for the period of 2005 and 2010. The initial findings from six different stochastic frontier models reveal that

Turkish HEIs are performing quite satisfactory concerning their overall efficiency values, although there are lots of variations among them. According to Battese and Coelli's (1992) time-variant model estimations, the Turkish HEIs have not shown any improvement in their cost efficiency during the five full academic terms. The paper of Erkoc (2013) also exposes that the determinants of inefficiencies in those universities are dependent upon the size of HEIs (e.g., big size institutions are highly probable to have relatively lower efficiency results) and the load factor (e.g., HEIs with lower load factor show worse efficiency performance as anticipated). Similarly, the percentage of foreign students, percentage of full-time faculty, having a medical school and the age of the university are among the other variables reducing efficiency in Turkish institutions. However, the percentage of professors in the faculty does not expose any impact on the inefficiencies.

Among the high-income countries in Asia, to the best of my knowledge, economic efficiency of the Taiwanese public universities was evaluated first. This empirical study was conducted by Jenn-Shyong Kuo and Yi-Cheng Ho in 2008. In Taiwan, the University Operation Fund (UOF) was implemented in order to decrease the government's funding burden by increasing cost efficiency in HEIs. These Taiwanese researchers evaluate the cost efficiency of the UOF scheme on public HEIs using stochastic frontier multiple-product cost function. The investigations are conducted based on panel date collected from 34 public HEIs in Taiwan for the academic years 1992-2000. The paper lacks data on the quality of the research and educational output produced by HEIs, as many other empirical studies. Results show that the implementation of the UOF has had a significantly negative influence on the cost efficiency of public HEIs. Kuo and Ho (2008) explain their findings by denoting that "the effect of the UOF may be nonlinear. This is the limitation of the model's specification in this study, and the UOF might slowly improve in efficiency, since some selective funding policies have been

implemented since 2000" (p. 611). Therefore, all these factors could have a considerable influence on the final outcome that has been found by the scholars.

One of the first empirical contributions which measures efficiency in institutions of higher education across various countries using SFA approach is conducted by Aubyn et al. (2008). An average cost efficiency of public HEIs in 17 European countries including the US and Japan is examined. According to the estimated mean scores, public universities in the UK were the most efficient while Greek universities were the less efficient. The countries rankings have not varied much during the period of 1998 to 2005. While the UK was always the leader, followed by Japan and the Netherlands, Greece remained always in the last position. With mean scores not showing an improving tendency, the EU's more populous countries such as Italy, Germany, France and Spain were always far from efficiency frontier.

5.3.2 Studies which utilised DEA

Contrary to the findings of Horne and Hu (2008), Abbot and Doucouliagos (2003) outcomes reveal that Australian universities have had high levels of efficiency relative to each other in 1995. Abbot and Doucouliagos (2003) employed the DEA technique to calculate technical and scale efficiency of public universities, while Horne and Hu (2008) used the SFA to measure cost efficiency. As it is quite evident, the two groups of researchers found different results through employing two different efficiency measuring approaches and different academic periods. In addition, DEA technique recognises two or more main decision making units which performs at the best practice (Abbot and Doucouliagos, 2003). That means, several universities are given a score of one (where a score of one represents efficiency) if their efficiency scores are better than other universities in Australia. However, in practice even the best performing university may not be operating on the frontier. This may be a problem if all universities are inefficient to some degree.

One of the most recent productivity and efficiency analyses is presented by Worthington and Lee (2008) in the case of Australian universities. Their study focuses on estimating productivity growth in 35 Australian HEIs for the period 1998-2003. The productivity growth is decomposed into technical efficiency and technological change. The initial findings show that on average, annual productivity growth is more than 3 per cent across all institutions. Their other investigations on teaching-only and research-only productivity show that the greatest source of gain is attributable to improvements in research-only productivity allied with pure technical and some scale efficiency improvements. Whereas most of the gain is attributed to improvement in teaching-only productivity linked with technological progress.

The approach of DEA is also utilised to measuring technical and scale efficiency of public and private HEIs in England by Johnes (2006). Data collected on inputs and outputs for more than 100 English HEIs is only for one academic year 2000-2001. The paper reveals a result that the level of efficiency in English institutions of higher education was high in that academic year. One of the main limitations of this study is that the scholar does not consider the quality of instruction, research and service outputs as a separate output during the estimation process and the scholar has failed to reveal a valid explanation for the exclusion of appropriate measures for the quality of outputs.

Some empirical studies on higher education systems' efficiency in the case of several European countries have started to emerge over the recent years. For example, evaluating the efficiency of publicly funded German HEIs has received considerable attention among scholars of higher education due to the reduced government funding in this country. By implementing both DEA and SFA approaches, Kempkes and Pohl (2010) estimate the overall efficiency of more than 70 public universities for the period of 1998 to 2003. Their primary

conclusion is that West German universities have not performed better in total factor productivity change relative to universities in East Germany.

Another recent empirical work that estimates the economies of scale and scope as well as technical efficiency of German higher education sector is conducted by Olivares and Wetzel (2011). A sample of the study consists of 154 HEIs and 6 academic years. Utilising an input-oriented distance function method, the researchers find that small and medium-sized HEIs of applied sciences need to specialise in the research and teaching activities they conduct. In contrast, the activities of large institutions need to be directed to the concept of a full-HEI that mixes teaching and research activities across a board range of subjects.

Utilising this form of non-parametric estimation, Leitner et al. (2007) investigate the performance efficiency of natural and technical science departments at 12 Austrian HEIs for the years 2000 and 2001. The scholars implement a multiple-input and multiple-output variables approach. OLS regression and correlation analysis are used to determine suitable input and output variables. Findings expose the performance differences and scale effects. The results also reveal that both large and small departments perform above than average, but the departmental size influences its overall and specification performance which signals that simple linear scale effects are absent.

Agasisti and Salerno (2007) contributed to efficiency analyses of Italian HEIs by estimating the cost efficiency of 52 public institutions. Empirical findings show that when quality of education measures are output or input based then efficiency scores are revealed to vary significantly. Interestingly, the authors conclude that increasing enrolments in some institutions while restricting the enrolment growth in other institutions could improve economic efficiency and decrease system-wide costs.

Afonso and Santos (2005) first showed an initiative to examine the relative efficiency of public universities in Portugal. The study uses data mainly for a single year - 2003 and for 52 faculties, institutes and universities. The number of academic staff and total expenditure of universities are used as the input measures, while the undergraduate success rate and the number of doctoral theses per 100 teachers are taken as the output measures. However, the study does not include measure of success for postgraduate students as the one used for undergraduate students. Findings reveal that on average, the faculties, institutes and universities could achieve the same level of performance by utilising fewer amounts of input which they were using. In other words, the resources were utilised inefficiently by Portuguese universities and their faculties in 2003.

The first empirical study which measures technical efficiency of Turkish HEIs using the non-parametric approach is conducted by Cokgezen (2009). This study compares technical efficiency of 70 public and private universities' faculties of economics for the academic year 2003/2004. Results of DEA estimations show that the mean technical efficiency of the public faculties of economics is estimated to be greater than that of private ones. However, the author emphasizes that the private HEIs are normally funded via tuition and other user fees, while the public institutions are almost free and overcrowded. For these reasons, quality approximations should be considered to eliminate these differences and quality-adjusted efficiency scores should be estimated. According to the findings that most efficient private faculties are those with the greatest quantity of publications, while most efficient public faculties are found to be those with the highest number of enrolled students.

Utilising a non-parametric approach, Kipesha and Msigwa (2013) examine the technical efficiency of 7 public universities in Tanzania. To the best of my knowledge, this is one of the first attempts to evaluate the efficiency of public universities in low and middle income

countries. An input is measured by the human resources that used to produce outputs which are measured by the number of degrees conferred and internal income generated. Results of the estimations expose that the Tanzanian public universities, on average, efficient in the utilisation of input (human resources) to produce the first form of output (the number of graduates). Although, the results also show that public HEIs are inefficient in the revenue generation activities. The researchers explain their findings by stating that the available human resources are not utilised efficiently in the acquiring of revenues from tuition fees, investments, consultancies and research activities at the Tanzanian universities. Therefore, as the authors advised that "Tanzanian public universities should improve their internal revenue generation as the way to reduce their dependence on government and donors" (Kipesha and Msigwa, 2013; p. 63).

In one of the most influential studies in which non-parametric approach is implemented, Agasisti and Johnes (2009) evaluate the efficiency of public HEIs across more than one country. The study aims to examine technical efficiency of Italian and English universities for the year 2003/2004. Findings reveal that on average, universities in both countries are quite efficient in relation to the country-specific frontier. However, the English HEIs are more efficient than those in Italy when their performances are compared. These researchers also examine the changes of technical efficiency scores over a four-year period (2002/2003-2004/2005), and the result shows that English institutions are gaining stable technical efficiency scores while Italian institutions are increasing their efficiency.

Another remarkable work that worth examining in this study is conducted by Wolszczak and Parteka (2011) using a panel data on European public HEIs for the time period of 2001-2005. The paper evaluates economic efficiency and its determinants in 259 public HEIs of 7 European countries, utilising a two stage DEA approach. First, DEA scores estimated and

then regressed on potential covariates by using a bootstrapped truncated regression. Findings expose a significant variability of efficiency scores within each country. Through the second stage of the analysis, size of the institution, faculty composition, funding sources and gender structure of the academic staff are found to be statistically significant determinants of efficiency and performance of HEIs. Particularly, the results suggest that a greater number of women among academic personnel and a greater share of funding from external sources improve the economic efficiency of the European public HEIs.

One of the most recent empirical works on efficiency of universities in multiple countries was published by Joanna Wolszczak in 2014. This study aims to examine the technical efficiency of 500 HEIs in 10 European countries and the US covering the years between 2000 and 2010. Mean efficiency scores are estimated by implementing the DEA with different input and output sets. The scholar mainly evaluates the external factors, such as departmental size, funding structure and location, influencing the level of institutional inefficiency. Findings reveal that the role of the HEI financing structure in institution technical efficiency is dissimilar in Europe and in the US. The main result exhibits that "increased government funding is associated with an increase in inefficiency only in the case of European units, while the share of funds from tuition fees decreases the efficiency of American public institutions but relates to efficiency improvements in European universities" (Wolszczak, 2014; p. 4). To the best of my knowledge, this study was a first attempt to compare the technical efficiency of US and European HEIs.

Table 5.2 Empirical studies on the efficiency of HEIs in various countries

Study	***Country***	***Data***	***Approaches to Measure Efficiencies***	***Findings***
Robst (2001)	USA	1991-1995; all public HEIs	SFA	HEIs with greater public funds are more cost efficient than HEIs with smaller public funds
Sav (2012)	USA	2005-2009; 257 public and 297 private non-profit institutions	SFA	The reducing government funding decreases the cost efficiency of public HEIs but it helps to improve efficiency among private institutions
Agasisti and Johnes (2015)	USA	2003-2006; 954 public and private institutions	SFA	Findings suggest that global economies could be achieved by effecting a reduction in the number of institutions providing bachelor education, while increasing the number of HEI engaged in postgraduate Instruction.
Johnes (1996)	UK	1989-1990; traditional universities of the UK	SFA	In comparison with the OLS results the maximum likelihood estimates of all coefficients except the constant are unchanged at four significant digits. So that synergies are absent.
Stevens (2001)	UK	1995-1999; 80 English and Welsh HEIs	SFA	On average, HEIs are not operating cost efficiently
Izadi et al. (2002)	UK	1994-1995; 99 British universities	SFA	Significant technical inefficiency remains in the UK higher education system
Johnes (2006)	UK	2000-2001; 100 English HEIs	DEA	The technical and scale efficiency in the English higher education sector appears to be high

Johnes and Johnes (2009)	UK	2000-2003; 121 English HEIs	SFA	Average incremental costs as well as returns to scale and scope presented a quite high results
Johnes and Johnes (2013)	UK	2003-2011; 90 English universities	SFA	The variation in cost efficiency scores across HEIs is highly reduced over the sample period
Abbot and Doucouliagos (2003)	Australia	1995; all public HEIs	DEA	Universities had high levels of efficiency relative to each other
Worthington and Lee (2008)	Australia	1998-2003; 35 public universities	DEA	Annual productivity growth (on average) is more than 3 per cent across all institutions of higher education
Horne and Hu (2008)	Australia	1995-2002; 36 public universities	SFA	HEIs have not operated cost efficiently relative to each other
Kempkes and Pohl (2010)	Germany	1998-2003; 70 public HEIs	SFA and DEA	West German HEIs have not performed better in total factor productivity change compared to the universities in East Germany
Olivares and Wetzel (2011)	Germany	6 academic years and 154 universities	DEA	Only small and medium-sized HEIs of applied sciences operated technical efficiently
Johnes and Salas-Velasco (2007)	Spain	1998, 2000, 2002 and 2004; 26 HEIs	SFA	All institutions in the sample achieved high levels of efficiency
Agasisti and Salerno (2007)	Italy	2003; 52 public institutions	DEA	Increasing enrolments in some HEs while restricting the enrolment growth in other HEIs improve economic efficiency
Agasisti and Johnes (2010)	Italy	2001-2003; 57 public universities	SFA	The examined technical efficiency is high with a mean efficiency score of 81 per cent

Cokgezen (2009)	Turkey	2003-2004; 70 public and private universities' faculties of economics	DEA	The mean technical efficiency of public faculties of economics is estimated to be greater than that of private ones
Erkoc (2013)	Turkey	2005-2010; 50 public HEIs	SFA	HEIs are performing quite satisfactory concerning their overall efficiency, although there are lots of variations among them
Leitner et al. (2007)	Austria	2000-2001; 12 institutions	DEA	Both large and small departments perform above the average
Afonso and Santos (2005)	Portugal	2003; 52 faculties, institutes and universities	DEA	The faculties and universities could achieve the same level of efficiency by using fewer amounts of academic staff
Kuo and Ho (2008)	Taiwan	1992-2000; 34 public HEIs	SFA	The implementation of the UOF has had a significantly negative influence on the cost efficiency of HEIs
Kipesha and Msigwa (2013)	Tanzania	2007-2012; 7 public HEIs	DEA	Public HEIs are efficient in the utilisation of human resources to produce the number of graduates. Although the public HEIs are inefficient in the revenue generation activities
Agasisti and Johnes (2009)	Italy and England	2003-2004; 57 public Italian and 127 public English HEIs	DEA	English HEIs are gaining stable technical efficiency scores while Italian institutions are trying to improve their efficiency
Aubyn et al. (2008)	17 European countries including the US and Japan	1998-2005	SFA	Public universities in the UK are the most efficient while Greek universities are the less efficient

Wolszczak and Parteka (2011)	7 European countries	2001-2005; 259 public HEIs in seven European countries	DEA	A greater share of finance from external sources improve the economic efficiency of the European public HEIs
Wolszczak (2014)	USA and 10 European countries	2000-2010; 500 HEIs in ten European countries and the US	DEA	Increased public funding is associated with an increase in inefficiency only in the case of European units, while the share of tuition revenue drops the efficiency of American public HEIs but relates to efficiency improvements in the European institutions

5.4 Summary

This chapter reviewed the several existing theoretical and empirical contributions on the efficiency analysis as well as on the development of SFA and DEA techniques in the context of higher education. Particularly, the definitions of four types of efficiency (technical, allocative, economic and scale) those are most frequently utilised in the higher education were extensively discussed throughout the first main section. The second main section was dedicated to discussing the most recent and most cited empirical contributions that applied one of the two frontier approaches to measure efficiency of universities.

According to the review of existing literature, most of the recent frontier and efficiency studies were conducted in the case of HEIs located in upper-middle or high income countries; such as in the United States of America, and lately in the United Kingdom, Australia and the Netherlands. Therefore, we came to the conclusion that there is no empirical study which measures the economic efficiency of HEIs in low or middle income countries. Moreover, majority of the current empirical works do not contain reliable variables for measuring quality of institutional outputs and inputs. To the best of my knowledge, the previous stochastic frontier and efficiency studies on higher education were limited with short sample periods, for example in the Horne and Hu (2008)'s paper the longest time period relative to the other efficiency studies was used, 8-year panel data. Thus, the next chapter aims to contribute to the existing literature through filling all these mentioned research gaps.

Chapter 6: COST EFFICIENCY ANALYSIS OF PUBLIC HEIs

6.1 Introduction

Findings of the preceding chapters exposed the changing revenue sources at public HEIs from government funding to students or self-funding schemes during the period 2000-2013. The aim of Chapter 4 was examining to what extent the changes in income structure effected on the behaviours of public universities in Uzbekistan. More specifically, the study investigated whether or not the Uzbek HEIs increased shares of funding allocated to the education and other related activities when these institutions derived most part of their income from tuition. Results revealed that a largest fraction of institutional revenue allocated to education activities as institutions became more dependent on tuition revenue. However, findings of the first empirical chapter cannot answer the critical and obvious question of whether or not this shift in resource allocation is associated with increased institutional cost efficiency. Therefore, it is a vital to examine whether or not the institutional revenues generated from various financial sources have been utilised efficiently at the Uzbek HEIs.

This analysis is expected to be the first cost efficiency study in the case of public HEIs in low and middle income countries. As the study of Stevens (2005), we use a method that allows us to not only account for inefficiency in HEI provision, but also examine the influences on inefficiency. During the analysis, we also use longer time period, t=14 years, compared to the existing stochastic frontier studies. In addition, two student specific factors are used in this study in order to account for the quality of outputs produced by the Uzbek HEIs. This chapter also contributes to the existing literature through examining the cost efficiencies of different

groups of public HEIs divided according to the percentage of funding received from government. This examination helps to identify whether those Uzbek universities with a smaller share of public allocations are more cost efficient relative to those universities with a greater share of public funding.

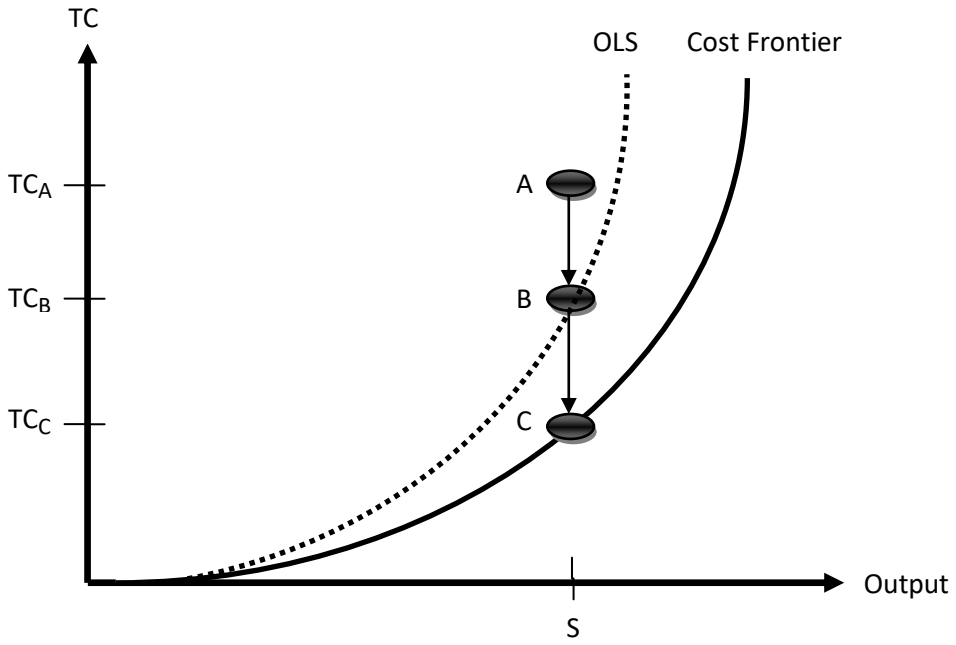
After this brief introductory section, the next section describes the models, methods and data which are utilised to measuring cost efficiency of public HEIs in Uzbekistan. Section 6.3 discusses empirical results which were estimated by applying the method of Battese and Coelli (1995). At the end of this section, mean inefficiency scores and re-estimated government funding effects are also exposed. Section 6.4 reveals a summary of the chapter.

6.2 Methodology and Data

6.2.1 Stochastic cost frontier analysis

Using information on the outputs and the price of the input, together with a behavioural assumption that public universities' objective is to minimise costs, the cost frontier and efficiency of the Uzbek HEIs can be estimated (Kumbhakar and Lovell, 2000). This assumption seems a plausible since all public higher education establishments in Uzbekistan are not-for-profit entities, as in many other countries (NHDR, 2011).

Figure 6.1: An illustration of the cost frontier (OLS vs. cost frontier)



The cost frontier shows the best that can be attained economically, and it also describes standards against that the economic efficiency of institutions can be measured (Kumbhakar and Lovell, 2000). In other words, in a given output level and input prices relying on available technology of production that the stochastic cost frontier model estimates minimum cost. Afterwards, institutional cost efficiency can be defined by dividing the estimated (minimum) cost to actual (observed) cost. The concept of cost frontier analysis and cost

inefficiency is presented in Figure 6.1 in order to give a more intuitive explanation for how SFA works.

The figure above describes the relationship between total costs (TC) and an output (e.g., a FTE student) of institutions. As an example, the author uses three imaginary HEIs (A, B and C) each with different costs but produce same level of output, S. A typical regression analysis such as OLS characterises the relationship between average costs and output, thus it predicts the behaviour of the average institution (Wooldridge, 2002). In the OLS estimation, contrary to the cost-minimisation assumption, some observations can lay below the regression line as a university C in Figure 6.1. However, the stochastic frontier predicts a minimum cost at given level of output relative to OLS, therefore there cannot be any institution with observed cost less than the minimum cost. According to the SFA, the university C is cost efficient and it shows the minimum feasible cost for producing a FTE student. However, universities A and B are less cost efficient in producing output, S. The cost inefficiency for university B with output, S, and total cost, TC_B, is the ratio of the distance between C and S to the distance between B and S. Therefore, the institution A is less efficient or more inefficient than institution B, because the distance AC is longer than distance BC. Since actual total costs, TC_A, TC_B and $TC_{C,}$ are observable, estimation of cost frontier is required to evaluate cost efficiency level of the HEIs.

According to many scholars, universities should be treated as multiproduct organisations, since their activities are aimed to education, research and public services (Cohn et al., 1989). The traditional multiple-output cost function which examines the impacts of the multiple outputs and input prices on the institutional cost is usually interpreted as:

$$TC = c(y, w; \beta, \gamma) \qquad (6.1)$$

Where, TC - is the total cost; y - is a vector of output variables; w - is a vector of input prices; and β and γ are parameters to be estimated.

Stochastic frontier cost function (SFCF) following the pioneering works of Aigner, Lowell and Schmidt (1977) and Meeusen and Van den Broeck (1977) is specified as:

$$TC_i = c(y_i, w_i; \beta, \gamma) + v_i + u_i \quad \text{or} \quad TC_i = \beta y_i + \gamma w_i + v_i + u_i \qquad (6.2)$$

Where, $\beta y_i + \gamma w_i + v_i$ is the optimal, frontier target (e.g., the minimum cost) pursued by institution. $\beta y_i + \gamma w_i$ is the deterministic fraction of the frontier and $v \sim N[0, \sigma_v^2]$ is the stochastic fraction, these two parts together constitute the stochastic frontier (Greene, 2008). v_{it}[22] - a normally distributed random error that captures the factors outside the control of the institutions, measurement errors and the usual statistical noise. u_{it} - evaluates the causes of cost efficiency such as input characteristics, various environmental factors and managerial decisions. This term can be measured in the following way:

$$Cost\ efficiency = \frac{\beta y_{it} + \gamma w_{it} + \theta z_{it} + v_{it}}{\beta y_{it} + \gamma w_{it} + \theta z_{it} + v_{it} + u_{it}} = \frac{TC_{it}^M}{TC_{it}^O} \qquad (6.3)$$

Usually, an analyst should specify the shape of the distribution of the efficiency term a priori. Until now, Aigner et al. (1977) used half-normal, Stevenson (1980) proposed truncated normal, Greene (1980) applied gamma as well as Beckers and Hammond (1987) extended exponential distribution function for inefficiency component of error term. To choose the best fitted distribution is very problematic, previous theoretical insights of scholars do shape this decision making process. However, Coelli et al., (2005) suggest that a half-normal and an exponential distribution are the best candidates which have simpler structures compared to the other options. In the present study, the half-normal distribution truncated at zero was

[22] The random error is assumed to be independently and identically distributed (i.i.d) with zero mean and variance σ^2. v_{it} and u_{it} are distributed independently of each other.

employed; thus the cost efficiency is assumed to have a strictly non-negative distribution, $u_{it} \geq 0$.[23]

SFCF was extended to panel data by Battese and Coelli (1993, 1995), and the general form of total cost for university *i* and time *t* can be represented as:

$$TC_{it} = c(y_{it}, w_{it}, z_{it}; \beta, \gamma, \theta) + v_{it} + u_{it} \qquad (6.4)$$

$$i = 1, 2, \dots, N; \qquad t = 1, 2, \dots, T,$$

z_{it} - is a vector of observable explanatory variables that impact costs directly, and θ - is a parameter to be estimated.

Also, equation (6.4) can be interpreted in the following way:

$$TC_{it}^{M} = \beta y_{it} + \gamma w_{it} + \theta z_{it} + v_{it} \leq TC_{it}^{O} \qquad (6.5)$$

$$TC_{it}^{O} = TC_{it}^{M} + u_{it} \qquad (6.6)$$

Where, $u_{it} \geq 0$.

TC_{it}^{M} - represents university *i*'s minimum potential (estimated) cost at time period *t*; TC_{it}^{O} - the actual (observed) total expenditures for university *i* and time *t*. The institution's actual total cost (TC_{it}^{O}) is normally greater than or equal to the minimum estimated cost (TC_{it}^{M}).

Combining equations (6.5) and (6.6) leads to:

$$TC_{it}^{O} = \beta y_{it} + \gamma w_{it} + \theta z_{it} + \varepsilon_{it} \qquad (6.7)$$

$$\varepsilon_{it} = v_{it} + u_{it}$$

[23] A HEI can be interpreted as fully cost efficient if that institution reaches its minimum cost, where ($u_{it} = 0$).

SFA characteristically assumes that the regression residual consists of two error components: the first error component is a normally distributed random error; and the second component is the cost efficiency term.

In the early 1990s, Kumbhakar, Gosh and McGulkin (1991) introduced a method for measuring both frontier and inefficiency term of firms with external factors serving as determinants of inefficiency. Further, Battese and Coelli (1993, 1995) modified the method for panel data with time-varying inefficiency which allows inefficiency to change over time. In this efficiency analysis, we employ the method of Battese and Coelli (1995) which can rest upon the assumption that the cost frontier is indirectly influenced by the external factors through influencing the inefficiency term. Therefore, z_{it} are assumed as determinants of cost inefficiency and this inefficiency influence in the stochastic cost frontier equation (6.7) are defined as:

$$u_{it} = \delta_0 + \sum \delta z_{it} + w_{it} \qquad (6.8)$$

Where w_{it} is the random variable which is defined by the truncation of the normal distribution with zero mean and (σ^2), such that ($w_{it} \geq -\sum \delta z_{it}$). Battese and Coelli (1995) suggest that "these assumptions are consistent with u_{it} being a non-negative truncation of the $N(\delta z_{it}, \sigma^2)$ distribution".

6.2.2 Functional forms

The next step is to choose a relevant functional form in order to assess the relationship between the institutional expenditure and explanatory variables. Since the true shape of the functional form is not obvious, the decision to select a functional form for empirical analysis is not straightforward (Robst, 2001). According to the previous stochastic frontier studies, some researchers opted for the Cobb-Douglas, Leontief or CES cost function models which

are usually more restrictive and impose numerous restrictions upon parameters of the cost function. Nevertheless, these functional forms have simplistic structure and usually require less data for estimations (McMillan and Chan, 2006).

Some of the scholars, however, prefer to use more flexible functional forms, such as translog, Quadratic or Generalised translog. These cost function models are less restrictive and they provide local second-order approximation to any well-behaved underlining cost function. However, it is important to take into account that the analysis of those less restrictive functional forms usually requires a large sample size. In addition, the model parameters can be imprecisely estimated because of multicolinearity among the regressors (Kumbhakar and Lovell, 2000). In general, the selection of functional form is mostly motivated by the data character and availability, as well as by sample size.

In the context of higher education, the total costs of universities have been estimated using different functional forms in the case of different countries. For example, Izadi et al. (2002) opted for CES functional form for the UK HEIs; McMillan and Chan (2006) used Cobb-Douglas functional form for the Canadian universities; in their recent published papers, Daghbashyan (2011) and Sav (2012) applied Cobb-Douglas cost function for the Swedish and American universities, respectively. However, there are some other scholars who preferred to use the more flexible functional forms: Agasisti (2016), Horne and Hu (2008) and Robst (2001) utilised translog cost function for the HEIs in Australia, Taiwan and America, respectively; Johnes and Johnes (2009) as well as Agasisti and Johnes (2015) opted for Quadratic cost functional form for the British HEIs. In his recent study, Erkoc (2013) used both Cobb-Douglas and translog cost function models for the Turkish institutions of higher education.

In many efficiency studies, the translog and Cobb-Douglas specifications have been eschewed by many scholars considering the costs of multiproduct entities because the predicted values of costs for HEIs that produce zero values of some outputs are nonsensical. According to Baumol, Panzar, and Willig (1982) that the cost function of a multiproduct entities should meet a number of requirements. Foremost, "cost functions must allow sensible predictions to be made for the costs of institutions that produce zero levels of some outputs" (Agasisti and Johnes, 2015; p. 71). In this study, none of the HEI in the sample produces zero of any of the outputs. Therefore, this research does not violate the desiderata of Baumol et al. (1982). Moreover, the function need not be linear in order to allow for economies of scale or scope. Since the main purpose of this study is to measure efficiency level of HEIs using the determinants of inefficiency rather than issues such as economies of scale and scope, this study does not face this problem and can apply the translog functional form. I specify the following translog cost function, which will be estimated using the SFA:

$$lnTC_{it} = \beta_0 + \beta_1 lnUG_{it} + \beta_2 lnPG_{it} + \beta_3 lnRES_{it} + \gamma_1 \, ln\, SALARY_{it} + 0.5\beta_{11}(lnUG)^2 + 0.5\beta_{22}(lnPG)^2 + 0.5\beta_{33}(lnRES)^2 + 0.5\gamma_{11}(lnSALARY)^2 + \beta_{12} lnUG lnPG + \beta_{13} lnUG lnRES + \beta_{14} lnUG lnSALARY + \beta_{23} lnPG lnRES + \beta_{24} lnPG lnSALARY + \beta_{34} lnRES lnSALARY + \sum_m^8 \theta_m Z_{m,it} + v_{it} + u_{it} \quad (6.9)$$

Where UG_{it}, PG_{it} and RES_{it} are outputs produced by institution *i* during time *t.* UG_{it} - is number of full time equivalent undergraduate students, PG_{it} - is number of full time equivalent postgraduate students, and RES_{it} - is total revenue generated from research and other non-tuition activities. The input price in this analysis is average staff expenditures (total staff costs divided by staff FTE), $SALARY_{it}$. Z_{it} - captures the determinants of cost inefficiency which are institution, staff and student specific characteristics, including two revenue sources; the share of government allocations and the share of tuition revenue. Finally, v_{it} – is a symmetric error component reflects the statistical noise and u_{it} – is a non-negative truncated distribution captures the influences of inefficiency. Additional to the

outputs, input-price and determinants of efficiency, this flexible functional form contains quadratics for each output and input variable as well as six interaction terms in order to account for possible nonlinearities.

Battese and Coelli (1995) time-variant inefficiency model is narrated as:

$$u_{it} = \delta_o + \delta_1 PROF_{it} + \delta_2 FTS_{it} + \delta_3 SIZE_{it} + \delta_4 MED_{it} + \delta_5 STIP_{it} + \delta_6 LOAD_{it} + \delta_7 GA_{it} + \delta_8 TR_{it} + w_{it} \qquad (6.10)$$

Through assuming that v_{it} and w_{it} are distributed independently of each other, a simultaneous equations approach that uses one-stage Maximum Likelihood Estimation (MLE) method is applied in this study. The MLE is employed in order to estimate the regressors' parameters of the cost function and the cost inefficiency effect model.

6.2.3 Data description

For the present study, a major proportion of the data for individual universities are collected from the MDFSS&S under the Ministry of Finance of Uzbekistan.[24] All institutional financial data, such as institutions total costs, institutional revenues from research and other private activities, average annual salaries, and average annual stipends, are derived from the Annual Financial Reports (AFR) of public HEIs in Uzbekistan. These reports were originally conducted by the MDFSS&S. Moreover, the share of government allocations[25] and the share of tuition revenue[26] variables are estimated using the data from the AFR of public HEIs.

Two output indicators such as the number of FTE undergraduate and postgraduate students, as well as institutional and student characteristics are drawn from the annual reports prepared

[24] The author has visited to the MFUZB for the second time between the period 05/01/2015 and 23/01/2015. A confirmation letter from this ministry can be found from the Appendix C, but an original copy is available from the author upon request.
[25] The share of government allocations = (amount of government allocations/total institutional revenue)*100
[26] The share of tuition revenue = (amount of tuition revenue/total institutional revenue)*100

by the MDFSS&S. The data on staff characteristics are available from the official web-site of the MHSSE, but not for the all required period. Therefore, the data on staff characteristics for the entire period are collected by cooperating with the Department of Financing and Accounting under the MHSSE.[27] Furthermore, all the financial data those derived from the MFUZB are available only in the national currency of Uzbekistan. Accordingly, the nominal Uzbek Soms data are transferred into real Uzbek Soms using the CPI inflation measurement for each study year.[28]

The sample size of this study initially consisted of 62 public HEIs and 14 years sample period, same as the sample size of the previous empirical chapter. However, data for the majority variables and years are missing for the four institutions of higher education. Moreover, these four HEIs produced zero teaching and research outputs during sample period. Such as, Tashkent State Aviation Institute have not conducted research, but produced postgraduate students between 2002 and 2007 only. The rest of three HEIs, Fergana branch of Medicine Academy, Uzbekistan State Conservatory and Nukus branch of Arts and Culture Institute, produced neither research nor postgraduate outputs. Therefore, these institutions are withdrawn from the analysis and a balanced sample consists of 812 institution-year observations representing 58 public institutions of higher education each with 14 year variables. 21 HEIs out of 58 opened up and operates in the capital city, Tashkent, and the remaining of the institutions are dispersed almost homogenously all around the country.

[27] The author greatly appreciates the valuable and useful comments of Sarvar Buzrukhonov, Head of Financing and Accounting Department of the MHSSE.
[28] All financial data are deflated to 2013 UZB Soms [Source: IMF World Economic Outlook Database (2015)]

Table 6.1: Changes in inflation adjusted government allocations and tuition revenue (2000 compared to 2013)

	Tuition Revenue		
	Increased	*Decreased*	*Total*
Government Allocations			
Increased	01	0	01
Decreased	57	0	57
Total	58	0	

One of the main goals of this chapter is to examine the impact of the changed institutional revenue structure on institutional cost efficiency. Thus, Table 6.1 exposes the shifting emphasis from government allocations to tuition revenue. In other words, the table above describes the reducing importance of government funding as a main financial source at the Uzbek public institutions between 2000 and 2013. Among 58 HEIs, inflation adjusted tuition revenue increased for 57 over the period of 2000 to 2013, while their income from government allocations considerably decreased. This finding is consistent with other scholars' findings (e.g. Healy and Schmidt, 1997; Robst, 2001). Thus, the costs of HEIs were heavily shifted from citizens who pay taxes to students. Only the National University of Uzbekistan, which has the highest FTE student enrolments, has experienced both increased inflation adjusted tuition and government funding during the sample period.

The descriptive statistics of all variables utilised during the empirical estimations are presented in Table 6.2. The table below shows that, on average, the total expenditure of 58 HEIs was more than 8 billion real UZB Soms during the period 2000-2013, of which 40 percent spends for faculty expenditures. The share of revenue from tuition and government allocations averaged 54 per cent and 46 per cent, respectively, over the 14 years. However,

revenues from research and other private activities are very low (almost insignificant) relative to the other two main income sources. Since the conducting research is not first priority for the Uzbek universities, a huge portion of the institutional expenditures are mainly disbursed for educating undergraduate and postgraduate students (NHDR, 2011).

Table 6.2: Descriptive statistics of the key variables

Variable Description	Abbreviation	Mean	St. Dev.	Min	Max
Total Annual Expenditures					
Total Cost (in real 2013 UZB Soms million)	TC	8,220	8,700	51	54,000
Output Indicators					
Undergraduate Students	UG	3,189	2,306	181	12,090
Postgraduate Students	PG	185	232	3	1,630
Incomes from research & other activities (in real 2013 UZB Soms million)	RES	276	431	0.01	3,800
Input Price					
Average staff costs (in real 2013 UZB Soms million)	SALARY	4	3	0.23	18
Exogenous Factors					
Annual stipends per student (in real 2013 UZB Soms million)	STIP	0.8	0.6	0.02	5.1
Number of students per teacher	LOAD	8	3	1	20
% of professors	PROF	4	4	0	20
% of full time staff	FTS	53	12	11	99
FTE enrolled students	SIZE	3,374	2,413	204	12,648
Dummy for medical HEI	MED	0.14	0.35	0	1
Revenues					
Share of government allocations (%)	GA	43	16	4	94
Share of tuition revenue (%)	TR	55	16	6	95

The number of FTE undergraduate students, on average, was around 3,189 with a range of 181 to 12,090 between the years 2000-2013. However, on average, over 17 times less amount of FTE postgraduate students with a range of 3 and 1630 were 'produced' at the Uzbek HEIs during the sample period. The annual salary of both academic and administrative personnel is used as the input price in this study. On average, more than 4 million real UZB Soms were paid to per faculty and non-faculty personnel over the 14 years at public HEIs. Overall, the

eight observable external variables are chosen to account for the possible influences of the changing characteristics associated with student, staff, institution and two institutional main income sources. Detailed discussions of the all selected variables are given in the next sub-section.

6.2.4 Selection of variables

The costs measure includes both current and capital expenditures (in the form of depreciation). In addition to the total cost factor, the traditionally required data for estimation of cost frontier and efficiency analysis are the output and input variables as well as the observable explanatory variables which may have impacts on total costs through an inefficiency term. In this sub-section, the selected institutional outputs and input-price features are discussed along with their quality capturing limitations. Moreover, several students, staff and institutional characteristics which serve as inefficiency determinants are presented at the end of this sub-section.

Outputs and input-price of HEIs

It is well acknowledged that the main objective of any HEI is to "produce" knowledge based outputs, such as education and research, by utilising physical input units (technical efficiency) or expenditure-based units (cost efficiency). Another institutional output measure is public service that is used a very rarely in the higher education efficiency studies. It is normally entirely immeasurable. The selections of outputs, which can be the best proxies for outputs of education, have always been subject to significant disagreement among scholars of higher education. Therefore, majority of the institutional production and cost based studies acknowledge that the estimated coefficients are frequently distorted because of challenges in efficiently accounting for outputs' quality (Dundar and Lewis, 1995; Sav, 2012).

In many efficiency studies, the most frequently utilised measures of higher education outputs are the FTE number of undergraduate and postgraduate students (Cohn et al., 1989; Robst, 2001; Salerno, 2003; Stevens, 2005). These easy identifiable outputs are the most commonly used variables in the efficiency literature despite of their well-documented limitations on accounting for quality of students produced at HEIs. For example, consider two institutions which educating the equal number of students where one provides a "standard" education while another provides an "excellent" education. In a efficiency study, if these two institutions are compared based on their FTE student enrolments, the institution that educating more students per (academic) staff can be regarded as more cost efficient, not the one that providing better quality education. In other words, one university may offer a high quality education for only few students but another university may provide a mass education but does not put considerable effort into teaching. However, the latter university would be regarded as more efficient over the former. The failure to account for this form of quality factors may emerge misleading analysis and comparison.

Another alternative education output is number of degrees granted which is less commonly used indicator relative to other output proxy, such as the physical headcounts of FTE enrolments. One of the main drawbacks of this measure of education output is that it reflects the outputs of HEI operation in preceding years by ignoring the fact that students who could not finish education may continue receiving one or more years' worth of instruction. In other words, the number of degrees granted variable does not account for students who have not yet completed their instruction but already received one, two or three years' worth of education. Therefore, most of the scholars stress that degrees awarded cannot adequately capture the production of education in the efficiency studies (Stevens, 2005; Agasisti, 2016). Since *the number of FTE undergraduate and postgraduate students* are the best accessible outputs

which can be obtained from the available data, this study employs these two proxies for measuring outputs of education while recognizing the existence of quality limitations.

The same quantity and quality puzzle also exist in measuring the research output. From the previous studies, it is evident that they are almost exclusively employed either publication counts or research expenditures for measuring research output. However, both of these proxies come with their own shortcomings. For example, not every research output is in the form of journal publications, such as patents issued, conference papers and book reviews are all feasible research outputs and simply selecting one over others may lead to imprecise evaluation and results. At the same time, the research expenditure is in fact an input and not an output in the production process. Whereas, most of the empirical studies also use the institutional research revenue as an output measure through suggesting that the ability of HEI to generate funding from research activities is closely related with its research output (Cohn et al., 1989).

According to Johnes (2014), the use of research grants as an output "is also an attractive measure of research in that it provides an up-to-date picture of research activity and output in the current academic year". In the present study, *the research income* is used as a proxy for research output of the Uzbek HEIs despite of all the potential drawbacks of this approach. Nevertheless, Cohn et al. (1989) suggest that a weighted measure of all the various research outputs would be the supreme output measure. Unfortunately, the data in the hands are not reach enough for taking weights of all various research outputs produced at the public universities in Uzbekistan. Although this is common problem in almost all cost and production studies of higher education.

In the cost and production estimations, input prices are the next category of factors must be included into the model. What form of input measure to use is depends on what form of

efficiency is being examined. Physical input units (usually measured by FTE faculty numbers) are used in the technical efficiency analyses, while expenditure-based units are employed in the cost efficiency assessments (Kumbahakar and Lovell, 2000). In the previous cost efficiency studies, inputs are usually measured either by annual faculty salary (Stevens, 2005) or annual capital expenditures (Erkoc, 2013). In the both cases, there is no practical approach to control quality of input prices.

Some scholars argue that faculty quality can be evaluated by using faculty salary data (Dundar and Lewis, 1995), although it does not seem a very plausible assumption in the context of higher education. For example, consider that two HEIs spend the same amount of financial resources on their academic and non-academic staff as a form of annual salary. However, a "staff expenditures" input measure cannot discriminate between universities employing well experienced and qualified versus average experienced and unqualified faculty members (Salerno, 2003). In this analysis, *the average annual salaries* (total staff cost divided by FTE staff) of teaching, research and administrative personnel is used as the input-price. Nevertheless, it would be a great contribution to the existing cost efficiency literature if we had data which help to distinguish between the expenditures spent to different staff categories. The capital expenditure is not included to the current analysis due to the data limitations, but as Daghbashyan (2011) argued "this is a common problem, and as a result it is unusual for capital input measures to appear in HE cost studies" (p. 9).

Observable explanatory variables

The cost efficiency estimation normally has two components. The first is the evaluation of a stochastic cost frontier which serves as a benchmark against that to evaluate the cost efficiency of institutions. The second component is also vital, because it concerns the association of exogenous factors, which are neither outputs of production nor inputs to the production process (Robst, 2001). However, the determinants of efficiency influence on total

cost either directly through affecting the cost frontier, (TC_{it}), or indirectly through affecting the inefficiency term (Kumbhakar and Lovell, 2000). Examples for the exogenous variables, which characterise the environment in which "production" occurs, can be input and output quality indicators, various staff characteristics, ownership forms and the like. Certainly, the selection of such variables is controlled by data availability (Stevens, 2005). In this study, several determinants of efficiency which may influence on the cost efficiency of public HEIs are separated into several following categories.

Two student characteristics are included to the analysis in order to account for quality of educational outputs (or quality of students). The first variable is *the annual stipends per student* serves to measure quality of students and may work a very-well in the context of public HEIs in Uzbekistan. As it is discussed in Chapter 2, every FTE enrolled student of the Uzbek universities must be provided with the institutional stipends in each month of student's study period. However, an amount of the monthly stipends depends on a student's average grade from the preceding semester. For example, students receive small, medium or high levels of stipends according to the following grading scales: if a student's average grade lower than 70 per cent (situated between 55-70) receives the smaller stipends, while a student with average rating between 71-85 per cent receives the medium stipends, or one can have the highest stipends with an average grade over 86 per cent (situated between 86-100). In other words, “higher” quality students receive higher monthly stipends relative to "lower" quality students at the Uzbek HEIs. This leads us to make an assumption that a university with greater number of "excellent" students is more likely to have higher teaching quality and greater institutional expenditures dedicated to monthly stipends. The second quality measure is *the load per academic staff*, defined as the ratio of FTE students to the number of faculty members. Usually, the increase in this indicator would lead to decline in the institutional cost

and to growth in the cost efficiency, while it may have an opposite impact on the quality of educational outputs.

The current study contains also two staff specific factors such as *the share of professors in academic staff* and *the share of full time working personnel*. The former factor selected as a measure of academic personnel quality which may improve the efficient operation of HEIs by having influence on the education outputs. At the same time, it is more likely to increase institutional expenditures. The latter factor may also have significant impact on total costs of HEIs. For example, an institution with greater number of full-time based staff is more likely to have greater salary expenditures relative to another institution which employs fewer full-time based personnel. If it is plausible to make an assumption that an institution with the greater share of professors and full-time personnel provides better quality education, then this institution is more likely to have higher educational costs and thereby lower cost efficiency (Erkoc, 2013).

Two institutional specific factors are also included to the cost efficiency analysis as the exogenous factors in order to capture their potential influences on the cost efficiency of the HEIs. The first institution specific variable is the size of university proxied by *the total number of FTE enrolled students*. This indicator is usually expected to increase institutional expenditures, but it may reduce the costs if a university operates under increasing return to scale (Koshal and Koshal, 1999). The second institution specific factor captures *medical institutes* which can have considerably positive impact on institutional costs. In other words, total expenditures of medicine based institutes are normally much higher than other subjects based HEIs, thus medical institutes are usually less cost efficient (Agasisti, 2016). In the context of the Uzbek higher education sector, medical institutes have higher institutional expenditures relative to other HEIs which offer humanities, social science and engineering

based educations (MFUZB, 2013). Therefore, the inclusion of that determinant is necessary for examining its possible influence on cost efficiency.

The last two determinants of efficiency, *the share of government allocations* and *the share of tuition revenue*, represent the impacts of the main institutional income sources on the cost efficiency of the public universities. Over the last decade, majority of the HEIs were jointly financed through government funding (43%) and tuition income (55%), the rest generated from the other external sources (MFUZB, 2013). Since the higher education sector is not only financed by the government's purse but also funded through the private financial sources, the share of government allocations and the share of tuition revenue vary across the Uzbek HEIs.[29] Therefore, it would be beneficial to find out whether public HEIs are more cost efficient when they are mostly funded by the government or when they are funded by the external stakeholders.

[29] See Figure 4.1.

6.3 Empirical Results

The first sub-section discusses the outcomes of the maximum likelihood estimation of the stochastic cost frontier and the determinants of efficiency, which are estimated using the more flexible translog multiproduct specification. As a robustness check, the discussion of Cobb-Douglas outcomes is provided in Appendix H.[30] The Battese and Coelli (1995) time-variant inefficiency effect model is utilised in order to evaluate the possible influences of the determinants of efficiency on the cost efficiency of public universities. Afterwards, Sub-Section 6.3.2 discusses the estimated average inefficiency scores of the public HEIs. The re-estimated influence of government allocations on the cost efficiency of three different groups of HEIs is presented in the last sub-section.

6.3.1 Cost frontier and efficiency estimates

This sub-section presents the estimated parameters conducted through employing Battese and Coelli (1995) time-variant inefficiency model. This model allows us to estimate conditional mean model with several observable external variables as determinants of inefficiency (u_i). The one-stage MLE is used in order to estimate the parameters of the regressors for the translog cost function after making an assumption that w_{it} in Eq. (6.10) and u_i in Eq. (6.9) are distributed independently of each other (Kumbhakar and Lovell, 2000). Three maximum likelihood regressions are carried out and every regression contains the same number of variables which used to evaluate the cost frontier. Whereas, the selected variables to measure cost inefficiency are not the same for the all models:[31] Model 1 contains only four determinants of efficiency, staff and institution specific factors; Model 2 includes two

[30] In this study, we used the Cobb-Douglas functional form as a robustness check. According to results of Likelihood Ratio test, all the coefficients of second-order terms equal to zero are statistically rejected. In other words, the trans-log specifications have an obvious superiority over the Cobb-Douglas specifications when the method of Battese and Coelli (1995) is used.

[31] As it is stated by Battese and Coelli (1995), coefficients of the determinants of efficiency are interpretable in terms of their signs but not magnitudes.

additional factors which show student specific characteristics in order to account for the quality of outputs produced; and in addition to the institution, staff and student specific characteristics, Model 3 encompasses the two main revenue sources of the Uzbek HEIs.

Table 6.3 presents the cost frontier and inefficiency estimates of the translog cost function pertaining to three different models. The lambda, λ, of all three models are highly significant at 1 per cent level that proves the fact that the divergence from the cost frontier function is to a great extent explained by heterogeneous inefficiency. In other words, the cost inefficiency exists in the provision of higher education at the Uzbek HEIs. The total institutional cost positively correlated to UG and these relationships are statistically significant in the all three models. Unsurprisingly, the influence of PG on the total costs is positive and statistically significant in every model. RES is positively but insignificantly correlated to the institutional expenditures in the first two models. However, the coefficient of this output is statistically significant in 10 per cent level in the third model. The single input factor in the analyses, SALARY, is exposing insignificant values (in Models 1 and 3) and negative sign in the first model only. This variable's coefficient is significantly and positively correlated to the total costs in the third model, and the cost elasticity with respect to the personnel salary is considerably high 1.74.

With regards to the interaction terms, Table 6.3 shows the coefficients of interaction terms between UG and PG as well as PG and RES are significantly negative at 1 per cent level in the all three models. This means that a substitution effect exists between them. The interactions between UG and SALARY is not significant in Model 2, also the coefficients of UG with RES and SALARY are insignificant in the last model. However, the interactions between PG with SALARY are insignificantly positive for the all models. Regarding the findings of exogenous variables, FTS value is negative and insignificant in the all models except the second model. PROF is showing significantly negative correlations to the

institutional inefficiencies in every model. Surprisingly, having greater the share of professors or the share of full-time based personnel decreased the cost inefficiency of the Uzbek HEIs. In the first two models, the total FTE enrolment (SIZE) that is used as a proxy variable for the institutions size is one of the statistically significant factors but with negative signs. The increase in the SIZE of universities may decrease the total expenditures and thus may end up with reduced cost inefficiencies. This outcome can be explained by the greatly increased number of FTE enrolled students relative to the number of academic staff at the Uzbek HEIs during the entire sample period. The findings suggest that these institutions are working under the economies of scale. Unexpectedly, the relationships between the institutions providing medicine-oriented education (MED) and the cost inefficiency are negative but highly significant in the all models, suggesting that having MED is diminishing the institutional efficiency.

With the regards to the determinants of inefficiency, the coefficients of STIP and LOAD are highly significant for the all three models. STIP has positive but LOAD has negative influence on the cost inefficiency as would be anticipated. Perhaps, the positive correlation between the annual average stipends and the institutional spending is signalling for the improving quality of educational outputs produced at the Uzbek HEIs. However, the increase in the ratio of students over faculty personnel may lead to decreased quality of teaching provision, while it may considerably reduce the total institutional expenditures. The results also show that government allocations and tuition revenue coefficients are positive and statistically significant at 5 and 10 per cent levels, respectively. In other words, the growth in the share of GA or TR has increased the cost inefficiency during the sample period.

Table 6.3: Stochastic cost frontier and inefficiency effects

Cost frontier						
	Model 1		*Model 2*		*Model 3*	
Constant	4.045	(3.77)	-7.935**	(3.34)	1.818	(3.25)
LNUG	0.876*	(0.47)	1.466***	(0.34)	0.917***	(0.33)
LNPG	0.833***	(0.23)	0.613***	(0.19)	0.496**	(0.20)
LNRES	0.243	(0.15)	0.004	(0.11)	0.248*	(0.13)
LNSALARY	0.060	(0.48)	1.736***	(0.44)	0.588	(0.46)
LNUGSQ	0.002	(0.03)	0.004	(0.02)	0.021	(0.02)
LNPGSQ	0.056***	(0.01)	0.039***	(0.01)	0.025***	(0.01)
LNRESSQ	0.013***	(0.01)	0.001	(0.00)	0.011***	(0.00)
LNSALARYSQ	0.044**	(0.02)	-0.016	(0.02)	0.023	(0.02)
LNUGPG	-0.055**	(0.02)	-0.0423**	(0.02)	-0.058***	(0.02)
LNUGRES	0.003	(0.01)	0.027***	(0.01)	-0.001	(0.01)
LNUGSALARY	0.014	(0.02)	-0.059***	(0.02)	-0.006	(0.02)
LNPGRES	-0.048***	(0.01)	-0.024***	(0.01)	-0.026***	(0.01)
LNPGSALARY	0.008	(0.02)	0.00444	(0.01)	0.019	(0.01)
LNRESSALARY	-0.030***	(0.01)	-0.00685	(0.01)	-0.032***	(0.01)
Determinants of inefficiency						
Constant	1.622***	(0.19)	3.008***	(0.28)	-2.547	(1.98)
PROF	-0.007	(0.01)	-0.011*	(0.01)	-0.006	(0.01)
FTS	-0.014***	(0.00)	-0.024***	(0.00)	-0.021***	(0.00)
SIZE	-0.0004***	(9.77e-05)	-7.37e-05***	(2.67e-05)	1.27e-05	(2.77e-05)
MED	-0.376***	(0.13)	-0.269***	(0.07)	-0.189***	(0.07)
STIP			0.001***	(0.00)	0.001***	(0.00)
LOAD			-0.126***	(0.02)	-0.077***	(0.02)
GA					0.051**	(0.02)
TR					0.035*	(0.02)
σ_u	0.477***	(0.06)	0.311***	(0.03)	0.274***	(0.03)
σ_v	0.201***	(0.02)	0.172***	(0.01)	0.179***	(0.01)
λ (= σ_u/σ_v)	2.371***	(0.06)	1.805***	(0.03)	1.528***	(0.04)
Log likelihood	-214.70		-77.13		-68.00	
Number of HEIs	58		58		58	

Asymptotic standard errors are in parentheses.
* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

6.3.2 Cost inefficiency estimates by years and HEIs[32]

The purpose of this sub-section is to analyse average inefficiency level of the Uzbek HEIs for the period of 2000 to 2013. Mean inefficiency scores of the all models, where the institution, student and staff based characteristics were captured, are evaluated and discussed in this sub-section. The descriptive statistics for the mean inefficiency scores are presented in Table 6.4. The average scores are revealed by years for each model in that table.

Table 6.4: Descriptive statistics for the cost inefficiency

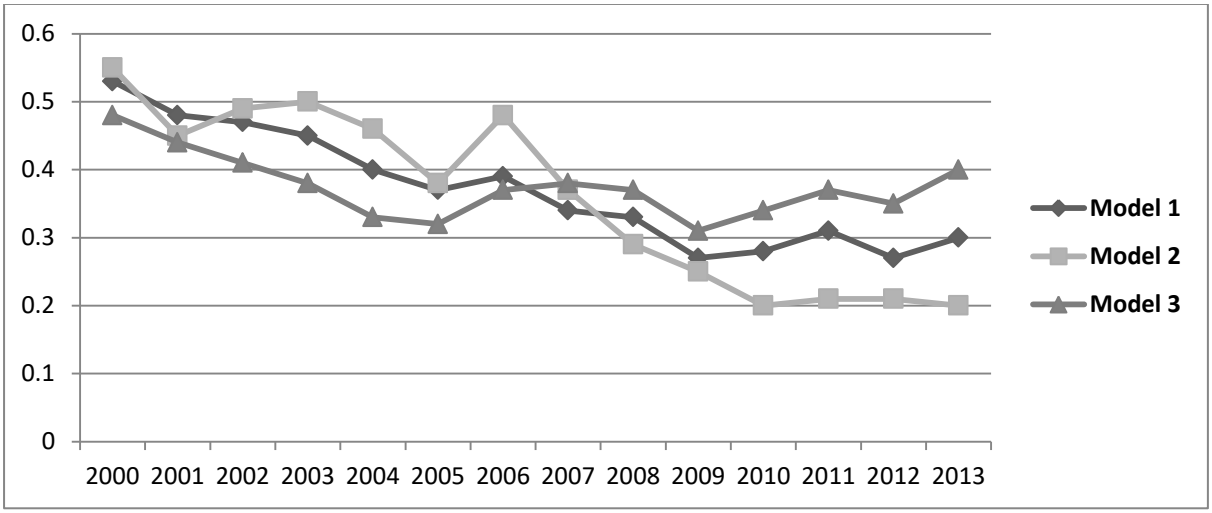
	Model 1		*Model 2*		*Model 3*	
2000	0.53		0.55		0.48	
2001	0.48	-9.4%	0.45	-18.2%	0.44	-8.3%
2002	0.47	-1.7%	0.49	8.9%	0.41	-6.8%
2003	0.45	-4.1%	0.50	2.0%	0.38	-7.3%
2004	0.40	-10.3%	0.46	-8.0%	0.33	-13.2%
2005	0.37	-8.7%	0.38	-17.4%	0.32	-3.0%
2006	0.39	4.9%	0.48	26.3%	0.37	15.6%
2007	0.34	-10.6%	0.37	-22.9%	0.38	2.7%
2008	0.33	-4.4%	0.29	-21.6%	0.37	-2.6%
2009	0.27	-19.5%	0.25	-13.8%	0.31	-16.2%
2010	0.28	6.4%	0.20	-20.0%	0.34	9.7%
2011	0.31	8.5%	0.21	5.0%	0.37	8.8%
2012	0.27	-10.5%	0.21	0.0%	0.35	-5.4%
2013	0.30	9.9%	0.20	-4.8%	0.40	14.3%
Mean	***0.37***		***0.36***		***0.37***	
Median	0.24		0.24		0.29	
Num of HEIs	*58*		*58*		*58*	

The mean inefficiency estimates are not relatively sensitive to model selection. The first model reveals a continuously inefficiency reduction from the period of 2001 to 2009 and in 2012, but this decreasing rate of inefficiency is slowdown and the mean inefficiency started to increase in 2010 by 6, in 2013 by over 8.5 and by 10 percent in 2013. A very similar

[32] Results of average cost inefficiency estimates for each HEI are presented in Figure I1 and Table I1 in Appendix I.

picture emerges in the last model. The second model shows a substantial inefficiency slowdown in the years 2001, 2004, 2005, 2007, 2008, 2009, 2010, and 2013 but the inefficiency increased by 9 in 2002, by 2 in 2003, by 26 in 2006 and by 5 per cent in 2011. According to Figure 6.2, the Uzbek HEIs have managed to constantly reduce the cost inefficiency throughout the sample period. That is, the inefficiencies in the three models are ranged from 48 to 55 per cent in 2000, but they are ranged from 20 to 40 per cent in 2013.

Figure 6.2 Average cost inefficiency scores for the all three models



A mean inefficiency performance of public HEIs in Uzbekistan are not dispersed ranging between 36 to 37 per cent, and it does not vary considerably from one model to another. In other words, the cost efficiency of the 58 public HEIs, on average, ranged from 64 to 63 per cent during the period of 2000 to 2013. Even though there are institutions those mean efficiency scores are corresponding to the values less than 50 per cent, it seems that institutions in Uzbekistan are operating efficiently (see both Figure I1 and Table I1). Moreover, the number of public universities those operating less efficient than 30 per cent and more efficient than 85 per cent are very scarce. Based on the empirical findings, we suggest to the CMUZB to encourage a new set of policy-making decisions which could "force" less cost efficient HEIs (1) to utilise their existing resources more efficiently, as well as (2) to learn how operate more cost efficiently from 'better' efficiently running institutions.

6.3.3 Re-estimated GA effect and inefficiencies

Since one of the main aims of this study is to analyse whether the Uzbek HEIs are more cost efficient with the smaller or greater share of government financing, the public HEIs divided into three different groups according to the percentage of their incomes received from government allocations (GA). Accordingly, the "small" group consist of universities with smaller share of government funding (GA<40%) but with greater share of tuition revenue (TR); the "medium" group has universities with equal proportion of government allocations (40%≤GA<50%) and tuition revenue; finally, the "large" group of institutions with greater share of government allocations (GA≥50%) but with smaller share of tuition income.[33] Table 6.8 illustrates the re-estimated GA effect on cost inefficiency as well as the mean inefficiency scores which are re-estimated using the method of Battese and Coellli (1995) for the each group of HEIs and study years.

The estimated results show that the coefficient of GA effect is negative but statistically significant in 1 per cent level for public HEIs with the state funding lower than 40 per cent. In the case of institutions in the "medium" group, GA effect becomes inefficiency improving and significant at the 5 per cent level. However, GA effect is negative and statistically insignificant for the institutions with the state funding greater than 50 per cent. These findings suggest that the increase in GA improves cost efficiency of the HEIs with lower level of public funding, but the increase in GA reduces cost efficiency of the group of HEIs with the same percentage of public and private financings. According to the re-estimates, the public HEIs with smaller percentage of government funding are, on average, more cost efficient than the institutions with greater share of GA. The Uzbek HEIs those heavily dependent on government funding (GA≥50%) for their daily operation are showing 68 per

[33] Public HEIs in Uzbekistan have two main income sources, such as government allocations and tuition revenue (see Figure 4.1 for more information). Therefore, it seems plausible to assume that a HEI with a greater share of government funding is more likely to have a smaller share of tuition income, and vice versa.

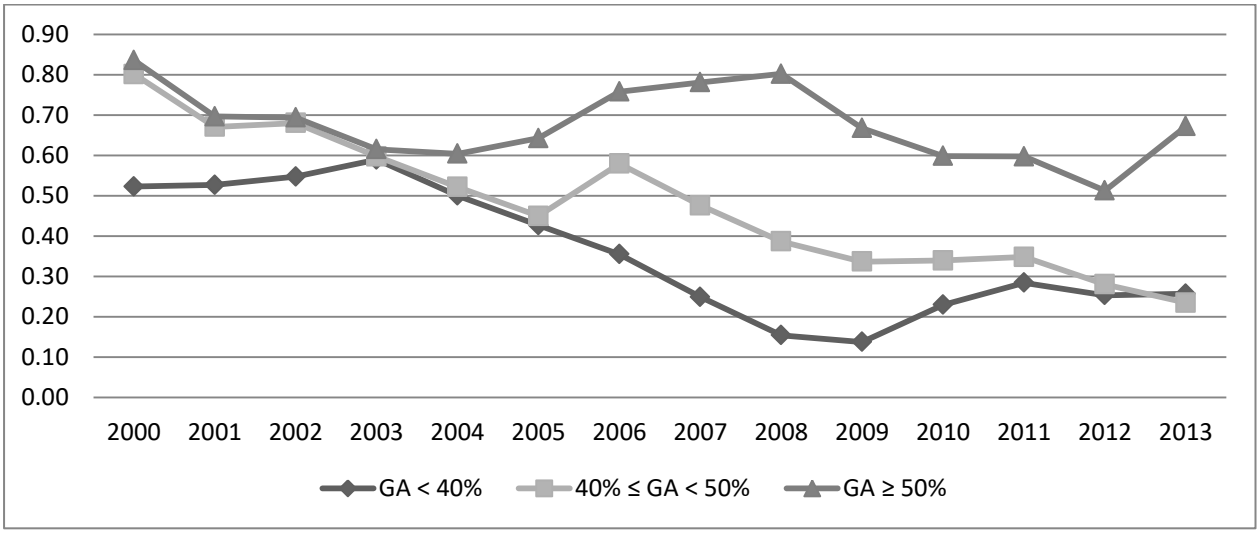
cent average cost inefficiency value, while universities those mostly rely on tuition revenue and receive smaller share of their total income from public funding (GA<40%) are showing 36 per cent mean inefficiency score.

Table 6.5 Re-estimated GA effect and cost inefficiencies

	GA<40%		***40%≤GA<50%***		***GA≥50%***	
GA	*-0.011***(0.002)*		*0.018**(0.006)*		*-0.001(0.004)*	
Inefficiencies						
2000	0.52		0.80		0.84	
2001	0.53	0.7%	0.67	-16.3%	0.70	-16.7%
2002	0.55	3.9%	0.68	1.4%	0.69	-0.4%
2003	0.59	7.7%	0.60	-12.2%	0.61	-11.4%
2004	0.50	-15.1%	0.52	-12.7%	0.60	-1.8%
2005	0.43	-14.7%	0.45	-13.8%	0.64	6.4%
2006	0.35	-16.9%	0.58	28.9%	0.76	18.0%
2007	0.25	-29.9%	0.48	-17.9%	0.78	3.1%
2008	0.15	-38.1%	0.39	-18.8%	0.80	2.7%
2009	0.14	-10.8%	0.34	-12.9%	0.67	-16.7%
2010	0.23	67.2%	0.34	0.8%	0.60	-10.4%
2011	0.28	23.7%	0.35	2.6%	0.60	-0.2%
2012	0.25	-10.8%	0.28	-19.4%	0.51	-14.2%
2013	0.26	1.4%	0.23	-16.4%	0.67	31.2%
Mean	**0.36**		**0.48**		**0.68**	
Median	0.28		0.36		0.57	
Num of HEIs	26		18		14	

Asymptotic standard errors are in parentheses.
* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

Figure 6.3 Average cost inefficiency scores for the three groups of HEIs



According to both Table 6.5 and Figure 6.3, the average cost inefficiency scores for the all groups of public HEIs have noticeably decreased during the sample period. However, those universities with the greater share of government funding have experienced less cost inefficiency reductions than the institutions with smaller percentage of GA during the entire sample period. The cost inefficiency of the "large" group of HEIs has only reduced from 84 to 67 per cent throughout the sample period. The inefficiency of the "small" group of institutions has dramatically decreased during the period of 2003 to 2009, but slightly increased between the years 2009 and 2013. The cost inefficiency trend of the «medium» group of HEIs is exposing very similar findings with the "small" group. All these estimated results suggest that the Uzbek universities with a smaller percentage of GA but with a greater share of TR are more cost efficient than the universities with "medium" or "large" percentage of public funding.

6.4 Summary

This chapter was dedicated to analysing whether the shifted revenue structure at the Uzbek HEIs has increased or reduced the cost efficiency of these institutions during the period of 2000 to 2013. For these purposes, the cost frontier that shows minimum feasible cost for HEIs was estimated using the SFA technique. The potential impacts of the several determinants of efficiency, such as student and staff and institutional characteristics, on the cost efficiency of public universities were also evaluated by employing the method of Battese and Coelli (1995). According to the mean inefficiency scores that the Uzbek HEIs are not remarkably cost efficient in producing educational and research outputs, although the significant improvements in the cost efficiency followed throughout the entire sample period.

Given the overall variation existence in the government allocations, it was thought to be useful to divide the sample size into three different groups of institutions. Consequently, the estimated results reveal that HEIs with the smaller percentage of GA are more cost efficient than the institutions with the greater share of GA. These findings suggest that public HEIs in Uzbekistan should to continue generating a major fraction of their revenue from tuition and other private income sources, but at the same time they have to try not to be heavily dependent on external stakeholders.

Based on the estimated results of the previous and the current empirical chapters, more comprehensive discussions of the findings as well as recommendations to administrative bodies of the Uzbek HEIs and governmental institutions are provided in the next chapter.

Chapter 7: CONCLUSIONS

7.1 Discussion of the findings and policy implications

This study revealed that the revenue structure of public HEIs in Uzbekistan has changed from full government funding to mostly tuition funding over the last 14 years. The main aim of this study was to examine the impact of this shift in the institutional funding structure on behaviour and resource utilisation of state HEIs. For these purposes, this thesis used RDT to analyse and to explain to what extent the increased dependence on tuition payments as a main source of revenue changed behaviours of public universities. The cost efficiency of public higher education establishments was also evaluated in order to find out whether or not institutional fiscal resources were efficiently utilised, as HEIs become more dependent on tuition funding. The findings of this study are expected to offer considerable policy suggestions to administrative bodies of public HEIs and the governmental institutions in Uzbekistan. In this section, key findings of the first empirical chapter (Chapter 4) are discussed first, followed by policy implications. Afterwards, a discussion of the results and policy implications for the second empirical chapter (Chapter 6) are revealed.

The analysis in Chapter 2 exposed that public institutions have funded their operational expenses mostly from tuition income, while the second main source of income for Uzbek HEIs was government allocations during the period 2000-2013. Moreover, the outcomes of the TSLS test which was conducted in Chapter 4 expose that shifts in institutional revenue sources from government funding towards tuition revenue yield powerful shifts in institutional expenditures allocated to educational expenses. In other words, the institutional

expenditures dedicated to education and other student related activities have considerably increased at public HEIs, when these institutions had greater resource dependence on tuition revenue. Therefore, this finding is consistent with the predictions of the RDT. This empirical finding is in the line with findings of Fowles (2013), Slaughter and Leslie (1997) and Tolbert (1985). These scholars find that the American public HEIs relied more on incomes from tuition and other user fees for financing their educational and other related expenses due to the reduced state appropriations. Nevertheless, these findings suggest that this declined government financial support may have serious influences on the outputs produced by public universities.

As it was remarked earlier that universities are multi-output institutions that serve a diverse clientele of internal and external stakeholders. Therefore, when universities seek out external financial sources to fill the gap left by the reduced public funding, they enter into implicit contracts with those stakeholders which may change behaviours of universities. According to my findings, the Uzbek universities have focused more on financing educational activities when they became more dependent on tuition income. At the same time other forms of institutional activities, such as applied research through partnerships with private or public entities, have not been adequately supported by public HEIs.

Since the early 2000s, CMUZB has demanded from all public HEIs to derive a main fraction of their income by charging tuition and other user fees. Therefore, tuition revenue has been seen as the main replacement source to the reducing public subsidies at the Uzbek HEIs. However, as Fowles (2013) notes that "the strings attached to new funding steers faculty and administrators in new directions that are potentially at odds with institutional missions, at least as these core missions have been defined historically". That is, if CMUZB has implicit bargain with the HEIs which aims to direct government allocations to the provision of free education to the state grant-based students or which requires the government allocations to be

spent mainly for public services and research endeavours that may bring considerable benefits to the public, then the increased dependence on tuition revenue will likely be accompanied by a reduction in the production of these activities.

Throughout the last decade, the Uzbek government and public HEIs have accepted this trade-off through directing a huge share of institutional expenditures for educational activities. A very insignificant share of institutional funds is allocated to carrying out research activities at public institutions, and this issue is repeatedly and admittedly emphasised in the annual reports of MHSSE. In addition, to the best of my knowledge, none of the Uzbek HEI has dedicated any fraction of its financial resources for improving and supporting public services yet. Fowles (2013) proposed a plausible suggestion in the case that if this trade-off is permissible to policymakers, "if so, it seems that prudent public policy would suggest making this bargain explicitly and accompanying it with a fundamental renegotiation of the relationship between public institutions and the state in which they reside, rather than introducing these changes as an accidental consequence of evolving state expenditure patterns" (p. 284).

The Uzbek government bodies need to consider introducing policy decisions which could give more financial flexibility to public HEIs in managing their fiscal resources. Once the policies are in place, CMUZB should to demand from the all institutions to increase their financial supports to not student related expenses only but to other institutional activities as well (e.g., to improve scientific research). Although allocations of the greatest share of tuition income to the educational activities at the Uzbek HEIs seem totally fair from the RDT perspective. However, the policy decisions must be powerful enough to 'force' administrative bodies of public universities to allocate a significant fraction of their institutional income for improving quality of research activities and public services.

At the same time, the Uzbek HEIs need to improve their cooperation with foreign organisations those are operating in Uzbekistan, such as EBRD, The World Bank, Asian Development Bank, UNESCO and many others, in order to obtain more research funding and grants. Another way to generate considerable research income could be by creating entrepreneurial centres at the Uzbek HEIs for developing businesses and innovative projects initiated by academic staff. This type of entrepreneurial centres is already implemented at most of the public HEIs in the US and the UK, and projects which are conducted in these centres bring a considerable amount of private funds for these universities.

The empirical study conducted in Chapter 4, however, is not able to answer the critical and obvious question of whether or not this increased educational expenditure at public HEIs is actually associated with increased quality of institutional outputs and increased institutional efficiency. A few but growing empirical evidences reveal that the increased educational expenditures do not always lead to successful long-term student outcomes (Coupet, 2013; Pike et al., 2006). To some extent, the second empirical part (Chapter 6) answered to this question through examining the efficient utilisation of fiscal resources at the universities.

Using SFA technique and the method of Battese and Coelli (1995), the cost frontier and cost efficiency of 58 public HEIs for the period of 2000 to 2013 were estimated. The results show that the Uzbek universities mostly focused on producing teaching-based outputs, while paying less attention to conduct research-based activities. Relative to the other institutional outputs, the number of undergraduate students can have a greater influence on the total expenditure as anticipated. These findings can be interpreted as; the Uzbek HEIs have increased production of undergraduate students through increasing institutional expenditures, whereas the increases in enrolments of postgraduate students and research activities have not been significantly supported by the institutional purse. Therefore, it seems plausible to expect

that public institutions with a greater share of undergraduate enrolments were less cost efficient than institutions with a smaller share of undergraduate students.

The determinants of efficiency usually have considerable impacts on the institutional total costs through the inefficiency term. In the majority of efficiency studies, measuring the quality of outputs produced by higher education establishments was one of the challenging tasks. In this study, we used the "brand-new" STIP factor (developed based on the context of Uzbek HES) and more often utilised the students/staff ratio factor in order to examine whether or not the increased production of education-based outputs are associated with improved quality of students at public HEIs. According to Table 6.3, the increase in LOAD led to reduction in the institutional cost inefficiency but the growth in STIP increased the cost inefficiency as anticipated. However, education quality is more likely to decline in the case of increased LOAD and decreased institutional STIP. In the future, all these findings of the current analysis should to serve for improving cost efficiency of Uzbek HEIs.

If a main objective of the Uzbek HEIs is to improve quality of education and not cost efficiency, then the shares of both professors and full-time staff should be increased. In addition, the number of FTE enrolled students should be increased to reduce cost inefficiency and institutional cost. In most of the cases, expanding SIZE of HEIs increases the student and staff ratio and therefore the education quality is more likely to shrink. Since HEIs with medical schools are both labour and cost intensive, these institutions are expected to have greater cost inefficiency compare to the institutions without medical schools. Surprisingly, the Uzbek HEIs those provide medical instructions have not experienced the growth in the total expenditures and cost inefficiencies during the sample period. Perhaps, one of the reasonable explanations for this outcome can be the low level of staff salaries at the medical institutions in Uzbekistan. In other words, annual wages of academic staff at the medicine

oriented institutions do not significantly differ from annual salaries of personnel at the non-medicine oriented institutions.

Since this study has some limitations which are outlined in the next section, the Uzbek policymakers are required to be extremely cautious before making any decision on increasing or decreasing any of the university-based characteristic. Furthermore, the mean inefficiency scores of public HEIs exposed interesting results which deserve to be discussed more in detail. To estimate the mean inefficiency scores was a very important in order to analyse the financial performance of public HEIs operating in Uzbekistan. The estimated results reveal that the mean cost efficiency scores were not remarkably high, even though there are signs of efficiency improvements among the HEIs over the last 14 years.

The findings of the average inefficiency evaluations suggest that the legislative bodies of Uzbekistan should to encourage a new set of policy-making decisions which could 'force' the less cost efficient HEIs to utilise their resources more efficiently and to learn from their prosperous counterparts how to operate more cost efficiently. In other words, administrative bodies of the Uzbek HEIs should to take these average efficiency findings as a lesson and should to strive operating above than the mean efficiency scores. Whereas, public institutions those have a very high cost efficiency values need to keep their financial performance high utilising the right combinations of institution, student and staff specific factors.

The incomes from government and tuition have been the main financial resources for the all Uzbek HEIs during the period 2000 and 2013. According to my findings, institutions with the greater share of tuition revenue but with the smaller share of public funding were more cost efficient compared to institutions with the smaller fraction of tuition revenue but with the greater fraction of government allocations. Particularly, all HEIs' public share of revenue has reduced during the sample period but institutions with the greater public share reductions

(GA<40%) increased cost efficiency more than institutions with smaller public share declines (GA≥50). These results are not consistent with findings of Robst (2001) and Sav (2012) who conducted cost efficiency analyses in the case of the American public HEIs. To the best of my knowledge, there is no other empirical study which examines the impact of the reduced public funding or the increased tuition revenue on the cost efficiency of universities.

Based on these findings, we can infer that the Uzbek HEIs with greater tuition income shares have utilised their fiscal recourses more prudently and wisely relative to those public institutions with greater government funding shares. Consequently, these findings have important policy implications given administrative bodies of CMUZB use of tuition revenue to influence institutions efficiency. Although the Uzbek legislators' influences were not strong enough to make public institutions, particularly HEIs with GA≥50, utilise the government allocations more efficiently during the sample period.

Since I am working for the Banking-Finance Academy under the CMUZB as a dean of postgraduate faculty, the policy implications those are reviewed in this study would be useful for conducting more comprehensive research and extending my knowledge on HES of Uzbekistan.

7.2 Limitations of the study

There are some key limitations to the research conducted in this thesis. First, the dataset which was utilised in this thesis captures almost entire universe of public HEIs in Uzbekistan, but it does not contain data on the seven branches of foreign HEIs operating in Tashkent. Data on these universities were not available from MFUZB, MHSSE and other governmental institutions. Perhaps, the empirical results would considerably be changed with the increased number of observations. Second, the two student characteristic factors (STIP and LOAD) were situated into the SFA model in order to measure quality of education-outputs, but the cost efficiency findings might still be suffering from quality problem which is the common issue in the efficiency literature. Therefore, the quality of education-outputs and particularly research-output may not be measured properly owing to lack of data in those aspects. Moreover, the "staff salary" is employed only during the estimations of cost frontier due to lack of data in other types of input-price factor. The research findings could dramatically be changed after inclusion of more input price factors, such as capital expenses.

Third, as Greene (2005) already explained in true effects model that the estimations of the determinants of inefficiency could suffer from omitted factors problem and this may create biased evaluations of inefficiencies. Therefore, the exogenous factors that are used in the conditional mean functions of cost inefficiencies may not be reflecting the entire influences which are considerably motivating cost inefficiencies among public universities in Uzbekistan. Finally, this research used the translog functional form for estimating the cost frontier of the Uzbek HEIs. Although one might have significantly different and more sophisticated results by implementing other types of functional form, such as CES, Leontief or Quadratic. Preferably, the specifications that do not violate the Baumol et al. (1982) desiderata should be used for the future efficiency studies relaying on more enriched dataset.

7.3 Directions for future research

The research presented in this thesis can be extended in a number of directions. Therefore, this section proposes some suggestions for future research:

This study revealed that public HEIs in Uzbekistan were responding to the reductions in government funding through increasing tuition prices and improving the efficient utilization of fiscal resources. However, further research studies should consider analysing and discussing other potential responses to the public funding cuts in the context of Uzbek higher education system. For example, the Uzbek legislators could consider the privatization of public HEIs in the near future which can be seen as one of the "extreme" responses to the government funding cuts.

The theory of resource dependence integrated with other organisational theoretical models might provide strong theoretical frame for future research. For facilitating the development of a better understanding of the role of environment in understanding institutional behaviours, researchers should seek to apply and examine the different theoretical frameworks developed in the organisational behaviour and related literatures. A next step to this research could be to study the roles of institutional isomorphism, network organisation and population ecology theories in explaining how the Uzbek HEIs shape and are shaped by the environment in which they operate. "Only through such endeavours can scholars begin to develop a more comprehensive conceptual model which integrates the complex interrelationships between stakeholders, resources, institutions, and ultimately, organisational outcomes" (Fowles, 2013; p. 285).

Since the RDT is organisational based, it is generalizable to other educational situations. As in many other countries, all the departments and faculties compete for scarce funding within the public HEIs in Uzbekistan. Therefore, we advise to conduct further empirical researches

through broadening this study into other contexts within institutional departments or faculties using more enriched and extended departmental- or faculty-level data. Furthermore, if data permits, another empirical analysis on the economic efficiency of the Uzbek HEIs should be conducted by utilising DEA approach. Afterwards, DEA outcomes could be compared to the findings estimated using SFA approach.

From the data quality perspective, one of the significant improvements to the research conducted in this thesis would be the inclusion of more reliable and valid instrumental variables in order to solve the endogeneity problem. Moreover, the dataset that is employed throughout the first empirical estimations should be enriched and extended with more detailed institutional-level data which contains not only output but also outcome based data. The dataset used in Chapter 6 should be extended by incorporating new institutional output and input variables, efficiency determinants as well as quality measuring indicators in order to develop more comprehensive models and receive more accurate results. The income from research activities was used as one of the institutional outputs during the cost efficiency estimations in the preceding chapter. If future studies could offer better proxy variables for the research output, then it would be a significant contribution for enriching the present dataset. For this purpose, some empirical works should be conducted to find out the main determinants of research activities among the Uzbek HEIs.

Throughout the two empirical chapters, the estimations were carried out using the two separate datasets which were developed by the author. The similar datasets should be employed to conduct the similar empirical analyses for public HEIs operating in the other CARs or in the other lower-middle income countries, such as Armenia, Georgia, Moldova and Ukraine. Findings could then be compared to the findings obtained for Uzbekistan. Since quality of institutional-level data is more likely to vary by country, empirical results of two different groups of public HEIs in two different countries should always be compared and

interpreted with caution. For example, Salerno (2003) argues that most of the variations in institutional efficiency scores arise due to differences in data quality rather than productivity or cost efficiency. Therefore, even a more rigorous estimation of cost efficiency but integrated with poor quality measures is more likely to result in greater variation with respect to average efficiency scores.

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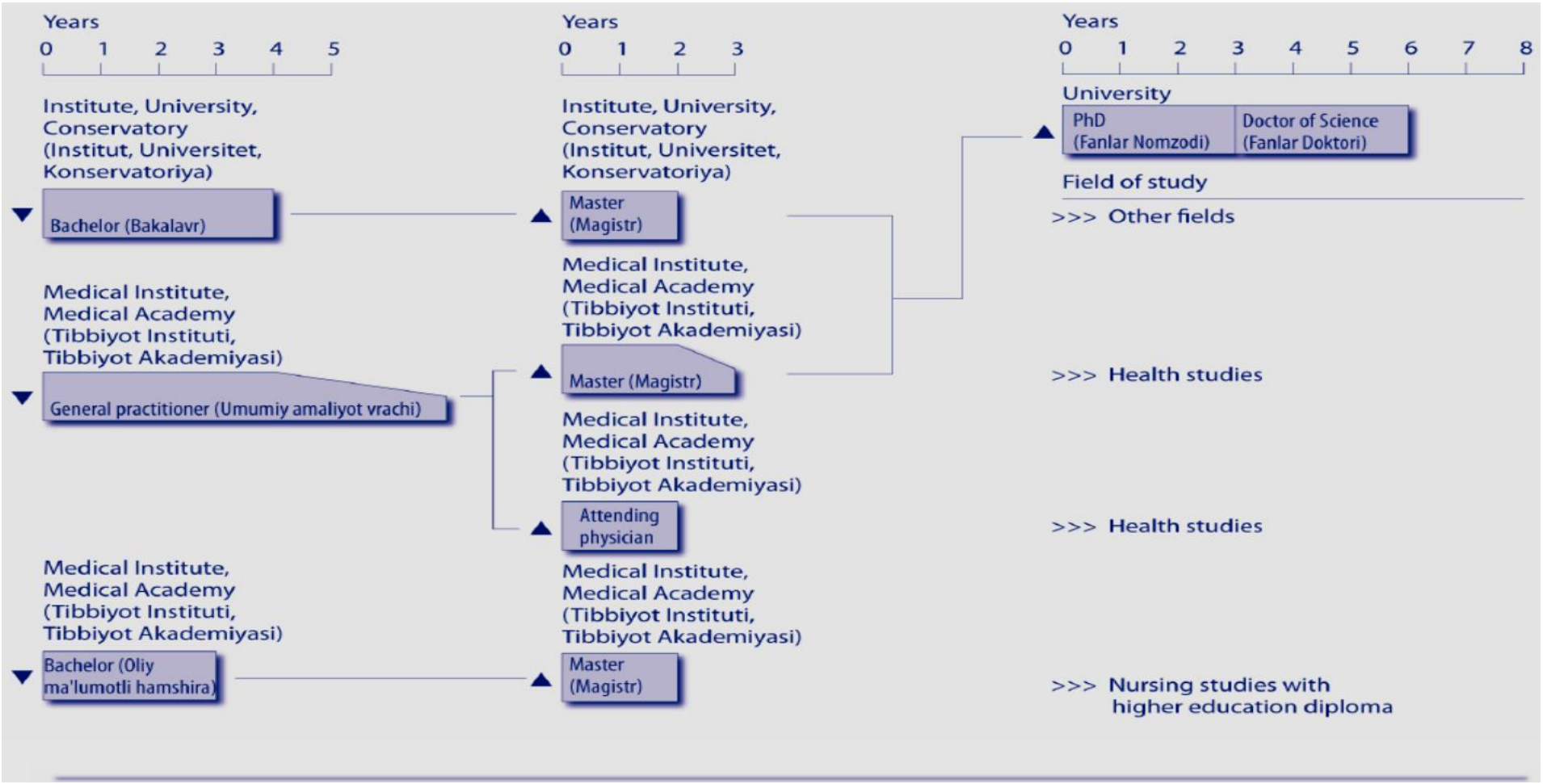
Appendix A

Figure A1: The higher education system of Uzbekistan



Source: EU Tempus (2010)

Appendix B

Appendix C

Appendix D Figure D1: Graphic representations of the share of educational expenditures and the share of tuition revenue for 62 public HEIs in Uzbekistan

Appendix E

Summary statistics of the key variables for Chapter 4, (2000-2013)

Table E1:

This table describes the mean, the standard deviation, the minimum and the maximum data values of the share of total institutional expenditures dedicated to educational expenses, the share of institutional revenues derived from tuition, FTE student enrolment, tuition price (in 2013 UZB Soms), duration of postgraduate programs, number of academic and administrative staff, as well as two instrumental variables "Development Fund" (in 2013 UZB Soms) and dummy additional admission allowances.

Variable	Observations	Mean	Std. Dev.	Min	Max
SHEE	857	0.80	0.094	0.16	0.98
SHTR	857	0.541	0.161	0.06	0.95
SIZE	857	3231	2424	60	12648
TP (000)	857	2265	1589	393	6050
DurPP	857	63	26	0	102
NumStaff	857	783	507	34	2950
DevFund (million)	857	1995	2420	0	13209
DumAdAdm	857	0.891	0.311	0	1

Note: Author's calculations

Appendix F

Robustness Checks: The GDP-deflator of Uzbekistan

This appendix shows the results of OLS and TSLS estimations which are evaluated using the GDP-deflator of Uzbekistan in order to examine the robustness of the principal results discussed in Chapter 4. The data for the GDP-deflator in Uzbekistan, which were estimated by the World Bank, are available at the Trading Economics official web-site. The CPI inflation measurement is replaced to the GDP-deflator in order to check to what extent the principal results will be changed by this adjustment. The tables below present the results of OLS and TSLS estimations each with four specifications:

Table F1: OLS estimation results with the dependent variable: share of institutional expenditures dedicated to educational activities ($SHEE_{it}$)

VARIABLES	Spec.1	Spec.2	Spec.3	Spec.4
SHTR	0.0661**	0.0902***	0.107***	0.298***
	(0.0289)	(0.0296)	(0.0323)	(0.0998)
TP	4.54e-08***	7.24e-08***	7.35e-08***	-0.0767
	(7.15e-09)	(1.07e-08)	(1.08e-08)	(0.0591)
TPSQ	-0***	-0***	-0***	-0.102
	(0)	(0)	(0)	(0.189)
SIZE	-1.81e-05***	-1.50e-05***	-2.18e-05***	0.0315**
	(5.30e-06)	(5.33e-06)	(5.98e-06)	(0.0120)
SIZESQ	1.28e-09***	1.09e-09**	1.36e-09***	0.417***
	(4.34e-10)	(4.35e-10)	(4.85e-10)	(0.109)
DURPP	0.000190	0.000235	0.000316	0.116**
	(0.000175)	(0.000174)	(0.000208)	(0.0504)
NUMSTAFF	2.41e-05	3.25e-05**	4.79e-05**	-0.00606*
	(1.58e-05)	(1.58e-05)	(2.10e-05)	(0.00351)
YEAR		-0.00705***		8.189**
		(0.00208)		(3.275)
Institutional fixed effects	*NO*	*NO*	*YES*	*YES*
Observations	*857*	*857*	*857*	*857*
Number of HEIs	*62*	*62*	*62*	*62*

Cluster-robust standard errors in parentheses
* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

Table F2: TSLS estimation results with the dependent variable: share of institutional expenditures dedicated to educational activities ($SHEE_{it}$)

VARIABLES	Spec.1	Spec.2	Spec.3	Spec.4
SHTR	-0.550	-1.111**	0.504***	0.864***
	(0.355)	(0.559)	(0.160)	(0.289)
TP	1.01e-07**	1.37e-07***	-2.62e-09	4.00e-08**
	(4.16e-08)	(4.01e-08)	(2.13e-08)	(1.85e-08)
TPSQ	-0**	-0***	0	-0
	(0)	(0)	(0)	(0)
SIZE	3.67e-05	6.99e-05**	-4.11e-05***	-3.52e-05***
	(2.26e-05)	(3.38e-05)	(8.36e-06)	(9.32e-06)
SIZESQ	-1.65e-09	-3.70e-09*	2.89e-09***	2.27e-09***
	(1.42e-09)	(2.17e-09)	(6.63e-10)	(7.30e-10)
DURPP	0.001**	0.002**	-6.60e-05	8.75e-05
	(0.0005)	(0.001)	(0.0003)	(0.0003)
NUMSTAFF	-5.14e-05*	-9.15e-05**	2.18e-05	0.0001***
	(2.99e-05)	(4.46e-05)	(2.17e-05)	(3.50e-05)
YEAR		0.006		0.027***
		(0.008)		(0.007)
Institutional fixed effects	*NO*	*NO*	*YES*	*YES*
Observations	*857*	*857*	*857*	*857*
Number of HEIs	*62*	*62*	*62*	*62*

Cluster-robust standard errors in parentheses

* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

The both tables reveal that the findings of OLS with CPI and the findings of OLS with GDP-deflator are not significantly different in the all specifications. According to the OLS estimations, however, the main independent variable has significant magnitudes in every specification when the GDP-deflator is used, while the coefficients of SHTR were not statistically significant in Specifications 1 and 3 when CPI is used. According to TSLS estimation results the correlations between the main explanatory variable and the dependent variable are statistically significant in the all specifications, except the first specification. The TSLS results also expose that most of the explanatory variables have statistically significant correlations on the dependent variable, particularly when the linear time trend or both institutional fixed effects and time trend are included to the models.

According to the model diagnostic tests, the findings here (when the GDP-deflator is utilised) are very similar with the principal findings (when the CPI inflation measurement is used).

Table F3: First-stage results with the dependent variable: share of institutional revenue derived from tuition $(SHTR_{it})$

VARIABLES	Spec.1	Spec.2	Spec.3	Spec.4
TP	1.09e-07***	5.17e-08***	1.31e-07***	5.36e-08***
	(9.97e-09)	(1.84e-08)	(7.78e-09)	(1.22e-08)
TPSQ	-1.45e-14***	-8.48e-15***	-1.52e-14***	-8.01e-15***
	(1.86e-15)	(2.46e-15)	(1.36e-15)	(1.58e-15)
SIZE	0.0001***	0.0001***	0.00003***	0.00002***
	(6.00e-06)	(6.01e-06)	(6.50e-06)	6.53e-06
SIZESQ	-3.66e-09***	-3.68e-09***	-1.92e-09***	-7.20e-10
	(5.57e-10)	(5.53e-10)	(5.33e-10)	(5.33e-10)
DURPP	0.001***	0.001***	0.001***	0.0003
	(0.0001)	(0.0002)	(0.0002)	(0.0002)
NUMSTAFF	-0.0001***	-0.0001***	-9.96e-06	-0.0001***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)
DevFund	*5.00e-12*	*7.45e-12**	*-1.20e-11****	*-9.79e-12****
	(3.97e-12)	*(4.00e-12)*	*(2.80e-12)*	*(2.70e-12)*
DumAdAdm	*0.032***	*0.021*	*0.039****	*0.022***
	(0.013)	*(0.014)*	*(0.009)*	*(0.009)*
YEAR		0.012***		0.021***
		(0.003)		(0.003)
Institutional fixed effects	*NO*	*NO*	*YES*	*YES*
Observations	*857*	*857*	*857*	*857*
Number of HEIs	*62*	*62*	*62*	*62*

Cluster-robust standard errors in parentheses

* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

Table F4: Model diagnostic tests

Tests of endogeneity			
Durbin-Wu-Hausman chi-squaresd statistic	18.38	*p=0.000*	Reject Ho
Durbin-Wu-Hausman F-statistic	17.23	*p=0.000*	
Under-identification			
Angrist-Pischke first stage chi-squaresd statistic	5.11	*p=0.078*	Reject Ho
Kleibergen-Paap rk LM chi-squaresd statistic	16.27	*p=0.000*	Reject Ho
Weak-identification			
Angrist-Pischke first stage F-statistic	2.53	*p=0.081*	Reject Ho
Kleibergen-Paap Wald rk F-statistic	18.54		Reject Ho
Over-identification			
Hansen J-statistic	1.49	*p=0.22*	Do not Reject Ho

Note: Institutional fixed effects and linear time trend are included and cluster-robust standard errors are reported. Test statistics: Number of clusters-62; Observations-857; Endogenous regressor-1; Excluded instruments-2.

Appendix G

Likelihood ratio test for the all specifications

The likelihood ratio test is a statistical test of the goodness-of-fit between two models. This test is frequently conducted in order to compare a relatively more complex model (unrestricted) to a simpler model (restricted) to see if it fits a particular dataset significantly better. This test is only valid if utilised to compare hierarchically nested models. As such, the more complex model must differ from the simple model only by the addition of one, two or more parameters. Normally, adding extra parameters to a model will result in a greater likelihood score. Although there comes a point when adding more parameters is no longer justified in terms of significant improvement in fit of a model to a particular dataset. Thus, the likelihood ratio test offers an objective criterion for choosing among possible models.

The test begins with a comparison of the likelihood values of the two models:

$$LRT = -2log_e\left(\frac{L_r}{L_u}\right)$$

$$LRT = -2\left(log_e\, L_r - log_e\, L_u\right)$$

$$= -2\, log_e\, L_r + 2\, log_e\, L_u$$

After deriving the probability and p-value of the obtained difference, the question of whether unrestricted model with more parameters fits significantly better and should it be preferred can be answered. For this purpose, the probability of the test statistic can be approximated by a chi-square distribution with $(df_1 - df_2)$ degrees of freedom. In this case, $df_1$and df_2 are the degrees of freedom of Cobb-Douglas and translog models, respectively.

The null hypothesis for the likelihood ratio test is: the restricted model (Cobb-Douglas) does not have significantly different log-likelihood scores compared to the unrestricted model

(translog). Accordingly, the null hypothesis should be rejected when the likelihood ratio test statistic gets higher score relative to the appropriate critical value from the chi-square table.

According to the estimation results presented in Table G1, the null hypotheses of the all likelihood ratio tests must be rejected; which means that the restrictions on translog in terms of the number of (additional) parameters are invalid.

Table G1

Hypothesis Testing: Cobb-Douglas (CD) vs. translog (TL)

Models	***Null Hypothesis***	***LR-Test statistic***	***Decision***
CD1 vs. TL1	H_o: $\beta_{11}=\beta_{22}=\beta_{33}=\gamma_{11}=\beta_{12}=\beta_{13}=\beta_{14}=\beta_{23}=\beta_{24}=\beta_{34}=0$	102.22***	Reject H_o
CD2 vs. TL2	H_o: $\beta_{11}=\beta_{22}=\beta_{33}=\gamma_{11}=\beta_{12}=\beta_{13}=\beta_{14}=\beta_{23}=\beta_{24}=\beta_{34}=0$	141.54***	Reject H_o
CD3 vs. TL3	H_o: $\beta_{11}=\beta_{22}=\beta_{33}=\gamma_{11}=\beta_{12}=\beta_{13}=\beta_{14}=\beta_{23}=\beta_{24}=\beta_{34}=0$	57.71***	Reject H_o

***Significantly different from zero with *p=0.01*

Appendix H

Robustness checks: Cobb-Douglas cost function

The Cobb-Douglass specification allows overcoming the multicollinearity issue associated to calculate a few number of parameters with respect to the translog specification. For this reason, this functional form is less susceptible to multicollinearity and degrees of freedom problems compare to the translog (Agasisti et al. 2015). An initial formulation of Cobb-Douglass function was developed by Paul Douglas in 1927, which is specified in our case as:

$$lnTC_{it} = \beta_0 + \beta_1 lnUG_{it} + \beta_2 lnPG_{it} + \beta_3 lnRES_{it} + \gamma_1 \ln SALARY_{it} + \sum_m^8 \theta_m Z_{m,it} + v_{it} + u_{it}$$

Table H1 presents the results of all three models for the Cobb-Douglass cost function which were evaluated using the method of Battese and Coelli (1995). The institutional outputs and input-price are highly significant at 1 per cent level and with anticipated signs. As it is expected that the growth in the undergraduate enrolments has greater influence on the increased institutional total costs compared to the postgraduate enrolments and the research revenue variables in the all models. The staff salary input factor has a significantly positive coefficient in every model, and it is one of the most influential variables to the total institutional expenditures. A unity increase in the SALARY leads to, on average, 0.79 per cent increase in the total cost.

In the table below, the estimated results imply that coefficients of most determinants of inefficiency are showing the expected signs and they are statistically significant at 1 per cent level. MED is statistically insignificant in the first model, although it becomes significant at 1 per cent level in Models 2 and 3. However, the coefficients of MED negatively correlated with cost inefficiency which was not anticipated. The previous stochastic cost frontier studies showed that HEIs with provision of medical education have significantly positive influences

on the institutional cost inefficiency (Daghbashyan 2011; Erkoc 2013). Therefore, an institution that provides medicine-based instructions has usually greater total costs than an institution does not. The growth in the amount of stipends per student increases the cost inefficiency of HEIs, suggesting the improvement in the quality of students. At the same time, the growth in LOAD factor decreases institutional cost inefficiency, but this may lead to provision of lower quality education at those institutions.

Table H1: Stochastic cost frontier and inefficiency effects

Cost function						
	Model 1		Model 2		Model 3	
Constant	0.541*	(0.33)	3.403***	(0.37)	2.275***	(0.35)
LNUG	0.907***	(0.02)	0.911***	(0.03)	0.945***	(0.02)
LNPG	0.126***	(0.01)	0.060***	(0.01)	0.0727***	(0.01)
LNRES	0.053***	(0.01)	-0.008	(0.01)	0.0256***	(0.01)
LNSALARY	0.860***	(0.02)	0.752***	(0.02)	0.741***	(0.02)
Determinants of inefficiency						
Constant	1.309***	(0.17)	1.573***	(0.14)	0.589	(0.78)
PROF	0.009	(0.01)	-0.008**	(0.00)	-0.006	(0.01)
FTS	-0.012***	(0.00)	-0.015***	(0.00)	-0.021***	(0.00)
SIZE	-0.0003***	(5.91e-05)	1.31e-05	(9.95e-06)	-4.40e-05**	(1.98e-05)
MED	-0.188	(0.12)	-0.088***	(0.03)	-0.175***	(0.06)
STIP			0.001***	(5.65e-05)	0.000***	(0.00)
LOAD			-0.089***	(0.01)	-0.131***	(0.02)
GOVALL					0.023***	(0.01)
TUITREV					0.022**	(0.01)
σ_u	0.522***	(0.06)	0.048***	(0.06)	0.329***	(0.02)
σ_v	0.202***	(0.02)	0.282***	(0.01)	0.161***	(0.01)
λ (= σ_u/σ_v)	2.586***	(0.06)	0.170***	(0.07)	2.047***	(0.03)
Number of HEIs	58		58		58	
Log likelihood	-265.70		-133.36		-96.84	

Asymptotic standard errors are in parentheses.
* Significant at 10% level, ** Significant at 5% level and *** Significant at 1% level

The coefficients of two staff specific factors have negative associations with the inefficiency, implying that if the proportions of professors and full-time working personnel at the Uzbek HEIs increase then the cost inefficiency of institutions reduce. Furthermore, SIZE has highly

significant coefficients but with negative signs in the first and third models. In the last model, the coefficients of the share of government allocations and the share of tuition revenue are exposing positive signs and significant correlations to the cost inefficiency. This can be explained that an institution with greater proportions of GOVALL and TUITREV may have greater cost inefficiency. Among the variance parameters of the all models, the lambda coefficients – which represent the relative contribution of inefficiency and random error terms to the full error component – are significantly different from zero suggesting cost inefficiency variation among the public HEIs.

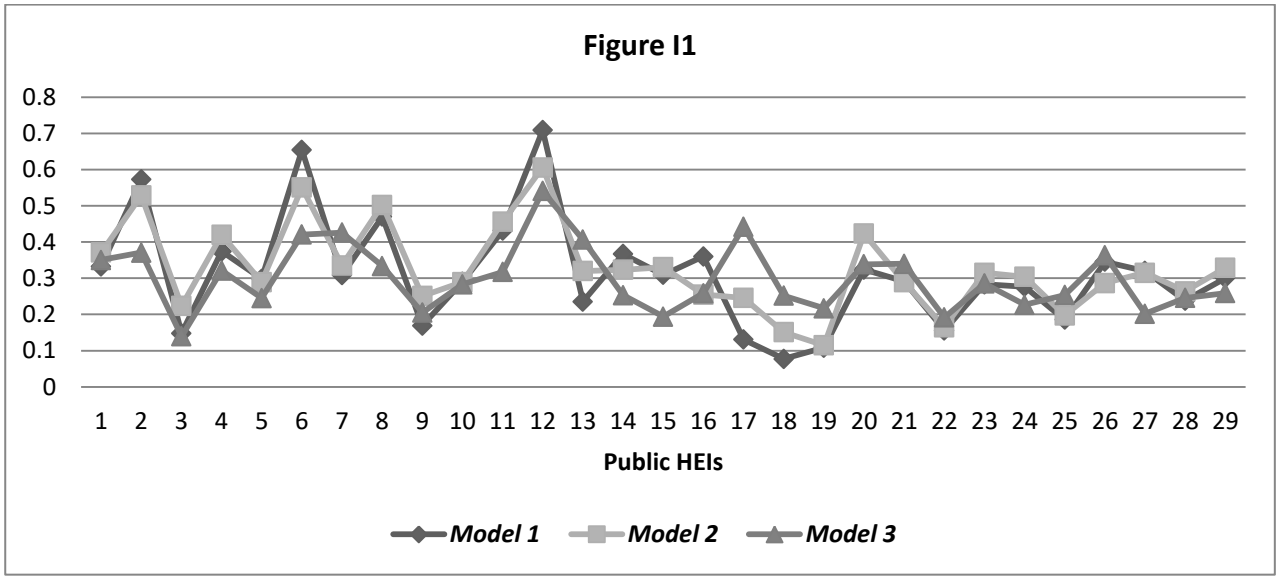
Table H2 reveals the mean inefficiency scores, which were estimated after using Cobb-Douglas functional form, for the Uzbek HEIs for the period of 2000 to 2013. Findings suggest that the average inefficiency values in Table H2 are not significantly differ from the average inefficiency scores in Table 6.4.

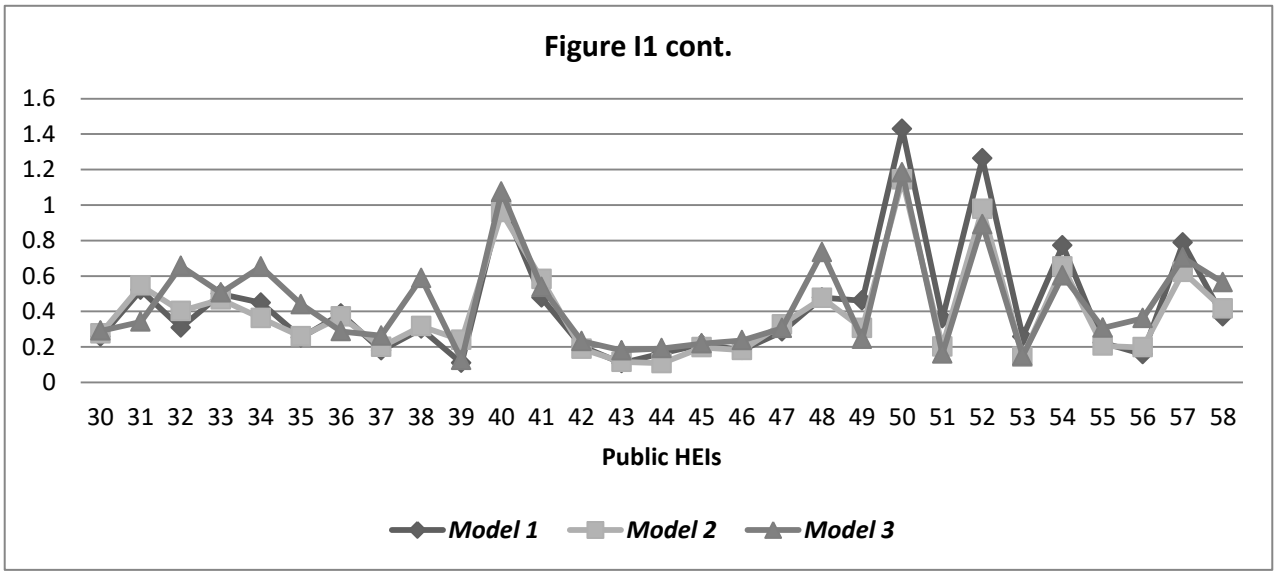
Table H2: Descriptive statistics for the cost inefficiency

	Model 1		***Model 2***		***Model 3***	
2000	0.58		0.49		0.56	
2001	0.50	-13.4%	0.53	8.2%	0.47	-16.1%
2002	0.49	-1.2%	0.50	-5.7%	0.52	10.6%
2003	0.47	-5.1%	0.48	-4.0%	0.53	1.9%
2004	0.41	-12%	0.47	-2.1%	0.49	-7.5%
2005	0.38	-8.5%	0.50	6.4%	0.42	-14.3%
2006	0.40	6.9%	0.43	-14.0%	0.54	28.6%
2007	0.36	-10.9%	0.42	-2.3%	0.44	-18.5%
2008	0.34	-5.3%	0.42	0.0%	0.35	-20.5%
2009	0.29	-15.3%	0.41	-2.4%	0.31	-11.4%
2010	0.29	0.0%	0.57	39.0%	0.27	-12.9%
2011	0.34	18.8%	0.65	14.0%	0.26	-3.7%
2012	0.31	-10.8%	0.56	-13.8%	0.26	0.0%
2013	0.34	10.5%	0.63	12.5%	0.25	-3.8%
Mean	***0.40***		***0.50***		***0.41***	
Median	0.28		0.53		0.35	
Num of HEIs	*58*		*58*		*58*	

Appendix I

Mean cost inefficiency scores that are estimated using the method of Battese & Coelli (1995) for the 58 public HEIs and for the period 2000-2013.





The figure above illustrates the convergence of results from the BC (1995) method. Although the cost inefficiency scores of the Uzbek HEIs vary across the models, their relative ranking is very similar. It seems that most of the HEIs from the first 29 institutions (the first part of Figure I1) performed more efficiently relative to the average inefficiency score *(37 per cent)*, while only few institutions in the second set of 29 HEIs exhibit cost inefficiency above than the average (the second part of Figure I1).

Table I1: Mean inefficiency scores for the each Uzbek HEI (2000-2013)

	Public HEIs	Model 1	Model 2	Model 3	Average
1	Andijan State University	0.33	0.37	0.35	**0.35**
2	Andijan Engineering - Economics Institute	0.57	0.53	0.37	**0.49**
3	Buxara State University	0.15	0.22	0.14	**0.17**
4	Buxara Engineering - Technology Institute	0.37	0.42	0.32	**0.37**
5	Gulistan State University	0.30	0.29	0.24	**0.28**
6	Djizzak Polytechnic Institute	0.65	0.55	0.42	**0.54**
7	Karshi State University	0.31	0.34	0.43	**0.36**
8	Karshi Engineering - Economics Institute	0.47	0.50	0.33	**0.44**
9	Karakalpakistan State University	0.17	0.25	0.21	**0.21**
10	Namangan State University	0.29	0.29	0.28	**0.29**
11	Namangan Engineering - Pedagogical Institute	0.43	0.46	0.32	**0.40**
12	Namangan Engineering - Technology Institute	0.71	0.61	0.54	**0.62**
13	Samarkand State University	0.24	0.32	0.41	**0.32**
14	Samarkand State Foreign Language Institute	0.37	0.32	0.25	**0.31**
15	Samarkand State Architecture-Construction Institute	0.31	0.33	0.19	**0.28**
16	Samarkand Economics and Service Institute	0.36	0.25	0.26	**0.29**
17	National University of Uzbekistan	0.13	0.25	0.44	**0.27**
18	Tashkent State University of Technology	0.08	0.15	0.25	**0.16**
19	Tashkent State Pedagogical University	0.11	0.11	0.22	**0.15**
20	Tashkent institute of Textile and Light Industry	0.32	0.42	0.34	**0.36**
21	Tashkent State University of Economics	0.29	0.29	0.34	**0.31**
22	Uzbekistan State World Languages University	0.16	0.16	0.19	**0.17**
23	Tashkent Automobile-Roads Institute	0.28	0.32	0.29	**0.29**

24	Tashkent Architecture-Construction Institute	0.28	0.30	0.23	**0.27**
25	Tashkent Chemistry - Technology institute	0.19	0.20	0.25	**0.21**
26	Tashkent State Institute of Oriental Studies	0.35	0.29	0.36	**0.33**
27	Tashkent Financial Institute	0.32	0.31	0.20	**0.28**
28	Termiz State University	0.24	0.26	0.25	**0.25**
29	Urganch State University	0.30	0.33	0.26	**0.30**
30	Fergana State University	0.26	0.28	0.29	**0.27**
31	Ferghana Polytechnic Institute	0.52	0.55	0.34	**0.47**
32	Tashkent Medical Academy (TMA)	0.31	0.40	0.66	**0.46**
33	Urganch Branch of (TMA)	0.50	0.47	0.51	**0.49**
34	Andijan State Medical Institute	0.45	0.36	0.65	**0.49**
35	Tashkent Pediatric Medical Institute (TPMI)	0.25	0.26	0.44	**0.32**
36	Tashkent Pharmaceutical Institute	0.39	0.37	0.29	**0.35**
37	Nukus Branch of (TPMI)	0.18	0.20	0.26	**0.21**
38	Samarkand State Medical Institute	0.30	0.32	0.59	**0.40**
39	Bukhara State Medical Institute	0.11	0.24	0.13	**0.16**
40	Tashkent State Higher School of National Dance and Choreography	1.02	0.96	1.08	**1.02**
41	Tashkent State Art Institute	0.48	0.58	0.54	**0.53**
42	Uzbekistan State Institute of Arts and Culture	0.20	0.19	0.23	**0.21**
43	Nukus State Pedagogical Institute	0.11	0.11	0.18	**0.13**
44	Tashkent State Pedagogical Institute	0.16	0.11	0.19	**0.15**
45	Djizak State Pedagogical Institute	0.21	0.20	0.22	**0.21**
46	Navoi State Pedagogical Institute	0.18	0.18	0.24	**0.20**
47	Kokand State Pedagogical Institute	0.29	0.33	0.31	**0.31**
48	Tashkent University of Information Technology (TUIT)	0.48	0.48	0.73	**0.56**
49	Karshi Branch of TUIT	0.46	0.31	0.24	**0.34**

50	Nukus Branch of TUIT	1.43	1.14	1.18	**1.25**
51	Samarkand Branch of TUIT	0.36	0.20	0.16	**0.24**
52	Urganch Branch of TUIT	1.26	0.98	0.89	**1.04**
53	Fergana Branch of TUIT	0.26	0.14	0.15	**0.18**
54	Andijan Agricultural Institute	0.77	0.65	0.60	**0.68**
55	Samarkand Agricultural Institute	0.22	0.21	0.31	**0.25**
56	Tashkent State Agrarian University (TSAU)	0.16	0.20	0.36	**0.24**
57	Nukus Branch of (TSAU)	0.79	0.62	0.70	**0.70**
58	Tashkent Institute of Irrigation and Melioration	0.37	0.42	0.56	**0.45**
	Average	***0.37***	***0.36***	***0.37***	