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EVALUATION OF REFORM IN TURKISH ELECTRICITY SECTOR: A CGE ANALYSIS

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"I, Erisa Dautaj Şenerdem, confirm that the work presented in this dissertation is my own. Where information has been derived from other sources, I confirm that this has been indicated in the disertation."

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ABSTRACT

EVALUATION OF REFORM IN TURKISH ELECTRICITY SECTOR:
A CGE ANALYSIS
Erisa Dautaj Şenerdem

Doctor of Philosophy in Economics

Advisor: Doç. Dr. K. Ali Akkemik

January, 2016

Turkey's electricity market has undergone extensive reform since 2001 through market liberalization, unbundling, privatization, and establishment of organized power markets, retail market opening, and the establishment of an independent energy regulatory authority. I employ a static computable general equilibrium (CGE) model to test the impact of power sector reform on the economy. Major findings suggest reform has been beneficial to the economy. Market liberalization has a positive impact on gross domestic product when implemented on all state-run companies simultaneously. Stronger participation of state-run companies in the day-ahead market generates a positive effect on the economy similar to that of larger private participation in the sector, with the GDP turning around 0.2-0.3% above its base levels after each shock. Stronger demand-side participation also affects the economy positively. A simulation of all reform elements combined generates a deviation of GDP by 0.2% above its baseline.

Keywords: power economics, computable general equilibrium modeling, social accounting matrix, reform

ÖZET

EVALUATION OF REFORM IN TURKISH ELECTRICITY SECTOR:
A CGE ANALYSIS

Erisa Dautaj Şenerdem

Ekonomi Doktorası

Danışman: Doç. Dr. K. Ali Akkemik

Ocak 2016

P

Türkiye elektrik piyasası 2001 yılından bu yana piyasanın serbestleştirilmesi, ayrıştırma, özelleştirme, organize elektrik piyasasının kurulması, perakende pazarının açılması ve bağımsız enerji piyasası denetim kumunun oluşturulması anlamında kapsamlı bir reform sürecinden geçmiştir. Bu doktora tezi, elektrik sektöründeki reformların ekonomiye etkisini statik hesaplanabilir genel denge (CGE) modeliyle incelenmektedir. Elde edilen sonuçlar, yapılan reformların ekonomiye büyük ölçüde olumlu etki ettiğini göstermektedir. Tüm kamu şirketlerin aynı anda serbestleştirilmesinin gayri safi yurtiçi hasılaya pozitif etki ettiği sonucuna varılmıştır. Kamu şirketlerinin gün öncesi piyasasına daha etkin katılımı da, özel sektördeki daha yaygın katılımın yarattığı etkiye benzer biçimde ekonomiye olumlu etki etmektedir. Her iki şokun ardından GSYH baz seviyelerinin %0,2-%0,3 üzerine çıkmaktadır. Talep tarafının piyasaya katılımın daha güçlü olması da ekonomiyi olumlu etkilemektedir. Tüm reform unsurlarının dahil edildiği simülasyon GSYH'yı baz seviyesinin üzerinde %0,2 bir etki yaratmaktadır.

Anahtar Kelimeler: elektrik enerjisi ekonomisi, hesaplanabilir genel denge modeli, sosyal hesaplar matrisi, reform

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List of Abbrevations

BNEF	Bloomberg New Energy Finance
BO	Build-Operate (Yap – Islet)
BOO	Build-Operate-Own (Yap – Islet – Devret)
BOT	Build-Operate-Transfer (Kullanim Hakki Devri)
BOTAS	State-run Turkish Pipeline Corporation
BP	British Petroleum
CAPEX	Capital Expenditure Rate
CBRT	Central Bank of the Republic of Turkey
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CGE	Computable General Equilibrium
CHEM	Chemicals and Petrochemicals
DAM	Day-Ahead Market
DAP	Day-Ahead Planning
DPT	State Planning Organization (Devlet Planlama Teskilati)
EDAS	Electricity Distribution Corporation (Elektrik Dagitim A.S.)
EdF	Electricity of France (Électricité de France)
EML	Electricity Market Law
ENEL	National Entity of Electrical Energy (Ente Nazionale per l'Energia Elettrica)

ENTSO-E European Network of Transmission System Operators for Electricity

EPDK Energy Markets Regulatory Authority (Enerji Piyasalari Duzenleme Kurumu)

EPIAS Energy Market Operator Inc. (Enerji Piyasaları İşletme A.Ş.)

ETD Energy Trading Association of Turkey

ETKB Ministry of Energy and Natural Resources (Enerji ve Tabii Kaynaklar Bakanlığı)

EU European Union

EUAS Energy Generation Corporation (Enerji Uretimi A.S.)

F-BSR Final Balancing and Settlement Regulation

FSU Former Soviet Union

GAMS General Algebraic Modeling System

GASOIL Natural Gas and Oil, sector

GDP Gross Domestic Product

GE General Electric

GENG State Generation, sector

GENP Private Generation, sector

GOV Government Consumption

GTAP Global Trade Analysis Project

GW GigaWatt

HOH Private (Household) Consumption

IAE	International Aero Engines
IEA	International Energy Agency
IFPRI	*International Food Policy Research Institute*
IMF	World Economic Outlook and Turkish State Agencies
INVPR	Private Capital Accumulation
INVPU	State Capital Accumulation
IO	Input-Output
IPP	Independent Private Producers
ISIC	International Standard Industrial Classification of All Economic Activities
ISO	Istanbul Chamber of Commerce (Istanbul Sanayi Odasi)
ISPAT	Investment Support and Promotion Agency of Turkey
KKGD	The Public Sector's General Balance (Kamu Kesimi Genel Dengesi)
kWh	kiloWatt-hour
LES	Linear Expenditure System
LNG	Liquefied Natural Gas
MENR	Ministry of Energy and Natural Resources
MSE	Maximum Sum of Entropies
MW	MegaWatt
MWh	MegaWatt-hour

NACE Statistical Classification of Economic Activities in the European Community

nTPA negotiated Third-Party Access

OECD Organisation for Economic Co-operation and Development

OFFER Office of Electricity Regulation (UK)

OFGEM Office of Gas and Electricity Markets (UK)

OIB Turkey's Privatisation Administration (Ozellestirme Idaresi Baskanligi)

OPEX Operating Expense Rate

OTC Over-The-Counter

PAPR Paper, Wood and Printing, sector

PMUM Market Financial Settlement Center (Piyasa Mali Uzlaştırma Merkezi)

PSGB Public Sector General Balance

PSIG Private Savings-Investment Gap

PwC Pricewaterhouse Coopers

ROR Rate-of-Return

ROW Rest-Of-the-World

rTPA regulated Third-Party Access

SAM Social Accounting Matrices

SGK Social Security Institution (Sosyal Guvenlik Kurumu)

SIPs System Imbalance Prices

SMP System Marginal Price

SNA System of National Accounting

T&D Europe The European Association of the Electricity Transmission and Distribution Equipment and Services Industry.

T-BSR Temporary Balancing and Settlement Regulation

TCDD State-Run Railway Corporation

TCMB Central Bank of the Republic of Turkey (Turkiye Cumhiuriyeti Merkez Bankasi)

TEAS Turkish Power Corporation (Turkiye Elektrick A. S.)

TEDAS Turkish Power Distribution Corporation (Turkiye Elektrik Dagitim A. S.)

TEIAS Turkish Electricity Transmission Corporation (Turkiye Elektrik Iletim A. S.)

TEK Turkish Electricity Administration (Turkiye Elektrik Kurumu)

TETAS Turkish Electricity Trading and Contracting Corporation (Turkiye Elektrik Toptan A. S.)

TL Turkish Lira

TOOR Transfer of Operating Rights

TSO Transmission System Operator

TUIK Turkish Statistical Institute (Türkiye İstatistik Kurumu)

TWh TeraWatt-hour

UECM Amount [of power] Drawn upon Settlement (Uzlastirmaya Esas Cekis Miktari)

UK United Kingdom

UN	United Nations
US	United States
USAID	United States Agency for International Development
VAT	Value-Added Tax
VIOP	Future’s and Options Market (Vadeli Islemer ve Opsiyon Platformu)
WEO	World Economic Outlook

CHAPTER 1

INTRODUCTION

Turkey's power industry has undergone considerable transformation since a new electricity market law (EML) was approved in 2001. EML introduced large-scale reform in the sector. The aim of this dissertation is to test the impact of power market reform on Turkish economy, employing a static computable general equilibrium (CGE) model. The impact of potential electricity sector policy shocks on the economy is also examined.

The hypothesis tested here is whether achieving reform's ultimate objectives set in its first article – including the development of a "*financially sound and transparent electricity market operating in a competitive environment under provisions of civil law and the delivery of sufficient, good quality, low cost and environment-friendly electricity to consumers* ..." – has had a positive effect on the Turkish economy.

Major findings from policy simulations show that market liberalization benefits the economy the most if undertaken for all state-run power companies simultaneously, and a reduction operational inefficiencies of state-run companies, stronger private-sector participation in the generation segment and establishment of the day-ahead market all have positive effects on the Turkish economy.

The removal of a 10% monopolistic mark-up on prices for commodities produced by state-run power companies, including generation, wholesale trading and distribution segments, leads to a positive deviation of GDP by 0.35% above its baseline.

A rise in private-sector's share in total generation as it also subsitutes for lower public-sector generation identical to changes accrued in the 2010-2012 period, boosts the GDP to 0.18% above its base level.

More interestingly, simulation results suggest that the impact of higher participation of state-run companies to the day-ahead market is positive and similar in magnitude to the impact from an increase in private-sector's share in generation. GDP settles 0.25% above tis base level when sales of state-run generation and state-owned wholesale segments to the day-ahead market increase by four folds each.

Stronger demand-side participation also exhibits positive effects on the economy. Similarly, a reduction in technical and theft lossess combined by higher investment as well as elimination of X-inefficiencies in the distribution sector have smaller, yet positive impacts on value added.

A simulation of all reform elements combined generates a deviation of GDP by 0.20% above the baseline.

This dissertation is organized as follows: The rest of this chapter offers an overview of power sector developments globally as well as in Turkey. The second chapter continues with a summary of literature on electricity sector reform, followed by a detailed account of Turkey's reform in chapter three. Chapter four explains the methodology used to construct the database for the CGE model and chapter five explains the structure of the CGE model employed for the Turkish economy. Chapter six reports findings from simulations and concludes.

1.1 Power Sector Outlook: Facts and Figures

The long quest for optimal allocation of power resources has pushed for fundamental reform in the electricity sector in many countries during past decades. The liberalization wave embraced by the global economy in the beginning of the 1980s has also touched the power sector. But there still exist challenges to opening up power markets completely and the reform is ongoing even in pioneering countries, due to the sector's complexity and new challenges arising from various generation sources and environmental concerns.

Electricity cannot be stored and has to be generated and consumed simultaneously which makes it different from other traded commodities. The sector is regulated as to ensure supply and demand are always balanced so that the system does not collapse. The sector has traditionally been recognized as strategic and managed by the public sector usually through a state-run vertically integrated monopoly, with prices set lower than marginal costs as a tool for social and economic policies. But this approach has led to high inefficiencies and large burdens on state budgets. The trend reversed in the beginning of the 1980s, upon arguments that it was possible and economically viable to open up the power sector to competition, at least for certain segments within the industry.

Reforms were launched in a number of countries with Chile, the UK, Argentina, Norway, New Zealand and Australia being the pioneers. Turkey has been no exception. Early attempts to liberalize electricity markets in the 1980s proved unsuccessful and the country underwent an extensive reform program starting as of 2001.

Key reform steps were unbundling of generation, transmission, distribution and trading activities, establishment of an independent regulatory body, the launch of wholesale power trading through the day-ahead balancing market and the completion of the privatization of all distribution companies in 2013.

The Turkish government is set to continue reforms with a new electricity market law enacted in March 2013. Major changes brought by this law are separation of market operator from system operator, establishment of an energy exchange, establishment of an intra-day power trading platform, privatization of generation assets, removal of autoproducers' status for private generators.

Power is a vital source of energy for households and a key input for agriculture and industry consumers. While sustainable and environmentally friendly power generation and quality services at low costs are the rationale for reform, it is also crucial to analyse how reform affects other sectors in the economy.

In this section I present some brief facts and figures on the global power sector outlook, followed by a detailed discussion of the power sector developments in Turkey.

Global power demand has almost doubled in the 1990-2011 period, with an average annual growth rate of 3.1%, the fastest growing of any final form of energy (IEA, 2013). It is expected to grow by almost two thirds during 2011-2035, at an average 2.2% per year, with demand in non-OECD countries accounting for the major part of this increase. Growth in global power demand is strongly linked to overall economic performance and will highly depend on future government policies, efficiency and innovation in the sector, as well as environmental and supply security concerns.

Shares in generation mix are also expected to change, although coal is forecast to maintain its largest share in global power generation at 33% in 2035, from 41% in 2012 (IEA, 2013). According to the same forecasts, the share of renewables will rise to 31% from 20% and the shares of gas and nuclear will remain flat at 22% and 12% respectively, over the same period of time. And the shift towards lower carbon sources and more efficient power plants will be translated to a 30% fall in CO_2 intensity in the sector. Table 1.1 below shows development of demand and generation from 1990 to 2035 forecasted levels.

Global installed capacity in 2013 was about 5,950 GW in 2013 and is expected to rise to 9,760GW in 2035 (IEA, 2013). According to the IAE's world energy outlook published in 2013 major gross cumulative additions during 2013-2035 will be in gas, wind and coal capacity with 23%, 21% and 20% of the total 6,053GW additions during the period respectively[1]. Of these, about two thirds are expected to be built in non-OECD countries.

Power prices are also expected to rise in the coming years, although industrial prices in the US are expected to be half their level in the EU and 40% lower than those in China, with crucial implications regarding competitiveness of industrial product in each region (IEA, 2013).

Table1.1 Electricity demand and generation by region (TWh)

	Demand				**Generation**			
			New policies*				**New policies***	
	1990	**2011**	**2035**	**2011-2035**	**1990**	**2011**	**2035**	**2011-2035**
OECD	6,591	9,552	11,745	0.9%	7,629	10,796	13,104	0.8%
US	2,713	3,883	4,753	0.8%	3,203	4,327	5,253	0.8%
EU	2,241	2,852	3,246	0.5%	2,577	3,257	3,610	0.4%
Non-OECD	3,493	9,453	20,405	3.3%	4,189	11,317	23,983	3.2%
World	1,085	19,004	32,150	2.2%	11,818	22,113	37,087	2.2%

Source: IEA, WEO 2013. *Forecast according to the new policies scenario.

[1] Estimations according to the New Policies Scenario. For more details see IEA (2013).

1.2 Power Sector Developments in Turkey

Turkey's average annual per capita GDP growth during the 2000-2013 period was 3%, while power demand has increased by 5.3% for the same period. This shows growth in power demand has been performing at a faster rate than per capita output in the past 14 years. But power demand has underperformed by around 1% compared with per capita real GDP growth rate in 2013 (see Figure 1.1 below), a worrying development for the industry as well as for the economy.

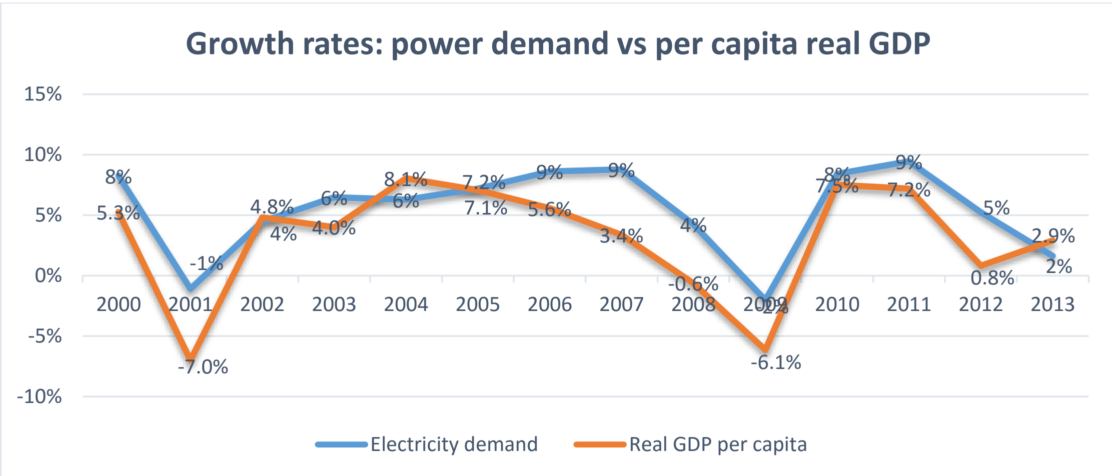

Figure 1.1 Growth rates: power demand vs. per capita real GDP

Per capita real GDP growth rate is expected to increase from 2.5% in 2014 to 3.8% in 2015 and to 5.5% and 6% in 2016 and 2017 respectively, according to the government's medium term program expectations. This suggests energy demand might also experience faster growth in the coming years. Energy ministry expects power demand to grow at 5.6% annually on average during 2013-2022 (TEIAS, 2013, p 17) [2].

1.2.1 Power Consumption

Gross power demand totalled 257TWh in 2014, double the demand for electricity in the country in 2000. Annual average per capita power consumption was 3,327kWh in 2014. And the figure for 2011 was 3,070kWh or less than half the 6,626kWh Euro area average[3]. Given that Turkey is an emerging economy, its per capita power consumption is expected to rise as the economy advances.

The share of commercial power consumption has changed considerably in the past decade, rising to 18.9% in 2013 from 9.5% in 2000, as shown in Figure 1.2 below. While household and industrial consumers have given up 1.6% and 2.6% of their shares to total consumption down to 22.7% and 47.1% respectively, for the same period.

[2] Capacity projections published in November 2013. Calculations by author.
[3] For more details see tables at World Bank's World Development Indicators, available at http://wdi.worldbank.org/table/5.11 as of 16 November 2013. Comparison is made in 2011 figures, the most recent data made available by World Bank statistics.

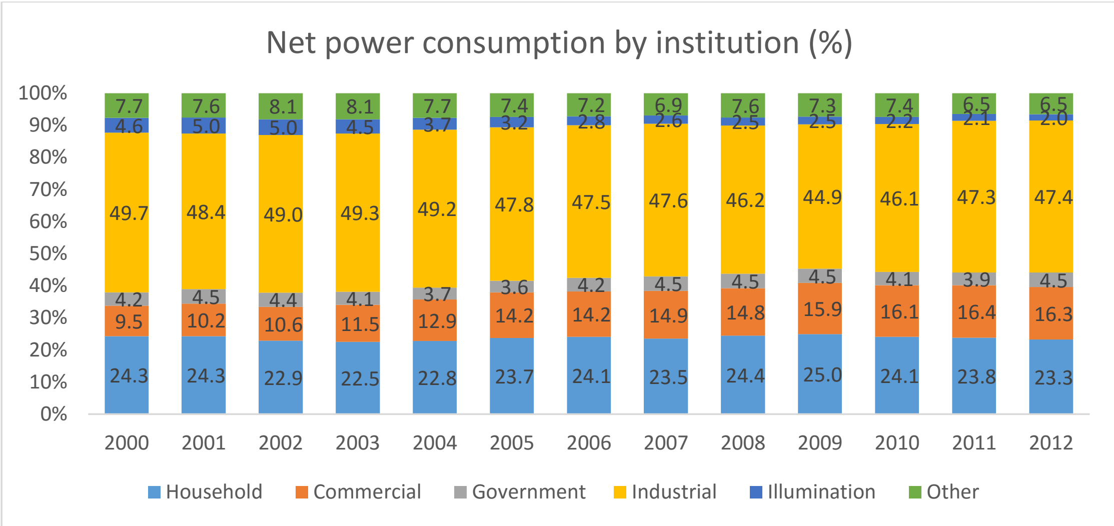

Figure 1.2 Net power consumption by institution (%)

Source: TUIK.

1.2.2 Generation Mix

Total power generation was 252TWh in 2014, which is 5% higher year on year. Of this, natural gas had the lion's share of 47.9%, 30.3% was coal-fired, 16.1% hydro, 3.4% wind and the remaining fuel oil, waste and other renewable generations.

Natural gas has by far the largest stake in the generation mix, although it has been falling in recent years. Some 44% of Turkey's total power output was gas-fired in 2013, up by 7 percentage points compared to its shares in 2001 but lower than the 46.5% stake of gas-fired output in the generation mix in 2010, the base year for the model constructed in this dissertation. The overall picture has changed substantially from 2000, as shown by the pie graphs in Figure 1.3below:

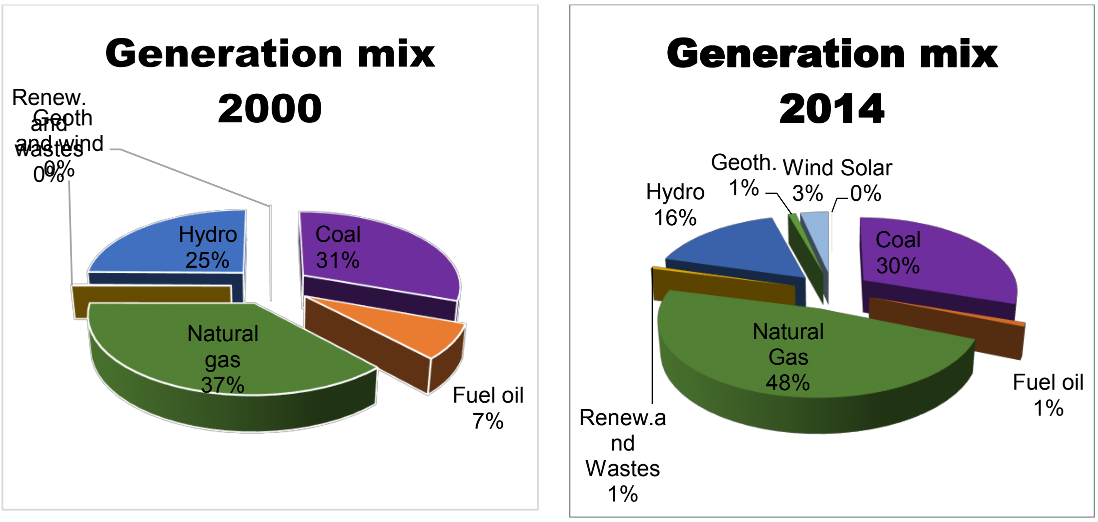

Figure 1.3 Generation mix: 2000 vs. 2014

Natural gas, geothermal and wind have replaced oil and coal fired generation in the past 14 years. Turkey's increased dependency on gas in this period exposes the country to security of supply risks due to high dependence on foreign resources. It also leads to a heavy burden on the economy's current account balance.

Therefore, one major target for public policy is to encourage diversification of resources and of countries of origin for imported energy commodities.

The Strategy Paper on Energy Market and Security of Supply approved in 2009 has set goals to reach at least a 30% share in renewables, with the target for wind capacity set at 20,000MW by 2023[4](DPT, 2009). Also, Turkey is committed to reach 600MW

[4] 2023 marks the 100th anniversary of the establishment of the Turkish Republic.

geothermal capacity and reduce natural gas share in the generation mix below 30% by the same time.

The country is also adding nuclear power to its generation portfolio. The strategy paper aims to ensure at least a 5% in total generation by 2020, and the first 1.2GW unit of the Akkuyu nuclear plant – Turkey's first – is expected to go online by 2019[5], with the remaining three units planned to start their commercial activities within the following three years.

All in all, shares in the generation mix by 2023 are calculated to be 30-30-24-6% for gas, renewable,coal, and nuclear generation technologies respectively. Given respective shares in 2014 and ongoing power plant projects, although not impossible, meeting this target by 2023 may prove challenging.

A recent report by Bloomberg New Energy Finance concludes government projections for power demand and generation mix by 2023 will not be met given current energy policies in Turkey (BNEF, 2014). It estimates just half of the planned wind capacity will come on line by that time, while Turkey's first nuclear reactor could come on line in 2022 (ibid., p 2). If nuclear plans are on schedule, nuclear could start substituting for gas, whose share in total generation is estimated to be 32% in 2023 (ibid., p 7).

[5] See http://www.akkunpp.com/akkuyuda-ilk-elektrik-uretimi-2019da-baslayacak available on 14 November 2014.

1.2.3 Installed Capacity

Installed capacity rose by 155% from 27.3GW to 69.5GW in the 2000-2014 period. Of the total 2014 capacity, hydro held the largest stake at 34%[6], followed by natural gas with 26.9%, coal with 21.3%, other thermal capacity with 11.9% and wind with 5.2%. In addition, EPDK data show that of the 40GW power capacity under construction in January 2014, 32% is natural gas, 28% hydro, 20% coal, 17% wind and the remaining 3 % other thermal and renewable capacity. With natural gas still baring the largest share in current capacity under construction, lowering gas' share in total generation below 30% by 2023 could prove challenging for Turkey.

Table 1.2 Resource distribution of capacity currently under construction

	Natural gas	Coal	Other thermal	Hydro	Wind	Other renewables	Total
Capacity under construction*	12,824	8,244	834	11,402	6,773	386	40,463
Share	32%	20%	2%	28%	17%	1%	

Source: EPDK. *Note:* *as of January 2014.

Having recognized the ever-increasing demand for electricity of Turkey's emerging economy, the government has put maximum effort to support private sector investment in power generation capacity, even before the 2001 reform was launched. And grid operator (TEIAS) projections show determinacy in carrying on current public and

[6] Here, one fourth of hydro resources are run-of-river power plants that are highly dependent on the water flow on the run of river thus cannot be operated as base-load capacity and can get highly volatile.

private sector power plant projects is crucial for supply to meet demand in coming years.

TEIAS capacity projections for 2013-2017 suggest supply will meet demand at the following extents, assuming that some 3GW and 16GW capacity under construction by public and private sector respectively as of 1 January 2013:

1. Given only the existing capacity, supply will be 3% below demand as of 2015 and the situation gets worse in 2016 and 2017, with supply at 7.3% and 11.8% below demand respectively;
2. Given existing capacity and only public sector plants come on line in due time, power generation still falls short of demand by 3% in 2015, and by 4% and 8.7% in 2016 and 2017 respectively;
3. Assuming that all public and private sector plant projects will be completed in due time, the reserve margin becomes positive, for all years, with supply 15.9% above demand in 2015, and 17.8% and 16.2% in the coming two years chronologically.

These three scenarios clearly indicate how crucial the role of private sector investments is for supply security of electricity in coming years. According to an independent study, Turkey's total installed capacity should increase from 57GW to 125GW in the coming decade, in order to meet the ever growing industrial demand (Accenture, 2013). This implies some $130bn additional investment in the power sector over the period.

1.2.4 Generation by Institution

Private sector involvement in the electricity sector in Turkey was very limited until the beginning of the 2000s, as Figure 1.4 indicates. Private generation counted for just 23% of the total generation in 2000 – of which 10% were production companies and 13% were auto-producers which were utilities that were excluded from the oblication of holding a license and generated for their own power needs[7]. While the majority of generation, around 74%, was covered by public generator EUAS and its affiliates.

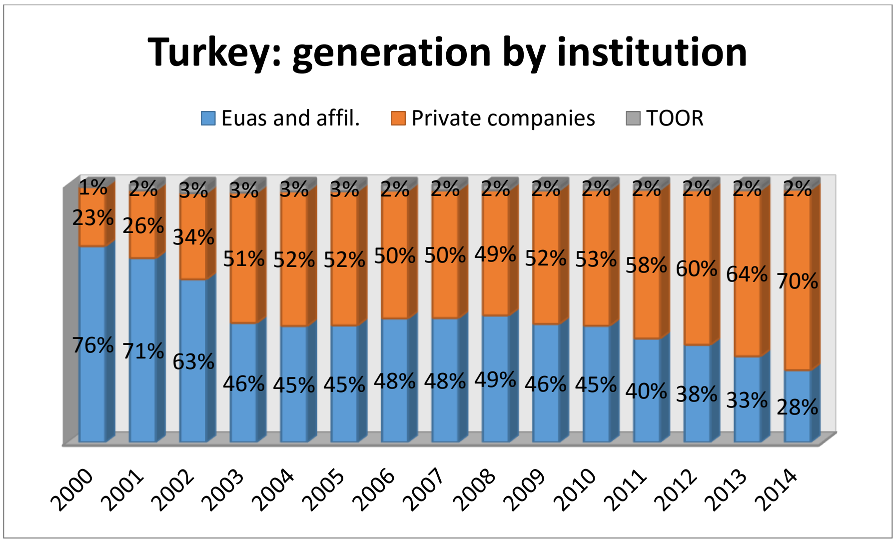

Figure 1.4 Power generation by institution[8]

*Source:*TEIAS. Note: TOOR refers to state-owned plants ran by private companies under transfer-of-operating-rights contracts.

This has changed in about one and a half decade, with EUAS and its affiliates generating just 28% of local output, 2% met by TOOR plants and the remaining 70% of

[7] They could sell up to 20% of their yearly output to other parties.

[8]TOOR refers to the 'transfer-of-operation-rights' business model, where a utility is owned by public sector but operated for a certain period of time by a private sector company. For details see Chapter 3.

power generated by private companies in 2014. However, it is key to note that 22 percentage points in private generation[9] in 2014 was output by plants operated by private companies underBuild-Operate (BO) and Build-Operate-Transfer (BOT) contracts, whom the state guarantees sales[10] at a fixed price revised by the energy regulator EPDK. Given the state support, these firms guaranteed returns to investment plus lucrative earnings on top of costs, thus being not fully exposed to commercial risks. For these reasons, they will be considered as part of the public stake in the Turkish power market in the database and in simulations in the following chapters.

1.2.5 Power Trade Flows

Turkey has imported power since 1975 with imported volumes always making up for a very small share in Turkey's total generation, thus their effect on domestic markets has been limited. Figure 1.5 shows how imported power volume has increased considerably since 2010 due to expansion of interconnection lines at border points in recent years and higher participation of private wholesale trading companies in cross-border trading since the establishment of Turkey's day-ahead market in 2011.

Imports from Georgia and Iran have traditionally been high partly due to bilateral power-exchange programs[11] between Turkey and each of these countries. Azeri imports started with 15.3GWh in 2007 and have significantly increased since then. And imports from western borders with Greece and Bulgaria have revived as of 2011 owing to

[9] In other words, about half of the private generation in 2013 was realized by BO and BOT plants.
[10] In general, up to 85% of the plant's total output.
[11] Carried by state-run wholesale trading company TETAS.

higher cross-border trading activity by private companies. Similarly, Turkey has exported power to Azerbaijan and Iraq since 1992 and 1994 respectively. While power exports to Georgia, Syria, Greece and Bulgaria started after 2005.

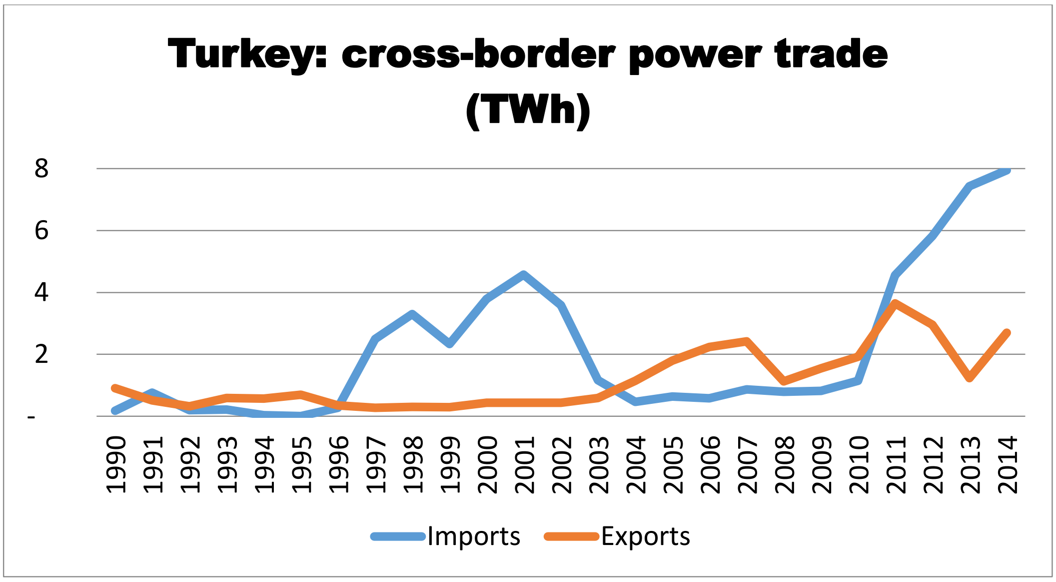

Figure 1.5 Turkish power imports vs. exports (TWh)

Turkey plans to join the European Network of Transmission System Operators (ENTSO-e), which could encourage development of new cross-border capacity and increases in cross-border trade volumes in the medium term[12]. This will increase cross-border trading's impact on domestic wholesale prices.

[12] Turkish grid operator TEIAS joined ENTSO-e as an observer member in January 2016.

1.2.6 Day-ahead Price

Turkey established a day-ahead pricing (DAP) mechanism in 2009, which went through a day-ahead planning phase (2009-2011) and a fully-functioning day-ahead market[13] was launched in end-2011. Figure 1.6 shows how the level of day-ahead prices has evolved since 2009. Its average has increased since establishment of the market, as indicated by the trend line in red and there have been spikes and troughs at certain points in time.

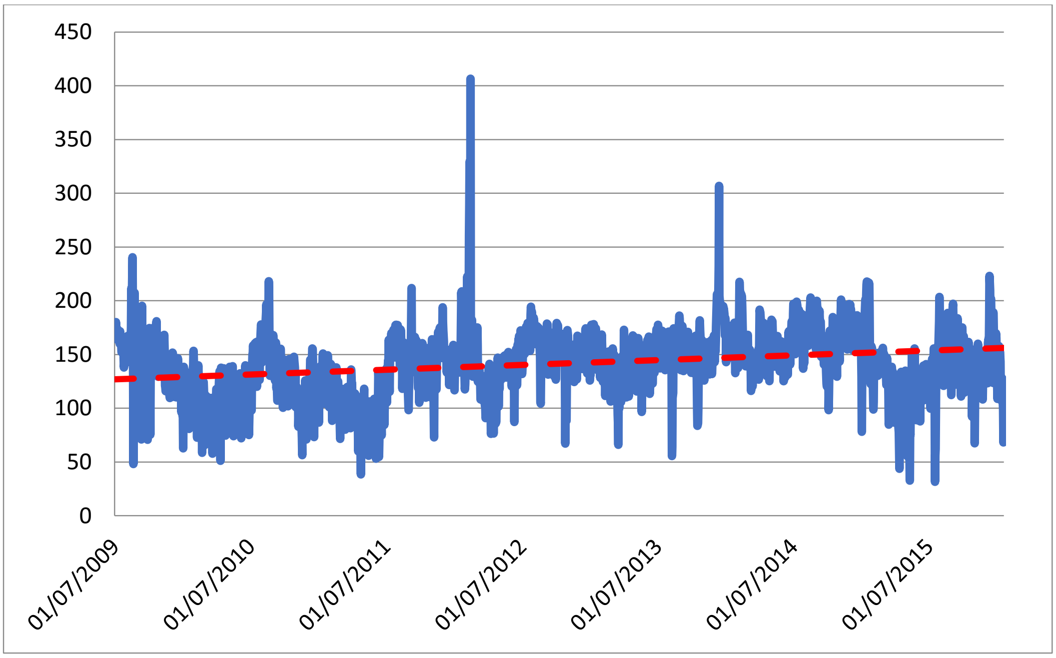

Figure 1.6 Average daily day-ahead price
Source: PMUM-TEIAS.

[13] For details see Chapter 3.

DAP hit a record high of 406 Turkish liras/MWh (TL/MWh) on 13 February 2012 due to limited gas inflows from Azerbaijan and Iran due to technical problems as the country was experiencing the coldest winter in recent years[14]. Similarly, in December 2013 day-ahead prices soared to 307 TL/MWh as gas supplies failed to meet peak demand in very cold weather; and to a smaller extent in February 2014, when prices averaged 206 TL/MWh during 6-12 February, compared to an average of 163 TL/MWh the previous month[15].

Turkey has a limited natural gas distribution infrastructure, which causeslimitations in supplies to commercial and household gas consumers in peak demand times even if imports were to meet demand. This constitutes an upside risk for prices in peak demand periods and the risk premium will continue to be paid by consumers unless infrastructure is not improved.

On the downside, prices sometimes slumped to the TL30-50/MWh levels in times of low demand combined with high wind and hydropower generation.

1.2.7 Retail Prices

A key objective of the 2001 law was to deliver affordable and fair power prices to end users. Figure 1.7 shows how retail power prices have evolved since 2006. Clearly,

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[14] See the report for climate during 2012 published by the Turkish State Meteorological Service (MGM), downloadable at http://www.mgm.gov.tr/FILES/iklim/2012-yili-iklim-degerlendirmesi.pdf as of January 2016.

[15] Day-ahead prices are published on market operator EPIAS' (then PMUM) website and can be found here: https://rapor.epias.com.tr/rapor/xhtml/ptfSmfListeleme.xhtml .

prices have been increasing for both household and industrial users, therefore missing the ultimate target.

Power prices in Turkey are more of a political commodity, and the Turkish government has traditionally depressed them through subsidization of the state-run power and companies. As a rule of thumb, prices will go flat in pre-election years and end-user tariffs are increased in the post-election period.

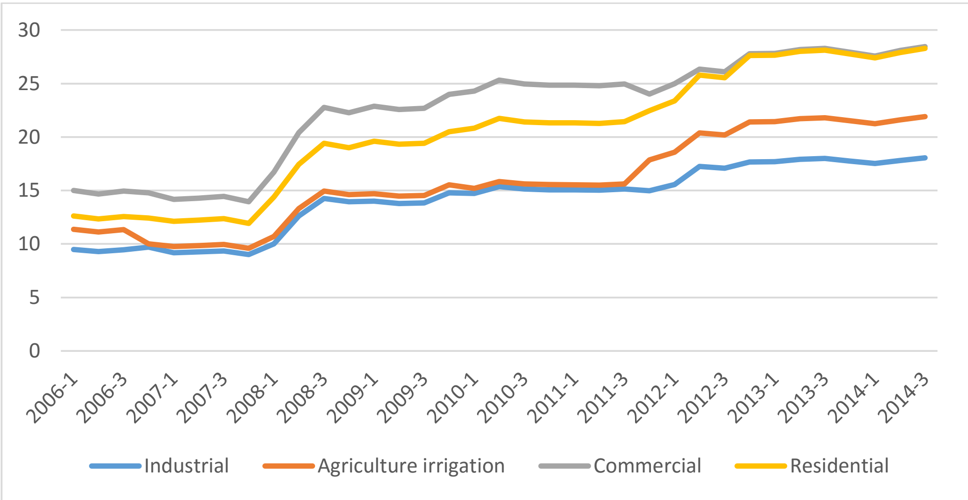

Figure 1.7 End-user power prices (TL cent / kWh, inflation-adjusted[16])
Source: EPDK, own calculations.

1.2.8 Day-ahead market vs. bilateral agreements

Turkey's power market model was designed as a market where bilateral agreements would dominate and the day-ahead market would complement for the remaining electricity needs. However, physical volumes of the day-ahead market have increased

[16] Using Producers Price Index.

significantly since its establishment in the end of 2009 and over-passed bilateral agreements' market share reaching 53% in the end of September 2015 as shown in Figure 1.8.

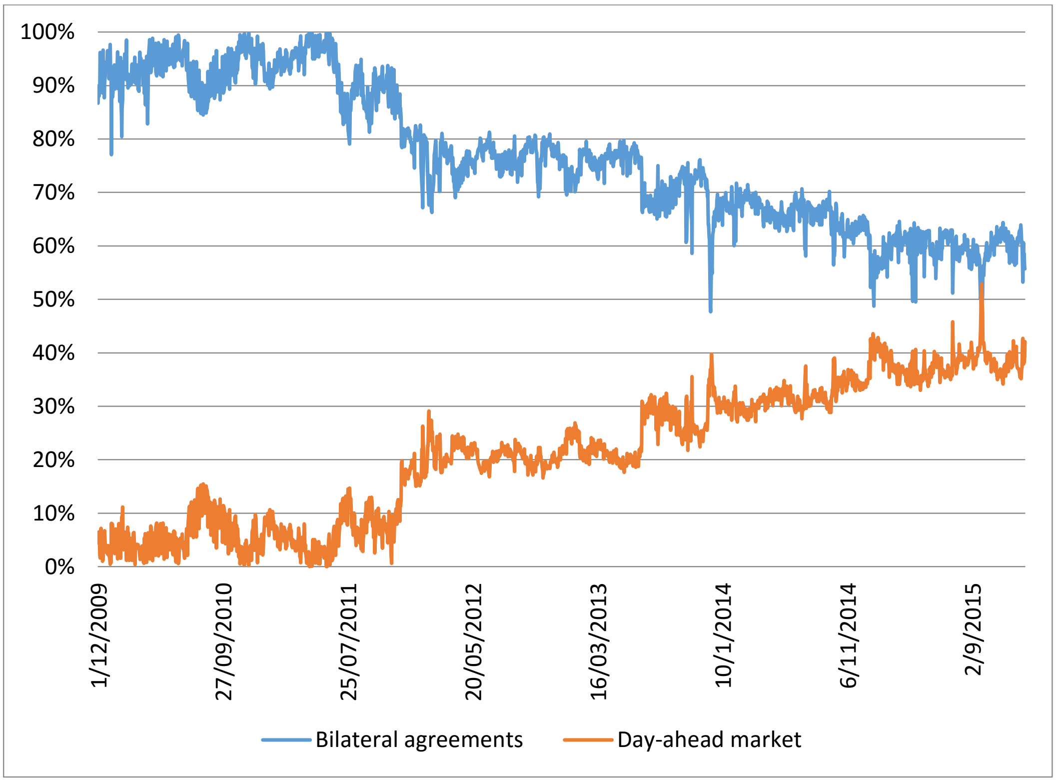

Figure 1.8 Day-ahead market vs. bilateral agreements share to total market volumes

To conclude for this chapter, Turkey's power sector has undergone a comprehensive reform process since 2001. An independent regulatory body has been established with the approval of the new power market law. Organized markets, including a day-ahead, a balancing and settlement, an intra-day market as well as a power exchange have been established, in a bid to generate price signals for future investment in the sector. The day-ahead price has increased on average since the market was established. End-user retail prices remain regulated and they have also increased through time.

The incumbent electricity company was unbundled into generation, transmission, distribution and supply and retail segments (see Chapter 3 for details). All regional distribution companies were privatized and privatization process in generation is ongoing. The share of private sector participation in the power markets has increased through time, although state-run companies still hold the lion's share in all segemnts. Demand-side participation has also started to evolve, as gradual reduction of the lower consumption limit for large eligible consumers has encouraged competition among power firms.

The share of gas in generation mix has increased substantially, also increasing the country's dependency on foreign resources. Renewables installed capacity and generation has also increased but at a slower pace. Demand for power has increased since introduction of reform, but failed to meet high expectations of around 8% average annual growth.

CHAPTER 2

POWER SECTOR REFORM

Electricity sector reform has taken different forms depending on a number of factors such as a country's natural resource abundance, the geographic position, political developments, as well as institutional and other factors. However, there are a number of common features seen in almost all reforming countries. These include market liberalization, restructuring, regulation, competition, privatization and the establishment of an independent regulatory body.

Evaluation of reform – the main task of this dissertation – is a complex and challenging task. This is because reform is usually an ongoing process, thus it is difficult to conclude on reform effects at a certain point in time as it might have not delivered completely. Moreover, many reform elements interact with each other and it is difficult to evaluate which elements should be attributed to which effects (Pollit, 2007). The presence of endogeneity also threatens accuracy of outcomes in the case of econometric models.

Reform in electricity sector differs substantially from that in other utilities, given certain physical and economic attributes. Electricity is not storable, thus supply has to meet demand instantaneously. This is not an easy task for physical and behavioural reasons. For instance, unless changes in demand for electricity due to unpredictable factors such as weather conditions are instantaneously met by the supply side, this may lead to major imbalances in the transmission system leading to extreme levels of voltage and thus to an overall failure followed by large-scale outages[17].

Moreover, short-term demand elasticity for electricity is very low and supply may also become highly inelastic in case demand increases at a sudden and maximum capacity starts being used (Joskow, 2003). This causes high price volatility in the market. Thus a balancing mechanism is necessary for that supply and demand to clear in real-time electricity markets.

[17] For example, see most recent outages in North Holland on 27 March 2015 and Turkey in 31 March 2015.

This section summarizes the literature related to electricity sector reform, including experience at an international, European Union and individual country level. A brief discussion on the reform in Turkey follows.

2.1 Rationale for Reform

Different meanings are attached to reform and liberalization in the literature, sometimes using them as substitutes. Thus, an attempt to provide meanings such terms will refer to when used in this dissertation might be useful.

Jamasb and Pollitt define liberalization as the process requiring at least one of the following inter-related steps: *"sector restructuring, introduction of competition in wholesale generation and retail supply, incentive regulation of transmission and distribution networks, establishing an independent regulator and privatization*" (2005: 13).

Alternatively, Newbery (2001) uses the term to refer to guaranteeing access to network to competitive entrants while maintaining the vertically integrated incumbent who owns the network. This definition will apply here.

Further on reform, Joskow (2008) counts a number of elements that characterize what he calls "*textbook architecture of desirable features for restructuring, regulatory reform and the development of competitive markets for power*" (2008: 11-12). These include privatization of traditionally state-owned electricity monopolies, vertical disintegration of potentially competitive segments, establishment of public wholesale spot and operating reserve market institutions, development of the demand side of electricity markets, efficient access to transmission networks, unbundling of retail tariffs, creation of an independent regulatory agency and transition mechanisms to pass from the old to the new system.

In their search for conceptualization of liberalization in electricity, Arentsen and Kunneke (1996) offer three main categories of coordinating mechanisms in the sector as shown in Table 2.1. They argue that while all mechanisms co-exist at all times, there is one that is dominant in the sector and reform occurs when there is a shift in dominant mechanisms, for example, from hierarchy to network-dominated or from network to a market-dominated structure.

Table 2.1 Characteristics of basic coordinating systems

Coordinating mechanism	**Unit of decision making**	**Mechanism of allocation**	**Dominant economic goal**
Market	Individual	Price setting	Individual profitability and continuity
Network	Group	Agreement	Collective profitability and continuity
Hierarchy	Public authority	Directive	National public interest

Source: Atentsen and Kunneke (1996).

Erdogdu (2007) defines reform as the set of measures to address problems in the energy sector, excluding single steps taken to postpone problems from this definition, with a major focus on the reform in Turkey.

Here I will use the reform system in a wider context, sometimes even referring to just a number of steps taken in a bid to change existing status quo of the sector without necessarily including a set of extensive measures covering all aspects of the sector, for practicality reasons.

Electricity industry has traditionally been characterized by a monopolistic structure. Large sunk costs give the industry features of a natural monopoly. Moreover, segments in the supply side – generation, transmission, distribution and retail supply and trade – have traditionally been vertically integrated.

Davies et.al. (2005) argue that reasons for initiating a reform program differ between developed and developing countries with the first group motivated to improve efficiency and economic performance and the latter interested in lowering the burden of utility sectors on the state budget, attract investment, both domestic and international, as well as lower losses from theft or network inefficiencies.

However, it is difficult to strictly divide motivation for reform among different levels of countries' economic development. The UK example of power reform shows the then-ruling government opted for reform for almost all above-mentioned reasons, and not only.

Economic conjuncture at a national and international level is crucial, as Helm (2003) describes in his account of the power sector reform in Britain. The author explains how the mismatch of oil and gas prices – with the latter lagging behind following the second oil crisis in 1979, concerns over (in)efficienciesof state-owned energy enterprises, a rapidly increasing demand that led to UK's plans to go nuclear and Britain's coal sector crisis in 1981 all were pushing factors towards reforming energy sectors in England and Wales in 1980-1983.

Other macroeconomic variables, namely increasing unemployment and excess capital capacity, deteriorating value of the domestic currency against dollar and a sharp fall in oil prices also contributed to reform commitment (ibid.). Eventually, higher interest rates increased higher costs of financing public debt, and need for private-sector investment also rose.

International lending organizations such as the International Monetary Fund and the World Bank have also pushed for liberalization in network industries – particularly in developing countries – with the primary goal of eliminating the burden on state finances, which would eventually lead to increased efficiency in these industries.

Bhattacharyya (2011) lists a number of reasons for deregulation, including the decline of natural monopoly rationale, failure to provide incentives for state-owned companies to increase efficiency (or lack of sufficient punishment to inefficiencies), state-owned incumbent's burden on national debt and political capture of such organizations.

With the new wave of reform in the 1980s "*market solutions were proclaimed as ways out of the impasse of the stagflationary seventies*" (Roberts, Elliott and Houghton, 1991, p 9). The belief that at least some segments of network industries carried contestable markets features became widespread.

Identification is more straightforward with the electricity sector, where network-linked segments, namely transmission and distribution, are the ones that carry natural monopoly features due to high sunk costs and economies of scale. While the remaining generation and supply segments and their related services (contracting, metering, billing) offer competitive-market features. Therefore, these segments can open to competition, as it did happen in a good number of economies after power sector reform was first launched in the early 1980s.

Asymmetric information between the regulator and the incumbent, as well as allowing for cross-subsidization among different segments, resulted in high inefficiencies in state-owned vertically integrated enterprises and in a failure to properly punish such inefficiencies due to superiority of the enterprise above monitoring authority regarding the state of the sector.

Political capture of publicly owned and managed electricity enterprises also leads to a tendency of using cost advantages from economies of scale for over-employment, which can be translated into lower investments and higher operational inefficiencies arising from larger size of the organization.

Lastly, relieving fiscal burden of state-owned power enterprises is a self-explanatory motivation for reform. Roberts, Elliott and Houghton (1991) who discuss privatisation in UK's electricity sector from a critical view, sees the process as a "tactic for a government holding the general policy objective of disengagement from the economy," which they argue is the result of increasing share of public expenditures to gross national product (GNP) in a period of slow economic growth.

2.2 Reform Elements for Power Sector

Here I discuss elements of the "*textbook reform*" (Joskow, 2008), namely restructuring, privatization, establishment of wholesale, spot and reserve markets, demand-side development, access to transmission networks, establishment of an independent regulatory body and transition mechanisms.

The design of power sector reform is key for its success and all country conditions should be considered before making decisions that will likely affect at a large scale distribution of rents and risks, investment trends and catching up with latest technological developments. The choice of including all elements of *textbook reform* or just a part depends on the final objective of each country opting for reform as well as initial conditions of the sector for that particular country.

For instance, if the ultimate goal is to reach fully competitive markets, a country is more likely to disintegrate the sector and privatize the spin-off companies to foster competition in a utility sector.

Newbery (2001) presents two main ways to introduce competition into network utilities – including electricity: unbundling and liberalization.

While the first requires a separation of supply-chain segments, i.e. generation, transmission, distribution and supply activities to then introduce competition to its contestable parts, the liberalization alternative preserves incumbent’s vertically integrated structure and its ownership rights on networks by just introducing the right of access to network by other competitors. The latter pay a transmission fee to the incumbent.

Liberalizing entry to already existing integrated structures is a less disruptive form of reform but bares the risk of predatory pricing by the incumbent in order to eliminate competition in the market and maintain its monopoly power. One example is designing transmission tariffs in a way that discourages market entry (ibid.).

European Union’s first electricity market directive embraced liberalization as one of the models to reform member countries’ power sectors to facilitate creation of a single power market. According to the directive, this could be achieved through three main models, namely the single-buyer model, regulated third-party access (rTPA) and a negotiated third-party access (nTPA)[18]. In the single-buyer model, the incumbent company (single buyer) is entitled to purchase power from independent generators and sell to end-users by just charging a transmission tariff.

[18] For more details see Bergman et. al. (1999).

Potential disadvantages of this model are predatory-pricing through high levels of tariffs and incumbent's market dominance, cross-subsidization among different segments as allowed by the vertically integrated structure, and patronage issues – particularly if the incumbent is kept in public hands.

Under the nTPA model, power suppliers and consumers negotiate the network tariff with the grid operator, while under the rTPA model, the fees for access to network are pre-defined by the regulator and are not subject to negotiation.

Unbundling, on the other hand, requires a separation of accounts of generation, transmission, distribution and supply activities, in order to provide equal access to all entrants. There are four main categories of unbundling: accounting, management, legal and ownership unbundling – listed from the mildest to the strongest form of separation[19].

The first EU directive on power markets adopted in 1996 required that countries impose at least unbundling of management and accounts at least between generation and transmission, although most member countries have gone beyond this step, introducing legal separation between these segments.

Minimizing coordination costs between generation and transmission has traditionally been presented as a key argument in favour of preserving the vertically integrated

[19]Pollit (2007) presents a detailed table including theoretical benefits and costs of ownership unbundling. Also see Koten and Ortmann(2008), Gugler, Rammerstorfer, and Schmitt (2013). Green (2006) provides a more critical view on de-regulation of power industry in the EU.

structure of incumbents in power sector. However, these costs have been far weighted out by benefits from increased competition in countries where unbundling has been completed (Bergman et.al., 1999). The UK and the Nordic countries exhibit good practice examples in this respect.

One more advanced form is ownership unbundling, which should in theory eliminate incentives for discrimination to third party access to networks. However, giving up from economies of scale could also have detrimental effects on investment in network infrastructure.

Gugler, Rammerstorfer, and Schmitt (2013) argue that regulation affecting the incumbent – particularly through ownership unbundling, may lead to double marginalization through a detrimental effect on both rents and investment. However, double marginalization is unlikely to exist with multiple-tariff pricing regimes, depends on concentration of power in the downstream direction which may not exist for certain countries, and should not exist with a cost-based regulatory access charges (ibid.).

Pollit (2007) analyses effects of reform in electricity on a case-study basis, concluding that ownership unbundling contributed to increased competition in the sector, with also some evidence that investment could have been affected negatively. Another finding is that accompanying unbundling with more radical steps such as ending exclusive monopoly rights for power supply of distribution companies can help deliver better results.

More recently, Gugler, Rammerstorfer, and Schmitt (2013) test the effects of ownership unbundling and prices on investment in 16 European economies during 1998-2008. For the first time, they use time-series variations to disentangle overlapping impact of various reform steps. Their study concludes that there are trade-offs between static and dynamic synergies and between vertical integration versus competition practice. They find that ownership unbundling reduces investment by transmission network companies by about 10% and that third party access also has a detrimental effect on investment.

Authors stress that the way competition is introduced in the power sector rather than competition per se will likely have a diminishing effect on investments. Third party access through cost-based access charges or ownership unbundling leads to diseconomies of scale, while opening the sector through market-based measures such as by establishing a wholesale market or full retail openness by giving all end-users the right to choose their provider will likely encourage aggregate investment.

On the other side, higher retail prices result to have led to higher investment rates by companies, in line with theoretical predictions.

More on unbundling impact on the economy, Steiner (2001) analyses the effect of re-structuring and regulation on capacity utilization rates for power sector and on prices for 19 OECD countries during 1986-1996 concluding that while unbundling of transmission from generation does not lead to lower prices, it leads to higher utilization rates for the sector.

Changing ownership of incumbent firms through privatization is not a necessary condition for successful reform in the power sector and the European Union does not require privatization either in its directives, although a good number of member countries have opted for this step.

In the case of reform in England and Wales, state-owned nuclear plants resulted unsalable forcing the government to take them under a single shell – the Nuclear Electric public limited corporation. Although ownership remained with the government, this company had to compete with privatized generators in the day-ahead electricity pool showing significant improvements in performance for the following half-decade (Newbery, 2001). Another interesting case is that of Norway, where municipalities own utilities, with intra-municipality competitive pressure and budget limitations motivating them to behave competitively in the market.[20]

The primary question to be addressed by the policy maker before deciding on ownership of a utility is whether privatization will lead to a maximization of benefits from competition (Newbery, 2001).

Tavera (2001) mentions four reasons why countries opt for privatization, namely, *efficiency enhancement* as private firms are less politicized and focus their activity on good governance practices and profit maximization; *revenue generation* for public sector after state-owned assets are sold; *allocative efficiency* which aims to transfer

[20] Municipally-owned utility behaviour changes substantially from that of state-owned ones. See Newbery (2001, pp. 177-178) for further details in the Norway example.

production to most efficient players; and finally *redistribution of income*. The role of state has to change from managing to regulatory once privatization is fulfilled. Ex-ante, it is crucial to choose a proper method for privatization to ensure transfer of services and goods to the most efficient companies.

Gugler, Rammerstorfer, and Schmitt (2013) argue that ownership structure of a company could affect through efficiency and incentives. While state-owned monopolies may suffer from X-inefficiencies, their incentives may differ from those of private agents' in that they are likely to focus on the development of a secure network rather than on maximizing profits.

On the other hand, Newbery (2001) argues that it is more likely that privatized utilities will attract new entry and hence enforce competition in the sector. Whereas in the case of state companies, new entrants risk to be discouraged by certain advantages of the first, such as access to cheap finance and political power.

Countries generally prefer to go for restructuring some time before privatization to test the new markets and make sure companies will operate effectively under the new settlement. It is crucial to net off costs of restructuring when estimating profits from privatization[21].

[21] See Chisari, Estache and Romero (1997), Baer, and McDonald (1998), Bitranand Serra (1998), Davies, Wright and and Price (2005), Domahand Pollitt (2001), Roberts, Elliott and Houghton (1991) for more on privatization.

A well-established institutional framework, a strong and independent regulatory body and a strong judiciary with well-settled dispute resolving mechanisms are also key elements to ensure a business-friendly investment climate and achieve ultimate goals of reform.

Independence of the regulatory agency is key to a successful implementation of reform, however, experience in a majority of countries shows that high-level officials managing these are appointed by governments, and hence political pressure affecting their decisions.

In his analysis of the privatization process in Peru, Tavera (2001) concludes that lack of reliability in judiciary, limited financial resources for the regulator, and political pressure on the latter all had an adverse impact on the proper implementation of reform. One key finding of the study is that privatization has helped to improve efficiency in power and telecommunications sectors.

It is worth noting that pre-reform institutional framework is also crucial as to how far a country could go with reform. Koten and Ortmann (2008) find that a higher corrupted EU member states are more likely to go for milder forms of unbundling of network from generation and supply. And given that institutional settings cannot be easily changed – at least for the short term – they are likely to affect the ability of a certain country to absorb deep changes with reform and succeed in achieving final objectives.

Finally, transition mechanisms are crucial for reform impact. Criqui and Zerah (2015) compare strategies of electricity companies in Delhi. They observe that despite being bound by the same regulatory framework, the three distribution companies that took over the sector after privatization in 2000 in the Indian capital have applied different strategies, depending on the socio-economic composition and the geographical and spatial features of regions they cover. For instance, in regions where the poorest reside – which have high theft rates, – or where spatial conditions of the city architecture is constantly changing, particularly through vertical growth by adding more floors to buildings, companies tend to engage more in technical transition trying to increase efficiency of network rather than expand it. Also, regions with an intensity in large institutional consumers are more likely to pay high gains to the distribution company, which could in turn invest more to improve and expand the network. This is more difficult to be achieved in areas with fewer large consumers and a high concentration of residential users.

The authors conclude that specific spatial and social geographies should be considered carefully by the policy maker prior to deciding on reforming the sector. One key finding of the study is that privatization has succeeded to increase electrification in the capital.

The following section briefly discusses how reform was introduced in a number of individual countries.

2.3 Reform at Country Level

Chile is the first country to have carried a comprehensive electricity reform. Chilean reform began in 1982 after the Electricity Act was approved, with vertical and horizontal unbundling of electricity assets, commercialization and part privatization – the latter started at a large scale as of 1986. Although there was no example set to be followed by the time Chile launched its reform program, it did include elements from electricity sectors in the UK, France and Belgium. It separated generation and distribution companies – like in the UK, set a marginal-cost based pricing system for its distribution system – like the French company EdF had done, and established a trading system between generators and customers – like in Belgium (Pollitt, 2004). Despite problems, Pollit concludes that overall Chilean reform implementation was very successful.

The amount of investments into the sector has increased substantially after privatization (Bitran and Serra, 1998). Private sector firms have improved efficiency through a sharp reduction in distribution losses and higher generation per their employees in the first decade following introduction of reform in Chile, thanks to a well-established regulatory framework (ibid.)[22].

But despite the success, regulation after reform failed to produce lower prices for despite efficiency improvements, with profits mainly transferred to the regulated

[22] Unlike in Peru, where conflicts ended up being resolved by the regulatory due to insufficiency and lack of competences of the judiciary (Tavera 2001), in Chile disputes were resolved by the judiciary.

companies rather than final users. Britan and Serra conclude that the Chilean energy regulator has failed to ensure fair distribution of benefits in this respect due to lack of information and capacities compared to companies it regulated. Also, market concentration Chile gives companies more negotiating power that affects policies by the decision maker (ibid.).

The UK is another pioneering country in electricity reform. The government launched plans to privatize electricity utilities in 1988 and privatization occurred in 1990, right after 12 area boards to which the Central Electricity Generating Board sold electricity in England and Wales, were re-structured into 12 regional electricity companies (Domah and Pollitt, 2001). OFFER was the independent regulatory body for the electricity sector and it would then merge with the gas regulator to create OFGEM, which has regulated both sectors to date. The UK has also been the first country to introduce 100% retail competition in 1999, thus, introducing choice of suppliers. About 40% percent of consumers changed their electricity providers in the first four years (Salies and Price, 2004; Green, 2006).

Different studies have assessed electricity reform outcomes in the UK, and there is general consensus that reform has been successful and beneficial – although differently spread across time and groups in society (Domah and Pollitt, 2001). Although retail competition would theoretically benefit small consumers, evidence shows that the main beneficiaries have been large industrial and commercial customers, while for small residential consumers this remains to be seen in the future (Joskow, 2003).

Competition in supply has not yet proven efficient in many EU countries with low rates of switching providers in countries such as UK, Norway and Germany (Green, 2006). It is harder for companies to operate in the retail segment where gains are much less compared to wholesale, while they have to incur considerable marketing costs to convince small residential consumers to switch provider. Prices offered should be considerably below those of the incumbent or the spin-off company to incentivize such switching, which squeezes profits even more and discourages entry.

Reform in Norway was introduced in 1990 with the creation of a wholesale market and legal unbundling of state-owned incumbent Statkraft into a generation and a transmission spin off. However, Norway did not opt for privatization of its state-owned companies. The country first used rate-of-return regulation, with the regulatory agency deciding on a reasonable rate of return to capital for the companies, but this changed to revenue-cap regulation which provides more incentives to reduce costs and increase efficiency of network companies (see Green et.al., 2006; Joskow, 2006; Nepal, Glachant et.al., 2012; Menezes and Jamasb, 2014 for more details on regulation).

Brazil reformed the sector by transferring ownership of public utilities to the private sector in the mid 1990ies through concessions. It amended legislation to ensure third party access to the national transmission network. The country had since the 1950s used power tariffs for reaching macroeconomic targets rather than serve the sector, which had a detrimental effect on investments. This situation was swung following the privatization of generating assets, with most companies announcing they had experienced considerable increases in profits in the first year after privatization due to tariff adjustments (Baer and McDonald, 1998). Another factor that helped improvement in performance was abolishment of a single national tariff and introduction of regional power tariffs. The limit for eligible consumers was also reduced gradually and consumers were allowed to purchase electricity directly from independent generators[23].

The strategy followed by the Brazilian government succeeded to attract capital into the sector (Baer and McDonald, 1998). However, one major problem faced in implementation of Brazilian reform was incomplete regulatory framework, which bares the risk of discouraging private companies from investing. Other countries that have carried successful electricity sector reforms include Argentina, Australia, New Zealand as well as Texas in the US. But reform has not come without costs in other countries as the case of California's electricity crisis in 2000-2001 shows.

The California energy crisis of 2000-2001 has made reform in the electricity sector, particularly deregulation, at the time infamous, with electricity prices spiking up to 450 US dollars in November 2000. However, Sweeney (2002) argues that the reason for the crisis does not lie in deregulation itself, but in the way it was carried on in California. The problem in California was "*price regulation at the retail level and rigid regulation prohibiting long-term contracts at the wholesale level*," which were the result of mismanagement of politics (Sweeney, 2002: 10). In California, changes in wholesale market prices were not reflected to retail prices, due to retail price controls. Moreover, long-term contracts were not allowed in California electricity markets, which raised

[23] There was an upper consumption limit of 10MW initially but this was eliminated within three years following the approval of the independent power producers' law in 1995.

average cost to investor-owned utilities, compared to the average costs to municipal utilities or those of other states.

"*Isolation of the supply side of the market from the demand side breeds disaster*" according to Sweeney (2002: 14) who concludes enough incentives have to be given to the sector players to invest in electricity infrastructure for the creation of future generation capacity and that political intervention in the sector should be kept at minimum. Monitoring and flexible management should also accompany the reform process.

Although they have not experienced a crisis as deep as in California, most of continental Europe, most states in the US, Japan, Brazil and other countries have also lagged behind regarding electricity reform, by only partially liberalizing the sector and failing to have a clear blueprint prepared ahead of launching the reform (Joskow, 2008; Genoud et. al., 2004).

The following section provides with a brief discussion on the EU policy and stance on power sector reform.

2.4 Reform at EU Level

Electricity sector reform in the European Union (EU) has been carried in two levels: at a national level, following the EU electricity market directives and other related legislation; and at the Union level, which has mainly focused on improving cross-border trade and transmission networks.

Directives 96/92 and 2003/54 that set rules on the internal market in electricity required member states to reform their electricity sectors by unbundling supply segments, opening national markets, improving regulation regarding third party access to networks and establishing independent regulatory authorities. The EU did not urge member states towards privatization of their electricity assets in the related common legislation. The Commission has been pushing for more steps towards the internal market for electricity since the approval ofthe third legislative package[24] adopted in 2009.

The first directive approved in 1996 set out the general framework for introduction of competition in the sector but did not suggest a specific market design. The Florence Electricity Regulation Forum was established in 1998 as a platform for informal discussion among regulatory bodies and authorities of member states but its recommendations were not binding. Main focus was setting principles for cross border tarification, inter-TSO compensation and congestion management (Squicciarini et. al., 2010).

The second directive on electricity approved in 2003 went deeper imposing legal unbundling of transmission networks and regulated third party access to networks, which had been non-binding in the first directive. Along with the directive, the

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[24] The third package for electricity and gas markets introduced ownership unbundling of generation and supply from distribution and consists of a number of EU directives and regulations. For more details see http://ec.europa.eu/energy/gas_electricity/legislation/third_legislative_package_en.htm .

Electricity Cross-Border Regulation[25] aimed at harmonising access conditions to the European electricity network. Congestion management would be market-based and interconnection capacity reservation for long term contracts was reduced in scope (ibid.).

But so far regulation failed to specify the method of congestion management at a national level which led to lack of coordination at the EU and national levels. The first European Union directive on electricity market allows three forms of liberalization: (i) the single-buyer model, third-party access, and the pool.[26]

As Jamasb and Pollit argue in their 2005 paper a European internal market for energy seems not to be an option for the near future, but an intermediate step could be through regional markets (Jamasb and Pollitt, 2005).

The European Commission's 2004 paper on the future of the internal electricity market paved the way for the regional approach, given that there was already some coordination among several countries in different regions. Regional harmonization would eventually translate to a common market for electricity, but the Commission did not provide with specifics how this could be achieved.

[25] In EU law, directives set out the final targets and it is left to the national states to choose the means with which to achieve those targets. While EU regulations are binding in all their provisions for the member states.

[26]For more details on EU energy directives see Bergman et. al. (1999), Newbery (2001, 2002a), Jamasb and Pollitt (2005), Green (2006). See also previous section for details on the three forms.

Squiccirarini et. al. (2010) present a full account of achievements and weak points of the regional approach, suggesting that failure to coordinate at both an intra and inter-national level is not sustainable and should be abolished if the EU aims at integrating power markets. They argue that managing congestion through re-dispatches, the approach used at a national level by member states, is inefficient and that regional power prices should be presented within countries. But this is something difficult to be achieved politically, as the third legislative package, which inherits the two-tier system of within-country congestion management at the country level and the cross-border congestion management under discretion of EU policy and administration.

To sum up, the electricity reform in the EU has mainly focused on market opening. Wholesale competition is complete in all member states and a large proportion of consumers – both domestic and industrial – can chose their own supplier. However, "*declared market opening does not necessarily imply effective competition and competitive prices*" and low price responsiveness by consumers and small number of players in markets of member states have hindered competition in EU member states (Jamasb and Pollitt, 2005: 24).

Regarding restructuring, transmission and distribution have been unbundled to different extents in various EU member states and that although not required by the directives, horizontal unbundling of companies such as Italy's ENEL and France's EdF has been required.

But the tendency for market concentration has increased in both national and EU level, which restrains effectiveness of competition. One reason for concentration is market share restrictions in home markets for large companies. Green (2006) lists examples of horizontal expansion of large European power companies through mergers and acquisitions in other countries[27], arguing that given benefits from economies of scale, such companies will likely opt for further concentration. This could in turn harm end-users in the union.

Newbery (2002a) discusses challenges of electricity liberalization in the EU, noting that the main concern is "*the tension between the desire for efficient, competitive and unregulated wholesale and retail markets, and for long-term investment and security of supply*" (p. 9). Prices can be determined by suppliers in concentrated markets, due to market power. In this way, they can set prices above variable cost and compensate for their fixed costs. Being a price-maker also reduces investment risk in the long term, according to the author.

The EU model is still to be tested for all the 27 member states. For this reason, it is difficult to claim that electricity reform in the EU could be a model for Southeast European Countries (Pollitt, 2007), unlike it is the case for other sectors. However, individual countries could be inspired and learn from experience of countries that have already undertaken reform and have been successful in achieving its final goals.

[27] See also Codognet et al. (2002) for an extensive list of EU mergers and acquisitions in electricity.

The following chapter provides a detailed overview of the power sector reform in Turkey.

CHAPTER 3

POWER REFORM IN TURKEY

Before the 1980s, the Turkish electricity sector was in monopoly hands of a vertically integrated state-owned incumbent[28] Turkish Electricity Administration (TEK). The first attempt to open the industry to the private sector was made in 1984 through Law. No. 3096, which allowed private participation in the sector through Build-Operate-Transfer (BOT) contracts. The private investor would build and operate power plants for a given period of time (15 years in practice) and transfer its ownership to the state at no cost

[28] Like in most European countries at the time. For a more detailed account on the situation of the Turkish power sector before the 1980s see Ultanir(1998) , Atiyas and Dutz (2004), Erdogdu (2006), Ozkan (2011)and Tiryaki (2013).

after due date. Private participation was also allowed for distribution and transmission sectors, although interest was limited for these (Ultanir, 1998; Ozkivrak, 2005).

The same law introduced Transfer of Operating Rights (TOOR) contracts for existing generation[29], where a private company would take over management of a state-owned plant and also invest in its rehabilitation where necessary and then hand operating rights back to the state after the due date.

The concept of power generation for companies' own needs referred to as auto-producers was another novice of law no. 3096. These would produce for their own needs and sell up to 20% of their sales the previous year to other parties without holding a generation license.

International organizations such as the World Bank and the International Monetary Fund encouraged the new reforming steps, which would in theory reduce the financial burden from state and encourage efficiency improvements. But agreements between private participants and the Turkish state ended being of the "take-or-pay" nature, with the Treasury guaranteeing purchase of power generated in the framework of BOT and TOOR contracts at fixed price formulas, creating an over-burden rather than releasing state finances.

[29] For more details on TOOR, BO and BOT contracts see Ultanir (1998), Atiyas and Dutz (2004), Ozkivrak (2005), Erdogdu (2006), Tiryaki(2013).

Also, investors faced bureaucratic barriers which lead to considerable delays to the aimed reforms. There were interventions by the constitutional court regarding the jurisdiction under which power sector contracts would fall. Power sector was still perceived as a public service with the court arguing related contracts had to fall under public rather than private law (Ozkivrak, 2005; Erdogdu, 2007; Dastan, 2011; Tiryaki, 2013). These slowed down the process substantially, with construction of first private power plants built only 12 years after the law was approved.

In need of new investments and in a bid to deepen the reform in order to attract investment, incumbent Turkish Electricity Administration (TEK) was divided into two sister companies following approval of a related government decree in 1993. The spun-off companies were TEAS, responsible for generation and transmission and TETAS, responsible for electricity distribution.

In 1996, another model of private participation was introduced, namely the Build-Operate-Own (BOO) model[30], with the Treasury guaranteeing sales of BOO power plants for 15 years and then ownership remaining with the private investor who would compete at market conditions thereafter. But even this model failed to attract much investments in the beginning, generating just 2.4GW of new capacity (Tiryaki, 2013).

Heavy bureaucracy and the lack of strong institutions – particularly a guaranteed independent and well-functioning conflict resolving mechanism and judiciary –

[30] Only thermal energy was subject to BOO contracts, as the law was kept exempt from other sources like nuclear, hydro, geothermal and other renewable resources.

inevitably discouraged private investors although the ministry raised the guarantee period to 20 years. Hence another law followed in 1997, offering 15-years sales guarantees, tax exemptions and international arbitration for potential conflicts arising from BOO contracts. Some 6GW new capacity was invested following recent regulation.

The BOT, BOO and TOOR contracts could not attract the desired investment levels into the country, given bureaucratic and legislative barriers as well as the lack of a comprehensive reforming framework for the sector. Table 3.1 shows Turkey's total installed capacity by institution by the end of 2014 when capacity of BOT, BOO and TOOR plants totalled 9.4GW counting for 13.5% of the total capacity at the time.

Table 3.1 Turkey's installed capacity by institution, end-2014

Institutions	Installed capacity (MW)	Share (%)
EUAS	20,845.20	30
EUAS affiliates	1,034.00	1.5
TOOR	946.20	1.4
BOO	6,101.80	8.8
BOT	2,319.30	3.3
Independent power producers	38,193.40	54.9
Auto-producers	27.2	0
Unlicensed	52.8	0.1
Total	**69,519.80**	**100**

Source: TEIAS.

Also, this model failed to promote competition in the electricity market due to the take-or-pay stances which guaranteed sales of 85% or more of their output hence eliminating their exposure to market risks and any incentive to increase efficiency (Erdogdu, 2007; Baş and Ülgen, 2008; Tiryaki, 2013).

Turkey undertook a comprehensive power sector reform in 2001, aiming at most of Joskow's (2008) "textbook model" elements, namely, market liberalization, restructuring, (de)regulation, privatization and the establishment an independent regulatory body. Following the approval of the Electricity Market Law (EML) no. 4628 in 2001, TEAS, the publicly owned vertically integrated incumbent, was restructured into three new state-owned enterprises: Turkish Electricity Transmission Corporation (TEIAS), electricity Generation Corporation (EUAS) and Turkish Electricity Trading and Contracting Corporation(TETAS).

The Energy Market Regulatory Authority (EPDK) was established, primarily charged with licensing activities, regulation of contracts concluded before EML, monitoring market performance, drafting, amending enforcing and auditing performance standards and distribution as well as customer services codes, setting out pricing principles and monitor their implementation.

Following the approval of secondary legislation in 2002, EPDK defined four stages to competitive power markets as follows (Hepbasli, 2005): (i) licensing power and gas firms; (ii) give eligible consumers the right to choose their supplier; (iii) establishing a Market Financial Reconciliation Center; and (iv) make this center work.

In essence, EML aimed a power market model dominated by voluntary bilateral agreements and complemented by a balancing and settlement mechanism. Regulated third party access to the grid under EPDK supervision was also introduced.

All market activities became subject to licensing and were opened to the private sector except transmission services. Cross-subsidization among activities or utilities is banned by the law.

Further to promoting competition, the EML introduced a 20% market share cap for private generators, but kept state-owned companies exempt from this application – a major shortcoming (Oguz, 2010; Tiryaki, 2013).

In the framework of the new law consumers were classified as eligible consumers[31] who are able to choose their electricity provider and non-eligible consumers – mostly households – who is supplied electricity only from retail sale companies or from the distribution company holding a retail sale license in its region. The lower limit of consumption for eligible consumers was reduced to 4.5MWh per annum in 2014, compared to 30 MWh in 2011 and 7.8 GWhin 2004[32]. The number of eligible consumers has increased radically, hitting 447,422 in December 2013 compared with

[31] The concept of large (eligible) consumers had been introduced earlier – with these being able to directly connect to the grid, but they did not have the right to choose their own supplier.
[32] The eligible consumers limit is revised annually by EPDK's board and is available in the agency's official website.

just 27,486 in December 2012 and 7,556 in January 2011 (EPDK, 2012a, TEIAS 2013[33]). The ultimate goal is 100 percent market opening by 2016 (MENR, 2014)[34].

As is the case in other reforming countries, theoretical openness does not necessarily imply openness at the same rates in practice[35]. However, elimination of the eligible consumer limitations helps develop the demand side of the market, hence increasing flexibility and promoting more competition in the market.

Turkey applies a revenue-cap pricing approach for transmission and distribution revenues[36] (USAID, 2006). The allowed revenues for companies include both operational and capital considerations – namely OPEX which is return to operations, and CAPEX – payments for physical capital depreciation – plus stranded costs. For the regional distribution companies EPDK employs a number of quantitative methods and benchmarking to assess operational expenditures, while the latter submit regular investment proposals for the measurement of depreciation expenditures (see USAID 2006 for details). Both these items are then reflected into distribution fees to be paid by end users.

Final user's power prices are also subject to a cap which is reviewed by the regulator quarterly, and include the following fees: theft/loss fee, connection and system-use fees,

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[33] TEIAS Annual Report 2013.
[34] There is no online version of the draft strategy paper, but a few details are available on http://www.kanalahaber.com/haber/ekonomi/yoksul-vatandaslara-elektrik-destegi-206125/ as of 11 January 2015.
[35] See for eg. Littlechild (2006) on the case of UK.
[36] Fees for these and TETAS services were introduced by EML.

transmission fee, distribution fee, retail sale and related services fee, municipality tax fee, and a Turkish Radio and Television Corporation Fund fee[37].

The privatization process in Turkey has been completed for all 20 regional distribution companies and is still ongoing for generation assets as of early 2015.

On the distribution segment, as perfect competition is not feasible given its natural monopoly nature, the country went for competition for the market, rather than in the market. The privatization process for 20 of 21[38] regional distribution companies was finalized in 2013, almost a decade from the initially aimed schedule[39].

Main drivers for distribution were efficiency considerations – on grounds of increasing empirical evidence on inefficient management of state-run distribution monopolies, as well as the need for new investments in the network – as the state lacked needed

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[37] Turkey applies a single national tariff despite an EPDK attempt to pass to regional pricing in 2003 (see Cetin and Oguz, 2007; Oguz, 2010; and Durakoglu, 2011 for more) due to very high ratios of illegal use (theft) particularly in eastern Anatolian regions where these rates could overpass 50%. The theft-loss fee was separated from the "active" electricity price in 2011 appearing as a separate item in power bills as well. Former TEDAS general manager Nuri Osman Dogan argues in an article published in Electricity Generators Association (EUD) website that the retail sale fees are unfairly applied on a cent/KWh basis while costs for such services are fixed independent of the amount of power consumed. For more details see http://www.eud.org.tr/TR/Genel/BelgeGoster.aspx?F6E10F8892433CFFA79D6F5E6C1B43FFF8E1302CA0BA6395 available as of May 2015. Concerns have also been voiced on the Radio and Television fee, on the grounds that Turkish state television should fairly compete with other media broadcasting in the country rather than being mainly financed by electricity consumers.

[38] The Kayseri distribution company (Kcetas) has been owned and operated by the private sector since its establishment in 1926. For more info see its official website http://www.kcetas.com.tr/?kanal=tarihce available as of May 2015.

[39] A strategy paper approved in 2004 set targets for privatisation of power distribution and generation assets. The process for 20 publicly owned distribution companies would start in 2005 and be finalized in 2006. However, countries may sometimes choose to postpone privatization for some time after the re-structuring of the incumbent company to see what impact that first step will have on the sector and whether it will be successful. Privatization of generation assets would follow and was expected to last until 2012 according to the 2004 strategy paper.

financial instruments to incur such investments particularly following one of Turkey's harshest economic crises in 2001. International lenders also encouraged the country towards privatization of its then state-run network industry companies to ease public finances from privatization revenues.

Privatization of regional distribution companies[40] was realized through the transfer of operating rights approach. Elements such as technical losses and illegal use (theft) ratios, operating and investment costs are all taken into account by the regulator for determining distribution fees and final prices applied to end-users. This approach is envisaged to encourage private companies increase efficiency, by allowing them to keep any profits from over-scoring efficiency improvement rates.

Provisions related to privatization of generation were brought through amendments to EML in 2006. The Privatisation Administration (OIB) finalized the privatisation process of 9 power plants[41] of 141MW total capacity in 2008. Some 50 run-of-river power plants of about the same capacity were privatised between 2010 and 2014.

[40] These also included retail activities in respective regions. Unbundling of distribution and retail activities was introduced in the new electricity market law in 2013.
[41] Of these, 7 were hydro power plants, one geothermal and one gas-fired plants. For more details see http://www.oib.gov.tr/portfoy/elek_uretim_santralleri.htm available as of 11 January 2015.

More than 5.8GW of major thermal capacity has been transferred from EUAS to the private sector, as shown in Table3.2 below. Additionally, EUAS aims to privatise another 10.5GW capacity by 2016[42].

Table 3.2 Privatisation of EUAS plants in Turkey

TRANSFER DATE	***Plant***	***Capacity (MW)***	***Fuel type***	***Purchasing private company***
01.08.2013	Hamitabat	1,200	gas	Limak Doğalgaz Elektrik Üretim
17.06.2013	Seyitomer	600	lignite	Çelikler Seyitömer Elektrik Üretim
14.08.2013	Kangal	457	lignite	Kangal Termik Santral Elektrik Üretim
01.12.2014	Yatağan	630	lignite	Yatağan Termik Enerji Üretim
22.12.2014	Çatalağzı	314	coal	Bereket Enerji
23.12.2014	Yeniköy	420	lignite	Ic-Ictas Enerji, Limak Enerji
23.12.2014	Kemerköy	630	lignite	Ic-Ictas Enerji, Limak Enerji
22.06.2015	Soma B	990	lignite	Konya Şeker Enerji
22.06.2015	Orhaneli	210	lignite	Celikler Holding
22.06.2015	Tuncbilek	365	lignite	Celikler Holding
Total privatised		**5,816**		

Source: OIB[43].

Reform in the electricity market has been expanded through a new electricity market law (new EML) enacted in March 2013. It brought complementary provisions to the unbundling of retail and distribution activities, including clauses that prevent direct partnership of a distribution company into a retail one and vice versa, and also explicitly stating "*distribution companies cannot engage in any activity other than distribution*" (Art. 9).

[42] See http://www.eud.org.tr/TR/Genel/BelgeGoster.aspx?F6E10F8892433CFF7A2395174CFB32E1B3F1BDC60F597ECC for more details. Available on 11 January 2015.
[43] Available at http://www.oib.gov.tr/program/uygulamalar.htm , last accessed on January 2016.

However, Tiryaki (2013) argues that attaching activities considered as competitive segments of the power sector, such as counter reading and billing and maintenance services to distribution with the new EML marked "*one of the most prominent losses of liberalization movement*" in the country (p. 23).

An essential change introduced by the new law is separation of market operator from system operator activities – both currently[44] held by grid operator TEIAS. EML envisioned the creation of an energy stock exchange through establishment of a trading platform company – EPIAS – to carry out market operator duties, where electricity will be traded like other commodities such as oil, natural gas on the bourse. A new type of license – market operation license – was introduced in the law to empower EPIAS operate the market. Until its launch TEIAS will operate the balancing and settlement mechanism. It is also charged with operating ancillary services market in the new EML. Another newly introduced license type was the supply license, which takes previous wholesale and retail licenses under one single shelter.

The doubling of threshold for unlicensed generation to 1GW was undoubtedly a positive aspect of the new law. The Council of Ministers has authority to increase this limit up to 5GW, which is also set as a target in the recent national action plan for renewables (ETKB, 2014).

[44] Mid-2015.

The new EML excluded all provisions on auto-producers, generators that used most of their output for their own consumption needs[45], however, it envisaged that any participant holding a generation license that transferred a part of its output for use by its own facilities or parent company without using transmission and distribution grids, will be kept exempt of taxes and other market limitations (Tiryaki, 2013).

There existed a need to address auto-producer issues, as these manipulated the system in accordance with their own needs by purchasing power from own plants during peak hours and buying from the market in off-peak hours, which increased electricity costs for end-users (Oguz, 2010; Tiryaki, 2013). But above-mentioned clauses preserved the notion of auto-producers with the only difference that from this time on, any company with a generating license that did not use the national and regional grids was eligible for 'auto-producer benefits'.

3.1 Model of Competition

On the supply side, EML introduced unbundling of generation, transmission, distribution, wholesale and retail segments and opened all but transmission to the private sector. Out of 21 distribution companies only one was privately-owned in 2001 and the privatization of the remaining 20 was finalized in 2013, much later than the initially set deadline in 2006. A part of the state-owned generation assets have also been transferred to the private sector while others remain to be privatised (see sub-section

[45] These gained for certain advantages compared to other users, as they were kept exempt of taxes.

below). While power transmission (TEIAS) still remains a publicly owned monopoly and state representatives have stated there is no intention to open transmission to the private sector any time soon[46].

Hunt and Shuttleworth (1996, quoted in Kirschen and Strbac, 2010) suggest four models of competition for power markets, exhibited in Figures 3.1-3.4 below according to their degree of openness from monopoly to fully competitive markets.

The monopoly model in 3.1(a) represents the competitive structure of almost all power markets before reform started in the 1980s, where all segments, namely generation, transmission and distribution are vertically integrated under a single incumbent firm. This represents the Turkish power market structure before the first attempts in 1984 when all segments were integrated under the Turkish Electricity Organization (TEK).

[46] The minister of energy and natural resources said the Turkish government was not in favour of opening transmission to the private sector at any point in the medium or long run in a speech at Ankara Chamber of Commerce's symposium on electricity market developments on 19 December 2013, re-confirming Turkey's stance regarding public monopoly of the transmission sector previously expressed in related legislation and strategy papers. See http://www.atonet.org.tr/yeni/index.php?p=2667&l=1 for more details on the minister speech. Available on 11 January 2015.

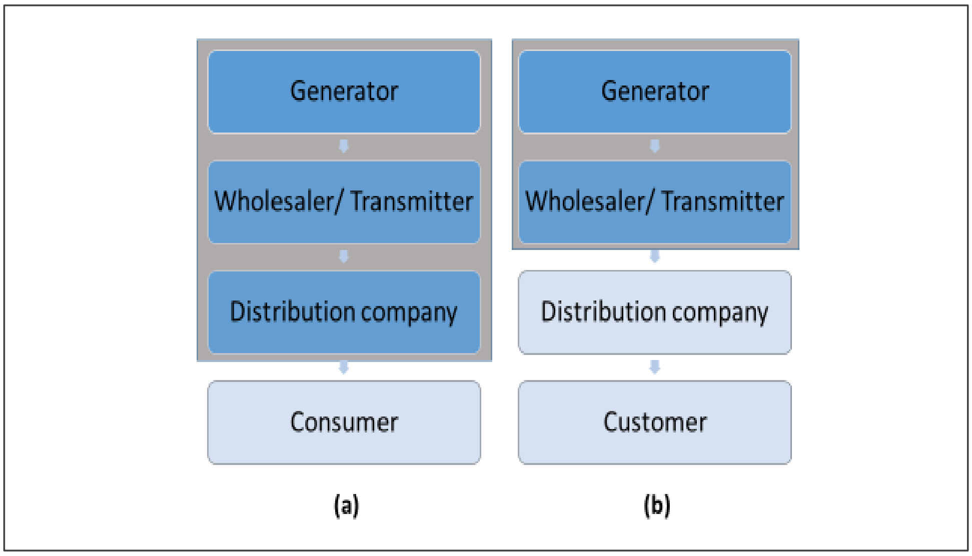


Figure 3.1Monopoly model

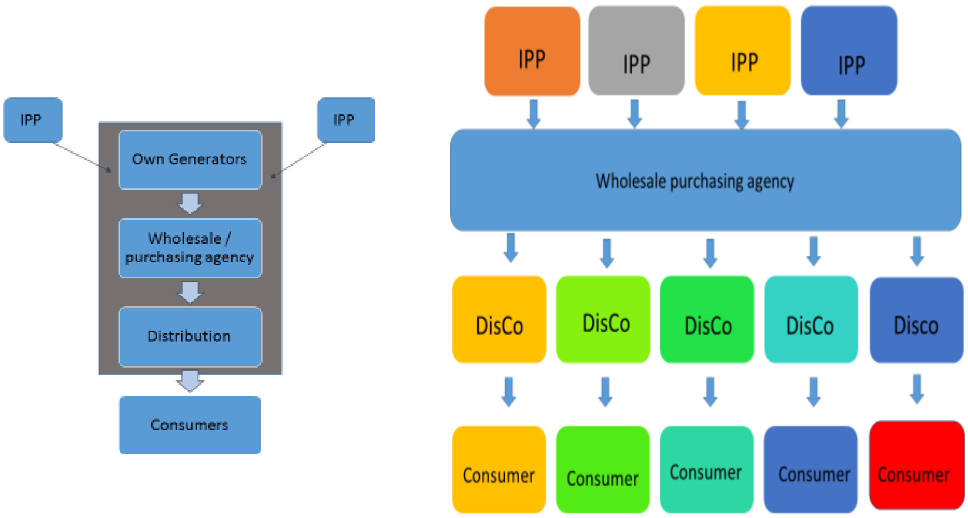
Source: Hunt and Shuttleworth (1996, quoted in Kirschen and Strbac, 2010).

Figure 3.1(b) displays a monopolistic structure for generation and transmission activities while distribution is run separately by one or a number of firms.

One step further, the purchasing agency model presents the case in which private companies are able to enter the generation sector. Figure 3.2(a) displays the integrated version, which suits Turkish power markets between 1984-1994 when a number of private companies started generating power with state support through sales and price guarantees.

In the disaggregated version of the purchasing agency model in 3.2(b) generation is completely run by private sector, the wholesale purchasing company – after which the stage is named – is still a monopoly and distribution and retail are disaggregated.

Turkish market structure during 1994-2001 represents a modified version of Figure 3.2 panel (b), with a major stake of generation still in public hands and just one out of 21 regional distribution companies run privately. Privatization of all distribution companies was completed in 2013 and disintegration of distribution from retail was achieved the same year after the new electricity market law was approved.



(a) **(b)**

Figure 3.2 Purchasing agency model
Source: Hunt and Shuttleworth (1996, quoted in Kirschen and Strbac, 2010). *Note*: IPP stands for independent private generator, DisCo for distribution companies.

In the wholesale competition stage shown in Figure 3.3, distribution firms purchase power from generators in the wholesale market, where large consumers – often referred to as "eligible consumers" – are also able to purchase power from. Here households are still provided electricity by distribution companies, which own exclusive rights for their assigned regions. This is the main feature that distinguishes this model from retail competition.

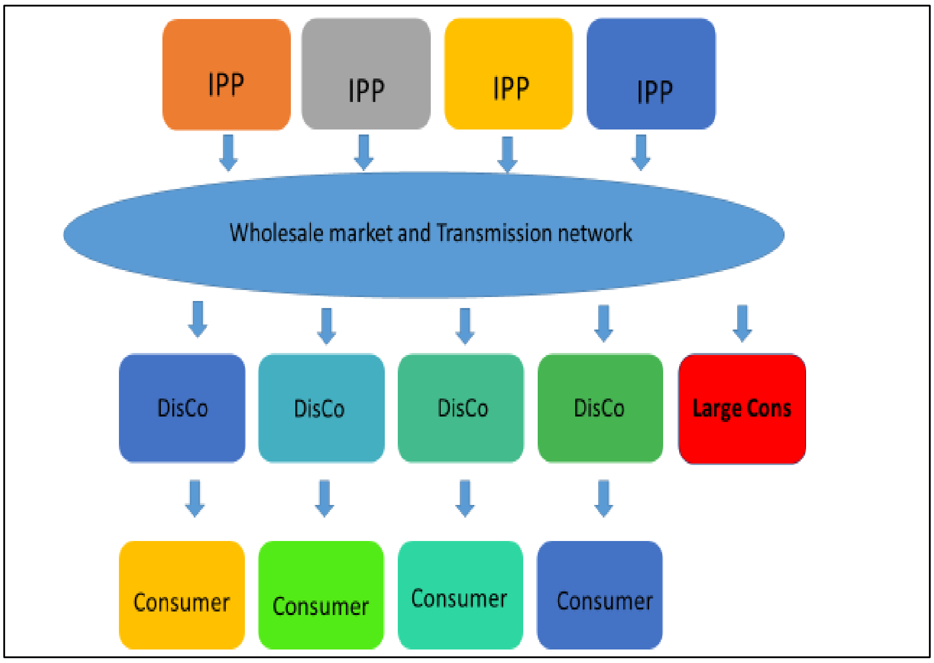


Figure 3.3 Wholesale competition.

Source: Hunt and Shuttleworth (1996, quoted in Kirschen and Strbac, 2010). *Note*: IPP stands for independent private generator, DisCo for distribution companies.

The latter, shown in Figure 3.4, marks the final stage of market openness, where any consumer can choose their power supplier. Turkey aims to achieve 100% retail market opening by 2016 (MENR, 2014)[47].

After reform was introduced in 2001 in Turkey, the market structure changed substantially following unbundling of generation, transmission and distribution

[47] See note no. 16.

activities. Yet, the Turkish power market accommodated just a number of features from the wholesale competition stage. The new law introduced wholesale competition to power markets, which is still deepening to date (see following section). But co-existence of public and private utilities, and that of a purchasing agency (TETAS) and a wholesale market, even at present day, pour complexity to the Turkish market. Thus, it is difficult to fit this market in one single model of competition as defined in Hunt and Shuttleworth (1996, quoted in Kirschen and Strbac, 2010) as it has rather adopted elements from each stage without fully completing any of them.

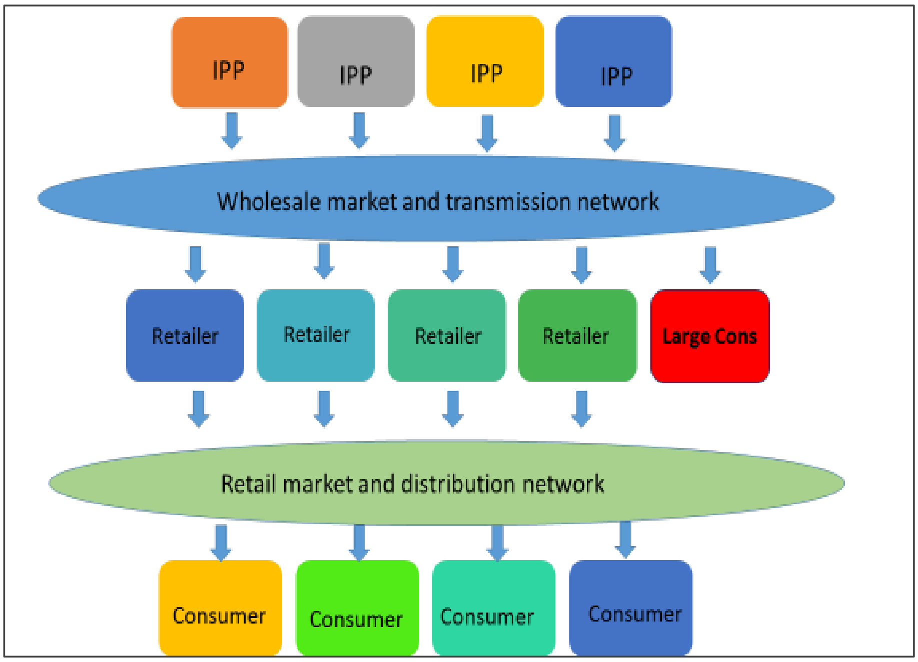


Figure 3.4 Wholesale and retail competition
Source: Hunt and Shuttleworth (1996, quoted in Kirschen and Strbac, 2010). *Note*: IPP stands for independent private generator, DisCo for distribution companies.

3.2 Trading Power Markets

Unlike other commodities, electricity cannot be stored – at least not at any viable costs – hence it has to be delivered and used simultaneously. Moreover, electricity is not a valuable commodity per se, but it becomes so when it is delivered and used in the right place and time. For example, providing electricity to an industrial plant during the weekend when the plant is closed will not be of any use for the plant. Similarly, being unable to deliver power to a plant during a weekday when it is operational will not make power delivered to another location any valuable for the said plant.

Producers will not know the exact actual demand for power at a certain point in time, as consumers can use electrical devices whenever they want.

For these reasons, providing electricity requires planning ahead of time and regulation and trading[48] power is convenient. Participants trade power in spot or in forward markets, the difference among which is briefly discussed below.

In a spot market, the traded commodity has to be delivered instantaneously. Not everyone can trade power on the spot, as it is quite impossible to predict what the exact demand for power will be at a certain point in time. Thus only generating utilities and those that can use power immediately are able to trade in spot power markets. Such

[48] In trading markets one can buy, sell and exchange commodities unlike in cash markets where a commodity bought can not necessarily be sold again. For a more detailed discussion see Edwards (2010), Harris (2003) and Kirschen and Strbac (2010).

markets can be highly volatile in the case of abrupt changes in weather conditions, unplanned outages or other unpredictable situations.

In forward markets, counterparties agree on buying and selling power ahead of consumption or delivery time. A major advantage of forward trading is that it increases visibility of the amount of power to be delivered and used in the future hence lowering risks attached to short-term volatilities.

It is possible to trade physical or financial contracts in forward markets. In a physical settlement, the offering party has the responsibility to deliver power physically in the agreed time and location and the bidding party has to consume all the agreed quantity, time and location. Whereas in financial contracts, also referred to as future contracts, participants are not limited to parties that produce or consume power. These could be speculators who will buy a contract for delivery in the future if they are expecting its price will rise so that they can sell it in a later date. Similarly, speculators can sell future contracts if they expect their price will fall, when they can buy the same product for a lower price. Markets where future contracts trade are also called future or *secondary* markets. Forward markets can be categorized into two major groups in terms of the number of counterparties involved in a transaction: bilateral trading and electricity pools.

In bilateral trading there are two counterparties involved in a transaction, namely a buyer and a seller. Kirschen and Strbac (2010) list three types of bilateral trading:

Customized long-term contracts: negotiated privately for long delivery periods and large volumes. Contracts are curtailed according to the needs and aims of both parties.

Over-the-counter trading: transactions that occur at arms' length, generally smaller volumes traded for shorter periods of time. Unlike in power exchanges, non-standardized contracts can also trade here.

Electronic trading: these are computerized trading platforms where all participants can see bids and offers but the identity of bidding parties is not revealed. Trade occurs when an individual bid meets an individual offer.

Prices in all bilateral trading forms are set by counterparties, and not defined by the energy regulator or other state authorities.

Electricity pools are another way of matching suppliers and consumers where unlike in electronic bilateral trading where parties interact at an individual level, here all bids and offers are presented in a single pool which are then ranked to form supply and demand curves. The intersection point of both determines the market clearing price or the system marginal price (SMP). In general these include power exchanges, which help reduce counterparty risk as collaterals are required from all members. Here a party interacts with the exchange after having signed an agreement with it, instead of signing an agreement with each other counterparty it will interact while trading power. This substantially reduces costs and time required for trading.

3.2.1 Wholesale Markets

The strategy paper published in 2004 (MENR, 2004) envisaged an energy market based on bilateral contracts, complemented by the balancing and settlement mechanism. This market philosophy was re-confirmed in the 2009 strategy paper.

The wholesale power market in Turkey was initially comprised of a balancing and a day-ahead market which took many years to be established.

With more secondary legislation in place in 2003-2004, the settlement of the spot market went through three main stages: (i) Initiation of financial settlement applications, 2004-2006; (ii) Temporary balancing and settlement regulation period (T-BSR), implemented in 2006-2009; and (iii) Final balancing and settlement regulation period (F-BSR), implemented in 2009-2011.

During the T-BSR period, real time imbalances were eliminated by instantly buying or selling electricity at the system imbalance prices (SIPs) settled monthly for three different periods of the day; namely night, day and peak (EPDK, 2011).

Meanwhile in the F-BSR period day-ahead balancing and real-time balancing were separated from each other and the day-ahead planning mechanism in this period served as a transition to the day-ahead market mechanism introduced as of January 2011.

The difference between a balancing and a day-ahead market (DAM) lies in the delivery date corresponding to transactions settled in each.

The balancing market is a managed spot market which deals with balancing power shortages or surpluses in real time, in order to maintain integrity of the system. This market is essential because actual demand is difficult to forecast – thus it will hardly exactly match with the amount forecast by TEIAS the day ahead, and due to unexpected events in generating facilities such as sudden trips can affect output on the downside. As Kirschen and Strbac (2010) put it, the "… *managed spot market is the market of last resort for electrical energy*", that serves "*to match residual load and generation by adjusting the production of flexible generators and curtailing the demand of willing consumers*" (p 51-59).

Whereas in the DAM suppliers send their bids to the market operator (TEIAS) one day ahead the delivery date. In this sense, the DAM is a forward market operating at the very short term.[49] The grid operator (TEIAS[50]) is charged with forecasting demand for the following day. Given expected demand and offers by suppliers, the DAM price clears at the intersection point between the two.

Turkey launched an intra-day market on 1 July 2015 (MENR, 2014)[51] after years of delay, where power will be traded up to 2 hours[52] ahead of delivery. The intra-day market helps address short-term volatilities in power generation and consumption and

[49] There also exist intra-day markets where bids and offers for power are taken 15 minutes before power is delivered.
[50] In Turkey, the transmission company is charged with both operating the grid and the market. When the energy exchange (EPIAS) becomes operational, it will be the new market operator while TEIAS will only carry the duty of a transmission system (grid) operator, or TSO.
[51] See note no. 16.
[52] This period is aimed to be gradually lowered to 45 minutes.

provide real-time competitive trading for renewable generation which is bound by real-time weather conditions.

Figure 3.5 displays power trading markets with respect to the time of power delivery.

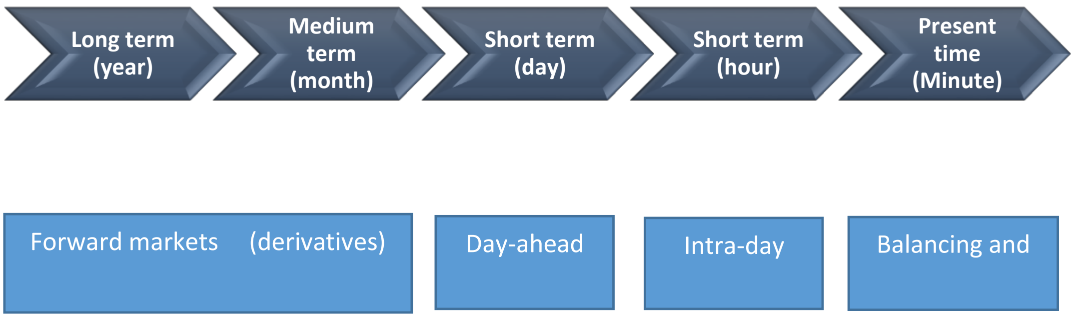


Figure 3.5 Power trading markets

Turkey's market operator went through corporatization in March 2015 and market operator was separated from grid operator as of 1 September 2015. An energy exchange where only electricity forward financial contracts are traded was also launched in 1 October 2015. Maximum delivery period for power contracts traded on Borsa Istanbul's Futures and Options Market (VIOP) is currently one month, but cascading of products is planned to be launched by the end of 2016. Futures contracts will also be introduced later in time.

Before EPIAS was established, both system operator and market operator duties are held by grid operator TEIAS. The establishment of the exchange was formalized in the new electricity market law approved in 2013 and is expected to provide the right price signals to draw investments from local and international firms.

A 30% EPIAS stake is held by grid operator TEIAS, 30% by the Istanbul Bourse – which operates the futures and forward markets – and the remaining 40% is held by private shareholders representatives in the power market such as utilities, distribution and power trading companies. The shareholders structure was finalized by EPDK[53] on 16 December 2014, with 109 private companies having gained shareholder rights for EPIAS.

3.3 Evaluation of Reform: Lessons Learnt from Turkey

Reform has brought fundamental changes to the Turkish power sector since 2001. Liquidity has increased in a properly functioning day-ahead market. Volume in the over-the-counter (OTC) market has been increasing since its launch in 2011. The intra-day market to be launched on 1 July could help better balance the system and give renewable generation an option to sell power in real time. And the start-up of the EPIAS trading platform is expected to generate clear price signals to attract more investments into the sector.

More than 2.3 billion US dollars were invested in power generation between 2004 and 2012 in Turkey (ISPAT, 2013). The share of independent generators in total installed capacity over-passed that of EUAS, its affiliates and companies backed by state

[53] For more details please see EPDK announcement downloadable on http://www.epdk.gov.tr/index.php/tum-duyurular/24-strateji-duyurular/1641-duyuru-1104 available as of 11 January 2015.

guarantees in 2014, and more capacity is expected to be transferred from state to private sector in the coming years.

Privatization for all regional distribution companies concluded in 2013 and the private sector is expected to improve distribution services through investments and efficiency improvements.

There were 190 companies holding a power supply license and 1,547 with a generation license by the end of 2014 (EPDK, 2015), compared to just a few companies active in the sector right ahead of introduction of reform in 2001. But despite all achievements, there is still room for improvement.

Dominance of state-owned companies in potentially competitive segments and application of double standards for state and privately-run companies constitute serious threats to market competitiveness and liberalization.

EUAS, its affiliates and companies backed with state guaranties – i.e. BOT, TOOR, BOO – generated TWh or 52.2% of the country's total output in 2014. The market share cap of 20% for private generators[54] does not apply for EUAS, thus allowing for market concentration and exposes this segment to the risk of dominant position abuses as. EUAS owns 53% of total hydro installed capacity which enables it to have a significant impact on day-ahead prices. Hourly prices have often been artificially capped by

[54] In the EU, the market share cap is 20% for individual companies and 40% for total share of any three firms, see for example Green et.al. (2006).

EUAS[55] in peak demand periods by increasing storage hydro generation which for old plants has almost zero operating costs.

Figure 3.6 below shows peak-shaving of hourly day-ahead prices in January 2015 where obviously prices do not exceed the TL225/MWh level (the red dashed line) although gas supplies to a number of power plants were limited or interrupted to prioritise household gas consumption during a cold spell, in which case past experience shows hourly hours could have hit TL300/MWh or above.

State-run wholesale company TETAS has sold 121.6TWh or 49% of the total power consumed in the country in 2014, obviously holding a dominant position in the wholesale market. Although the TETAS wholesale price is regulated by EPDK, any move in TETAS prices or traded volumes will affectthe market significantly, so the company should be kept under strict scrutiny so that its policies do not undermine the market[56].

This is particularly concerning in a highly politically-affected environment as in Turkey. The competition authority does not have any supervisory powers over energy regulator EPDK except for mergers and acquisitions issues (Oguz, 2010), thus the latter

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[55] Participants refer to this as the "invisible hand" of Turkish power sector.

[56] Note that state-run companies like EUAS and TETAS, were not inherited in the UK model (Dastan, 2011). Even the nuclear power plants which the private sector showed no interest in during privatization in 1980s, were unbundled and operated under competitive market conditions (see Newbery 2001 for example), which helped increase efficiency considerably. However, the UK is mulling to encourage new investments in thermal power plants through state-backed price guarantees to meet projected future needs.

must make sure it develops all the infrastructure and human resources to monitor competition in the market.

Uncertainty on the approach to be followed with BOT and TOOR plants is like a ‘black hole’ in the sector’s future in the eye of investors. Relevant authorities, including regulator EPDK and the energy ministry ought to display a clear action plan on the methodology they will address these plants when contracts reach their due date, by clearly stating if they will be taken under EUAS portfolio, remain in incumbents’ hands or be subject to privatization through a competitive tendering process.

Lowering power prices was a key objective explicitly mentioned in both 2001 and 2013 laws. But retail prices were 124% higher in 2014 compared to 2006. Akkemik (2009) compares technological change in Turkish power generation sector before and after the 2001 reform. He finds out it has deteriorated from 1984-1993 to 1994-2001 but has increased after 2002 with the launch of reform. However, these have not been reflected in end-user tariffs, which have increased gradually (see Figure 3.6), particularly following general election years – suggesting electricity is also used as a political commodity.

Only in the 2008-2009 period prices have increased by around 50% after cost-based pricing mechanism was introduced in line with the launch of the privatization process for regional distribution companies (Durakoglu, 2011; Zhang, 2015).

However, Karahan and Toptas (2013) observe that a decrease in wholesale power prices has not always led to a decrease in retail prices during the 2009-2013 period. The authors find out that while wholesale tariffs have fallen by 10% (by 1.4 Turkish lira cents per kWh), retail prices have increased by 5.9% (1.2 Turkish lira cents per kWh), which suggests that privatization of distribution companies has not resulted in price reductions for this period[57].

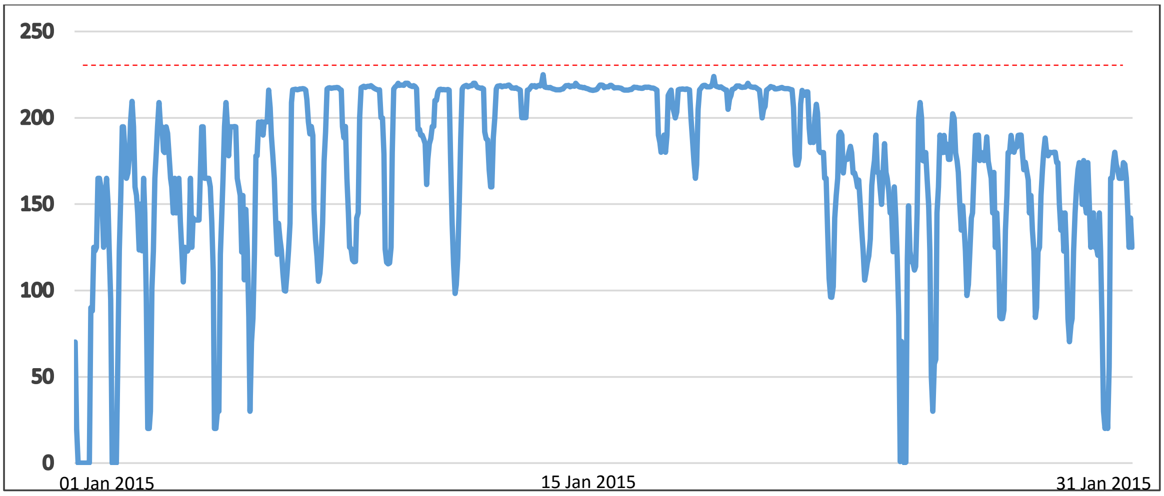


Figure 3.6 Price-shaving in Turkey: hourly day-ahead prices (PMUM, TL/MWh)
Source: TEIAS/PMUM

Introduction of reform does not necessarily lead to a decrease in prices for the commodity. On the contrary, it could even result in higher prices[58] if these have been suppressed during the pre-reform period.

[57] The difference between these two prices is the amount charged by distribution companies, which has increased contrary to what laws foresaw.
[58]Oguz (2010) mentions that tariffs in European countries and the US have increased after reforms.

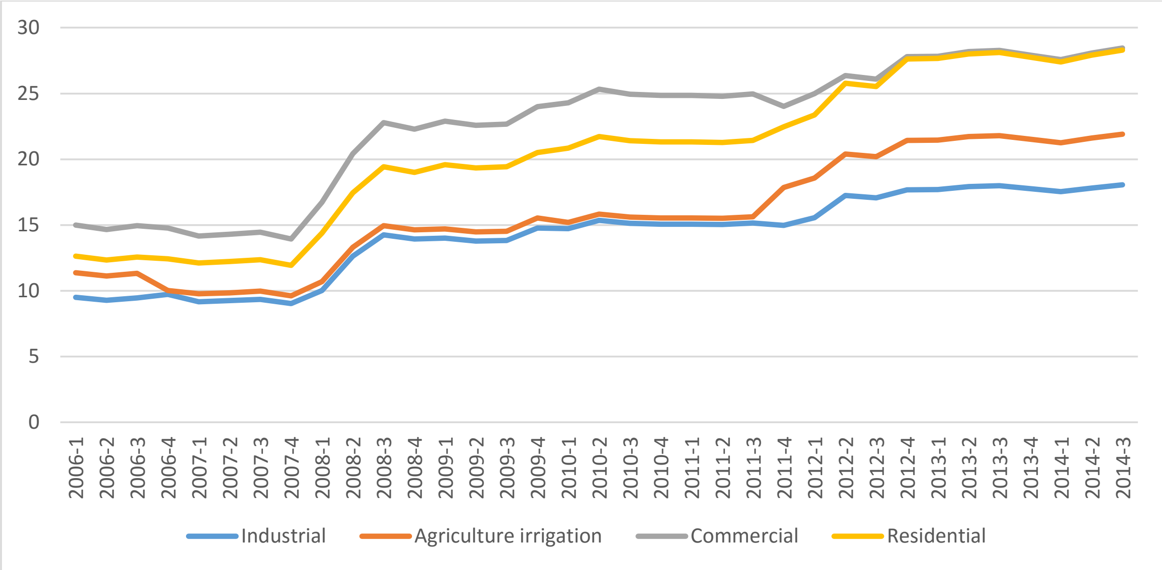


Figure 3.7 End-user power prices (TL cent / kWh, inflation-adjusted[59])

Source: EPDK, own calculations.

Turkish power sector reform has coincided with the same political party ruling for three consecutive mandates, thus, political pressure on EPDK – given that its decision-making body is appointed by the Council of Ministers – and other energy policy-making bodies or state-run companies has been constant. Turkey has traditionally used electricity as a political commodity, with prices kept constant between political cycles and increased just after general elections. Thus, although costs might have increased during the flat-price period, they have been pressed through cross-subsidization among state-run companies and have not been reflected in prices. This suggests markets should expect price hikes in regular cycles despite progress in reform stages, unlike orthodox reform literature suggests.

[59] Using Producers Price Index.

Lack of transparency is another major drawback in Turkish energy markets. The success of the upcoming intra-day and energy exchange platforms will strongly depend on the willingness of Turkish authorities to increase transparency particularly regarding EUAS and TETAS policies and how they optimize their portfolio, what will happen to BOT, TOOR and BOO contract generators upon contracts' due time, reveal of pricing mechanisms for energy products of state-run companies – both for power and gas. Also, publication of more fundamental data would be useful, including full maintenance schedule for all power plants at the start of each year and related updates through the year, hydro data disaggregated into storage and run-of-river at a daily basis[60], export and import data according to borders and the like.

Finally, Turkey's reluctance to reform the natural gas sector is a major drawback for power reform. Gas-fired generation held a 48% share in total output in 2014, hence gas' importance for electricity.

Reform in Turkish gas markets is beyond the scope of this research work, but it is worth mentioning a few points. Turkey imports around 98% of its gas consumption and apart from security of supply issues, such dependence exposes the country to other related risks such as foreign exchange volatility, a large impact on the country's current

[60] This data is currently being published only at a monthly basis. Daily generation mix data show just the total hydro output in previous day.

account deficit and weaker position in talks for gas price cuts. Imports have increased exponentially since 1987[61].

State-run Turkish Pipeline Corporation (BOTAS) is the dominant gas company, with a few fringe competitors in all segments of the sector. The gas market law does not allow private companies to import from origin countries which BOTAS also imports from, with the only exception being contract transfers by BOTAS. The rationale behind this provision being security of supply concerns, constitutes a major barrier to liberalization in the gas market.

BOTAS was expected to gradually transfer its import contracts to the private sector until 80% of consumption would be provided by private importers, but it failed to achieve this target, and only a small fraction of around 9% of gas consumption was supplied to the market by private companies in 2012.

BOTAS was also kept exempt from the cost-based pricing mechanisms introduced for state-owned enterprises in 2008, and its business is highly subsidized by state finances, weighing on the budget and current account deficit. This allows BOTAS to have a dominant position in the market, providing no incentive for the company to increase

[61] Gas demand increased at an average rate of 20.5% during 1987-2012 according to PwC (2014). Russia was the country's largest supplier delivering 73.9 million cubic meters per day on average in 2014 – about 55% of total Turkish gas imports – and Iran followed with 24.4 million and Azerbaijan with 16.6 million cubic meters per day. High dependency on one single country – Russia – has been a major barrier to gas market liberalization in the past decade.

efficiency or play by market rules, which would have been the case under a competitive market.

Lagging behind in these and many other aspects, uncompleted reform in the gas market makes it impossible for investors to see price signals and understand what the real costs of the business will be when the sector is liberalized. This is a serious barrier to creating expectations for power prices in the medium and long run, given the high weight gas has in power generation.

CHAPTER4

METHODOLOGY

The core of this dissertation is construction of a static general equilibrium (CGE) model for the Turkish economy to examine the impact of power sector reform.

CGE modelling allows for the analysis of economy-wide effects following a policy shock, revealing production and consumption linkages and how agents respond to the shock. Unlike social-accounting-matrix (SAM) modelling, economic relations set in CGE equations are non-linear, hence reflecting a more realistic economic structure.

One major reason why CGE was preferred to econometric modelling is that the ‘ceteris paribus’ assumption – on which econometric models are based – is abolished here. Rather, CGE models allow for the impact of an external shock to penetrate through all structures of the economy through direct and indirect effects enabling a detailed analysis on how policy shocks are likely to affect the economy at a sector level and as a whole.

The database for generic CGE models is the social accounting matrix (SAM) which is a display of economy’s circular-flow diagram in a square-matrix format. The construction of SAM requires intermediate use data at a disaggregated sectoral basis which are displayed in countries’ input-output tables. Turkey’s most recent input-output table was published in 2002 by the official statistical agency TUIK. For this reason, I employ approaches developed byErten (2009) and Telli (2006) to estimate Turkey’s SAM for 2010 which is chosen as the base year for the model.

There are a number of reasons for choosing 2010 as the base year for this work: First and most importantly, availability of data at a sectoral level for energy sectors which were extracted from IEA’s related publications. Secondly, the year 2010 is a good starting point to examine and try to predict how power market reform will affect the sector itself, other sectors and the economy as the reform process has been carried for about a decade and more steps remain to be taken. Therefore, assumptions made in simulations are more realistic and likely to be more useful to reach to policy recommendations. Data availability by other local authorities are also abundant for 2010 as privatization process was in its first years by the time and data are not considered as commercially-sensitive information and are made available to the public.

Data are extracted from a number of sources, including but not limited to statistics agency TUIK, the treasury, the central bank, Ministry of Energy and Natural Resources (MENR), Ministry for Economy, grid operator TEIAS, state-run companies EUAS, TETAS and TEDAS and International Energy Agency (IEA) data. Maximum effort is put to so that the constructed database reflects the state of economy as near to accrued levels in the base year as possible.

A key contribution to the database is reflection of real-world data for intermediate use by and for energy sectors' output, using information published by IEA, grid operator TEIAS, regulator EPDK, state-run utility EUAS, state power wholesale company TETAS, state power retail company (T)EDAS, state gas company BOTAS, as well as private-sector power companies.

The electricity account is separated into public-sector and private-sector generation, and four new power-related "*satellite accounts*" (European Communities et. al., 2009) are added to the SAM, namely, state-run wholesale trading (TETAS), private-sector wholesale trading, organized power market(s) (PMUM)[62], and distribution companies (EDAS).

[62] This includes balancing and settlement market, as well as day-ahead planning for 2010 which is then transformed into a fully-functional organized day-ahead market in the following year.

Power generation account is disaggregated into public-sector and private-sector power generation. While the first represents power generated by EUAS, EUAS affiliates, BOO, BOT and TOOR plants, the latter counts for power generated by independent private generators and auto-producers. The reason for considering BOO, BOT and TOOR plant output as state-run their use of price-guarantees provided by the state for a certain period of time – usually 15-20 years. Therefore, sale of their output is guaranteed and they are not exposed to market risks, nor do these firms behave in line with incentives from competitive markets[63].

Ownership disaggregation will help measure policy impact on public and private sectors for generation, to test for privatization of state-run generation assets – a key objective of reform. It is useful to distinguish between two types of producers from the same main sector that act differently from each other in SAM, as also suggested in the System of National Accounts for 2008 (European Communities et. al. 2009).

A key distinction between state-run and private utilities' behaviour is their respective pricing policies. Private-sector power plants price their products under competitive-market pressure, sales of their output are not guaranteed so they have to operate in the most efficient way possible to be able to profitably sell electricity through bilateral agreements or in organized power markets.

[63] Generation decisions by such plants – e.g. during their maintenance period or when there is an unplanned outage – do affect market prices under certain circumstances. For instance, when a cut in their supply is combined with peaking demand for power, or with very low renewable generation. A good example for this are periods of dry hydrological conditions like in 2013 and 2014.

State-run utilities, on the other hand, guarantee sales for most of their generation in the form of bilateral agreements with TETAS and distribution companies with a universal service obligation[64]. In 2010, EUAS sold 25% of its total output of 92.6TWh to TETAS, 65% to distribution companies – which deliver to non-eligible end consumers[65]. Also, EUAS owns more than half the country's hydropower installed capacity and hold the largest share in the market in terms of installed capacity and generation mix. It generated 45% of Turkey's total power output in 2010. And BO, BOT and TOOR plants sell their output directly to TETAS at a previously agreed fixed price.

Therefore, these are not forced to aim at profit maximization as would be the case had they been exposed to market competition. Rather, they overtake on wider goals, such as security of supply in times of peaking demand and maintaining hourly power prices below an upper limit (price-shaving) – the latter is particularly the case with EUAS owing to its large storage hydropower portfolio.

Further on the electricity industry, four new satellite accounts are created in order to measure the impact the reform has had on power trading – by public and private sector companies, organized power markets (PMUM), and electricity distribution segments. It is important to mention here that although PMUM is a market-place, rather than a producer of a good or service, here it is treated as a separate account in SAM. This is due to the nature of this marketplace which resembles a pool where buying and selling

[64] TETAS also sells almost all of its power purchased from EUAS, BO, BOT and TOOR plants to distribution companies, as will be shown in a later section.
[65] Or eligible consumers which choose not to change their provider and be supplied with power from distribution companies with a universal service obligation.

counterparties make anonymous power trading transactions. Hence, the PMUM account represents activities by participants rather than the marketplace itself.

Another contribution to electricity-related data is on the demand side, as the amount of power used by industrial and residential final users are taken from IAE's Electricity Information 2012 publication.

Lastly on methodology, face-to-face interviews were made with nine sector representatives[66] during March 2013 – January 2014, for a better understanding of how Turkish power markets function in practice. The list of questions asked during face-to-face interviews is presented in Annex I[67].

The rest of the chapter provides a thorough description on the approach followed to generate Turkey's 2010 social accounting matrix, while the next chapter focuses on the structure of the CGE model employed.

4.1 Structure of SAM

The SAM is a detailed description of the inter-sectoral links in an economy. Thorbecke (2000: 2) defines SAM as "*a comprehensive and disaggregated snapshot of the socio-economic system during a given year*." The matrix maps inter-sectoral relations and inter-relations among various institutions such as households, firms, government, as

[66] Their identity remains confidential upon ethical considerations.
[67] The list is not exhaustive and other topics of interest have also been discussed during interviews.

well as capital and rest of the world accounts for an economy, widely used by analysts and policy makers (see UN, 1995; Thorbecke, 1995, 2000; Breisinger et. al., 2009 for details on SAM).

The SAM is a square matrix, as each entry has a column showing the sector/agent's expenditures and a row which indicates revenues earned by each account. For each agent, the sum of total spending equals total income. Accounts in a SAM can be categorized as endogenous and exogenous. For endogenous accounts, a change in income will be directly followed by a change in the level of expenditure. Meanwhile, expenditures of exogenous accounts are independent of income. The simple SAM setting is as shown in Figure 4.1 (Sadoulet and de Janvry, 1995):

	Endogenous accounts	Exogenous accounts	Total
Endogenous accounts	MX	F	X
Exogenous accounts	BX	L	
Total	X		

Figure 4.1 Simple SAM Setting

Here, X is the vector of total income of endogenous accounts, which given general equilibrium, equals expenditures of the same accounts. F and L, on the other hand, represent expenditures and income of exogenous accounts, respectively. M is a square matrix of input coefficients corresponding to endogenous accounts. The elements of matrix M – the input coefficients m_{ij} (i,j=1, 2, …, n, where n is the number of endogenous accounts) for each endogenous account – express the ratio of the value of each cell in SAM to the corresponding column sum. These are also referred to as input-output or technology coefficients. Finally, B is a rectangular matrix of coefficients with exogenous accounts as rows and endogenous accounts as columns.

SAM multiplier models are a primitive form of general equilibrium modelling, as all inter-agent relations are linear. Explaining how a shock introduced to an exogenous account is reflected into other parts of the economy through the simplified SAM setting is useful to grasp the way a policy shock affects each sector/agent directly or indirectly in a CGE model – with the difference that behaviour in the latter is expressed by non-linear equations.

Keeping the same matrix notation, the matrix of multipliers will be $(I-M)^{-1}$, where I is the identity matrix. A change in exogenous accounts will have direct and indirect impacts on the accounts where the shock is injected. For instance, an increase in the exogenous demand for goods produced by sector *i* will cause a direct effect on the production of this sector. This will in turn lead to a rise in output of other sectors *i* uses as inputs. Then, the latter sectors' demand for other intermediate inputs will increase, and so on. Consumption of goods produced in all affected sectors will also increase. The effects continue spreading throughout the economy round by round until they effectively come to an end.

In matrix notation, a change in exogenous accounts dF, will result in a change in income:

$$dX = [(I-M)-1] dF \quad (4.1)$$

The leakages from this exogenous shock will be:

$$dL = B dX. \quad (4.2)$$

The following section explains the general structure of Turkey's macro-SAM.

4.2 Macro-SAM for Turkey

The base year chosen for the model is 2010, but the most recent input-output data for the Turkish economy date back to 2002. As explained above, there are several considerations for this choice. First, 2010 is a year when most elements of power sector reform have already started to be implemented, which allows for the designation of the new power market structure to be included in the SAM.

Secondly, data availability is a major constraint when trying to establish the SAM for Turkey. Generation data made available to the author by TEIAS were as recent as 2013, however data on the demand side of electricity – namely, power consumption by various sectors of the economy, is not made available to the public. I make use of data on Turkey's power use by sectors made available in IEA's Electricity Statistics (2012) publication which are as recent as 2010.

Lastly, 2002 can be identified as a 'crisis year' as it follows Turkey's 2000-2001 financial crisis and as such, 2002 may not be the ideal benchmark year for modelling the Turkish economy. While aggregate figures on gross output are updated in line with statistical data published by TUIK for 2010, the input-output coefficients – which show the ratio of intermediate demand to total gross output in the SAM – are produced from Turkey's 2002 input-output tables due to lack more recent data. This leads to the imperative assumption that the Turkish economy's structure has not undergone any structural changes in the past decade. I am aware that this is as strong assumption.

Data published by Istanbul Industrial Chamber's report on the 500 top performing Turkish companies (ISO, 2011) is used for the best approximation of the value added to gross output ratio at a sectoral level, following Erten (2009). Further on the value added, 2010 statistics published by Turkey's Social Insurance Institution are used to compile labour market data in the SAM.

Also, detailed power sector supply-side data made available by grid operator TEIAS for the purpose of this study are used to establish real input-output coefficients for electricity sectors for 2010, while IEA's Electricity Statistics are used for the disaggregation of demand side data in the input-output data for the base year. These have served to construct a realistic picture of the power sector in related rows and columns in Turkey's SAM for 2010.

Estimation methods developed in previous studies (Telli, 2006; Erten, 2009) are employed to construct the 2010 social accounting matrix for Turkey whose macro structure is shown in Table 4.1with the estimated matrix presented in Table 4.2.

Activities and commodities in the SAM are partitioned into 21 sectors, namely: agriculture, transport, public-sector power generation, private-sector power generation, electricity retail, electricity wholesale, coal, oil and gas, metals, chemicals and petrochemicals, minerals, machinery, mining, food, paper, construction, textile, other industries and services. First, the input-output part of the matrix is calculated for a total of 16 sectors keeping electricity aggregated, and then disaggregation of the power sector is integrated into the SAM.

The derived SAM ends up unbalanced owing to usage of data from different sources. However, the total row sum in a SAM must equal the total sum for the respective account. Of the most common methods for SAM balancing – namely, the RAS and the Enthropy model – I employ the RAS method, which is "*an iterative method of bi-proportional adjustment of rows and columns*" (Ahmed and Preckel, 2007:6), commonly used to update IO tables[68] and SAMs.

[68] The United Nations Handbook of Input-Output Table Compilation and Analysis (1999) provides an insightful explanation of the use of RAS method.

Table 4.1 Structure of SAM

Incomes	1	2		3 Factors			4 Institutions (Expenditures)		5 Capital account		6	7
	Activities	Commodities	Labour	Private capital	Public capital	Households	Firms	Government	Private capital accum.	Public capital accum.	Rest of world	Total
1.Activities		Domestic sales									Export	Production
2.Commodities	Intermediate demand					Private consumption		Gov't consumption	Private investment	Public invest ment		Domestic Demand
3.Factors												
Labour	Wages											GDP at factor cost
Private capital	Rent (priv..cap.)											
Public capital	Rent (pu.cap.)											
4.Institutions												
Households			Labour income				Transfer s	Transfers			Worker remittances	Household income
Firms				Private capital return	Public capital return			Subsidies + Domestic debt interest payments			Firms' foreign exchange revenues	Firms income
Government	Taxes on production	Sales tax + customs duties + export tax	Unemploy ment benefits			Direct tax	Corpora te tax				Net outright transfers	Gov't income
5.Capital account												
Private capital accumulation						Private savings		Gov't savings				Total private savings
Public capital accumulation						Private savings – investment difference						Total public savings
6.Rest of world		Imports					Current transfers abroad	External debt interest payments			Current account balance	Rest of the world income
7.Total	Production	Domestic supply	Labour costs	Private capital cost	Public capital cost	Household expenditures	Firms expendit ures	Government expenditures	Private investment	Public invest ment	Rest of the world expenditures	

Table 4.2 Turkey macro-SAM (base year = 2010; in 1,000 Turkish liras)

	Activities	*Commodities*	*Labour*	*Public capital*	*Private capital*	*Household*	*Enterprise*	*Government*	*Public investment*	*Private investment*	*Rest of world*	***TOTAL***
Activities	-	1,170,957,798	-	-	-	-	-	-	-	-	231,441,343	**1,402,399,141**
Commodities	532,515,611	-	-	-	-	742,587,600	-	75,677,241	163,076,201	48,914,843	-	**1,562,771,496**
Labour	355,335,567	-	-	-	-	-	-	-	-	-	-	**355,335,568**
Public capital	434,611,270	-	-	-	-	-	-	-	-	-	-	**434,611,270**
Private capital	39,483,823	-	-	-	-	-	-	-	-	-	-	**39,483,823**
Household	-	-	337,448,311	-	-	-	490,704,434	93,463,797	-	-	1,489,877	**923,106,419**
Enterprise	-	-		434,611,270	39,483,823	-		47,965,442	-	-	1,617,886	**523,678,421**
Government	40,452,870	90,655,555	17,887,257	-	-	69,265,115	20,924,891	-	-	-	884,811	**240,070,499**
Public investment	-	-	-	-	-	163,076,201	-	-	-	-	-	**163,076,201**
Private investment	-	-	-	-	-	-51,822,497	-	16,982,116	-	-	83,755,224	**48,914,843**
Rest of world	-	301,158,142	-	-	-	-	12,049,096	5,981,902	-	-	-	**319,189,14**
TOTAL	**1,402,399,141**	**1,562,771,496**	**355,335,568**	**434,611,270**	**39,483,823**	**923,106,419**	**523,678,421**	**240,070,499**	**163,076,201**	**48,914,843**	**319,189,141**	

Activities and commodities are shown separately in the SAM. The first refers to entities that produce goods and services and the latter to the goods and services produced. The main reason for this is that certain activities may produce more than one kind of commodity, and vice versa: one commodity might be produced by more than one activity. Each sector is represented under both activities and commodities. Detailed data at a sector level for these accounts is found in input-output tables, whose most updated version dates 2002 for Turkey.

As shown in tables 4.1 and 4.2, there are three factors of production employed in the model, namely, labour, private-owned capital and state-owned capital (the latter noted as “public capital”). Institutions include households, enterprises, government, private sector and state savings as well as the rest of the world.

A detailed description of how each SAM account has been constructed follows for the remainder of the chapter.

4.3 Construction of Turkey SAM

Steps followed in this section are similar to those developed in Erten’s work (2009) for updating Turkey’s SAM given 2002 input-output tables and updated data on macroeconomic variables. It must be noted here that the SAM is first constructed with 16 sectors keeping electricity aggregated, due to availability of data related to this sector in 1998 and 2002 IO tables which are used to update inter-sectoral data for 2010.

4.3.1. Adapting 1998 and 2002 IO Tables

An input-output table "*focuses on the interrelationships between industries in an economy with respect to the production and uses of their products and the products imported from abroad*," according to the United Nations' Handbook of Input-Output Table Compilation and Analysis (1999: 4). A simple IO table is shown in Figure 4.2:

	Industries	Net final demand	Total output
Industries	F	Y	X
Value added (Primary inputs)	V		
Total input	X		

Figure 4.2 Simplified Input-Output table setting

An IO table assumes a fixed coefficient production function, where inputs used to produce a commodity are linearly related to outputs, all these at a given point in time. Letter *F* in Figure 4.2 exhibits all inter-sectoral links – each sector's intermediate demand – while *V* stands for the value added to gross production – the total labour and capital endowments used in the production of a certain commodity. Here no division is made between activities and commodities and *F* represents both of them upon the assumption that one type of producer produces only one type of product.

In a standard IO table each column indicates the production technology for the respective sector, including its use of intermediate inputs; payments made to factors of production; payments made to the government from taxation on production and import duties; and payments made to the rest of the world for the purchase of imports. In this way, each column sum expresses the respective sector's total supply ($X=F+V$) – i.e. the sum of domestic and foreign supply –at a given (base) year.

And the sum of rows for each sector, which is found by adding up intermediate inputs used by each sector in the production process and final-use block elements – namely, private and government consumption, private and public investment and export indicates total demand for goods and services produced by that sector ($X=F+Y$). The total demand is the sum of domestic and foreign demand.

Input-output coefficients, also referred to as technology coefficients, show the amount of input by a certain sector to produce one unit of output. In the above setting these are calculated through division of each element in matrix F by total output X.

It must be noted that the unit used to establish input-output tables and later on the social accounting matrix for our base year – 2010 – is thousands of Turkish liras (1,000 TL). As Ten Raa (2005) also notes, given that the input-output table unit is in money value rather than measured by physical units (e.g. kilograms for sugar used in production of jam), then inflation may affect the change in technical coefficients in two aspects. The increase in the price of input makes (current) coefficient larger (than it would have been if prices assumed constant, i.e. if measured in physical units) while a rise in the price of output would make the current coefficient smaller compared to the value of the same coefficient had prices been assumed constant.

The effect of inflation for the technology coefficient matrix should not be constraining for the current study, given that the CGE model treated here is static – i.e. scenario results evaluated compared to a single base year, no time series included due to lack of dynamics. This will be treated in more detail in the following chapter when the concept of *numeraire* is introduced.

Lastly on the IO setting, value-added coefficients are defined by division of each element in matrix V to total output X. The "*well-known condition*" (ten Raa, 2005: 17) stating that the column sum of input-output coefficients matrix is less than one, implying the value-added coefficients matrix is non-zero.

Input-output data for the Turkish economy in 2010 are derived using 1998 and 2002 tables. Turkey's 1998 IO table is prepared using United Nation's ISIC Rev.1 while the 2002 IO table uses European Union's NACE Rev.1 classification. Hence, the first task here is to re-organize sectors in each classification under the more aggregated 16 sectors used in the first phase of SAM construction (before power sector is disaggregated). Details on the re-organization of sectors for both IO tables are presented Annex II. Table 4.3 shows the 16 sectors involved in the first phase of calculating Turkey's SAM, before power sector disaggregation.

Table 4.3 Sectors for Turkey's IO tables

	Abbrev.	**Sector**
1	AGR	Agriculture
2	TRAN	Transportation
3	ELEC	Electricity
4	COAL	Coal
5	GASOIL	Oil and gas
6	MET	Metals
7	CHEM	Chemicals
8	MINR	Minerals
9	MACH	Machinery
10	MIN	Mining
11	FOOD	Food
12	PAPR	Paper
13	CONST	Construction
14	TEXT	Textile
15	OIND	Other industries
16	SERV	Services

The number of sectors shall increase to 21 at a later phase with the introduction of more detailed power sector data.

It is important to note here that the electricity sector includes "*electricity, gas, steam and hot water supply*"[69]. These are separated at this stage using IO 1998 coefficients, with electricity remaining in the account, town gas to gasoil, and steam and hot water supply to the services account.

Beyond re-organization of accounts, I also adjust for the sector named "private households with employed persons" that is present in the 2002 table but missing in that

[69] Nace Rev.1 nomenclature for the electricity ("ELEC") sector. Gas here refers to town gas.

of the year 1998, following Erten (2009). The figure from 2002 IO table is very close to the respective account in the new national income series published by TUIK for the same year. Thus, the equivalent 1998 figure for this sector in the new national income series is added to the "private consumption" row and "labour compensation" column in 1998 IO table.

Adjusted 1998 and 2002 IO tables are shown in tables Tables 4.4 and 4.5.

Table 4.4 Turkey input-output table for 1998 (million Turkish liras)

	Agr	Tran	Elec	Coal	Gasoil	Met	Chem	Minr	Mach	Min	Food	Papr	Const	Text	Oind	Serv	Private cons.	Govt. cons.	Private investm.	Govt. investm.	Stock changes	Exports	Total use (basic pr)
Agr	1,555	16	0	2	2	1	27	1	8	0	1,970	129	18	136	1	215	5,435	188	11	0	184	588	10,487
Tran	287	933	46	7	4	167	208	77	119	11	312	103	373	172	147	811	4,447	205	458	66	94	2,524	11,568
Elec	20	56	35	8	2	172	103	96	31	4	70	46	48	126	32	398	383	82	-	-	-	4	1,714
Coal	0	2	158	-	0	60	6	27	2	0	23	1	0	2	0	14	82	3	-	-	-10	0	370
Gasoil	0	1	239	-	0	0	594	12	1	0	33	0	0	0	0	9	-	-	-	-	-32	1	859
Met	13	30	30	2	0	1,455	93	54	506	1	39	22	1,053	34	772	87	293	5	40	13	280	597	5,421
Chem	548	1,390	45	17	1	143	1,213	90	108	27	231	107	252	303	82	351	2,196	247	6	1	-46	664	7,976
Minr	1	2	14	0	0	10	14	124	10	0	22	0	1,005	0	3	99	164	5	-	-	-73	204	1,604
Mach	42	34	26	4	0	42	16	22	343	1	33	18	241	28	47	170	1,363	41	1,932	384	129	410	5,326
Min	0	1	0	-	0	4	55	81	1	0	1	0	135	5	1	8	-	2	-	-	-0	52	346
Food	199	147	0	0	0	1	26	0	3	0	1,080	1	0	50	0	536	4,665	42	-	-	20	695	7,466
Papr	10	19	1	1	1	56	85	30	50	1	101	439	120	36	206	381	405	32	2	0	-15	74	2,037
Const	1	6	0	-	-	0	0	0	0	-	7	0	3	0	0	161	-	27	4,600	2,369	-	652	7,824
Text	50	50	2	0	1	27	42	3	28	3	69	6	1	1,681	56	35	996	57	127	6	-75	2,559	5,720
Oind	51	176	3	0	0	10	2	2	41	1	5	1	28	11	437	143	2,433	27	1,587	277	135	863	6,233
Serv	499	639	57	46	7	324	361	99	272	17	460	183	658	548	313	4,256	12,610	5,268	651	86	115	3,784	31,252
Net taxes	183	710	25	8	1	57	105	34	38	9	137	28	136	87	52	311	3,277	231	130	18	15	130	5,720
Labour compnstn	729	861	160	113	4	324	344	163	288	26	446	117	1,324	532	284	7,240	-	-	-	-	-	-	-
Direct purchases non-resid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-960	-	-	-	-	960	-
Net prod tx	-42	15	-26	1	0	20	49	12	18	1	-395	7	24	31	21	48	-	-	-	-	-	-	-
Fixed capital consmptn	231	331	101	15	8	160	185	117	95	92	133	48	48	268	111	1,609	-	-	-	-	-	-	-
Payments to other factors	5,540	5,079	768	29	67	615	1,999	434	621	111	2,167	472	2,309	889	1,043	13,138	-	-	-	-	-	-	-
Imports	572	1,071	28	118	762	1,774	2,449	128	2,743	41	522	309	50	782	2,623	1,232	-	-	-	-	-	-	-
Total supply (basic prices)	10,487	11,568	1,714	370	859	5,421	7,976	1,604	5,326	346	7,466	2,037	7,824	5,720	6,233	31,252	-	-	-	-	-	-	-

Table 4.5 Turkey input-output table for 2002

	Agr	Tran	Elec	Coal	Gasoil	Met	Chem	Minr	Mach	Min	Food	Papr	Const	Text	Oind	Serv	Hoh cons.	Govt. cons.	Gross capital formatn	Exports	Total use (basic prices)
Agr	7,330	54	7	19	0	10	402	4	26	5	17,623	512	9	1,459	23	2,489	20,699	94	1,314	2,337	54,418
Tran	1,448	18,529	414	72	13	1,180	2,303	664	816	229	2,395	592	1,509	2,546	1,821	10,234	31,510	189	3,166	9,438	89,067
Elec	236	395	7,687	70	27	829	449	313	410	94	317	365	86	714	152	2,910	3,736	-	-	24	18,814
Coal	14	72	509	23	0	45	15	147	16	3	89	11	9	14	2	612	1,271	68	-70	2	2,852
Gasoil	0	717	2,745	-	13	45	4,462	99	71	1	36	86	0	89	12	45	-	-	1,749	4	10,175
Met	26	489	151	61	20	8,861	696	143	3,394	46	357	111	4,784	166	4,901	1,632	472	-	282	5,316	31,910
Chem	2,827	4,338	85	92	11	661	9,041	748	1,088	229	2,089	1,255	1,448	5,841	1,836	6,042	10,994	716	-2,454	3,752	50,639
Minr	57	64	3	4	1	533	254	1,435	235	23	329	34	3,243	189	233	2,434	591	-	-628	1,820	10,852
Mach	549	730	581	110	2	418	232	197	2,486	131	221	147	1,293	271	513	2,531	3,718	7	13,341	3,863	31,344
Min	20	11	2	2	1	693	1,050	1,198	35	120	37	73	580	38	32	208	-	-	-1,261	377	3,217
Food	1,519	108	2	0	0	5	161	3	17	6	6,936	39	11	582	6	3,432	32,012	590	3,103	2,606	51,138
Papr	52	621	13	3	2	211	432	257	219	10	927	2,742	682	403	660	3,825	2,362	8	-997	586	13,021
Const	136	92	5	7	0	4	7	2	9	6	16	5	542	9	6	1,779	55	-	28,503	1,259	32,440
Text	46	294	12	7	0	70	241	12	60	9	108	134	60	22,955	605	1,787	16,656	522	3,555	15,573	62,703
Oind	178	2,393	46	10	10	105	54	25	415	19	82	48	93	188	4,563	2,858	10,713	74	6,119	8,860	36,853
Serv	2,735	9,008	526	129	89	2,209	4,135	1,172	2,103	314	4,591	1,499	3,279	6,610	2,667	38,004	95,522	42,106	5,413	8,723	230,833
Net taxes	2,146	4,156	106	61	3	251	901	159	132	130	482	95	793	622	140	2,370	29,143	243	594	-44	42,490
Labour compnstn	5,103	8,690	1,382	910	134	2,151	3,234	1,396	2,497	421	3,712	1,302	4,318	6,184	2,909	48,089	-	-	-	-	-
Net prodctn taxes	-154	21	-51	0	0	4	6	7	4	1	-95	3	12	22	5	-66	-	-	-	-	-
Capital deprec.	2,236	4,427	1,159	121	64	625	1,163	741	622	211	1,150	455	616	2,511	608	8,518	-	-	-	-	-
Net operating surplus	25,442	30,891	3,238	118	383	2,659	3,508	1,499	2,911	736	7,501	1,497	9,073	6,517	2,463	87,507	-	-	-	-	-
Imports	2,471	2,967	192	1,029	9,399	10,341	17,892	633	13,777	473	2,233	2,019	-	4,773	12,696	3,595	-	-	-	-	-
Tot supply (basic prices)	54,418	89,067	18,814	2,852	10,175	31,910	50,639	10,852	31,344	3,217	51,138	13,021	32,440	62,703	36,853	230,833	-	-	-	-	-

4.3.2 From IO Table to SAM

Before transforming the input-output table into a social accounting matrix (SAM), it is crucial to understand the valuation system used to construct an IO table. "*Model builders should try not only to maximize the homogeneity of establishments classified in the IO table, but also to use the same valuation for both goods and services supplied and used that eliminates the effects of government policies or costs of transactions on technical relations*" expressed in the table, according to UN's handbook for the compilation of IO tables (UN, 1999: 55).

The handbook explains the three ways goods and services can be valued in the system of national accounting (SNA), namely purchaser prices; producer prices; and basic prices.

IO tables published by TUIK are expressed in basic prices, that is, values of goods and services show the amount receivable by the producer, minus any tax payable plus any subsidy receivable and net of all trade and transport margins[70]. Basic prices express values of goods and services in the most homogeneous way possible, eliminating effects of differences in government policies and differences in trade and transport margins for different regions in a country.

To make the transition from an IO table prepared in basic prices into a social accounting matrix, elements in the final-use block should be expressed in producers'

[70]For details on how to transform purchasers' prices to basic prices look at the UN's Handbook of Input Output Table Compilation and Analysis (1999).

prices. The reason for this adjustment is to ensure balance between columns and rows, given that columns for each sector include taxes on production, namely sales taxes, customs duties and export levies, but rows do not.

Here I use tax matrices for 1998 and 2002[71]published by TUIKto make the adjustment. The amount of tax corresponding to final use blocks in the net tax matrices are added to corresponding accounts in the IO table (the private consumption, government consumption, gross capital formation and exports columns in tables 4.3 and 4.4 above.

4.4 Value added/output ratio

The social accounting matrix should match with the gross domestic production series. This implies that, for all sectors, the sum of final use and import accounts should equal the respective numbers in the GDP series published by TUIK. Similarly, the total sum of sectoral indirect taxes should equal the respective figure in the public sector general balance's (PSGB's) "indirect taxes" account[72].

Sectoral distribution for value added is published in TUIK's new GDP series. Disaggregated data at sector level for exports and imports of goods and services is also made available by the statistical agency. However, data on final uses – namely, private

[71] Tax matrix for 2002 is not publicly available on TUIK website; it was acquired from TUIK by the author.
[72] The PSBG series are published by the planning directorate at the ministry for development, formerly the State Planning Organization [Devlet Planlama Teskilati - DPT] under the prime ministry.

and public consumption and capital formation – at a NACE Rev.3 disaggregation level is not made available and will be estimated in sections below.

Also of sectoral value added data, the manufacturing sector is provided as an aggregate with figures related to sectors nested under this category lacking. The following approach is used to distribute manufacturing into its sub-sectors to reach a NACE Rev.3 level of data compatible with sectors used in this study:

First I establish a linear time-trend function to estimate by how much sectors under manufacturing's shelter have increased from 2002 to 2010. I make use of sectoral gross value added for 1998 and 2002 from respective input-output tables to solve a first degree equation with two variables as follows:

$$VA_t = a + bt \qquad (4.3)$$

where the term on the right refers to value added at year t (t=1 for 1998, …, and t=13 for 2010). This yields a total figure for manufacturing value added at 160.8bn Turkish liras in 2010, compared to the realized 172.1bn liras which appears in TUIK data. Lastly, I calculate the share for each estimated manufacturing sub-sector value added to that of total manufacturing, and use these shares to distribute the real manufacturing figure provided by TUIK's GDP series in conformity with sectors used in this study.

Further on TUIK's national accounts, intermediate use (inputs) data which is critical to build up a SAM is not published. For this reason, I follow Erten's (2009) approach to estimate the ratio of intermediate input to gross output for each sector.

Istanbul Industrial Chamber's (ISO's) list of top 500 Turkish companies is the only data available that suggests how the trend of value added share in gross output has evolved from 2002 to date for the Turkish economy.

First, I calculate the ratio of net value added to total assets for ISO 500 companies' totals for all years from 1998 to 2012. Changes in this ratio will be used to estimate how this ratio has changed for each sector through years, by making use of data in Turkey's 1998 and 2002 output.

ISO data is considered a good approximation for the trend in value added to GDP ratio in the Turkish economy, given the considerable share of the top 500 companies' gross value added to the country's total GDP, which for 2010 was 9.3%. Figure 4.3 below supports this assumption, showing how the trend in ISO's top 500 net value-added to assets ratio is in line with the trend in Turkey's GDP growth rate for the period between 1998[73] and 2012. Obviously, the two go in line with each other.

[73] GDP growth rate for 1998 is missing due to TUIK's new GDP series starting from this year (1998).

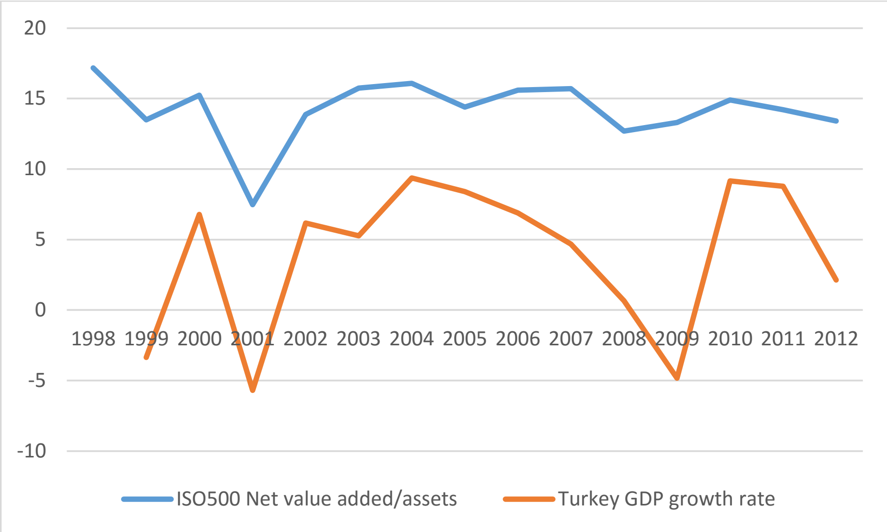


Figure 4.3 ISO500 Net value added/assets vs. Turkey's GDP growth (%)
Source: TUIK, ISO.

As the value added / gross output ratio must carry a value between 0 and 1,I follow Erten (2009) to establish a logit function to describe the ratio:

$$L = ln\left(\frac{P}{1-P}\right) (4.4).$$

Here, L refers to the logit function and P is the ratio we aim to estimate. From equation (1), the value of P can be derived as follows:

$$P = \frac{1}{1+e^{-L}} \quad (4.5)$$

As equation (4.5) shows, P's value approaches 1 as L goes to infinity and it approaches 0 as L goes to minus infinity. In this way, we guarantee that the condition $0 < P < 1$ is fulfilled.

The estimation of probability models require that the value of *L* be turned into an econometric function, for instance, it can be expressed as $L_i=\alpha+\beta X_i$. After *L* is estimated, it is possible to derive values of *P* as well.

Serving the needs for the model employed here, I establish a piecewise function for *L* as in Erten (2009) as follows:

$$L=\begin{cases} a+b\frac{(t-6)^2}{t^{9/8}}, & t=3 \\ a+b\frac{(t-4)^2}{t^{15/24}}, & t=7 \\ a+b\frac{(t-4)^2}{t^{3/2}}, & t=8 \\ a+b\frac{(t-5)^2}{t^{19/20}}, & t=10 \\ a+b\frac{(t-8)^2}{t^{2/3}}, & t=11 \\ a+b\frac{(t-7)^2}{t}, & t=12 \\ a+b\frac{(t-6)^2}{t}, & t=13 \\ a+b\frac{(t-4)^2}{t}, & \text{for all other t} \end{cases} \qquad (4.6)$$

Here, *L* indicates the logit function and *t* the corresponding year. Given the series starts from 1998, t=1 is equivalent to 1998, t=2 to 1999 … and so on, until t=13 for 2010. The function is extended from the original one in Erten (2009) whose focus years were 2003 through 2006. It is organized in a form that gives the lowest value for the crisis year 2001 and performs in accordance with trends shown by Figure 4.3 above.

Due to lack of data, it is impossible use an econometric time series to find values of *a* and *b*. But given the data on value added / output ratios for two distinct years – 1998 and 2002 – for which IO tables exist, the values of a and b are calculated from a first degree equation system with two unknowns. Finally, time series for *L* are used to calculate *P* values –that is, the value added / output ratio – for each sector in given years. These are presented inFigure 4.4.

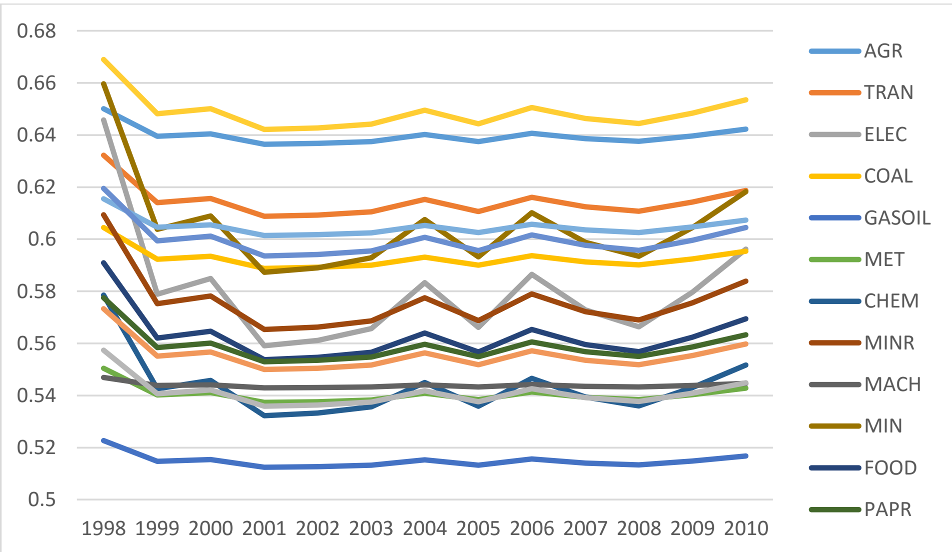


Figure 4.4 Estimated value added/output ratios for each sector (%)

Source: Author's own calculations.

Of these, I use 2010 ratios to estimate the distribution of Turkey's gross output through sectors – given TUIK's value added data at a sectoral level – and the difference between gross output and value added will obviously provide with total intermediate use by each sector.

Further disaggregation of intermediate use data – i.e. each sector's demand for each sector's output – will be made using input-output coefficients from Turkey's 2002 – given no other data available. However, I put maximum effort to calculate real figures for energy sectors given 2010 data provided by IEA and grid operator TEIAS as discussed in a later section.

4.5 Foreign Trade

Trade figures at a sectoral basis compatible with the SAM format are regularly published by TUIK at an annual basis. Apart from trade data, customs duties and export levies are also estimated following Erten (2009) but they are not involved in the model for simplification reasons.

First, I re-organize commodity export and import data published by TUIK into 16 sectors. Trade data for services are taken from the balance of payments tables published by the Central Bank of the Republic of Turkey (TCMB)[74].

[74] Available at http://evds.tcmb.gov.tr/index_en.html accessed on June 2013.

There is yet one particular issue to be addressed for import data: figures for the natural gas and oil imports are not directly reported but are rather included in one single account named "confidential data" – due to related Turkish legislation aimed at protecting secrecy of commercially sensitive information for the state-run natural gas company BOTAS.

For the estimation of natural gas imports – including LNG – amounts imported in 2010 are taken from EPDK's annual natural gas report published in 2011. Import prices vary with origin countries and are not officially announced by BOTAS. Therefore, here we use price approximations in line with media reports and expert assessments for natural gas imported from Russia, Iran and Azerbaijan. While for LNG imports from Algeria and Nigeria I use the average import price paid for LNG by Germany in the same year, available in BP's 2013 Statistical Review. Average price paid by the UK is used for spot LNG imports – as the UK is one of the most active spot LNG trading countries. This might underestimate Turkey's import costs for spot LNG which are thought to be above the average price paid by other western European countries but is used here due to lack of any other data available. Total payments for natural gas imports in US dollars as shown in Table 4.6 are then multiplied with TCMB's average liras/US dollars exchange rate for 2010.

Table 4.6 Natural gas imports by country in 2010

	Imports (million m3)	Estimated price ($/1,000 m3)[75]	Total payments (1,000$)
Russia	17,576	418	7,346,768
Iran	7,765	423	3,284,595
Azerbaijan	4,521	282	1,274,922
Algeria	3,906	291	1,136,149
Nigeria	1,189	291	345,848
Spot LNG	3,079	238	732,832
Total	**38,036**		**14,121,114**

Source: EPDK (2011), author's own calculations.

Turkey's total oil imports for 2010 are reported at $11,391mn in finance ministry's annual economic report for year 2011. This is multiplied by TCMB's average foreign exchange rate for 2010 to correct it into local currency.

Gas and oil imports during 2010 in US dollars and Turkish liras are presented in Table 4.7.

Confidential data in TUIK series is 35.1 billion Turkish liras compared to the 39.7billion liras of oil and gas imports estimated above. Given likely discrepancies in foreign exchange rates used – for instance, payments for imports could have occurred at a single day or at a regular monthly/quarterly basis and foreign exchange rates used in

[75] Reference prices for 2011 in a Reuters article are taken as the best approximate here. See http://www.eud.org.tr/TR/Genel/BelgeGoster.aspx?F6E10F8892433CFFA79D6F5E6C1B43FFEFF9A56CAA041EFE available in November 2015.

transactions could differ from the average rate used in author's calculations above[76] – I just add TUIK's "confidential data" figure to oil and gas imports.

Table 4.7 Turkish oil and gas imports for 2010

	1,000 USD	**1,000 TL**
Natural gas and LNG	14,121,114	21,842,362
Oil and oil products	11,391,000	17,619,456

Source: Ministry of Finance, author's own calculations.

Next, I correct for discrepancies regarding trade flows with Turkey's free trade zones – which are not included in GDP series published by TUIK, following Erten (2009). The method for the adjustment is explained below:

Total exports in GDP series Plus flows from free zones to third countries Minus flows from domestic market to zones	=	**Total exports in SAM**

Total imports in GDP series Plus flows from third countries to zones Minus flows from zones to domestic market	=	**Total imports in SAM**

Free zone trade data is reported in US dollars. To change to Turkish liras, implicit export and import exchange rates are calculated using amounts of exports and imports

[76] Also, it is thought that BOTAS benefits from more favourable foreign exchange rates – thus being less exposed to foreign exchange rate volatility – by the central bank.

in USD in TCMB's balance of payments and the amounts reported in Turkish liras by TUIK.

Free zone traded amountsare distributed through sectors proportionally to their respective share to total exports for 2010. Adjustments for imports to free zones are made in a similar fashion.

Customs duties and export taxes are also estimated for 2010 – using 2002 data – but are excluded from the model for simplification purposes. This should not affect the aim of this research substantially given that foreign trade is not the main focus here.

4.6 Indirect Taxes

State budget data made available by the finance and economy ministries do not present its distribution through sectors. Therefore these are calculated following a similar approach to that in Erten (2009). Simple linear time trending is employed here. I use tax data from 1998 and 2002 IO tables to create a system of equations with two variables as follows:

$$L = a + bt$$

where L is the amount of taxes paid at a certain year and t is the time trend (t_{1998}=1). After estimating 2010 figures I use sectoral shares and total taxes on production to distribute through sectors. Given no other data available, same ratios are used for the disaggregation of value-added taxes whose aggregate figures are taken from budget revenues accounts published by the ministry of finance. Both figures are arranged so that they equal net taxes from 2010 GDP series.

4.7 Labour Compensation

To estimate labour compensation by each sector I use statistics made available by the country's Social Security Institution (SGK) – the only official source that includes detailed disaggregation of labour data according to NACE Rev. 2 classification[77]. SGK statistics are made available in three main categories: (i) compulsory insured persons (under Article 4-1/a of Act 5510); (ii) self-employed insured persons, agriculture workers and pensioners (under Article 4-1/b of Act 5510); and, (iii) public servants. For each category, data on average daily salary – with salary intervals, eg. 34.01-41 Turkish liras, etc. – and the number of employed persons for each interval, are provided at a NACE Rev.2 disaggregation level.

First, I calculate total yearly labour compensation for all the three categories mentioned above at a NACE Rev. 2 level. I then re-organize all sectors into the 16 sectors treated up to here. One drawback with using these SGK statistics to estimate labour earnings is that salary is given in intervals – likely not to give an exact estimate on how much workers in a certain group have earned. I use average salary for each interval in calculations.

[77] TUIK labour statistics by sector present just major categories of the same classification, excluding detailed Nace Rev 2. classification for Divisions from 1 to 99. See Eurostat (2008) for more details on the classification.

Estimated total labour compensation turns out at 171.5 billion Turkish liras which just a small fraction of overall 2010 GDP at 1,098 billion liras, possibly due to issues with using SGK data as mentioned above as well as the undocumented worker phenomenon. Therefore, here I pursue a top-down approach to get to more realistic figures by first calculating total labour compensation from TUIK data and then disaggregating into sectors making use of shares to total compensation estimated from SGK data.

Most recent data on cost components of GDP are for 2006, leaving with the other difficulty of estimating the share of labour compensation and operating surplus to the GDP for 2010. I simply apply 2006 shares to calculate cost components of Turkey's GDP in 2010. Labour compensation constitutes 26.2% of the GDP calculated at 288.3 billion liras[78]. This figure is distributed through sectors using shares from SGK data.

Finally, one last adjustment made to labour compensation by sector to count for compensation of workers in the informal economy – quite widespread in Turkey. I add to each figure for private sectors – compensation in public administration is left unchanged as no undocumented workers can be employed in the public sector – the same proportions as in Erten (2009) to count for compensation in the informal economy. Percentages added are shown in Table 4.8[79].

[78]The remaining 50.1% corresponds to the share of operating surplus to GDP, 6.2% consumption of fixed capital (or depreciation) and 17.5% to the share of net taxes (taxes – subsidies) to GDP.
[79] Erten (2009) follows a more complex approach to tackle statistics issues and labour compensation for the informal economy, than just adding by these percentages given that labour market is the focus of his research work. The approach followed here is simpler. For more details on TUIK and SGK labour data compilation see Erten (2009).

Table 4.8 Undocumented labour percentages added (%)

Sector no.	Sector	Percentage added
1	AGR	40
2	TRAN	15
3	ELEC	15
4	COAL	30
5	GASOIL	30
6	MET	30
7	CHEM	30
8	MINR	30
9	MACH	15
10	MIN	30
11	FOOD	30
12	PAPR	30
13	CONST	15
14	TEXT	30
15	OIND	30
16	SERV	30

After these, total labour compensation turns out at 367 billion liras with sectoral distribution as shown in Table 4.9.

Table 4.9 Labour compensation by sector in 2010 (1,000TL)

Sector	Labour compensation
AGR	19,925,932
TRAN	29,460,775
ELEC	3,513,666
COAL	1,917,224
GASOIL	174,115
MET	18,890,150
CHEM	12,395,996
MINR	1,489,328
MACH	8,075,793
MIN	680,534
FOOD	9,470,404
PAPR	3,665,113
CONST	29,683,540
TEXT	16,559,963
OIND	3,864,889
SERV	207,261,915
Total	**367,029,338**

Source: Author's own calculations.

4.8 Operating Surplus

I have chosen to separate public sector operating surplus from that of private sector in order to be able to examine the impact of ownership changes in favour of a larger participation of private companies in the power sector – privatization is a key pillar of reform – on the economy.

Total operating surplus for state-owned companies is calculated as the sum of "factor income" from KKGD, as well as interest rate payments for social security bodies and public economic enterprises[80], following Erten (2009). Public economic enterprises' duty losses are also added here, given that KKGD does not include them. Ratios from 2006 figures in Erten (2009) are used to distribute this amount into sectors for the 2010 SAM. First estimations are made for eight sectors used in Erten's study – namely, agriculture, mining, consumption goods manufacturing, intermediate goods manufacturing, capital goods manufacturing, energy, construction, private sector services and public sector services. Further disaggregation to bring in line with sectors used here is made using 2002 IO table ratios.

Finally, private capital income is calculated as a residual, subtracting labour compensation, public sector's operating surplus and taxes on production from each sector's value added.

One issue here is that the private-sector operating surplus for metals sector turns out negative. This is as a result of labour compensation figure exceeding total net value added of the sector, which cannot be true. Therefore, labour compensation for metals is re-calculated making use of IO 2002 matrix for labour compensation to net value added ratio. The difference subtracted from labour compensation in metals is then added to services to net off the effect on total figures.

[80] Interest payment figures are retrieved from Treasury statistics at http://www.hazine.gov.tr/default.aspx?nsw=EilDPQez15w=-H7deC+LxBI8=&mid=59&cid=12&nm=33 as of 8 Oct. 2013.

4.9 Final Uses

There are four final use elements in Turkey's SAM for 2010 employed in this study, namely, private (household) consumption (HOH), government consumption (GOV), private capital accumulation (INVPR) and state capital accumulation (INVPU). Aggregate figures for these accounts are taken from GDP by expenditure series.

Distribution of household consumption through sectors is made making use of TUIK's Household Budget Survey data for 2010 and 2002 IO tables as well as IEA statistics for energy accounts.

The budget survey includes shares of household consumption for food, textile and services sectors to total household expenditures. The rest of the sectors are expressed in one single category named "various commodity and services". First, I calculate consumption expenditures for food, textile and services given their real shares to total consumption for 2010. Then, I calculate residential consumption of electricity, gas and oil, and coal using figures from related IEA publications. The remaining amount is distributed into the rest of accounts using shares in household consumption in Turkey's input-output tables for 2002.

On government consumption, the aggregate amount is taken from TUIK's GDP figures and sectoral distribution is made using shares to total in 2002 IO table. Figures for electricity (EDAS) and gasoil sectors are estimated using EDAS and IEA statistics.

On the distribution of public-sector capital formation into sectors, I use gross fixed investment figures by the Ministry of Development to separate into agriculture, mining, manufacture, energy, transportation and services. Investments in energy are further disaggregated making use of information available in TEIAS, TETAS, EDAS and EPDK's publications. And the manufacturing category is further disaggregated to be in line with sectors in this study by using Turkey's 2002 IO shares.

It shall be noted here that aggregate figures on state and private-sector gross fixed investments by ministry of development are slightly different from those in TUIK's GDP series. I use aggregate figures in TUIK's GDP series for consistency – given that these are also used in most of other accounts in the SAM estimated here.

The same procedure is used for separation of private sector's gross fixed investments. The only difference here is lack of information on power sector's further disaggregation into private generation, private wholesale trading sector and private distribution companies. Given no other data available, distribution is made using the same ratios for state generation, trading and distribution segments.

4.10 Intermediate Inputs

I use value added to gross output ratios estimated in section 4.4 and the technical coefficients from Turkey's 2002 IO table to construct the intermediate-use part of Turkey's SAM for 2010. Figures for total intermediate use by each sector as estimated by using ISO 500 data are disaggregated to a sectoral basis making use of input-output coefficients from the 2002 IO table. The only exception is data related to production and demand side of energy accounts.

Special care is taken to calculate data as near to realized amounts as possible for energy accounts, including electricity, gas and oil, and coal. This is done by making use of statistics made available by IEA's publications and other relevant documents such as annual reports published by regulator EPDK and state-run companies TEIAS, EUAS and TEDAS as well as electricity statistics published by the grid operator (TEIAS).

Separation of the electricity account into state and private-sector generation is presented first. Then I introduce four new satellite accounts related to electricity industry, namely: public-sector generation, independent private generation, public-sector suppliers, and private-sector suppliers. To the best of my knowledge, this is the first study that discriminates among public and private-sector generation and introduces supply segments of the power sector in a CGE study for Turkey.

This is followed by estimation of electricity industry's demand side in the IO section of Turkey's SAM, using IEA data. Similarly, supply and demand sides for the other energy accounts – "gasoil" and coal – are estimated using IEA statistics and data published by Turkish regulator EPDK.

4.10.1New Accounts for Electricity Industry

In this section I first introduce the dynamics of interaction among different categories of power sector participants in the IO section of the SAM. This is followed by separation of generation into private and public-sector and the introduction of four new satellite accounts for the electricity industry.

Intermediate power use by electricity sectors should reflect interaction among participants in the market and is strongly related to the market model and structure at a given time. The structure of Turkish power market has been evolving substantially since reform was first launched in 2001 and at this point it is essential to understand how it looked like in 2010 – our base year. Camadan and Erten (2011) offer a clear breakdown of the Turkish electricity market in 2010, as shown in Figure 4.5.

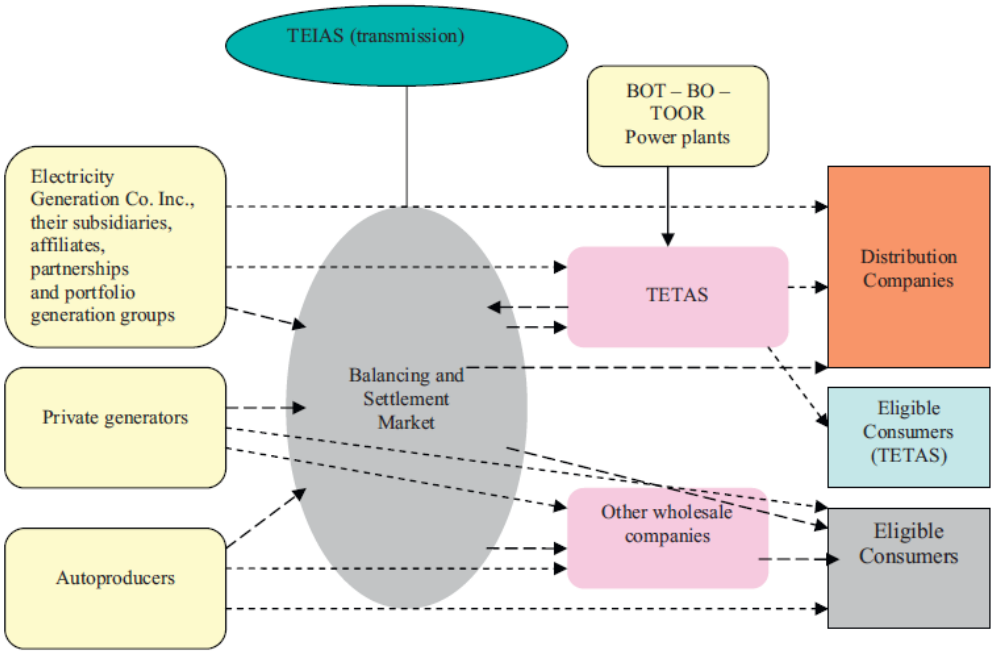


Figure 4.5 Structure of Turkish power market
Source: Camadan and Erten (2011: 1327).

As explained in previous chapters, the day-ahead planning period had just been launched in November 2009, after which participants submitted their bid and offer prices for each hour or in blocks to market operator TEIAS[81] at a daily frequency – in an earlier stage, prices were submitted bi-monthly – the day before. As the structure presented in the figure above shows, the interaction among participants is rather complex: for instance, state-generator EUAS can sell power to state-run wholesale company TETAS, distribution companies with a universal service obligation (EDAS) or at the balancing and settlement market (PMUM) – which includes the day-ahead market which is at an early stage of development at the time[82]; also, TETAS can buy and sell from PMUM, buys all the output of BO, BOT and TOOR plants, buys from EUAS, and can sell to distribution companies (EDAS) and to eligible consumers; and the like.

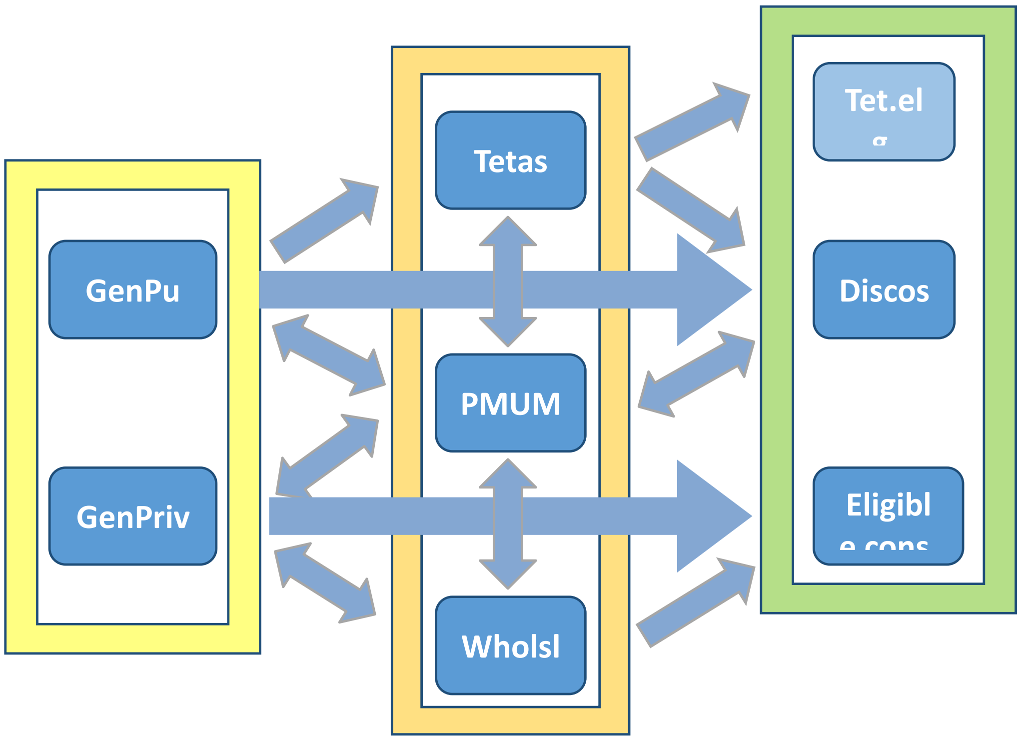
While a high level of disaggregation of data for volumes traded by each power market participantsin 2010 were made available by grid operator TEIAS for the purpose of this study, a more simplified/aggregated version of these inter-actions will be represented in Turkey's SAM here.

The simplified market structure is presented in Figure 4.6. I assume there are only two categories of generators: state and independent private generators. In the first, state-owned utility EUAS and BO, BOT and TOOR plants are included. The second group includes all auto-producers and independent private producers (IPP). On the wholesale

[81] TEIAS was both system (grid) and market operator at the time, these functions got separated as of 1 September 2015 when the newly incorporated EPIAS (Energy markets operating corporation) took over the duties of market operator for power while TEIAS continues to be in charge of grid operating.
[82] A fully functioning organized day-ahead market is launched in 2011.

segment, I introduce three new accounts, namely, state-owned wholesale company TETAS, organized power markets PMUM, and independent private wholesale power trading firms (Wholesale). Finally, distribution companies for 21 regions (EDAS) constitute another account for the electricity industry. It must be noted that distribution and retail activities were not unbundled until a new power law was approved in 2013, therefore they are considered in one single account in the SAM. Arrows in Figure 4.6 show flows of transactions.

Figure 4.6 Simplified Turkish electricity market structure



Note: Abbreviations in the figure respond to the following: GenPu – public sector power generation; GenPriv – private sector power generation; TETAS – state-run wholesale company TETAS; PMUM – balancing and settlement market; Wholsl – private sector wholesale trading companies; Disco-s – distribution companies; Tet.elg.cons. – TETAS eligible consumers; Eligible cons. – Eligible consumers.

Categorization of power market participants into each new sector spun from the electricity account is presented in Table 4.10. As mentioned before, BO, BOT and TOOR plants are all operated by private companies, but they sell their output to TETAS at previously agreed prices, therefore, they do not operate driven by competitive market incentives for profit maximization, nor are they exposed to any market risks. For these reasons, I categorize them under public sector generation.

Table 4.10 Power market participants for new accounts

SAM account	Explanation	Participants
GenPu	Public sector generation	EUAS and its affiliates; BO; BOT; TOOR
GenPri	Private sector generation	IPP; autoproducers.
TETAS	State-run wholesale company TETAS	TETAS
PMUM	Balancing and settlement market, Day-Ahead Planning	BSM, DAP
Wholesale	Private wholesale trading firms	Private-sector power trading companies
EDAS	Distribution companies	Distribution companies for 21 regions[83]

Further on, market volumes and prices (when available) will be presented in both the complex and simplified format as presented by Figures 4.5 and 4.6.

Table 4.10 shows Turkish power total market volumes and prices – when available – for each participant traded during 2010. One thing to be noted here is the *velocity of circulation of power*[84], that is, how fast power passes from one holder to the other.

[83] In 2010, retail activities were not yet separated from these companies so they have exclusivity for both distribution and retail to non-eligible consumers. They also have the obligation to offer retail services to consumers that qualify as eligible but do not exert their right of changing the power supplier as such.

[84] To the best of my knowledge, this term has not been used in the literature reviewed for this dissetation, another term could exist to refer to the same kind of measurement. The term is aimed at

While the total amount of power traded is 335TWh, the amount of power physically delivered by supplying parties and drawn from the system by final users on a contractual basis (UECM – uzlastirmaya esas cekis miktari) is just 188.4TWh. This suggests one physical unit of power has been changing hands 1.78 times[85] on average through physical and financial contract in 2010.

On the generation segment, obviously state-run EUAS holds the largest share of 48%, which adding BO, BOT and TOOR plants boosts the "public-sector generation" shares to 80%, with auto-producers and independent power producers covering for just 20% of Turkey's power output in 2010.

On the wholesale trading segment, state-run TETAS holds the lion's share of 60% of wholesale trading, followed by 39% of volumes traded in PMUM and only 2% traded by private power wholesale trading companies.

Lastly, on distribution and supply of power to end-users, distribution companies (EDAS) in 21 regions that hold universal service obligation have the largest share in power transmitted to end-users of 83%, followed by private wholesale companies which deliver %, independent private generators (IPP) and auto-producers with 6%, and TETAS and EUAS with 3% and 1% respectively.

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referring to the depth of the power market and can be thought as a concept parallel to the velocity of money in the quantity theory of money.

[85] Calculated as total sold volumes divided by the total amount of power drawn from the system on a contractual basis (UECM).

Needless to say, the stake of state-run companies is still large and significant in Turkish electricity market in 2010, but this will change for following years as will be shown in a later chapter.

Table 4.11 Turkish power market volumes (GWh) and prices (TL cent/kWh) in 2010

Sell/Buy	EUAS		TETAS		PMUM		Autoproducers		Retail (EDAS)		Wholesale		IPP		Exports		Eligible consumers		Total Sales	UECM[86]
	Volume	Price	Volume	Price	Volume	Price	Volume	Price	Volume	Price	Volume	Price	Volume	Price	Volume	Price	Volume	Price	Volume	Volume
EUAS			23,070	11.75	9,605	14.61			59,945	14.32									92,620	1,363
TETAS					4,431	14.57	178		75,494	14.67					627	19.46	4,225	13.55	80,103	4,880
PMUM	5,302	9.03	1,538	9.93			1,015	12.41	27,292	13.80	5,672	13.19	11,460	11.03					52,279	
Autoprod.					2,116	13.59					123						1,043		2,239	1,911
Retail (EDAS)					7,559	10.19											207		7,559	156,097
Wholesale					1,809	12.71			16		387		23		1,288		12,176		2,235	14,335
IPP					24,623	13.61	69		899		10,183		11				8,947		35,785	9,805
BO			43,984	13.30															43,984	
BOT			13,383	14.50															13,383	
TOOR			3,713	10.43															3,713	
Imports			932	5.80							210								1,142	
Total	**5,302**		**86,619**		**50,143**		**1,262**		**163,646**		**16,574**		**11,494**		**1,918**		**26,597**		**335,041**	**188,391**

Source: TEIAS/PMUM, TEIAS/MYTM, EUAS, EDAS, TETAS, EPDK.

Table 4.12 Simplified Turkish power market structure: volumes (1,000 TL) in 2010

Sell/Buy	GenPu	GenPri	TETAS	PMUM	Wholesale	EDAS	Exports	Eligible consumers
GenPu	-	-	10,888,285	1,403,430	-	8,584,108	-	-
GenPri	-	9,813	-	3,639,254	1,214,130	122,359	-	1,344,222
TETAS	-	22,063	-	645,803	-	11,075,035	121,975	572,501
PMUM	478,973	1,389,964	152,764	-	748,063	3,766,679	-	-
Wholesale	-	2,943	-	229,878	49,229	2,013	158,909	1,638,442
EDAS	-	-	-	770,223	-	-	-	28,564
Imports	-	-	54,044	-	26,885	-	-	-
	478,973	**1,424,782**	**11,095,093**	**6,688,588**	**2,038,307**	**23,550,194**	**280,884**	**3,583,729**

Source: TEIAS/PMUM, TEIAS/MYTM, EUAS, EDAS, TETAS, EPDK, author's calculations.

[86] Amount of power drawn from the system on a contractual basis [Uzlastirmaya Esas Cekilen Miktari].

While most average prices at which power is purchased and sold in various segments by market participants are made available by relevant institutions, some prices – unregulated prices determined through bilateral negotiations[87] between counterparties – are missing in Table 4.11. In order to calculate market volumes in monetary volumes for the SAM, the following assumptions are made on unregulated power prices:

1. I assume the price at which IPPs and auto-producers sell to eligible consumers is 2.5% lower from the regulated price [88] distribution companies sell to this group. This assumption is based on information acquired from face-to-face interviews with sector representatives and from a few industrial users[89].
2. The price at which wholesale companies sell to eligible consumers is assumed to be the same as the price these companies sold to PMUM.
3. Prices at which IPPs and private wholesale companies sell power to distribution companies (EDAS) are assumed to be the same with respective average prices the former two groups sold to PMUM during 2010.
4. The price at which auto-producers bought power from IPPs and TETAS is assumed to be the same with the price at which they bought from PMUM.

[87] These include potential over-the-counter (OTC) trades, although the OTC power market in Turkey was underdeveloped until 2011.
[88] Here only the "active energy" price – that is, regulated (average of various categories) price before fees and taxes – is taken as reference in line with the basic prices use rule for SAM construction.
[89] See Annex I for the interview questions.

5. The price at which IPPs bought electricity from IPPs is also assumed to be the same as the price this group bought power from PMUM.
6. It is assumed that wholesale companies sold to IPPs at the same price as they sold to PMUM.
7. The price at which private wholesale companies sold to other wholesale companies is also assumed to be the same as prices at which these firms sold to PMUM.
8. The price at which private wholesale companies bought power from IPPs and auto-producers is assumed to be the weighted average price at which these firms, IPPs and auto-producers bought power from PMUM.
9. The price at which private wholesale companies have exported power is calculated as follows: I take the difference between total power export figure in TUIK data and TETAS' exported volumes (in TL) and then divide it by physical volumes in (MW) exported by wholesale companies to obtain their average export price.
10. Finally, the price at which private wholesale companies have imported power from abroad is assumed to be the same as TETAS' power imports price.

There is a discrepancy between TUIK and TETAS' power imports data, as the latter's figure turns out to be larger than TUIK's figure for power imports, which is counter-intuitive as private sector companies are also reported to have imported power in 2010. One reason for this could be the fact that TETAS practices exchange of power with neighbouring countries – for instance, it could draw power from neighbouring Georgia in peaking demand times in Turkey on condition that the same amount of power is delivered back to Georgia at some point in time. Therefore, it is likely that not all the power delivered by TETAS to other countries has been reported as imports, resulting in underestimation of power imports by TEIAS. For this reason, I do not make any adjustments for the additional amounts of exports from electricity, but simply place calculated amounts in the SAM[90].

Further, I explain how the previous “Electricity” account in the SAM – which included the power generation segment as a whole – will be separated into private and public-sector generation. Calculation of fuel costs used to generate electricity are the most important intermediate inputs into these accounts, therefore special effort is put to calculate figures in line with accrued amounts. First, I calculate generation mix of state-run and private utilities using TEIAS and TETAS data, as shown in Table 4.13.

For costs of generation in monetary terms, costs in TL/MWh are necessary. While no such data is made available for state-run utilities, private-sector generation costs for each resource are made using 2013 data in Aksa Enerji’s – one of Turkey’s largest IPPs[91] – investor presentations (Aksa Enerji, 2014). Given no other information

[90] This means total Turkish exports for 2010 will be slightly higher than that calculated from TUIK figures.
[91] The company is listed in Borsa Istanbul (Istanbul Stock Exchange), therefore reveals a high degree of transparency for almost all segments in the power industry.

available, it is assumed that generation costs for the company have remained stable for the 2010-2013 period.

Table 4.13 Generation mix by state and private utilities in 2010 (GWh)

	GenPu	GenPriv
Hard coal, imported coal, asphaltite	14,225	4,879
Lignite	31,171	4,771
Fuel oil	62	2,082
Diesel oil	-	4
Naphtha	-	32
Natural Gas	66,284	31,860
Renewables, waste	-	458
Hydropower	42,353	9,442
Geothermal	-	668
Wind	46	2,870
Total	154,142	57,066

Source: TEIAS, TETAS.

Aksa's costs for unit of output are treated as the best available approximation for costs of IPPs taking into consideration the fact that it was Turkey's second largest IPP with an installed capacity of 2,052MW – or 2.3% of the country's total installed capacity – by the end of 2013. Aksa's market share in total generation of Turkish IPPs was 10.5% in 2010 and 10.8% in 2013.

The most expensive source for power generation is fuel-oil, followed by natural gas and lignite. And the cheapest energy is that produced from renewable resources (see Table 4.14). I assume lignite-fired and imported-coal or hard-coal fired electricity generation cost the same. Also, the cost of renewable energy is considered the same for all types of renewable resources – at 29 TL/MWh.

One thing to mention here is the fact that fuel costs are zero for renewable energy, therefore only operating expenses (OPEX) enter the cost function of these fuels. For this reason, I reflect costs of renewables incurred by generators to the services account in SAM.

Table 4.14 IPP generation costs by fuel (TL/MWh)

	Fuel cost	Non-fuel production cost	Total cost
Fuel oil	241	45	**286**
Natural gas	152	4	**156**
Lignite	70		**70**
Renewables		29	**29**

Source: Aksa Enerji (2014).

Once costs of fuel are calculated for private generation, I subtract these from overall costs for generation for the use of each fuel[92] type – i.e. payments made by private-sector generation to *gasoil*, coal and services accounts for fuel use – to find fuel costs for public generation.

Total power use by the generation sector calculated here is higher compared to its level estimated from 2002 input-output coefficients. Therefore, the resulting difference is netted off by subtracting the difference from each other spending item of generation proportionally to IO 2002 estimated figures.

[92] Accrued figures for generation's payments to gas and oil as well as coal industries are calculated using IEA figures as shown in respective sections. Whereas total payments made to services is taken from the previously estimated figure using 2002 IO input-output coefficients.

Then, I calculate shares of private and public-sector generation's spending on fuels to overall generation's use of fuels. These are used to separate the remaining of intermediate demand by private and state generation sectors, by being multiplied to figures estimated using 2002 IO data under the "electricity" account.

Lastly but importantly for this section, four new accounts introducing segments other than generation from power industry are introduced – namely, state-run wholesale trading TETAS, private wholesale companies, organized markets PMUM, and distribution companies EDAS.

Interactions of these sectors among each-other and with generation sectors have already been presented in Table 4.12 (simplified structure). Figures for the use of services by TETAS, PMUM and EDAS are estimated using information in reports published by TETAS, TEIAS and TEDAS, while use of goods and services by the new satellite accounts for the rest of sectors is assumed to be zero.

Finally, total intermediate use of the inserted new satellite accounts is subtracted from "services" account in order to avoid double-counting. The System of National Accounts for 2008 (European Communities et.al., 2009) dictates that it is important to create new accounts by deducting from existing accounts of the central system of national accounts to keep consistency with the latter. This practice is applied for other entries related to new satellite accounts, as will be noted in related sections.

4.10.2 Electricity – Demand Side

IEA's Electricity Information 2012 publication contains detailed information on power volumes used by each sector during 2010. The amounts – also shown in Table 4.15 – are then multiplied by average prices charged by each participating entity as explained in the previous section[93].

[93] The power price before taxes and fees is referred to as "active energy" in tariff tables published by Turish Electricity Distribution corporation (TEDAS). For more details see http://www.tEDAS.gov.tr/BilgiBankasi/Sayfalar/ElektrikTarifeleri.aspx available as of November 2015.

Table 4.15 Power production and consumption, 2010

	TWh
Gross production	**211.20**
Hydro	51.80
Geothermal	0.70
Wind	2.90
Combustible fuels	**155.80**
Coal	55.00
Oil	2.20
Natural gas	98.10
Biofuels & waste	0.50
Own use by power plant	8.20
Net production	**203.00**
Imports	1.10
Exports	1.90
Electrical energy supplied	**202.30**
Transmission and distribution losses	30.00
Total consumption	**172.10**
Energy industry consumption	2.20
Final consumption	**169.90**
Total industry (TWh)	**77.17**
Iron and steel	16.58
Chem. and petrochem	4.34
Non-ferrous metals	2.31
Non-metallic minerals	10.01
Transport equipment	-
Machinery	4.81
Mining and quarrying	1.88
Food and tobacco	5.13
Paper, pulp and printing	2.21
Wood and wood products	1.85
Construction	2.26
Textile and leather	13.89
Non specified/other	11.91

Source: IEA (2012).

Major features on the supply side are combustible fuels' large share in the generation mix, with hydro coming next while other renewable resources – like wind, geothermal, biomass – generation has just started to be developed in 2010. Given the country's high dependency on oil and gas imports, high shares in the mix expose Turkish power sector not just to domestic market risks but also to risks attached to foreign exchange and international energy commodity markets, as well as to geo-political riks[94].

On electricity demand side, obviously Turkey's largest industrial power consumers in 2010 are iron and steel, textile, non-metallic minerals, food and tobacco, and chemicals and petrochemicals. Of the industrial power consumers not classified according to the sector groupings here are coal, gas and oil and other industries. Given no other data available, separation is made according to shares in the 2002 IO table.

What is worth pointing here is the intolerably high level of losses in transmission and distribution network, mostly so due to high levels of electricity theft, rather than for technical reasons. This has pushed the government to opt for the privatization of the distribution network.

[94] For example Turkey's worsening ties with Israel after the Blue Marmara incident in 2010 have kept the two countries from considering any agreement in the energy field following discovery of offshore natural gas in the latter. Another more recent example is Turkey's stretchening ties with Russia following Turkey's downing of a Russian jet on 24 November 2015, which has supported wholesale power prices in forward markets due to a higher risk premium pricing of winter months upon expectations that Russia would not be willing to pump more gas for Turkey in the event of a peaking demand period during a cold spell. Also, other cooperations in the energy field have been affected, like suspension of works for the Akkuyu nuclear power plant project.

And residential consumption of power was 41.4TWh in 2010. This is entirely sold to households by distribution companies.

Before power sector reform was introduced in 2001, only distribution companies were eligible to deliver electricity to end users, both industrial and residential. But after reforms started to be implemented, more institutions gained the right to distribute power directly, for instance generators or wholesale companies could sell directly to end users in 2010, as is explained in the previous section – in the new power law approved in 2013 distinction between wholesale and retail companies were removed and these are all categorized as power suppliers presently, as distribution companies also had to unbundle their distribution and retail activities.

Information on which industries purchase power by which group of power market participants – i.e. generators, suppliers or organized markets – is not made available though. Therefore, here I assume all these participants distribute power to all sectors proportional to their shares from IEA 2010 data at a sector basis.

The only exception here is with TETAS' sales to eligible consumers: the organization has published amounts of its sales to three key categories of its eligible consumers – namely the state-run railway corporation TCDD, power sold for internal use purposes and to other industries in its annual report for 2012. Assuming these have not changed substantially, I use their shares to distribute TETAS' 2010 eligible consumers sales of around 2TWh to transportation (TCDD) – by 12%, TETAS (internal use) – by 1% – and the remaining 87%is distributed through the rest of sectors using proportions in IEA data on industrial use of power.

4.10.3 Other SAM Accounts for Power Industry

Distribution of labour compensation by private and state generation is done using previously estimated figure – from SGK data – and shares of each sector's fuel use to total fuel use in Turkish electricity generation sector in 2010. Separation of taxes on production is also made in a similar fashion.

Distribution of operating surplus to public and private sector capital providers is straightforward given the ownership nature of state and private generators. Previous figures remain unchanged.

Elements of value added – that is, enumeration of labour, of capital providers and payments to government in the form of taxes on production – for TETAS, PMUM and EDAS are made using information in reports and data published by TETAS, TEIAS, TEDAS and EPDK[95].

While value added for the private wholesale trading segment is estimated as a residual from difference between total use – i.e. intermediate plus final uses – by the sector and its total supply – i.e. domestic sales plus exports. Given lack of data on how to distribute among labour compensation and operating surplus, I attribute 10% of the residual to labour and the remaining 90% to operating surplus – based on the

[95] This goes for these sectors' payments to the "Services" account, where data was available.

observation that payments to labour are considerably lower compared to payments a trading company has to make to software, trading screens and other kinds of soft and hard-ware capital.

4.10.4 Oil and oil products – demand side

For sectoral disaggregation of oil data we use physical quantities reported by IEA's 2012 Oil Information publication at a NACE Rev.3 level as shown in Table 4.16.

Table 4.16 Oil supply and consumption in Turkey, 2010

	Gas/diesel oil (000 metric tons)	Fuel oil (residual, 000 metric tons)	Total products (000 metric tons)
Refinery output	**5,317**	**2,780**	**19,907**
Recycled products +	-	-	-
Imports +	9,682	651	18,343
Exports _	344	2,255	6,357
Intl. marine bunkers _	233	138	371
Transfers +	7	-	7
Stock change	22	(34)	(277)
Statistical difference -	-	-	-
Total Consumption	**14,451**	**1,004**	**31,252**
Transformation	**1**	**566**	**1,253**
Main activity producer electricity	1	305	306
Autoproducer electricity	-	159	172
Main activity CHP plants	-	-	-
Autoproducers of CHP	-	102	102
Main activity heat plants	-	-	-
Autoproducers heat plants	-	-	-
Petrochemical industry	-	-	596
Other transformation	-	-	77
Energy industry own use	**-**	**153**	**1,074**
Refinery fuel	-	153	1,074
Other energy industry	-	-	-
Final consumption	**14,450**	**285**	**28,925**
Transport	**9,023**	**51**	**15,741**
Industry	**665**	**128**	**7,467**

Iron and steel	58	-	136
Chemical (incl. pet chem)	77	97	2,380
Non-ferrous metals	-	4	4
Non-metallic minerals	276	17	319
Transport equipment	-	-	-
Machinery	-	-	-
Mining and quarrying	-	-	-
Food and tobacco	296	7	480
Pulp, paper and printing	-	3	320
Wood and wood products	-	-	-
Construction	-	-	2,478
Textiles and leather	-	-	213
Non-specified	124	-	1,137
Other	**4,378**	**106**	**5,717**
Commerce and public	-	-	-
Residential	-	106	1,339
Agriculture (incl. fishing)	4,378	-	4,378
Non-specified	-	-	-
Memo: non-energy use	***217***	**-**	**7,659**
Chem/petchem feedst.	*217*	-	2,207
Other	-	-	5,452
Closing Stock level	***1,445***	**345**	**3,120**

Source: IEA Oil Information (2012). *Note*: The plus (+) and minus (_) signs in some of the entries in the left-hand side column indicated whether the entry is added or subtracted to the total, respectively.

Oil and oil product prices in Turkey are not regulated so there is no single price for these commodities. Here I use indicative prices for diesel and fuel oil provided by EPDK's report (2011: 90) which correspond to average respective producer prices for diesel oil and fuel oil 6 in Turkey during December 2010[96].

While for the rest of products, an implied average price is calculated as follows: total indirect taxes paid by the oil sector amounted 35.6 billion liras according to the EPDK

[96] For details see Table 4.19 in page 90 of the report.

report (2011: 92)[97]. I subtract indirect tax payments by gasoil and fuel oil from the total and to get the total tax paid on other oil products which is then divided by 0.64 – the share of indirect tax to purchaser's price for unleaded gasoline reported in EPDK's report – to get the total amount spent for the rest of oil products. This total aggregate figure is distributed through sectors in line with physical volume shares for each sector to total oil consumption.

Residential oil consumption data – under "private consumption" account in final demand elements in SAM – is also calculated using physical volumes from IEA data and the indicative – after-tax – prices provided by the EPDK report for 2010.

4.10.5 Natural Gas – Demand Side

Physical volumes of natural gas used for each sector are acquired from IEA's Natural Gas Information report for 2012 which makes available data at a NACE Rev.3 disaggregation level suitable for sectors in this study, shown in Table 4.17. Regulated gas prices are used from BOTAS's official statistics to estimate gas consumption in monetary value. Industrial users including electricity sector are assumed to be purchasing gas at the wholesale price of "organized industrial zones and uninterrupted industrial" category[98] while the gas price for residential consumption is taken from the "subscribers" category of regulated prices charged by gas distribution companies[99].

[97] See Table 4.20 of the report.
[98] See http://www.botas.gov.tr/index/tur/faaliyetler/dogalgaz/tarifeSerTukV1.asp for details. Available as of November 2015.
[99] See http://www.botas.gov.tr/index/tur/faaliyetler/dogalgaz/tarifeDagSirV1.asp for details. Available as of November 2015.

For the estimation of the purchasers' price of household consumption of gas I assume that of the total natural gas bill, 76.2% is the cost of gas and the remaining 23.8% share counts for the gas distribution fee and indirect taxes[100].

Table 4.17 Natural gas supply and consumption in Turkey, 2010

	2010 (million cubic meters)
Indigenous production	**682**
From other sources	-
Imports	38,037
Exports	649
Stock changes	57
Statistical difference	-
Total consumption	**38,127**
Transformation	**20,708**
Main activity electricity	17,268
Autoproducers electricity	812
Main activity CHP plants	1,479
Autoproducers of CHP	1,149
Main activity heat plants	-
Autoproducers heat plants	-
Gas works	-
Gas to liquids	-
Other transformation	-
Energy industry own use	**1,462**
Coal mines	-
Oil and gas extraction	-
Gas inputs to oil refineries	1,120
Coke ovens	-
Gas works	-
Other energy	342
Losses	**4**
Final consumption	**15,953**
Industry	**7,663**
Iron and steel	550
Chemical	771

[100] Referring to an article published in a gas-sector related website: http://gazelektrik.com/enerji-piyasalari/dogal-gaz-vergi accessed in November 2015.

Non-ferrous metals	516
Non-metallic minerals	1,175
Transport equipment	47
Machinery	81
Mining and quarrying	67
Food and tobacco	647
Pulp, paper and printing	177
Wood and wood products	66
Construction	144
Textiles and leather	530
Non-specified	2,892
Transport	**265**
Road	71
Pipelines	194
Non-specified	-
Other	**7,787**
Commerce and public	1,872
Residential	5,888
Agriculture (incl. fishing)	27
Non-specified	-
Non-energy use (industry)	**238**
Petrochemical feedstocks	238
Other	-

Source: IEA (2012).

4.10.6 Coal – Demand Side

Both physical amounts and prices in Turkish liras are provided for steam coal and coking coal in the IEA's 2012 Coal Information report, but only physical amounts are made available for lignite. I use an approximate price for lignite based on information from energy minister's media statements[101]. The physical volumes as presented in the IEA report are shown in Table 4.18.

Further disaggregation is required for "other sectors" to make it consistent with sectors involved here. This group includes sectors as follows: residential, commercial and public services, agriculture/forestry, fishing, and non-specified other[102]. I distribute these proportionally to coefficients estimated from the 2002 IO table.

Table 4.18 Coal supply and consumption in Turkey, 2010

	Steam coal (mn tonnes)	Coking coal (mn tonnes)	Lignite (mn tonnes)
TOTAL	**18.5**	**7.52**	**69.24**
Electricity and heat gen.	**6.81**	**0.54**	**55.44**
Main activity producers	6.81	-	54.96
Autoproducers	-	0.54	0.48
Patent fuel/BKB plants	-	-	-
Coke ovens / Liquefaction	-	5.32	-
Blast furnace inputs	0.46	-	-
Gas Manufacture	-	-	-
Industry	**3.85**	**1.43**	**7.75**
Iron and steel	0.28	0.89	0.13
Chemical	0.08	-	0.49
Non-metallic minerals	-	-	0.14
Paper, pulp and print	-	-	0.02
Other industry	3.49	0.54	6.98
Other sectors	7.72	0.18	5.98
Non-energy use	**-**	**-**	**-**

Source: IEA Coal Information 2012.

[101] See for example: http://www.ahaber.com.tr/ekonomi/2015/10/08/bakan-acikladi-200-milyar-lik-rezerv-bulundu accessed on 23 November 2015.
[102] See notes to Table 6 for Turkey on page 340 of the report.

4.11 Other SAM Accounts

In this section estimation for the remaining entries in SAM accounts are briefly explained. Revenues are expressed as row sums while expenditures as column sums for each account in the SAM. And the row sum equals respective column sum for each account.

Now that the gross output column is complete, I find domestic sales for each sector by subtracting exports from gross output. This is taken as a residual given that no related data is available. In this way, all entries for the activity and commodity accounts is completed.

Here I assume a part of labour's income from production activities goes to unemployment benefit contributions. Therefore, in the labour account's column, income from labour to households equals total labour compensation by activities minus unemployment benefits. Flows from labour to government include unemployment benefit contributions made by labour.

Contributions from private and public sectors' capital holders to firms include respective total operating surplus payments made to capital holders by production activities.

Total household income is provided by labour compensation – excluding unemployment benefits, – profit transfers by firms, government transfers and worker remittances from abroad.

Government transfers to households include social security contributions – without unemployment benefits – and other transfers and is calculated as a residual from government revenues and spending. Profit transfer payments by enterprises to households are also found as a residual. Whereas workers' remittances from abroad are taken from TCMB's balance of payment data in US dollars and converted into liras using implicit foreign exchange rate[103].

On the expenditures block, households spend on consumption of goods and services – already calculated at a sector basis as in section 4.9 on final uses – on income and property taxes and non-tax transfers to the government and savings. Income and property taxes paid to the government are taken from consolidated budget figures while non-tax transfers to government from the public sector's general balance (KKGD). One last entry in the household column is the private savings-investment gap (PSIG) which is the extra amount needed to finance the country's total investments once public sector, private sector and foreign savings are counted for[104].

On firms' revenues side apart from income from operating surplus to capital holders (here assumed to be companies), firms also receive transfers from government in the form of production subsidies and government also pays domestic debt interest payments

[103] As with implicit export foreign exchange rate, this is also calculated by dividing total imports in Turkish liras published by TUIK by total imports expressed in US dollars in TCMB statistics.

[104] PSIG is calculated as difference between total private and public sector investments and state, private and foreign savings. Its value is negative in the SAM which translates that rather than paying to government savings, households have received the absolute value of the negative amount (negative expenditure implies income).

– both taken from consolidated budget. Also, firms receive income in foreign exchange from abroad.

On the enterprise expenditures block, apart from profit transfers to households, enterprises pay corporate taxes to government. Also, companies make external debt interest payments –taken from CBRT's external debt service statistics – and net profit transfers – taken from the net direct investment figure in CBRT's balance of payments statistics – to the rest of the world.

The government's revenues block consists of tax revenues from production activities, tax revenues from sales of goods and services (indirect taxes), revenues from income and property taxes, non-tax revenues from households, revenue from corporation taxes, public firms' factor (capital) income – taken from public sector general balance (KKGD) from Ministry of Development statistics – and net outright transfers from the rest of the world – the latter taken from balance of payment statistics. Tax revenue figures are all taken from consolidated budget.

The expenditures block for government consists of public sector consumption of goods and services – calculated in the final uses section; government transfers to households; transfers to companies in the form of production subsidies and domestic debt interest payments – both from consolidated budget figures; public sector savings – taken from the public sector general balance (KKGD); and government's foreign debt interest payments to the rest of the world – from consolidated budget figures.

From the revenues block for the rest-of-the-world (ROW) account, foreign debt interest payments made by the government to the rest of the world are taken from the “Foreign debt interest” entry in consolidated budget expenditures table prepared by the Ministry of Finance. Private sector’s external debt interest payments are taken from TCMB’s external debt service statistics as the sum of central bank’s and private sector’s short, medium and long term debt interest payments. As these are expressed in US dollars, I multiply them to an implicit exports foreign exchange rate – calculated by dividing Turkey’s total exports in 2010 shown in domestic currency by statistical agency TUIK and the same figure in US dollars published in TCMB’s balance of payments statistics.

Table 4.19 External debt stock in 2010

	Long term (million USD)	Short Term (million USD)	Total (million USD)	Total (1,000 TL)
TCMB	280	36	316	609,109
Banks	822	222	1,044	2,012,373
Other sectors	3,187	96	3,283	6,328,180
General Government	4,093	0	4,093	7,889,504

Source: TCMB.

Private enterprises’ net profit transfers to abroad are taken from the “net direct investment” expenditure from balance of payments and is multiplied to the implicit exports exchange rate.

Table 4.20 External debt interest payments, 2010

	Total payments (1,000 TL)
Private sector	8,949,662
Government	7,889,504

Source: TCMB, author's own calculations.

4.12 Balancing the SAM

SAM provides with a detailed presentation of flows among sectors and institutions, compiling data related to production and value added, consumption, investment and trade flows through activities by institutions such as households, enterprises, financial institutions, the public sector and the rest of the world. This requires a combination of data published by various institutions, which most of the time leads to a mismatch in aggregate figures in the SAM.

By definition, the total sum of each column in a SAM must equal the total sum of its respective row. Many methods have been developed to balance social accounting matrices, including the RAS, cross-entropy, least squares and linear programming approaches, with the first two being the most popular.

The RAS method is an iterative method of biproportional adjustment of rows and columns, developed independently first in disciplines other than economics. It was first used in the construction of IO tables by Sir Richard Stone in 1962, although the idea of a biproportional adjustment method for updating IO tables had been earlier mentioned by Leontief[105].

The cross entropy method, on the other hand, consists of an objective function which aims to minimize the cross-entropy measure of distance between an original and a new/updated SAM. It is possible to generate a new matrix given sum and column rows using maximum sum of entropies (MSE) approach (McDougall, 1999), which cannot be done using RAS.

However, given that all elements of Turkey's SAM have been estimated – so no introduction of more rows and tables – and the advantage of simple iteration, I have chosen to use RAS to balance the SAM.

A detailed discussion of all approaches is beyond the scope of this thesis, but I briefly describe below the RAS method used here. I do fix some of the accounts manually through the iterations while employing the RAS method (in Excel) to balance Turkey's SAM. This is because of data for certain accounts becoming irrationally large, small or negative due to the iterative nature of the RAS approach. As put by Thorbecke, "*it is far preferable to use judgments than mechanical approaches in ensuring that a SAM is consistent and balanced*" (2000:14). However, I take special care so that data is not disturbed in a biased manner to avoid creation of spurious mechanisms that may affect model results.

[105] For more details see McDougall, 1999; Planting and Guo, 2002; Ahmed and Preckel, 2007; Trinh and Phong, 2013; Lee and Su, 2014.

4.12.1 The RAS method

The RAS method, developed by economist Richard Stone in 1962 (McDougall, 1999), is widely used to update and revise input-output or supply-use tables when new information becomes available. The method works as follows (as explained in Fofana, Lemelin and Cockburn, 2005):

Assuming that T is the matrix of SAM transactions and t_{ij} is a cell value that satisfies the condition:

$$T_{.j} = \sum_i t_{ij} \ ,$$

where$T_{.j}$ refers to the column total.

As a next step, we construct a SAM coefficient matrix A from T by dividing the cells in each column of T by the column sums:

$$a_{ij} = tij/t_{.j} \ .$$

A new matrix A^1 from the initial A^0 must be generated by means of biproportional row and column operations, in order to provide a solution for our problem, that is, for reviewing the initial matrix given the new information.

Thus, we have:

$$a_{ij}^1 = r_i a_{ij}^0 s_j$$

where *r* and *s* stand for row and column multipliers, respectively. In matrix notation this can be written as:

$$A^1 = \tilde{R}A^0\tilde{S}$$

*w*here the sign ~ indicates a diagonal matrix of elements r_i and s_j.

The RAS method is an iterative algorithm of biproportional adjustment. The step-by-step iteration procedure, where superscripts 0,1,2 … refer to iteration steps and (^) to the new column or row values, can be summarized as follows (Fofana, Lemelin and Cockburn, 2005):

Step 1

$$a_i^1 = \frac{\widehat{x_{i.}}}{\sum_j x_{ij}^0} \quad => x_{ij}^1 = a_i^1 x_{ij}^0 \quad => b_j^1 = \frac{\widehat{x_{.j}}}{\sum_i x_{ij}^1} \quad => x_{ij}^2 = b_i^1 x_{ij}^1$$

Step 2

$$a_i^2 = \frac{\widehat{x_{i.}}}{\sum_j x_{ij}^2} \quad => x_{ij}^3 = a_i^2 x_{ij}^2 \quad => b_j^2 = \frac{\widehat{x_{.j}}}{\sum_i x_{ij}^3} \quad => x_{ij}^4 = b_i^2 x_{ij}^3$$

…

Step t

$$a_i^t = \frac{\widehat{x_{i.}}}{\sum_j x_{ij}^{2t-2}} \quad => x_{ij}^{2t-1} = a_i^t x_{ij}^{2t-2} \quad => b_j^t = \frac{\widehat{x_{.j}}}{\sum_i x_{ij}^{2t-1}} \quad => x_{ij}^{2t} = b_i^t x_{ij}^{2t-1}$$

The process is continued until the iterations converge.

CHAPTER 5

A CGE MODEL FOR TURKEY

General equilibrium modelling in the economics discipline became popular in the post-war period of the previous century, as researchers and policy makers followed their quest for methods to thoroughly analyse impact of – mainly tax – policy on resource allocation and general welfare which had not been captured by empirical models developed by the time.

Eventually, general equilibrium applications followed theoretical foundations set in the input-output analysis pioneered by Leontief and the formalization of existence of general equilibrium in 1874 by the French mathematical economist Leon Walras[106]. It was about a century later, in 1954, that Arrow and Debreu "*formalized*"the Walrasian general equilibrium structure "*from an abstract representation of an economy into realistic models of actual economies*" (Shoven and Whalley, 1992: 1). Along with parallel work by McKenzie (1954), they employed Bower's fixed-point theorem to prove existence of general equilibrium[107].

Applied general equilibrium models are mainly aimed at analysing possible policy outcomes in a given economic setting, rather than at forecasting future values of micro and macro-economic variables. The first works on applied general equilibrium models focused on effects of taxation on general welfare, while further work was expanded to examine policy outcomes in developing countries[108], as well as other fields of economy such as trade, environmental economics, energy, research and development and the like.

Johansen (1960, mentioned in Shoven and Whalley, 1992) is one of the first economists to introduce numerical applications of the general equilibrium models. Scarf (1967)[109] extended earlier work from Arrow and Debreu to strengthen ties between theory and applications of general equilibrium.

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[106] Nineteenth century economists were aware of the importance of general equilibrium but did not formulate a full such model until Walras.
[107] This theorem was first used by John Nash in 1950 to demonstrate equilibrium in a game but was later adopted to principles of welfare economics (see Starr, 2011).
[108] Pioneering work on developing countries include Dervis, de Melo and Robinson's research published by Cambridge University and the World Bank in 1989.
[109] For a simplified representation of his work see Shoven and Whalley (1992); Willenbockel (1994) and Starr (2011).

Initial work focused on static general equilibrium modelling, focusing on one fixed period of time – usually a base year, while later models introduced evolution of capital stocks and/or other variables through time to analyse dynamics of an economy through time following a shock. Dynamic CGE models may have an advantage over static ones when evolution of variables such as capital accumulation and economic growth is at the focus of research.

Another dimension added to general equilibrium modelling has been introduction of increasing returns to scale and imperfect competition[110]. Pioneering work includes Harris (1984) and Harris and Cox's work in the same year (the latter mentioned in Willenbockel, 1994). Harris (1984) defended the importance of incorporating industrial organization features to a GE trade model in both qualitative and quantitative terms. He developed a 29-sector static CGE model to examine the impact of trade liberalization for the Canadian economy in 1976. Key assumptions here are those of Canada being a small economy and scale economies internal to the firm – rather than external to the firm and internal to the industry – which implies imperfectly competitive related industries.

General equilibrium in the economic sense refers to the simultaneous clearing of markets at a given set of prices. And an applied general equilibrium is "*the numerical implementation of general equilibrium models calibrated to data*" (Kehoe and Prescott,

[110] Some have tried to establish a link between applied CGE modelling with these criteria to the theory of monopolist competition of Dixit and Stiglitz (1977) and to new trade theory by Helpman and Krugman (1985).

1995: 1). It is a computerized representation of an economy or a group of economies with economic agents – such as households, companies and governments – making transactions that are expressed in behavioural equations in the general equilibrium model.

Most studies to date elaborate the general equilibrium structure developed by Scarf (1967, 1973). Presentation of computation of a simple model with two-person trade general equilibrium model is nicely elaborated in Shoven and Whalley (1992) who also present with the proof of existence for this simple model. Theoretical background for more complex models are also explained there, as well as in Willenbockel (1994), Starr (2011), Burfisher (2011) and the like. The model developed in this dissertation also follows the standard model from Scarf but with more complicated features to adopt to features of the Turkish power sector and macro-economic structure.

Looking at Turkey, Dervis and Robinson (1978) have developed one of the earliest CGE models on the Turkish economy to study the effects of the 1977 crisis on the Turkish economy. This model is also elaborated in Dervis, de Melo and Robinson (1989) where authors also examine the impact of various policies on economic growth through a 19-sector computable general equilibrium model on an open economy. They individually quantify effects of inflation, increase in world oil prices, low remittances, and high export prices of OECD countries on the Turkish economy.

Other models have followed on Turkish economy with a main focus on trade and taxation– including environmental taxation (see for example Arikan and Kumbaroglu, 2001; Kumbaroglu, 2003), while to my best knowledge, Madlener, Kumbaroglu and Ediger (2004) are the first to apply a CGE model with a focus on Turkish electricity sector. The authors examine how energy conversion technology adoption under uncertainty has performed from an environmental and an investor's point of view to find out that gas-fired power generation technologies whose adoption increased significantly at the time while positively contributing to environmental sustainability do not carry as clear merits from an investor's perspective.

The following section presents a summary of literature on energy-related CGE applications – including studies with a focus on Turkey. The detailed structure of the CGE model employed in this dissertation is presented in the rest of the chapter.

5.1 Literature Review

Taxation and trade policy were the initial focus of applied CGE modelling, but as the approach became more popular given its advantages to empirical or simpler models of inter-sectoral analysis such as input-output or social accounting matrix models, it started being implemented in function of examining policy impact of a number of other fields, including environment, energy, research and development and the like.

CGE modelling is a powerful tool to examine the impact of energy market reform which had re-gained momentum in the 1980s. This is because energy is a vital input for both production and household consumption and is a well-integrated sector in the economy with strong forward and backward linkages. These and complexity of factors that might affect major moves in energy market make CGE analysis a useful tool to examine the impact new energy policies might have on the economy as a whole, sectors separately as well as economic welfare of agents, including governments, firms, households and/or the rest of the world.

Table 5.1exhibits a summary of CGE studies with a focus on energy market policy and reform. As can be seen, early CGE studies on energy marketsare relatively recent.

In their comprehensive 1999 study, Chisari and Estache analyse macroeconomic and distributional impacts of privatization in Argentina's network industries – including electricity, gas, water and sanitation, and telecommunications services. Authors calibrate a CGE model using 1993 – when most privatizations took place – as the base year. They employ three factors of production: labour, physical capital and financial capital and divide household into five categories according to their income level which enables to capture the impact of privatization in distribution of income.

Simulations here are defined based on changes undergone by these utilities between 1993 and 1995 through a set of indicators, namely: efficiency gains, measured as reduction in intermediate inputs purchases as a share of total sales; labour productivity gains, measured as sectors-of-interest output per staff; changes in investment, measured as concession contracts for gas and actual accrued investment for other sectors; changes in quality, measured as reductions in losses for power and gas, unaccounted water for water, and the ratio of lines in repair to lines in service for the phones; and lastly, changes in real average tariffs, defined as total sales value divided by total output.

The authors use closure rules in the model to simulate for efficient vs. inefficient regulation. First, they assume prices adjust freely throughout the economy when a shock is given which implies regulation is effective as private companies that took over the utilities are unable to create monopolistic rents given they are price-takers in the market. Alternatively, a closure in the model where prices of privatized utilities are assumed exogenous. Thus, if operating costs are reduced by companies due to say, efficiency gains, this cannot be translated into higher quantities of output – as would be the case in a competitive market – owing to regulated prices, so such firms can capture a monopoly rent instead.

Table 5.1 Major policy findings from energy CGE models

Model	Focus, policy intervention	Model and data used	Policy conclusions
Chisari et. al. (1999)	Impact of privatization of utilities and efficiency of regulator in Argentina.	Static CGE model, 1993 base year. 21 sectors, 3 factors of production, 5 household income groups.	Efficient regulation key for resource allocation and income distribution and benefits poorer groups more in relative terms compared to inefficient regulation.
Coupal and Holland (2002)	Impact of power deregulation in Washington.		
Kumbaroglu (2003)	Impact of environmental taxation in Turkey.	Seven sectors, structurally similar to Gouldler energy-economy 1994 model. Tax revenues are used in public consumption.	Economy also benefits apart from emission reduction from environmental taxation if imported fuels are the main source of pollution.
Riipinen (2003)	Energy liberalization in former Soviet Union (Russia[111]).	Multi-region (10), multi-country (10) model, GTAP database version 5. Two scenarios: elimination of all taxes and subsidies; and increase of export capacities of oil and gas to the EU, accession countries and Finland[112].	FSU loses from internal liberalization of energy markets due to worsening terms of trade, while EU and Finland are the main beneficiaries. While a rise in export capacity for oil and gas benefits all countries including FSU.
Kerkela (2004)	Distortions in Russian energy markets and impact of price liberalization.	Multi-region model using GTAP database 5.4. With 15 commodities and 7 country groups.	Subsidies in energy commodities, cost an equivalent of 6.2% of the GDP, with more than half the effect originating from gas. Regulated power and gas tariff hikes have a

[111] The author notes that in practice, FSU (Former Soviet Union) refers to Russia.
[112] Accession countries are the eight EU member countries that joined the union in 2004. Finland is taken as a separate region in the model – although it was an EU member country since 1995 as the country's energy sector is more connected with Russia owing to its geographical proximity.

			modest but positive effect in GDP and redirect sales from domestic markets to exports.
Madlener, Kumbaroglu and Ediger (2004)	Energy conversion technology adoption under uncertainty in Turkey.	Dynamic technology adoption model to evaluate irreversible investment options in power supply sector.	Gas technologies contribute positively to environmental sustainability but their impact on investment environment is not as clear.
Hosoe (2006)	Impact of deregulation – removal of rate-of-return regulation – in the Japanese power sector on the economy.	A static one-country CGE model with 20 production sectors, one representative household and one government. 1997 is taken as base year, but input-output data of 1995 are used[113].	Removal of ROR regulation leads to improved total factor productivity, stronger power consumption and welfare improvements (e.g. rise in Hicksian equivalent variations as high as 0.12% of the GDP when ROR removed for industrial and commercial users).
Kuster, Ellersdorfer and Fahl (2007)	Energy policies considering labour market imperfections and technology specifications.		
Aydin 2010	Expansion of hydro power share in generation mix in Turkey.	TurGEM-D, dynamic CGE based on ORANI-INT[114]. Electricity generation disaggregated in fossil-fuel and hydro power generation; 8 sectors (+1 from further disaggregation of electricity). Uses 2004 data for input-output and other macro variables.	Annual growth rate of real GDP, real consumption and real investment are 0.14%, 0.13% and 0.07% respectively. Biggest winner from expanding hydro are energy-intensive sectors. Carbon emissions fall by 0.012% per annum.

[113] Author assumes no major changes have occurred in the 1995-1997 period.
[114] This model was developed by Malakellis (2000).

Lu, Zhang and He (2010)	Impact of energy investment on economic growth and emissions in Shaanxi province of China.		
Akkemik and Oguz (2011)	Rate on return regulation is removed to promote fully competitive prices in Turkey.	Static CGE. 19 sectors of which 6 energy sectors – of the latter, 3 are electricity sectors. Uses 2002 input-output data.	GDP increases by 0.53%, utility – measured using Hicsian equivalent variations method – by 1.08%. Energy prices fall, efficiency gains in generation and distribution rise by 5.4% and 7.2%, inefficiency prevails in transmission.
PwC (2011)[115]	Shocks: to Turkish energy sector on prices and quantities and on higher generation capacity. A 20% fall in natural gas costs is assumed.	Static CGE using the multiregional Global Trade Analysis Project (GTAP). 10 sectors including energy and 12 regions including Turkey.	GDP rise by 2.6% from a fall in gas prices due to liberalization, compared to pre-liberalization scenario. Higher employment, imports, lower exports.
Chen and He (2013)	Impact of deregulation of power generation and retail sectors.	Static CGE. Two subsectors for electricity industry: generation and T&D (transmission and distribution); 14-sector model, 2007 as base year.	Deregulation improves efficiency in power generation, increases employment and enhances household welfare.
Lin and Ouyang (2014)	Impact of fossil-fuel subsidies in China.		

Their major findings suggest that effective regulation is crucial for both resource allocation and income distribution. If regulator is efficient and efficiency and quality

[115] There is no published work of this model, which was commissioned by Turkey's Energy Traders' Association (ETD). Details on the study presented here were provided to the author in hard copy by the ETD.

gains are passed from industry to final consumers, almost all sectors in the economy – except agriculture, fishing and forestry – and all income groups benefit from privatization. While in the case of ineffective regulation, more sectors will lose – agriculture, forestry and fisheries, lumber and wood manufacturing, transport material and equipment, and financial services, insurance and enterprise services – and all sectors except for construction will benefit less than compared to the case with an efficient regulator when prices for services of privatized utilities are exogenous. Also, the poorest households tend to gain more in relative terms from privatization than richest ones under efficient regulation.

Authors estimate that gains from effective regulation can save the economy about 0.35% of the country's GDP, in addition to gains from privatization estimated for the 1993-1995 period worth 0.9% of Argentina's GDP. They calculate ineffective regulation impact is equivalent to a 16% implicit tax on average consumer paid directly to private owners of utilities.

Although with a focus on environmental taxes, Kumbaroglu (2003) study is one of the first works involving energy-related analysis while applying a CGE model on Turkish economy. He employs an environment-energy-economy[116]dynamic CGE model whose structure is similar to Goulder's (1994, cited in Kumbaroglu, 2003) energy-economy model. The economy is organized in seven different sectors of which three are energy related, namely, electricity, oil and gas and solids. 1991 is taken as base year and

[116] Author uses acronym ENVEEM for the model.

simulations on five different environmental tax scenarios are made for four 10-year periods enabling to examine impact of such a policy on the economy as far as for 2030.

Kumbaroglu calculates that imposing emission taxation, substituting oil and gas instead of hard coal and lignite to reduce pollutant emissions and reducing energy imports could save the economy a 6% loss in GDP had these policies not been applied.

Riipinen (2003) examines the impact of energy markets liberalization in the former Soviet Union countries using a multi-regional model that employs the GTAP database. Reforms are assumed to take place in 2005, so the global economic setting of 1997 set in the GTAP database has been adopted to 2005 for creating scenarios.

In the first scenario, the author assumes internal energy market liberalization by removing all taxes and subsidies for activities in the five energy-related sectors. Simulation results suggest that the EU and Finland are the main beneficiaries of "total" liberalization of the energy market, while the change in Russia's welfare - somewhat counterintuitively – is negative. The reason lies in the deterioration in Russia's terms of trade as the export to import price ratio falls substantially after reform.

Riipinen's other simulation focuses on the increase of export capacity of either just oil or both oil and gas sectors by 20% and 40%, introduced in the model through imports-augmenting technical change for the industries. It reveals stronger welfare improvements and Russia turns out to be a net benefitting party too, due to improvements in the terms of trade.

Two main problems with Riipinen's work are lack of flexibility of the model given the general framework of the GTAP model – hence an economic setting characteristic to Russia is lacking; and limitation in the number of tools used in simulations – with abortion of taxes/subsidies being the main major tool for analysis in the model.

Kerkela (2004) also focuses on Russia, examining the impact of prices liberalization reforms in energy sectors on the economy put in a global context.

Kerkela first simulates the economy to examine the impact of a removal of all taxes and subsidies on energy sectors which leads to changes in production and trading partners. Results show that taxes and subsidies at the time cost Russian economy 6.2% of the GDP. Elimination in gas subsidies counts for over half of the improvement in GDP. And removal of export taxes would lead to higher oil and gas transit trade through Baltic countries.

Secondly, Kerkela examines the likely impact price liberalization reform has on Russian economy. The author estimates a 75% subsidy to domestic gas prices, based on the fact that domestic consumers pay one fourth of international gas price levels at the time of the study. This subsidy is valid for both gas and gas distribution sectors. Also, power prices for industrial and commercial users are found to be 1.8 times higher than those charged on residential consumers, and the author calculates a 56% subsidy to residential power users after assuming prices for industrial consumers are at market levels. Differently from power and gas, domestic oil prices are observed at a third of international prices for the commodity given lack of export capacity and limitations to exported amounts by government which are reflected into low local prices owing to oversupply of oil to domestic markets. Given these, the second simulation consists of 10% and 6% hikes for gas and power regulated tariffs respectively, given four different closures of the model. The price hikes have a 0.16% positive effect on GDP and 1.33% on exports while imports fall by 1.06% as they become less affordable. And the extra energy output is directed from domestic markets to exports.

It is key to note that post-reform prices increase in Russia, given that it is the world's second largest producer and exporter of oil after Saudi Arabia and the largest producer and exporter of gas globally at the time of the study (Kerkela, 2004). On the contrary, reform in importing countries – like Turkey – would in theory lead to a fall in energy commodity prices in the medium and long run following liberalization reforms.

The following papers will be analysed in more detail given their main focus on power sector reform in a number of countries and as they employ tools other than removal of taxes and subsidies to make simulations.

Hosoe (2006) employs a static CGE model with 20 sectors to analyse policy impact of Japan's reforms of liberalizing the electricity generating segment. He considers substitution between various energy sources, namely, electricity, town gas, petroleum and natural gas, and coal. Notably, energy sources are assumed to be non-substitutable for energy sectors in Hosoe (2006). Three are the sectors representing the electricity industry: generation, transmission and distribution.

The author makes simulations corresponding to two policy scenarios: first, he assumes rate-of-return (ROR) regulation is lifted and beneficiaries of reform are only industrial and commercial users of electricity. In the second simulation, ROR regulation takes place but differently from the first exercise, the scope of reform covers all user groups, including end users or households. Hosoe introduces a markup rate to keep the household charges at the Base Run level in the first simulation.

Results of the first scenario show that removal of ROR regulation for industrial and commercial users lead to a total factor productivity improvement of 3.5% in all power-related sectors while final prices charged on these consumers fall by about 19.3 percent which induces substitution of electricity for other energy sources. Household power consumption will also rise by 1.7%. Consumption for goods and services in all sectors will rise overall due to lower power prices, and this will lead to a welfare improvement calculated as 0.12% of the Japanese GDP. Carbon dioxide emissions also fall by 1.8% of existing quantities after the shock. Similar results are shown by the second policy simulation. Here households increase consumption of electricity by 12 percentage points compared to the first simulation, by14%.

Studies that employ computable equilibrium modelling with a focus on Turkish power sector are limited. Aydin (2010) adopts the dynamic ORANI-INT applied general equilibrium model developed by Malakellis (2000) for the Australian economy, to the Turkish economic structure to examine the impact of an increase in hydropower generation on the Turkish economy.

One adjustment made to the ORANI-INT model here is disaggregation of power generation sector into hydropower and fossil-fired power generation. Author first aggregates 2004 input-output data into seven sectors, namely agriculture, coal, oil, gas, oil products, energy intensive industries, electricity, other industries and services. Finally he disaggregates power sector data into thermal and hydropower generation.

Aydin (2010) unsurprisingly finds out that doubling hydro output – by increasing subsidies in production and investment – has a positive effect on the growth of real GDP, consumption and investment and a diminishing impact on carbon emissions. The author calculates that of the 0.14% increase in real GDP in the final year of simulation (2020) from base scenario, only 0.1 percentage points is absorbed by domestic economic agents, while the remaining 0.04 percentage points is available for foreign absorption. Finally, Aydin suggests environmental tax revenues could be used in developing new technologies to boost renewable share in the generation mix.

One weakness of the model could be the fact that the ORANI-INT model on which Aydin has based his Turkey CGE model, or TURGEM-D, is designed for the Australian economy thus, risks not fitting the Turkish economic structure features properly.

Akkemik and Oguz (2011) find stronger evidence of economic benefits from liberalization in power sector. They employ a static general equilibrium model and remove the regulated rate of return by eliminating the mark-up over marginal costs in electricity sectors, modelled as a mark-up on capital earnings. To my best knowledge, this is the first study to examine full power sector liberalization impacts on the Turkish economy.

A 19-sector model is employed, where three sectors are related to the electricity industry, namely, generation, transmission and distribution. Differently from Hosoe (2006), Akkemik and Oguz (2011) assume increasing returns to scale for all these three sectors. Given this assumption, electricity sectors earn a mark-up over marginal cost and the allowed real rate of return forthe regulated electricity sectors is modelled as a mark-up on capital earnings for the three sectors, as indicated by equation (5.1) below:

$$p_{K_j} K_j = (1 + \gamma_j) \bar{p}_{K_j} \overline{K}_j \quad (5.1)$$

where γ_j is the price mark-up. The terms in bars represent perfect competition.

To test the impact of a full liberalization of the electricity sector, the authors remove the mark-up. The counterfactual simulation results in a rise in GDP by 0.53% from the base, an improvement in overall welfare by 1.08% – measured by using Hicksian equivalent variations method, a 13.5% fall in household energy composite prices which lead to a 17.2% increase in consumption for energy composite. Power generation prices also fall by 3.8% and distribution prices fall by 11.7% – a straightforward outcome of reducing sector profits. Exports will fall due to real appreciation of the exchange rate.

In the labour market, an increased demand for labour due to higher production is translated into wage rises by 0.56% and profit rates decrease by 7.1% for the power generation sector. Overall, the authors conclude that deregulation in the power sector.

It is important to note at this point that end-user power prices of distribution or spin-off retail companies that supply final users continue to be regulated in Turkey, while generation prices are determined by free market conditions after the reform. However, due to the lack of a disaggregation between industrial/commercial and household consumption of electricity, it is quite difficult to limit simulation just for the latter group. An alternative could be removal of the rate of return just for the generation segment. Yet findings by Akkemik and Oguz (2011) suggest important possible outcomes for further reform in the power sector, in which full retail competition is aspired.

A study prepared by Pricewaterhouse Coopers later in the year (PwC, 2011)[117] also analysed energy and natural gas sector liberalization effects on the Turkish energy market, employing a multi-regional multi-sector general equilibrium model using the GTAP[118] database.

Complete liberalization of the energy sector in the model assumes transfer of ownership (privatization) in all power segments excluding transmission, complete market opening – including retail, establishment of an independent energy exchange and a functioning over-the-counter (OTC) market as well as full integration with the European grid association Entso-e. The study uses IMF's World Economic Outlook and Turkish state agencies' forecasts regarding macroeconomic and energy markets developments in

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[117] It was commissioned by the Energy Trading Association of Turkey (ETD) and presented in November 2011, after the Akkemik and Oguz (2011) study was published in April. Main features and conclusions of the study were made available to the author in hard copy by courtesy of ETD.

[118] Version 7.1.

Turkey, used in drafting scenarios. Developments in liquid energy markets, namely Germany, the Netherlands and the UK, are used as benchmark to estimate changes to energy market structure and participants, prices and trading volumes, the need of generation supply capacity, investments in infrastructure and generation capacities as well as governments' revenues.

The findings in PwC (2011) show that an anticipated gas price decrease of 20% following liberalization will lead to a rise by 2.6% in Turkey's GDP in 2019 as compared to the scenario without liberalization. In terms of GDP sources, distribution of such a change is as follows: 3.2% increase in income of households and private companies, 1.9% increase in government revenues and 0.1% increase in depreciations. While on the expenditure sides, private consumption will rise by 2.8%, investments by 4.5%, government expenditures by 3%, exports will fall by 0.2% and imports will rise by 2.2%.

In the labour market, power and gas sector employment is forecast to fall by 14.7% and 8.9% respectively, owing to an increase in labour productivity following international technology transfer assumed to take place after liberalization. While overall labor market estimated effect is a 3.1% increase in skilled and 3.4% increase in unskilled employment. The study finds no significant change in wage levels.

Further on CGE modelling with a focus on power sector reform in other countries, Chen and He (2013) examine reform in China, employing a static 14-sector CGE model.The production structure is almost identical with those presented in Hosoe (2006) and

Akkemik and Oguz (2011). One difference in model specification is the way the authors address consumer utility. They assume households have preferences of the consumption type captured by a linear expenditure system (LES).

They also assume that following removal of the rate on return regulation supply prices will lower and the service quality to consumers will improve. Chen and He (2013) assume only the transmission and distribution sectors can be involved in exporting and importing activities in the electricity industry. All electricity industry sectors are assumed to have increasing returns to scale, and authors follow Akkemik and Oguz (2011) using equation (5.1) above for this purpose.

Authors run two simulations: First, ROR regulation in generation is removed with just industrial consumers that use power as an intermediate input benefitting. In the second simulation all power consumers – including both industrial and household – benefit from deregulation. In the electricity sector, while removal of ROR regulation reduces profitability, real investment increases as overcapitalization of previously regulated companies (the Averch-Johnson effect) vanishes and utilization also increases with better allocation of resources.

Authors find out that real electricity output increases overall following reforms while value-added inputs for generation decrease, supporting theoretical predictions that removal of ROR regulation will have a positive impact on total factor productivity. Findings also show that demand for labour increases in the generation sector – likely to be a result of new entries into the sector post-liberalization whose demand for labour overwhelms the likely unemployment phenomenon in incumbent companies as new competitive pressure pushes the latter to better allocate their resources.

Effects are observed to be worse for the second simulation which includes opening of retail markets, with all power consumers benefitting from reform. This is mostly due to higher expenditures on electricity by households and hence a reduction of consumption of other sectors' goods and services. Authors suggest these results indicate that benefits of deregulation are limited to industrial power users in the early stages of reform.

5.2 An Energy-Focused CGE Model for Turkey

There are a number of novelties brought in this dissertation which are explained in this section. Data related to energy sectors in the SAM are estimated from actual figures available in reports by local authorities or IEA. I also separate between state-run and private sector generation and supply segments, to test how larger participation of the private sector in the electricity industry has affected the economy and what would be the impact of related future policies. These allow for the examination of the impact of various aspects of reform – not seen in previous research – on the economy, such as establishment of a day-ahead market, privatization or larger participation of the private sector and demand management (see chapter 6 for details).

Here, I follow the standard CGE model approaches developed in Scarf (1967, 1973), Dervis, de Melo and Robinson (1989) and in IFPRI (2002) to define how various economic agents interact in the economic framework set in Turkey's SAM for 2010.

The set of simultaneous equations describing this interaction is a combination of simple rules, derived first order conditions of optimization – of, for example, factors of production or consumption – as well as constraints necessary for the system – for instance the balance of payments constraint.

In a simple economic setting, typical households use their income on consumption of goods and services, make savings, provide with factors of production, pay taxes to the government and receive transfers from government or firms. Firms utilize factors of production and intermediate inputs to come up with final output, invest, pay taxes to government and get involved in international trade (in the case of an open economy) through importing and exporting activities. And the typical government will collect taxes – its main source for revenues, consume goods and services, save and invest.

I assume producers maximize their profits subject to the production technology as presented in Figure 5.1. The gross output function is organized in the simplest form as a Leontief production function, with fixed shares of value added and intermediate inputs.

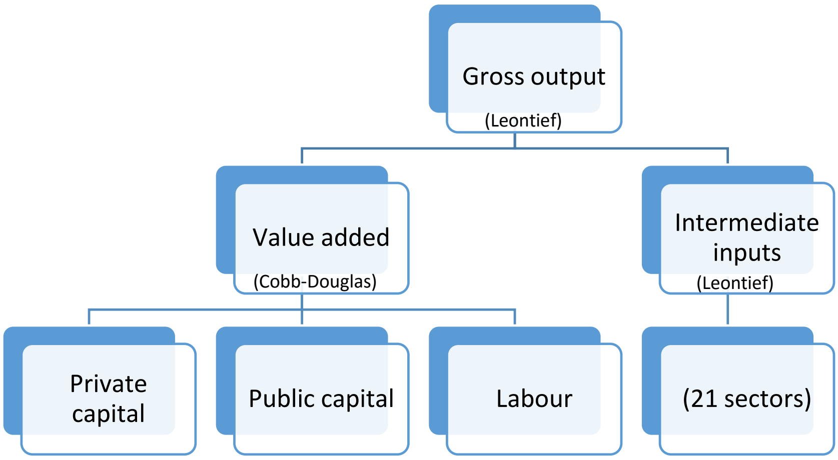

Figure 5.1 Production technology

At one lower level of the production structure, intermediate inputs are also put into the default setting of a Leontief production function, with each activity using fixed shares of intermediate inputs to produce one or more commodities. This is in line with the database (IO tables) structure.

Meanwhile, factors of production are aggregated to produce value added using a Cobb-Douglas production function. This is a simple functional form and it would have been desirable to use a constant elasticity of substitution (CES) production function as an optimal representation of production of value added in the Turkish economy. However, using CES requires knowledge of the elasticity of substitution between factors of production for each sector present in the model for the base year 2010.

Although theoretically it would be possible to distinguish between labour-intensive industries and capital-intensive industries, for which substitution of the dominant factor with the remaining factors would be more inelastic, a true measure of such parameters does not exist. And separation of capital ownership into privately and publicly-owned just adds to the complexity.

The Cobb-Douglas functional form is a simplified CES production function, in which elasticity of substitution is assumed to equal one. Therefore, this is preferred to Leontief function which is based on perfect complementarity of inputs.

Factors of production are used up to the point where their marginal revenue equals their marginal cost – i.e. the marginal capital rent or wage level – hence, the profit-maximization condition is satisfied.

Payments to factors – that is wage for labour and rent for capital – may differ across activities despite mobility of factors, in which case the model has to include such discrepancies that may be caused exogenously due to considerations such as status, health risks, etc. The model developed here also counts for discrepancies of payments to factors among sectors through distortion factors, as will be explained in the labour market section.

The default closure of fixed supply of labour and flexible wages. However, a different closure is assumed for the labour market here. I assume wages and the supply of labour are fixed while a change in demand for labour due to an external shock is met with a change – same in magnitude but opposite in direction – in the number of involuntarily unemployed labour force. This is upon considerations on the Turkish economy conditions with high unemployment levels due to high abundance of labour which among other factors,has resulted in sticky wages. Therefore assuming fixed salaries is more close to the actual labour market setting in Turkey. In capital markets I assume the default closure of fixed quantities of capital and flexible rents.

On the institutions side, there are four institutions represented in the CGE model here: households, enterprises, the government and the rest of the world. Households receive income from factors of production; from firms' transfers – these can be thought as indirect income from factors of production which are first paid to enterprises and then re-transferred to households by companies; transfers from government; and from the rest of the world – in the form of remittances. Households use their income to pay taxes to the government, to make savings and consume the remaining (disposable) income for consumption of commodities and services. Here we assume households consume only traded/sold commodities at consumer prices. While the shares of households' tax payments and savings to their total income are fixed.

Enterprises receive income from remuneration for use of privately and publicly-owned capital – i.e. operating surplus; from the government and from the rest of the world. It is assumed that enterprises do not consume commodities. They spend their income by paying transfers to households; taxes to the government; and by making foreign debt interest payments or direct investments to the rest of the world.

Lastly, the government earns income from tax revenues and outright transfers from the rest of the world and spends on transfers to other institutions and on public-sector savings.

In commodity markets, gross output is sold to domestic markets and the rest of the world with suppliers maximizing sales revenues as domestic sales and exports are assumed to be imperfectly transformable – expressedthrough a constant elasticity of transformation (CET) function. Demand for exports is infinitely elastic, hence world prices for exports are fixed.

Domestic sales are combined with imports through a constant elasticity of substitution (CES) function – also referred to as the Armington[119] function – to create a final composite commodity which is then sold in the domestic market. Similarly, supply for imported goods is perfectly elastic, hence word prices for imported goods are taken as given in the model.

In the final use block, households, government, private and public-sector investors and activities (for intermediate use purposes) buy composite commodities in the market as shown in Figure 5.2.

[119] Armington (1969) was the first to assume imperfect substitutability between domestic sales and imports.

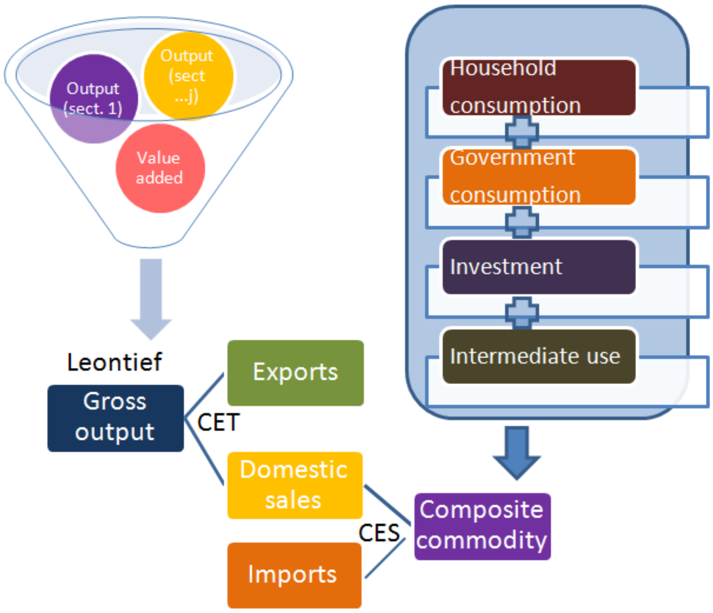

Figure 5.2 Output flows and final demands

Finally, I choose between alternative closures for each market represented in the model. For the government balance, I assume the default closure that government savings are flexible and all tax rates are fixed. Government consumption is kept fixed as a share of gross domestic product. For the balance for the rest of the world account I assume floating foreign exchange rates while foreign savings are fixed. Finally, on the savings-investment balance I assume a savings-driven closure where total investment equals the sum of household, government and foreign savings, which seems the most suitable alternative for Turkish economy.

The mathematical representation of model equations follows. For simplicity, equations are separated into four blocks, namely, prices, production, institutions and system constraint blocks.

5.3 Prices Block

Before displaying the price categories employed, it is important to note that prices in the model are normalized. That is, most of the initial prices are converted into unity. After price normalization, it is possible to read quantities – that is, the rest of the estimated amount for each entry in SAM – as quantity per unit currency[120]. CGE results are more about relative changes – e.g. in percentage change from the base scenario – rather than absolute changes in price or quantity.

5.3.1 Consumer prices

These are prices that consumers pay for the final commodity, which is a composite of domestic and imported goods. Consumer prices do not equal to one initially – given that price of domestic sales are initially normalized, and import prices also equal one (see below). Therefore, by definition the presence of sales tax rate in the left hand side of equation 5.1 implies consumer prices should not equal one.

$$(1 - salestax_i)PC_iCC_i = PD_iDC_i + PM_iM_i \qquad (5.1)$$

[120] In the case of the model employed in this thesis, it can be read as quantity per 1,000 Turkish liras, given the SAM's unit in thousands of liras.

Where

PC_i	Price of composite commodity produced by sector i
CC_i	Composite commodity produced by sector i
PD_i	Price of domestic sales
D_i	Domestic sales
PM_i	Imported goods price
M_i	Imports
$salestax_i$	Sales tax rate. Calibrated from the base data.

5.3.2 Import Prices

These are the prices of imported commodities expressed in local currency units and are normalized for the base data. As Turkey is a "small country" in international trade, I assume world prices for commodities purchased from – and sold to – the rest of the world are fixed while the foreign exchange rate is left floating – as it actually is. The exchange rate is also assumed to be equal to one in the base data, therefore by definition world prices also equal one initially.

$$PM_i = \varepsilon PWM_i \quad (5.2)$$

Where

ε	Nominal exchange rate
PWM_i	World prices of imported goods

5.3.3 Gross Output Prices

These are the final prices of produced commodity *i*, the product of a transformation function of domestic and exported goods.

$$PQ_iQ_i = PD_iD_i + PE_iE_i \quad (5.3)$$

Where

PQ_i	Gross output price
Q_i	Gross output
PE_i	Export price
E_i	Export

5.3.4 Export Price

These are prices for exports by each sector denominated in local currency and are normalized.Given initial foreign exchange rate equals one too in the base data, world export prices will also equal to one. The latter are assumed as exogenous in the model given that Turkey is a "small country" compared to the rest of the world therefore is a price-taker for world prices.

$$PE_i = \varepsilon PWE_i \qquad (5.4)$$

Where

PWE_i	World prices of exported goods

5.3.5 Value Added Price

This equation is one of the first order conditions for the gross output function – with prices for value added given net of production taxes. It expresses how all producer's revenues for activity *i* net of taxes are spent on payments for intermediate inputs (second term on the right hand side of equation 5.5) and for factors of production (right hand side).

$$PVA_j = \left(1 - prodtax_j\right)PQ_j - \sum_i PC_i a_{ij} \qquad (5.5)$$

Where

PVA_j	Price of value added.
$prodtax_j$	Tax rate on production for each activity *j*. Calibrated from the base data.
a_{ij}	Technology coefficient from input-output tables. Calibrated from the base data.

5.3.6 Consumer Price Index

The index is a weighted average of prices for commodity *i* multiplied by respective shares of consumption of each individual sector's (*i*) output to total household consumption. The CPI is fixed to one and is used as *numeraire* for the model, so that all other sets of prices solve relative to the index – i.e. commodity price level.

$$CPI = \sum_i cdshare_i PC_i \qquad (5.6)$$

Where

CPI	Consumer price index
$cdshare_i$	Share of consumption of commodity i in total consumption.Calibrated from the base data.

5.4 Production and Trade Block

5.4.1 Gross Output

The gross output is a nested function with Leontief-type fixed shares for the value added and aggregate intermediate demand for each of the 21 sectors.

$$Q_j = min\left[\frac{VA_j}{\alpha VA_j}, \frac{V_1}{a_{1j}}, \frac{V_2}{a_{2j}}, \dots, \frac{V_i}{a_{ij}}\right] \qquad (5.7)$$

Where

V_{ij}	Intermediate demand of activity j for commodity i. Calibrated from the base data.
a_{ij}	Technical coefficient, the shares of intermediate demand by activity *j* for good *i* to gross output. Calibrated from the base data.
αVA_j	Share of total value added of activity j to gross output. Calibrated from the base data.

Here, an additional assumption is made for power generation, distribution and state-run wholesale segments in the electricity industry which are far from being competitive markets but rather exhibit monopolistic market features in Turkey in the selected base year. Therefore, their costs do not necessarily reflect optimal allocation of resources. This is stated in the model by multiplying the share of value added to gross output for these sectors by (1-χ), where χ indicates the *X-inefficiency* level for each sector and the gross output equation for these sectors (i.e. only for *j*= GENPU, TETAS, EDAS) becomes as follows:

$$Q_j = min\left[\frac{VA_j}{(1-\chi)\alpha VA_j}, \frac{V_1}{a_{1j}}, \frac{V_2}{a_{2j}}, \dots, \frac{V_i}{a_{ij}}\right] \qquad (5.8)^{121}$$

χ is initially assumed at 0.16 following findings in Bagdadioglu, Price and Weyman-Jones (2006). Their findings show that after 82 distribution companies in Turkey merged to 21[122], potential efficiency gains would amount average reduction of inputs by 16 percent[123].

5.4.2 Value Added

I employ Cobb-Douglas production technology for the value added function. The power coefficients are shares of factors endowment in total value added, as calculated from first-order conditions of the profit maximization problem. And the shift parameter is calibrated by the base data of the model.

$$VA_i = \gamma VA_i \prod_f F_{fi}^{\alpha_{fi}} \qquad (5.9)$$

[121] Please note that this equation is made us of in policy simulations, and it does not affect the number of equations vs. the number of endogeneous variables in the model.
[122] There were 82 distribution companies in Turkey before the reform, until they were re-organized into 21 regional distribution companies in 2004 to later be privatized later.
[123] Due to lack of other data or studies available, χ is assumed the same for all state-run segments in electricity, although the Bagdadioglu, Price and Waddams (2006) article refers only to distribution sector.

Where

γVA_i	Shift parameter in value added function for activity i. Calibrated from the base data.
F_{fi}	Factor endowment for activity *i* where sub-index f refers to three categories of production factors, namely:
	KG – state-owned physical capital
	KP – privately-owned physical capital
	L – labour
α_{fi}	Share of factor *f* endowment in total value added for activity i. Calibrated from the base data.

5.4.3 Intermediate Demand

Intermediate demand is modelled in fixed-proportions to thegross output using input-output coefficients calculated from base data in Turkey's SAM for 2010. The functional form implies intermediate inputs for each production activity are perfect complements and any input added not in proportion with the coefficients cannot be used in the production function.

$$V_j = \sum_i a_{ij} Q_j \qquad (5.10)$$

Where

V_j	Total intermediate demand of activity j

Also, it is worth noting here that the right hand-side of the equation can be read as the sum of intermediate demand by activity$i$ for all commodities j so that $V_{ij} = a_{ij}Q_j$.

5.4.4 Factor Demands

Factor demands are derived from first-order conditions of the optimization of value added function[124].

$$PFD_{fi}\overline{PF_f}F_{fi} = \alpha_{fi}PVA_iVA_i \quad (5.11)$$

Where

PFD_{fi}	Distortion factor for the price of production-factor f (rent or wage) used in activity i. This is activity-specific and is kept fixed.[125]
$\overline{PF_f}$	Economy-wide return to factor of production f.

[124] Here I solved the problem of minimization of production factor inputs given the value added.

[125] This is calculated as $PFD_{fi} = \frac{\sum_i PF_{fi}F_{fi}}{FS_f}$ where *FS* is total endowment with factor *f* so that $FS_f = \sum_i F_{fi}$.

The model assumes fixed real wages and labour supply while demand for labour and unemployment levels are endogenized to capture high levels of unemployment, sticky wages and wage differentials among sectors for the Turkish economy. The product of the economy-wide wage and distortion factor for activity i results in the activity-specific wage for that sector PF_{Li}.[126] To keep wages/rents fixed, the economy-wide wage/rent will also be kept exogenous in the model.

5.4.5 Return on Capital for Electricity Sectors

Increasing returns to scale are assumed for power generation and distribution segments in the power industry which exhibit natural monopoly features. These are modelled in equation 5.12[127].

$$PF_{co}F_{co} = (1+\mu)\overline{\overline{PF_{co}F_{co}}} \qquad (5.12)^{128}$$

Where the index *c* refers to capital endowment – for both privately and publicly-owned capital – and index *o* (for $o\epsilon i$ and *o* = GENPU, TETAS, EDAS) refers to electricity sectors. The left-hand side represents monopoly rent and capital endowment while the

[126] See for example Devarajanet. al. (2011) for more on distortion factors. Authors model distortion by specifying fixed ratios of the marginal product of a factor in a sector to the average return of that factor which act as fixed-wage differentials across sectors for labour of the same type.
[127] Please note that the PFco capped with a double-bar in equation 5.12 represents the sector-specific capital rent rather than the economy-wide rent (which was noted with a single bar in equation 5.11). The double-bar notation indicates competitive rents.
[128] Please note that this equation is made us of in policy simulations, and it does not affect the number of equations vs. the number of endogeneous variables in the model.

terms noted with bar on the right-hand side of the equation are perfect-competition rents and capital endowment levels.

This condition is introduced to capture higher monopolistic markups for electricity sectors. Increasing returns to scale benefit producers with prices higher compared to competitive levels. Companies earn a mark-up over marginal costs (non-zero economic profit), expressed as *mu* in this equation. Following Akkemik and Oguz (2011) I assume the mark-up is initially 10 percent.

5.4.6 Output Transformation Function

Suppliers sell their output to domestic markets or export it to the rest of the world. Domestic sales and exports are modelled as imperfect substitutes using a constant elasticity of transformation (CET) function.

$$Q_i = \gamma_i^Q \left[\beta_i^E E_i^{\rho_i^Q} + (1-\beta_i^E) DC_i^{\rho_i^Q}\right]^{\frac{1}{\rho_i^Q}} \qquad (5.13)$$

Where

γ_i^Q	Shift coefficient for the CET function. Calibrated from the base data.
β_i^E	Share of exports in total gross output. Calibrated from the base data.
ρ_i^Q	Elasticity coefficient.

5.4.7 Export-Domestic Supply Ratio

This equation completes the first order conditions for maximization of producers' revenues subject to the CET function. It ensures that producers will be willing to increase domestic sales in the event of a rise in their prices relative to export prices; and similarly will be willing increase exports should their relative price to domestic sales increase.

$$\frac{E_i}{DC_i} = \left(\frac{PE_i}{PD_i} \cdot \frac{1-\beta_i^E}{\beta_i^E}\right)^{\frac{1}{\rho_i^Q - 1}} \qquad (5.14)$$

5.4.8 The Armington Function

The constant elasticity of substitution (CES) function combines domestic sales and imports into a single composite commodity for each sector *i*. Equation 5.15 implies domestic sales and imports are imperfect substitutes as set in Armington (1969) – hence the name of the function.

$$CC_i = \gamma_i^{CC}\left[\beta_i^M M_i^{-\rho_i^{CC}} + (1-\beta_i^M)_i DC_i^{-\rho CC_i}\right]^{-\frac{1}{\rho CC_i}} \qquad (5.15)$$

Where

γ_i^{CC}	Shift coefficient of the CES function. Calibrated from the base data.

β_i^M	Share of imports in total composite commodity. Calibrated from the base data.
ρ_i^{CC}	Elasticity coefficient for the CES function.

5.4.9 Import-Domestic Sales Ratio

This equation also goes in a similar fashion with equation (5.14), it is a first order condition for cost minimization subject to the Armington (CES) function and ensures that in the event of a change in domestic-import price ratio demand will be diverted to the source that becomes cheaper. Therefore, it helps find "optimal" amounts of exports and domestic sales allocated.

$$\frac{M_i}{DC_i} = \left(\frac{PD_i}{PM_i} \cdot \frac{\beta_i^M}{1-\beta_i^M}\right)^{\frac{1}{1+\rho_i^{CC}}} \qquad (5.16)$$

5.5 Institutions Block

Elements of income and expenditure sides for all institutions are presented in this section.

5.5.1 Factor Income

Aggregate factor income is generated by the sum of payments made to factors by each producing activity as shown in equation 5.17.

$$YF_f = \sum_i PFD_{fi}\overline{PF_f}F_{fi} \qquad (5.17)$$

Where

YF_f Aggregate income of factor *f*.

Here both distortion factors and the economy-wide wage are exogenous while factor supply is endogenous.

5.5.2 Aggregate Household Income

Households generate income from a variety of sources. First, they receive payments for their labour – with total wage payments being equal to labour income after tax net of unemployment benefit payments. Also, they receive transfers from firms, which can be thought as indirect payments for offering their labour. Government also makes transfers to households and lastly, workers' remittances from abroad are also a form of income provided by the rest of the world account in foreign exchange and multiplied by the foreign exchange rate to be transformed in Turkish liras.

$$YH = YF_L - UNEMPAY + ETRH + GTRH + \varepsilon ROWTRH \qquad (5.18)$$

Where

YH Household income.

$UNEMPAY$	Unemployment benefit payments.
$ETRH$	Enterprise transfers to household, calculated at a fixed share to firms' income (see below).
$GTRH$	Government transfers to households, at a fixed share to government income (see below).
$ROWTRH$	Transfers from the rest of the world to household, workers' remittances in foreign exchange. This is assumed as fixed.

5.5.3 Unemployment Benefit Payments

Unemployment in the model is expressed in the form of unemployment benefits paid by working labour to the government which in turn transfers them to involuntarily unemployed labour force. These benefit payments are stated in equation 5.19.

$$UNEMPAY = \overline{PF_L}UNEMP \qquad (5.19)$$

Where

$UNEMPAY$	Unemployment benefit payments.
$UNEMP$	Number of involuntarily unemployed people in the labour force.

The initial value of unemployment benefit payments is calculated as the product of the number of involuntary unemployed people and the minimum wage for 2010. However, here unemployment benefit payments are modelled differently in order to make a linkage to the current setting. Linking these payments to the labour supply function gives the possibility of substitution between employment and unemployment.

5.5.4 Household Expenditures

Households use their income to pay taxes, save and spend the rest of their disposable income for private consumption of goods and services.

$$EH = CP + TRH \qquad (5.20)$$

Where

EH	Household expenditures.
CP	Aggregate private consumption. Households spend all their disposable income for purchasing goods and services (see equation below).

TRH	Household's total direct (income and property) tax payments to government. This is kept at a fixed rate to aggregate household income (see "*income tax revenues*" section).

5.5.5 Aggregate Private Consumption

Households spend their disposable income – aggregate income minus tax payments and savings – for private consumption of goods and services[129].

$$CP = (1 - mps)(1 - incometax)YH \quad (5.21)$$

Where

CP	Total household consumption expenditures.
mps	Marginal propensity to save, defined as a ratio of private savings plus private savings-investment gap (PSIG, see below) to disposable income (net of taxes) in the model. Calibrated from the base data.

[129] Of the non-governmental instutitons only households and the rest of the world consume in the model – the first through private consumption and the latter through exports – while enterprises do not have a share in total private consumption.

$incometax$	Total household income tax payments to total household income YH. Calibrated from the base data.

5.5.6 Private Consumption by Sector

Households distribute their consumption through sectors at fixed shares for each good/service n total consumption as displayed in equation 5.22. These shares are also used in the calculation of consumer price index as presented earlier.

$$PC_i CP_i = cdshare_i CP \tag{5.22}$$

Where

CP_i	Private consumption of commodity *i*
$cdshare_i$	Share of private-sector consumption of commodity *i* in total private consumption. Calibrated from the base data.

5.5.7 Private Savings

Private savings, including private-savings investment gap are shown at a fixed share of household income net of household direct tax payments – the share referred to as the marginal propensity to save.

The private-savings investment gap is the amount necessary to finance the country's overall investments after it is accounted for private, public and foreign savings (this definition refers to the closure of the savings-investment block, see below). In the model it is made part of calculations in the marginal propensity to save which due to its negative sign can be interpreted the amount of private savings which is met by the government[130] and hence can be further spent on consumption of goods and services by households.

$$SP + PSIG = mps(1 - inctax)YH \qquad (5.23)$$

Where

SP	Private savings.
$PSIG$	Private savings-investment gap.

5.5.8 Corporate Income

Income to firms is provided by total operating surplus – net of corporate taxes, government transfers to firms in the form of production subsidies and interest payments to domestic debt, foreign exchange income from the rest of the world.

$$YE = (1 - corptax)\sum YF_c + GTRE + DDGPAY + \varepsilon ROWTRE$$

(5.24)

[130] This can be thought as a transfer by the government to household savings. Therefore households are enabled to spend the same amount on private consumption.

Where

YE	Firms' income.
$corptax$	Share of corporate tax payments to total operating surplus. Calibrated from the base data.
$GTRE$	Government transfers to firms, calculated at a fixed share to government income (see below).
$ROWTRE$	Transfers from the rest of the world to firms in foreign currency unit, assumed exogenous.
$DDGPAY$	Domestic debt payments by the public sector, assumed as fixed.

5.5.9 Firms Transfers to Households

Enterprises use their income to make transfers to households, pay corporate taxes, to pay for net publicly-owned factor income, to make interest payments for external debt as well as for making direct investments abroad. Firms' transfers to households are found as a residual, by subtracting from their aggregate income corporate tax payments, net public factor income,

$$ETRH = YE - FDPPAY - ETRROW \quad (5.25)$$

Where

$ETRH$	Firms' transfers to households.
$FDPPAY$	Total foreign debt interest payments to the rest of the world by private sector. This is an exogenous variable.
$ETRROW$	Net profit transfers to the rest of the world.

5.5.10 Firms Transfer to Rest of the World

Similarly, net profit transfers by enterprises to the rest of the world are expressed at a fixed share to firms' income net of direct corporate tax.

$$ETRROW = etrrowshare\ YE \quad (5.26)$$

Where

$etrrowshare$	Share of firms' net profit transfers to the rest of the world in their total income. Calibrated from the base data.

5.5.11 Government Income

The government earns its income from tax revenues, unemployment benefit payments made by labour and net outright transfers from the rest of the world which is multiplied to the exchange rate to be expressed in local currency.

$$YG = \sum_i prodtax_i PQ_i Q_i + \sum_i salestax_i PC_i CC_i + +UNEMPPAY + TRE + TRH + \varepsilon NOT$$

(5.27)

Where

YG	Government income.
TRE	Corporate tax revenues.
TRH	Income tax revenues (household income).
NOT	Net outright transfers, exogenous.

5.5.12 Corporate Tax Revenues

Corporate tax revenues are modelled at a fixed share to total operating surplus.

$$TRE = corptax \sum_c YF_c \quad (5.28)$$

Where

$corptax$	Share of corporate tax payments to total operating surplus. Calibrated from the base data.

5.5.13 Income Tax Revenues

Income tax revenues are shown at a fixed share to aggregate household income.

$$TRH = incometax * YH \quad (5.29)$$

Where

$incometax$	Share of income tax revenues to total household income. Calibrated from the base data.

5.5.14 Government Transfers to Firms

Transfers of government to firms in the form of production subsidies are shown at a fixed share of aggregate government income.

$$GTRE = gtreshare * YG \quad (5.30)$$

Where

$gtreshare$	Share of state transfers to enterprises in total government revenues. Calibrated from the base data.

5.5.15 Government Transfers to Households

Similarly, government transfers to households are also shown at a fixed share to government income.

$$GTRH = gtrhshare * YG \tag{5.31}$$

Where

$gtrhshare$	Share of state transfers to household in total government revenues. Calibrated from the base data.

5.5.16 Aggregate Government Consumption

I assume aggregate government consumption as a fixed share to gross domestic product rather than to the government income, in line with the argument made in Erten (2009) that the government will have to consume most goods and services regardless of changes in its income.

$$CG = congshareGDP \tag{5.32}$$

Where

CG	Total government consumption expenditures.
$congshare$	Share of government expenditures to gross domestic product. Calibrated from the base data.
GDP	Gross domestic product as defined below.

5.5.17 Government Consumption by Sector

Government's consumption of goods and services produced by each activity *i* is kept at a fixed share to the aggregate government consumption.

$$PC_iCG_i = cgshare_iCG \qquad (5.33)$$

Where

CG_i	Government consumption of commodity *i*
$cgshare_i$	Share of public-sector consumption of commodity *i* in total government consumption. Calibrated from the base data.

5.5.18 Private Investment by Activity

Private investment demand by each activity is shown at a fixed share to total private investment as expressed in equation 5.34.

$$ID_i = idshare_i \frac{IP}{PC_i} \tag{5.34}$$

Where

ID_i	Private investment demand for activity *i*.
IP	Aggregate investment demand by private sector.
$idshare_i$	The share of private investment demand for activity *i* in total private investment. Calibrated from the base data.

5.5.19 Government investment demand

Aggregate investment demand by the government is expressed at a fixed share to the gross domestic product.

$$IG = igshareGDP \tag{5.35}$$

Where

IG	Aggregate public-sector investment demand.
$igshare$	Share of total public investment in gross domestic product. Calibrated from the base data.

5.5.20 Public Investment Demand by Activity

Public investment demand for each activity is modelled at a fixed share to the total government investments as shown in equation 5.36.

$$GID_i = gidshare_i \frac{IG}{PC_i} \quad (5.36)$$

Where

GID_i	Public-sector investment demand by activity *i*.
$gidshare_i$	Share of public investment by *i* in total public investment. Calibrated from the base data.

5.6 System Constrains Block

5.6.1 Labour Endowment

The default closure for labour market would be to keep labour supply fixed and allow economy-wide wage to be endogenous so that it adjusts to shocks. Here, I have chosen to introduce unemployment to the model so that any change in labour demand will be met by a change – same in magnitude but opposite in direction – in the number of involuntarily unemployed while labour supply and wages are kept fixed[131]. Figure 5.3 illustrates the case when labour demand increases and unemployment adjusts by falling while economy-wide wage ($\overline{w}$) and labour supply (L^s) are kept unchanged.

[131] These assumptions are counterintuitive to economic theory but are the result of the way how unemployment is defined in the model. These are valid for shorter-term equilibrium analysis as in this CGE model.

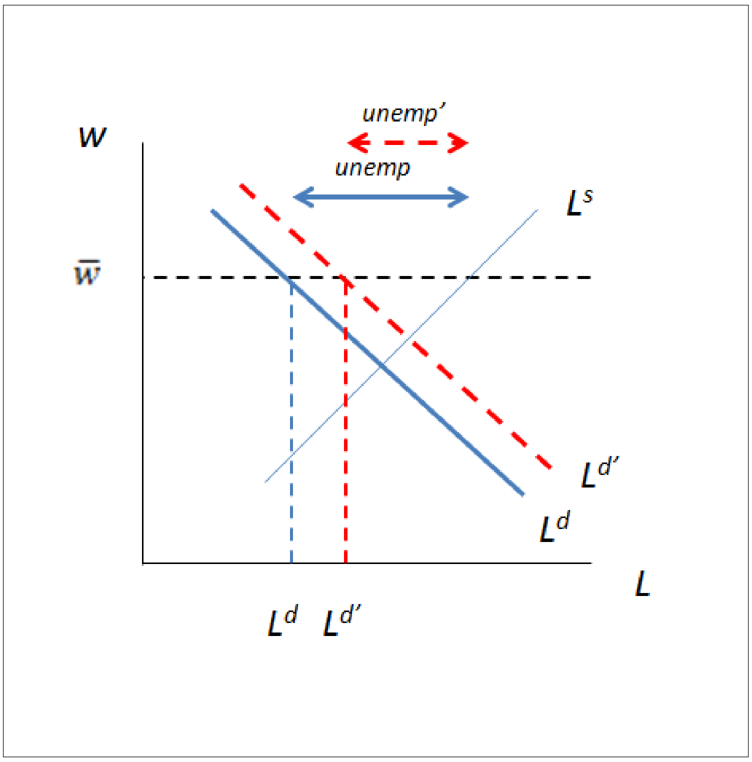

Figure 5.3 Labour market with unemployment

This choice is made in line with high unemployment rates in Turkey and sticky wages (at least for the short run, which is in line with the static CGE model here) in Turkey. Labour supply is modelled as shown in equation 5.37.

$$FS_L = \sum_i F_{Li} + UNEMP \qquad (5.37)$$

Where

FS_L	Labour supply

$UNEMP$	Unemployed labour

5.6.2 Capital Market

The default closure is chosen for publicly and privately-owned capital markets with supply fixed and rents modelled as endogenous to adjust to shocks. Capital supply is expressed in equation 5.38.

$$FS_c = \sum_i F_{ci} \qquad (5.38)$$

Where

FS_c	Capital endowment, with index c referring to both KP and KG, namely privately and publicly owned capital.
F_{ci}	Physical capital used by activity *i*.

5.6.3 Composite Commodity Markets

The composite commodity from the combination of domestic sales and imports as imperfect substitutes through a CES function – the Armington function – should equal intermediate and final demands as expressed in equation 5.39.

$$CC_i = V_i + CD_i + CG_i + ID_i + GID_i \qquad (5.39)$$

5.6.4 Government Balance

Government account's balance is expressed through the way how government savings is modelled as a residual between aggregate government income and government expenditures.

$$SG = YG - CG - GTRE - GTRH - DDGPAY - FDGPAY \qquad (5.40)$$

Where

$DDGPAY$	Domestic debt interest payment by government. Assumed exogenous.
$FDGPAY$	Foreign debt interest payment by government. Assumed exogenous.

5.6.5 Household Balance

Households use their income to pay taxes, make savings and consume. This equality is imposed in equation 5.41.

$$YH = EH + SP + PSIG \qquad (5.41)$$

5.6.6 Gross Domestic Product

By definition, gross domestic product equals aggregate private and public sector consumption and investments, plus aggregate exports minus total imports. The identity is shown in equation 5.42.

$$GDP = \sum_i PC_i(CP_i + CG_i + ID_i + GID_i) + \sum_i PE_iE_i - \sum_i PM_iM_i \quad (5.42)$$

5.6.7 Balance of Payments

Foreign exchange payments to the rest of the world equal transfers of foreign exchange from the rest of the world to various domestic institutions. The balance of payments is imposed in equation 5.43 below.

$$\frac{FDPPAY + FDGPAY}{\varepsilon} + \sum_i PWM_iM_i = ROWTRE + ROWTRH + NOT + SF + \sum_i PWE_iE_i \quad (5.43)$$

5.6.8 Savings – Investment Balance

Lastly, I present the model's savings-investment closure which states that total savings equal total investments. I assume that private savings equal private investments as displayed in equation 5.44.

$$SP = IP \quad (5.44)$$

And as noted earlier, the private savings-investment gap (PSIG) is the amount needed to afford total investments in the economy once public sector, private sector and foreign savings are counted for. Given the assumption in 5.44, private savings-investment gap equals the difference between government investment and public and foreign savings as shown in 5.45.

$$PSIG = IG - SG - \varepsilon SF \qquad (5.45)$$

The model is set so that savings equal investments and the difference between the two is minimized.

One last word on calibration of parameters: calibration of tax rates, shares of certain variables to others (as mentioned in equations presented in this chapter), shift parameters – for the value added, CET and Armington functions and input-output coefficients are calibrated from the base data. Whereas selection of coefficient of elasticities for CET and Armington functions is made based on choices presented in Erten (2009) and are presented in Table 5.2.

Table 5.2 Elasticities and respective parameters used in the model

	Elasticity parameter (ρ)	**Elasticity (θ)**
CET function	1.25	-4
Armington (CES) function	-0.67	3

Given the considerable increase in trade volumes since liberalization policies were in place in Turkey in 1990s, elasticity of transformation between domestic sales and exports as well as elasticity of substitution between domestic sales and imports are both assumed to be high, as will be noted by their respective values in table 5.2.

Sensitivity analysis was run on elasticity parameters, changing the CET and CES to -2 and 2 respectively from their values presented in table 5.2. Results are reported in Annex 4. The results seem fairly insensitive to the selection of elasticity parameters. It is possible, however, to assign different estimates of parameters using alternative methods such as time series econometric regression analysis. It is my expectation that the results presented here change only marginally and the qualitative findings remain unchanged.

I follow with the last chapter on policy simulation outcomes and conclusions.

CHAPTER 6

RESULTS FROM SIMULATIONS

The impact of various policy shocks that simulate reform in Turkey's power sector on the economy, within the power sector, and on other industries will be presented in this chapter. Concluding remarks will follow.

Simulations are organized into two groups: First, actual or potential changes within power market as a result of reform are simulated. Then, a number of macro-economic shocks are given to the model to analyze their impact on the power sector.

6.1 Market Liberalization

As one of the pillars of textbook reform, market liberalization is also a major objective in Turkey's 2001 energy market law. On theoretical grounds, market liberalization shall lead to less monopoly power to incumbent companies in network industries – including electricity – and encourage competition, which in turn results in higher efficiency gains and better services provided to end users.

In Chapter 2, I mention how liberalization differs from unbundling. Liberalization does not affect the structure of the incumbent, but rather, the latter is just required to allow third party access to infrastructure. The policy shock to mimic liberalization is given through a reduction in monopolistic rent of capital owned by state-run power companies – namely, EUAS, TETAS and EDAS – by eliminating the monopoly mark-up (μ) of these companies as explained by equation 5.12 in the previous chapter. Removal of monopolistic rent from EDAS is also tested separately.

Simulation results suggest that simultaneous removal of monopolistic rent from the state-run electricity companies has a positive impact on the economy. GDP performs 0.35% higher when μ=10% is removed for all state-run power companies, compared to its baseline. The direction of change from base is in line with findings in Akkemik and Oguz (2011), while magnitude of the impact varies – it is 0.8% of GDP in Akkemik and Oguz. This is likely due to different base years from their study from the base year selected here.

The GDP deviates below its base level when μ is removed for just one or two state-run power companies at a time. Removal of the monopoly mark-up on prices for just the distribution segment (EDAS) leads to a negative deviation of GDP by 0.38% from its baseline. Similarly, GDP deviates by 0.16% from its base level when μ is removed for the transmission and generation segments only, as shown in Table 6.1. It is worth noting that its negative deviation is lower as monopoly power is taken off hands of more state-run firms.

The deviation of equivalent variation[132] from its baseline is positive for all scenarios (1.1-1.3) which suggests households will benefit from a reduction in the monopolistic mark-up of power utilities. This result is straightforward, as the reduction in the mark-up has a direct impact on prices, enabling households to purchase the same service for less money.

Table 6.1 Market liberalization: macro-economic impact

	1.1	**1.2**	**1.3**
	Remove *mu*=10% for GENG, TETAS, EDAS	Remove *mu*=10% for GENG, TETAS	Remove *mu*=10% for EDAS
GDP	0.35	(0.16)	(0.38)
Equivalent variation	0.03	0.05	0.10
Government consumption	0.35	(0.16)	(0.38)
Private consumption	0.19	0.29	0.64
Government investment	0.35	(0.16)	(0.38)
Private investment	(2.70)	1.14	(1.98)
Private Savings-Investment Gap	22.15	3.85	15.64
Government savings	1.38	2.20	3.07
Private savings	4.31	1.19	1.65
Unemployment	2.01	3.09	3.71
Exchange rate	(0.01)	1.75	1.76

[132] Please note that equivalent variation here is calculated using only changes in private consumption and shows the welfare effect a certain policy shock has on household consumption.

The government will invest by 0.35% more after the removal of monopoly rent (scenario 1.1) compared to the baseline solution, and the magnitude of impact is the same as with GDP by definition of government consumption as a share to GDP in the model (see Chapter 5). Private consumption rises in almost all market liberalization scenarios compared to base equilibrium, as a strong rise in the private savings-investment gap may have contributed on the upside. Both private-sector and government savings are also boosted with market liberalization.

Table 6.2 Market liberalization: impact on intermediate demand

	1.1	1.2	1.3
	mu reduced by 10% for GENG, TETAS, EDAS	*mu* reduced by 10% for GENG, TETAS	*mu* reduced by 10% for EDAS
AGR	2.14	0.30	0.43
TRAN	(0.19)	0.27	(0.00)
GENG	(0.33)	(0.33)	(0.34)
GENP	(1.38)	0.34	(1.05)
TETAS	(0.37)	(0.37)	(0.32)
PMUM	(0.52)	(0.22)	(0.47)
WHOLE	(0.01)	(0.66)	(0.13)
EDAS	(0.34)	(0.32)	(0.34)
COAL	(0.41)	(0.18)	(0.11)
GASOIL	16.49	26.09	30.92
MET	-	(6.86)	-
CHEM	0.67	(5.46)	(5.61)
MINR	(0.61)	0.13	(0.43)
MACH	(10.01)	(2.62)	(2.54)
MIN	(1.17)	(1.03)	(0.94)
FOOD	10.49	0.47	0.60
PAPR	(0.23)	0.30	(0.20)
CON	(0.80)	0.40	(0.66)
TEXT	(0.15)	0.26	0.14
OIND	(0.00)	(1.12)	(1.12)
SERV	(0.06)	0.25	0.14

On the inter-sectoral impact of the removal of μ, intermediate demand for most sectors is lower[133] in all scenarios compared to the baseline, as shown in Table 6.2. The fall in intermediate demand may suggest there has been an increase in efficiency throughout all sectors following liberalization of the power industry.

Extended results on macro-variables for this and all other simulations are presented in Annex III.

Overall, the results suggest that the removal of the monopoly mark-up has a positive impact on the GDP only if such a change is applied to all the state-run power companies simultaneously.

In Turkey, privatization of distribution companies was completed in 2013, while the state-run utility EUAS still holds the lion's share in installed capacity and generation although it has gradually privatized most of its major thermal power plants. Moreover, the state-run TETAS continues to maintain a dominant position in wholesale power markets to date.

Findings from the first group of simulations suggest that the economy overall will be better off if all electricity sector segments are liberalized simultaneously.

[133] Note for e.g. that intermediate use of GASOIL and CHEM sectors increases for simulations 1.1 and 1.2.

6.2 Privatization, Losses, X-inefficiency

In power market reform, the alternative to liberalization is unbundling, that is, market re-structuring into segments where competition is believed can be promoted – such as generation and supply segments, and the segments that conserve natural monopoly features like distribution and transmission. Reform in 2001 introduced unbundling of then current two power incumbent firms – TEDAS, in charge of distribution and TEAS, in charge of other segments – to unbundle, with the latter being re-structured into three new companies, namely EUAS for generation, TETAS for wholesale trading and transmission monopoly firm TEIAS. Later on, in 2006 TEDAS was also re-organized into 20 regional distribution companies plus one[134], and all state-run distribution firms were included in Turkey's privatization portfolio.

The ultimate objective of restructuring and privatization is to promote competition which in turn will drive firms to become more efficient. In this section, I inject policy shocks that imitate these stages of power market reform to examine their impact.

Separation of generation data into state and privately owned in the SAM will help test the impact of privatization[135]. The shock introduced here is a change in technological (input-output) coefficients for state generation (GENG) and private generation (GENP).

[134] Kctas which had been privately managed since its establishment.

[135] This includes higher private-sector participation both due to transfer of ownership of state-owned utilities to the private sector and new projects developed by the private sector. It is not quite possible to isolate the effect of privatization due to lack of data availability.

Changes in power volumes between 2010-2012[136]presented in Table 6.3 are taken as a reference for the magnitude of the shock.

Data in Table 6.3 show that private generation's intermediate use by all sectors rose by 207.63% during the 2010-2012 period, while generation by the state-owned utility (EUAS) fell by 1.94% for the same period. I mimic the same changes by changing related input-output coefficients for state and private-sector generation accordingly.

[136] Changes over a period of two years are deemed realistic for this static CGE model. Had the model been dynamic, data for later years could have been considered.

Table 6.3 Changes in power market physical volumes between 2010-2012 (100%)[137]

	EUAS	TETAS	PMUM	Autoproducers	Retail (EDAS)	Wholesale (private)	IPP	Exports	Eligible consumers
EUAS	-	(0.13)	0.01	-	-				
TETAS	-	-	(0.60)	0.09	0.04			(0.98)	(0.53)
PMUM	(0.26)	1.56		0.04	0.22	1.63	0.10	-	-
Autoproducers	-	-	0.08		-	1.11	4.24	-	(0.55)
Retail (EDAS)	-	-	0.08		-		-	-	43.67
Wholesale (private)	-	-	2.81		133.02	9.73	1.74	0.10	1.50
IPP	-	-	0.49	(1.00)	(0.39)	1.80	12.35		0.11
BO	-	(0.05)	-	-	-		-	-	-
BOT	-	0.03	-	-	-		-	-	-
TOOR		(0.01)							
Imports	-	(0.66)				18.00	-	-	-

Note: Negative figures noted in brackets. *Source*: TEIAS, EUAS, TETAS, author's calculations.

137 See Table 4.10 for physical volumes in 2010.

Higher share of the private sector and lower state shares in generation leads to a positive deviation of GDP by 0.18% from the baseline (scenario 2.1 in Table 6.4). A larger share of private sector power generation – which partly substitutes for the fall in public sector electricity output – used as an input for the production of commodities, is matched by higher value added.

Investment and state and private consumption also benefit positively in this scenario – particularly the private-sector investment which is 2.38% above its baseline. This has likely contributed in the reduction of private savings-investment gap which deviates 4.33% below its base value. Domestic currency gains value after the shock.

Table 6.4 Privatization, losses, X-inefficiency: macro impact

	2.1	2.2	2.3	2.4
	GENP intermediate good sales up by 107.63%, GENG intermediate good sales down by 1.94%	Technical and theft losses reduced by 33%, EDAS's investment up by 5%	Eliminate *chi* for GENG, TETAS, EDAS	Eliminate *chi* for EDAS
GDP	0.18	0.01	0.00	0.01
Equivalent variation	0.12	0.07	0.07	0.07
Government consumption	0.18	0.01	0.00	0.01
Private consumption	0.76	0.41	0.41	0.41
Government investment	0.18	0.01	0.00	0.01
Private investment	2.38	0.48	0.49	0.48
Private Savings-Investment Gap	(4.33)	(1.03)	(2.57)	-
Government savings	12.28	9.74	1.64	1.63
Private savings	1.65	(0.86)	(0.49)	0.31
Unemployment	4.60	0.73	0.73	0.73
Exchange rate	(3.65)	(0.00)	(0.00)	(0.00)

On the inter-sectoral interaction, the impact of stronger independent private generators' participation and a fall in state-run generation varies among sectors.

The fall in state generation affects intermediate use by state-run wholesale TETAS and the distribution segment (EDAS) negatively compared to the base, which is an expected result due to links these companies have with state generation (GENG). The input-output coefficient corresponding to GENG's power sales to EDAS for intermediate use is 24% and that of GENG's sales to TETAS is 31%. The impact is also negative on intermediate demand by the coal industry which is about 5% lower compared to base. This is also in line with expectations as the technology coefficient corresponding to power sales – as an intermediate input – of GENG to COAL is 11%. The coefficient for intermediate input sales of GENG to GASOIL is 23%, which is reflected into a large impact on GASOIL's intermediate use after the shock.

Among the non-energy sectors, the most hit by the policy shock are chemicals and petrochemicals (CHEM) and paper, wood and printing (PAPR) due to their direct and indirect links to energy sectors.

While it is not quite possible to test the impact of privatization in distribution in the same fashion as with generation due to lack of disaggregated distribution data into state and private sector, it is still possible to test the impact of expected outcomes.

A key expectation from privatization of distribution companies is a reduction in technical and theft losses. Private sector companies have inherited serious levels of theft losses in the electricity distribution segment (see Table 6.6) and will have to increase their operational and investment performance – measured by *OPEX* and *CAPEX* rates[138] respectively and reflected in rate of return regulation – to lower these losses.

Table 6.5 Privatization, losses, X-inefficiency: impact on intermediate use

	2.1	**2.2**	**2.3**	**2.4**
	GENP intermediate good sales up by 107.63%, GENG intermediate good sales down by 1.94%	Technical and theft losses reduced by 33%, EDAS's investments up by 5%	Eliminate *chi* for GENG, TETAS, EDAS	Eliminate *chi* for EDAS
AGR	0.87	0.39	0.38	0.39
TRAN	0.76	0.29	0.29	0.29
GENG	(0.11)	0.09	0.09	0.10
GENP	3.91	0.23	0.24	0.23
TETAS	(0.17)	0.10	0.09	0.10
PMUM	2.41	0.10	0.11	0.10
WHOLE	4.02	(0.13)	(0.13)	(0.13)
EDAS	(0.07)	0.11	0.11	0.11
COAL	(4.74)	0.32	0.32	0.32
GASOIL	36.89	0.20	0.20	0.20
MET	0.22	(0.00)	-	-
CHEM	(13.01)	(0.01)	(0.01)	(0.01)
MINR	(1.12)	0.13	0.13	0.13
MACH	9.21	(10.01)	(10.01)	(10.01)
MIN	(0.99)	(0.54)	(0.54)	(0.54)
FOOD	(6.36)	0.47	0.47	0.47
PAPR	(20.64)	0.30	0.30	0.30
CON	1.09	0.30	0.30	0.30
TEXT	(5.80)	0.28	0.28	0.28
OIND	(0.75)	0.01	0.01	0.01
SERV	0.70	0.28	0.28	0.28

[138] OPEX and CAPEX stand for operating expenses and capital expenses, respectively.

The government has set targets for the reduction of distribution losses for each 5-year period in concessionary contracts signed with private firms and the latter group will be able to keep any profits if improvements exceed these required minimum improvements, but will be kept accountable for losses if minimum requirements on the reduction of losses is not met.

In the model data base, technical and theft losses in the distribution segment are expressed in the form of state subsidies to distribution companies[139]. In simulation 2.2, I inject a shock to mimic a 33% fall in distribution sector losses accompanied by a 5% rise in both public-sector and private-sector investment in the segment. Although marginal in magnitude, the impact turns out positive with GDP deviating by 0.01% above its baseline. Almost all macro-variables are positively affected by the shock as shown in Table 6.4. Notably, the government savings increase by 9.74% owing to the cut to subsidies provided to the distribution segment.

Electricity is a political commodity as much as an economic one (Oguz, Akkemik and Goksel, 2014). Turkish government has financed losses in the power sector through cross-subsidization of costs, as regulated power prices for the final consumer are unique (Turkey has a single national tariff for power) regardless of the level of theft loss rates in various regions. Deviation of the rest of macro-variables for simulation 2.2 are presented in Table 6.4.

[139] As a negative figure added to the total amount of sales tax for the sector.

Table 6.6 Technical and theft loss ratios for distribution regions (%)

Region	2007	2008	2009	2010	2011	2012	2013
Akdeniz	9.72	9.40	9.29	8.30	8.47	9.78	11.32
Akedas	7.95	7.84	8.44	8.17	8.33	7.22	6.70
Aras	29.32	27.16	27.67	25.47	34.02	33.79	27.58
Aydem	7.36	11.92	10.28	8.69	8.41	8.00	7.61
Ayedas	9.14	8.71	7.47	6.92	6.91	6.88	7.59
Baskent	8.63	8.48	8.88	8.55	9.17	8.67	7.90
Bogazici	12.15	10.84	9.56	9.75	10.76	10.24	9.89
Camlibel	8.76	9.21	8.10	7.31	9.20	8.32	7.58
Coruh	11.98	10.63	11.44	11.57	11.24	10.19	9.42
Dicle	64.81	64.54	73.39	65.48	76.55	71.74	75.03
Firat	10.99	10.44	13.61	12.24	11.11	10.85	9.49
Gediz	10.23	7.48	8.89	8.84	8.83	7.81	9.73
Kayseri	11.14	10.27	10.70	8.74	7.12	6.89	6.85
Meram	8.27	8.80	9.01	9.64	8.93	8.98	7.14
Osmangazi	6.26	5.64	6.78	9.11	7.14	7.15	7.86
Sedas	6.53	7.55	8.04	6.41	7.00	7.14	6.64
Toroslar	10.61	9.85	9.84	8.92	13.77	13.22	15.24
Trakya	7.61	7.18	7.11	6.80	8.26	6.46	6.14
Uludag	8.59	7.52	7.30	7.38	8.92	7.32	7.03
Vangolu	56.19	55.91	55.56	57.15	59.05	59.07	65.84
Yesilirmak	9.09	9.24	10.86	12.89	7.80	7.26	10.46

Source: Ministry of Energy[140].

The shock's impact on intermediate use by sectors is overall small in magnitude bu positive with the machinery sector being the only exception with a negative deviation

[140] Table made available on a parliamentary hearing of the ministry of energy. Document available at http://www2.tbmm.gov.tr/d24/7/7-42589c.pdf acessed in December 2015.

by 10.1% from its baseline. This is likely due to the sector's indirect links with the energy sector.

One last aspect of reform examined in this section is the increase in operational efficiency of state-run power companies, tested for all companies simultaneously and just for EDAS individually. Given natural monopoly features for state-run distribution and transmission, their costs do not necessarily reflect optimal allocation of resources. Therefore, an X-inefficiency rate (χ) is attached to the value-added share of state-run power sectors in gross output as expressed in equation 5.8 in the previous chapter. χ is initially assumed at 16% following findings in Bagdadioglu, Price and Weyman-Jones (2006).

The impact of removing χ on GDP is expectedly positive in both scenarios (2.3 and 2.4) although incremental in magnitude (by 0.004% and 0.006% respectively) as shown in table 6.4. Interestingly, GDP deviation from base is higher when X-inefficiencies are reduced just for distribution, rather than when the measure is implemented on all state-run segments simultaneously. This is despite the share of value added to gross output being larger for GENG initially – at 58%, compared to 28% for EDAS and 7% for TETAS. The larger impact on GDP for scenario 2.4 suggests that addressing inefficiency issues in the distribution sector should be of uttermost importance for the economy, given power distribution's strong backward and forward linkages with other sectors.

Households seem to be largest benefiters from improved operational efficiency for state-run electricity utilities, as private consumption is 0.41% above the base for both scenarios. Private investment also stands around 0.5% above its base level. However, the direction of policy impact for each scenario differs for private savings, which turns out below base when x-inefficiency is removed for all state companies but is positive when χ is removed for just EDAS.

Intermediate use of almost all sectors positively deviates from their baseline after the shock as shown in Table 6.5. The trend is similar for composite commodity supplies and domestic sales.

6.3 Establishment of Day-Ahead Market

Establishment of organized power markets which would generate the right signals for the sectors and investors has been a key reform pillar since the new electricity market law was approved in 2001. As explained in previous chapters, it has taken almost one decade before the day-ahead market launched full-scale operations in 2011, following implementation of two temporary periods in 2006-2009 and 2009-2011. In 2010 – the base year for the model – the day-ahead market was in the planning phase with participants already bidding in the market (see Chapter 3 for details).

In the 2010-2012 period, all power market participants except for TETAS increased their sales volumes to the day-ahead market (PMUM). Independent private generators[141]

[141] These include auto-producers.

(IPPs) sales to PMUM rose by 46% to 36,807 GWh in 2012 (see tables 5.10 and 6.3), which counts for 15% of Turkey's total power consumption in 2012. And private wholesale power trading companies' sales to the day-ahead market rose by 281% to 5,091GWh for the same period. EUAS and EDAS sales to PMUM also rose by 8% and 1% respectively.

In the first scenario (3.1), I test the impact that these actual changes in the power market have had on the economy. Input-output coefficients indicating sales of intermediate use to PMUM in SAM are changed accordingly to mimic the transformation in Turkey's power market during the 2010-2012 period.

The GDP turns 0.03% below its base level after policy shock in scenario 3.1 as shown in Table 6.7. Meanwhile, the impact on GDP when sales of private-sector generation and wholesale segments to the day-ahead market rise by four folds is positive, as it deviates by around 0.1% above its baseline. The impact is comparably higher when sales of state-run generation and wholesale trading segments (GENG and TETAS) to PMUM rise by four folds, with GDP turning 0.25% higher compared to the base level.

Interestingly, the impact on GDP is lower – although still positive – when sales of all the four segments representing generation and wholesale trading quadruple their sales to the day-ahead market.

Another interesting outcome is the considerable impact the expansion of the day-ahead market has on private investment which turns more than 20% above base levels for the first two scenarios presented in Table 6.6 when participation of private sector segments to the market rises. Higher participation by state-run generation and wholesale to the market also affect private investments positively, as the latter deviates by more than 6% from its baseline after the shock in simulation 3.3.

Table 6.7 Day-ahead market impact on macroeconomic variables

	3.1	3.2	3.3	3.4
	Changes in sales to PMUM as in 2010-2012	GENP and WHOLE sales to PMUM up by 400%	GENG and TETAS sales to PMUM up 400%	GENP, GENG, WHOLE and TETAS sales to PMUM up 400%
GDP	(0.03)	0.07	0.25	0.14
Equivalent variation	(0.48)	(0.58)	0.03	(0.00)
Government consumption	(0.03)	0.07	0.25	0.14
Private consumption	(2.94)	(3.55)	0.21	(0.03)
Government investment	(0.03)	0.07	0.25	0.14
Private investment	21.36	21.94	6.18	6.38
Private Savings-Investment Gap[142]	(16.52)	(67.07)	(14.97)	(15.98)
Government savings	8.84	8.43	12.00	11.40
Private savings	15.87	1.65	1.65	1.65
Unemployment	8.61	2.11	2.28	4.74
Exchange rate	(1.35)	(3.65)	(2.74)	(2.90)

A number of conclusions can be drawn here. First, higher participation to the day-ahead market increases benefits to the economy. Second, expansion and deepening of organized markets will likely boost savings and investment both for private and public

[142] The impact of policy shock on this variable is in general high in relative terms, due to its small initial value.

sectors. Lastly but importantly, higher participation of state-run segments to organized markets generate larger benefits for GDP compared to privatization (compare simulations 3.3 and 2.1).

Therefore, although existence of state-run electricity companies may last for many years to come – due to security of supply issues or the long-term nature of BO, BOT and TOOR contracts, including those signed for nuclear power supplies[143]; and for other political considerations[144] - this does not necessarily imply they will not improve efficiency by participating more in organized markets.

Results of scenario 3.3 are similar to what happened with UK's state-run nuclear utilities when reform was first introduced in 1989, which could not be privatized due to lack of interest by private investors. Although under continued state ownership, these companies' efficiency increased considerably amid competitive pressure in the years following introduction of reform, which benefitted the sector, power consumers and the economy as a whole (Newbery, 2001).

At the sectoral level, intermediate use as well as supplies of composite commodities for most sectors turn out above respective base values for most sectors after the day-ahead market shock as shown in Tables 6.7 and 6.8.

[143] Sales of power generated in the framework of these contracts are guaranteed by the state through TETAS. Therefore, the company is likely to continue operating for many decades to come.
[144] Like keeping regulated prices unchanged to avoid voters' discontent ahead of elections.

Composite commodity sales grow from baseline for all electricity sectors except for private-sector wholesale trading from a rise in power market activity. Impact is largest for private-sector generation whose sales turn 11.5% above the baseline for simulation 3.1 where actual changes in the sector are simulated.

Table 6.8 Day-ahead market impact on composite commodity supplies (%)

	3.1	3.2	3.3	3.4
	Changes in sales to PMUM as in 2010-2012	GENP and WHOLE sales to PMUM up by 400%	GENG and TETAS sales to PMUM up 400%	GENP, GENG, WHOLE and TETAS sales to PMUM up 400%
AGR	(1.53)	(2.83)	(0.37)	(0.20)
TRAN	1.35	1.21	0.96	0.92
GENG	4.49	2.19	1.52	3.48
GENP	11.53	15.50	3.18	1.17
TETAS	9.05	2.17	15.82	2.12
PMUM	3.44	4.56	1.37	(0.51)
WHOLE	6.96	(1.26)	(0.29)	(10.80)
EDAS	(0.56)	2.15	0.44	0.28
COAL	1.99	1.34	0.17	0.76
GASOIL	2.55	5.93	2.92	2.86
MET	7.49	8.66	2.49	3.27
CHEM	0.19	0.83	(0.18)	(0.53)
MINR	4.46	4.53	1.46	1.55
MACH	0.04	0.02	0.81	1.03
MIN	2.20	3.75	0.45	0.72
FOOD	(1.29)	(2.28)	0.07	0.07
PAPR	0.01	(0.49)	(1.43)	(1.08)
CON	6.67	6.73	2.28	2.27
TEXT	(0.60)	(1.63)	(0.64)	(1.84)
OIND	1.72	1.62	1.15	1.17
SERV	0.15	(0.12)	0.69	0.55

The most notable change in intermediate use from an energy market perspective is the fuel switching between coal and natural gas and oil, with the first using less intermediate inputs compared to the baseline while intermediate use for the GASOIL sector turns substantially above its base value after the shocks. This is due to the strong link the coal industry has with state-run power generation, and similarly, the strong link natural gas sector has with the private-sector generation segment.

Intermediate input for chemicals and petrochemicals deviated negatively by 16% from its baseline for simulation 3.1, despite the rise in the sector's composite commodity sales by 0.19%. This suggests an improved efficiency of the sector following the shock. The large magnitude of the impact on chemicals and petrochemicals is due to its indirect links to the power sector. The input-output coefficient corresponding to the sector's (CHEM) use of gas and oil (GASOIL) is 5%.

On a concluding note for this section, the share of day-ahead market (DAM) volumes to total market volumes in Turkey have constantly and considerably increased since the DAM was fully launched in 2011, taking the place of bilateral agreement volumes. The latter are longer term in nature. Expansion of DAM has had a good impact on the Turkish economy for the 2010-2012 period, as competition pressure forces utilities to increase efficiency and improve their performance.

However, increasing the market focus on shorter-term may not necessarily be good for the sector. Participants tend to avoid long-term commitments due to uncertainties still prevailing in the market. State-run companies have not made their pricing and/or production policies public yet, and regulated domestic power prices continue to be reviewed quarterly while natural gas prices monthly – which makes longer term forecasts for companies and investors more difficult. Adding to these, it is still not clear how will the BOT and TOOR plants be managed once their concessionary contracts with the state expires.

Table 6.9 Day-ahead market impact on intermediate use

	3.1	3.2	3.3	3.4
	Changes in sales to PMUM as in 2010-2012	GENP and WHOLE sales to PMUM up by 400%	GENG and TETAS sales to PMUM up 400%	GENP, GENG, WHOLE and TETAS sales to PMUM up 400%
AGR	(0.42)	(1.88)	0.46	0.94
TRAN	1.36	1.74	1.08	1.45
GENG	4.49	2.19	1.52	3.48
GENP	11.53	15.50	3.18	1.17
TETAS	9.05	2.16	15.82	2.12
PMUM	10.71	11.92	8.50	6.49
WHOLE	6.94	(1.26)	(0.30)	(10.77)
EDAS	(0.56)	2.15	0.44	0.28
COAL	(1.42)	(2.76)	(4.65)	(2.78)
GASOIL	11.09	39.61	28.71	29.14
MET	(0.00)	0.13	0.07	0.10
CHEM	(15.96)	1.37	(7.70)	(13.02)
MINR	2.68	2.45	(0.66)	(0.01)
MACH	(0.53)	6.40	2.63	8.98
MIN	1.43	2.80	(0.64)	(0.05)
FOOD	(2.27)	(9.59)	(6.81)	(3.94)
PAPR	(16.06)	(19.28)	(20.20)	(17.00)
CON	6.67	6.72	2.28	2.27
TEXT	(4.22)	(7.23)	(5.51)	(9.87)
OIND	(1.04)	(0.79)	(0.90)	(0.83)
SERV	0.15	(0.12)	0.69	0.55

The 672MW Birecik dam and hydropower plant is the first BO plant whose contract expires - estimated in October 2016 – but relevant authorities have not announced whether the plant will be transferred to state utility EUAS, will remain with the incumbent private owner or will be taken to the privatization portfolio and be offered for sale.

These constitute barriers to the formation of price signals in the Turkish electricity market, inhibiting bilateral agreements volumes to increase – therefore leaving the market highly exposed to short-term risks – and dampening power industry's investment environment.

6.4 Demand management

Introduction of the concept of eligible consumers – large electricity users that are free to chose their suppliers – has been another key novelty of reform in Turkish power markets. Energy regulator EPDK has regularly cut the minimum power consumption limit for eligible consumers which became 4GWh per annum for 2016 and is set to be totally eliminated in the near future for full retail market opening.

Power sales by private wholesale companies to eligible consumers increased by 150% in the 2010-2012 period to 30.4TWh, which counts for 13% of Turkey's total power consumption in 2012. Similarly, sales of distribution companies to eligible consumers also rose by about 44 times during the same period.

These are reflected in scenarios 4.1 and 4.2 by injecting the shock in the relevant input-output coefficients (see Table 6.9 for results) with the economy becoming worse off compared to base data when changes in private wholesale trading sector are simulated but better off when the shock is given to EDAS. The primary difference among the two is the large magnitude of shock to EDAS (44 times due to a relatively small volume traded originally). When both changes are injected simultaneously (scenario 4.3), the GDP turns 0.16% higher compared to the baseline. However, when an identical shock is injected to both sectors, the economy becomes better off with higher private firms' power sales to eligible consumers. While it stands below its base level when the same shock is injected to the distribution sector.

Table 6.10 Demand management impact on macroeconomic variables

	4.1	4.2	4.3	4.4	4.5	All
	WHOLE sales to eligible consumers up 150%	EDAS sales to elig. cons up 43.7 times	WHOLE sales to elig. cons up 150% EDAS up 43.7 times	WHOLE sales up 24 times	EDAS sales up 24 times	All reform elements combined
GDP	(0.15)	0.21	0.16	0.02	(0.35)	0.20
Equivalent variation	(0.39)	0.19	0.40	(0.49)	(0.04)	0.12
Government consumption	(0.15)	0.21	0.16	0.02	(0.35)	0.20
Private consumption	(2.39)	1.17	2.44	(3.01)	(0.27)	0.76
Government investment	(0.15)	0.21	0.16	0.02	(0.35)	0.20
Private investment	14.55	0.56	(3.53)	21.94	4.74	3.15
Private Savings-Investment Gap	(21.69)	1.45	17.25	(61.77)	(9.31)	(3.84)
Government savings	1.48	12.56	7.87	13.08	16.08	15.23
Private savings	7.45	1.65	1.93	1.65	1.65	1.65
Unemployment	2.98	4.10	1.65	8.41	14.67	5.17
Exchange rate	0.02	(3.65)	(1.46)	(1.36)	(3.20)	(2.43)

On a last note, the combination of all above-mentioned reform elements also generates a positive impact on GDP.

A simultaneous simulation on all reform elements discussed so far – namely, the removal of the 10% monopoly mark-up for all state-run power segments (simulation 1.1), increase in the private sector's share and reduction of the public sector's share in total generation as during the 2010-2012 period (simulation 2.1), a rise by four folds in sales of public and private generation and wholesale sectors to the day-ahead market (simulation 3.4), increase in private wholesale and distribution sales to eligible consumers by 150% and 437% respectively (simulation 4.3), reduction of X-inefficiencies in the distribution segment (simulation 2.4) and the reduction in technical and theft losses combined with a rise in investments (simulation 2.2) – simultaneously, generates a deviation of GDP by 0.20% above its baseline. Detailed impact on macro-variables is shown in the last column on Table 6.7.

6.5 Generation mix

Gas generation has maintained the lion's share in the country's generation mix in the past decade as can be seen from Figure 6.1. However, Turkey is committed to meet objectives set in the 2009 strategy paper on security of supply and aims to more than double current wind and solar installed capacity by 2023.

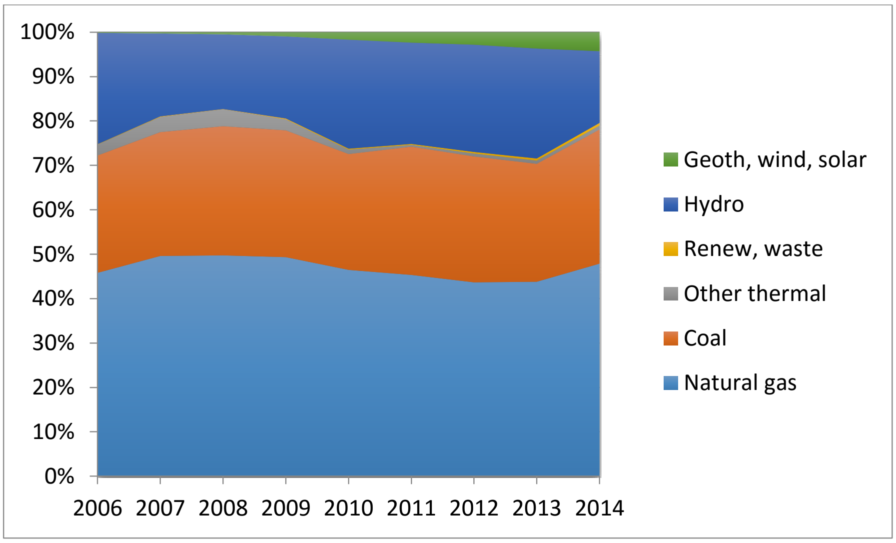

Figure 6.1 Generation mix
Source: TEIAS.

In this section I first simulate changes in generation mix for the 2010-2012 period and then carry a number of other simulations which reflect government objectives for installed capacity development in coming years. Analysis is conducted separately for private-sector and state-run utilities.

Coal and gas-fired generation by IPPs increased by 145% and 29% respectively in the period between 2010 and 2012, while their renewable generation is calculated to have fallen by around 80% for the same period. On the state utilities side, gas and coal fired generation fell by 2.3% and 4.2% respectively, while renewable generation is estimated to have increased by 6% from TEIAS data. All these changes are reflected in scenario 5.1 from table 6.11, with the shock performed by changes in input-output coefficients accordingly.

GDP deviates 0.16% below its base level after the shock. This could be due to lower thermal generation by state utilities. Private consumption also curbs by 5.2% compared to the baseline.

Simulations 5.2 to 5.4 refer only to changes in IPP generation. In scenario 5.2, a 10% reduction in gas and oil fired generation and a rise in renewables by 2 times is simulated while in scenario 5.3, there is a reduction in coal and a rise in renewables by the same amounts. Simulation results show that GDP deviates 0.14% below its base level when gas-fired generation is cut, while it increases by around 0.1% when coal generation is cut. One reason for this is gas sector's stronger ties with generation. As already mentioned before, input-output coefficients corresponding to the GASOIL intermediate use by public and private-sector generation segments are 23% and 42% respectively, compared to 11% and 5% for coal.

When an increase in private renewable generation is simulated in (5.4), the impact on the economy is positive, with GDP 0.1%, private consumption 1% and government savings 0.6% higher compared to respective base values.

The result for the "less coal" scenario (5.3) is somewhat counter-intuitive, given that coal is a cheap input and coal generation is highly profitable even during periods of bearish spot prices. Therefore, increasing coal use is expected to have a positive impact on the economy and decreasing the use of coal for power generation is expected to have a negative effect.

Table 6.11 Macro impact of generation mix changes: private sector

	5.1	5.2	5.3	5.4
	Generation mix changes in 2010-2012	Gas&oil use down 10%, renewb. up by 2 times	Coal use down 10%, renewb. up by 2 times	Renewables gen. up 200%
GDP	(0.16)	(0.14)	0.08	0.09
Equivalent variation	(0.84)	(0.00)	0.16	0.17
Government consumption	(0.16)	(0.14)	0.08	0.09
Private consumption	(5.20)	(0.02)	0.96	1.03
Government investment	(0.16)	(0.14)	0.08	0.09
Private investment	31.92	2.16	(1.83)	(2.12)
Private Savings-Investment Gap	(90.35)	(1.67)	(0.72)	(0.64)
Government savings	(2.03)	0.77	0.67	0.60
Private savings	2.48	0.60	(2.10)	(2.35)
Unemployment	(2.54)	0.55	(2.21)	(2.51)
Exchange rate	1.74	1.75	(0.01)	(0.01)

There are a number of potential reasons for this, including: (i) discrepancies between entries for energy-related and non-energy sectors in the input-output table, as the first are calculated making use of all available actual data whereas the latter are just estimated from the 2002 IO table; (ii) coal prices and conversions into power generation are estimated with the data available and actual values may prove somewhat different; (iii) a separate account for renewables generation is lacking, and it is included in the "SERVICES" account, therefore, related simulations may not reflect the impact on renewable generation accurately.

Similar generation mix policy shocks are injected to public-sector generation segment and the results are shown in Table 6.12. They suggest a cut in state gas and oil or coal generation has a negative impact on the economy, however, the magnitude of the impact of a cut in coal-fired generation is lower compared to gas and oil. Again, this is due to a better position of the GASOIL industry in the economy and its stronger links with power sectors, compared to COAL.

Table 6.12 Macro impact of generation mix changes: state utilities

	5.5	5.6	5.7	5.8	5.9
	Gas&oil use down 10%	Gas&oil use down 10%, renewb. up by 2 times	Coal use down by 10%	Coal use down 10%, renewb. up by 2 times	Renewables gen. up 200%
GDP	(0.59)	(0.20)	(0.28)	(0.03)	(0.08)
Equivalent variation	(0.85)	(0.85)	(0.86)	(0.04)	(0.31)
Government consumption	(0.59)	(0.20)	(0.28)	(0.03)	(0.08)
Private consumption	(5.24)	(5.27)	(5.30)	(0.24)	(1.90)
Government investment	(0.59)	(0.20)	(0.28)	(0.03)	(0.08)
Private investment	30.47	29.07	31.24	3.58	11.85
Private Savings-Investment Gap	(46.18)	(45.95)	(45.97)	(2.38)	(17.91)
Government savings	1.30	1.24	2.60	1.46	1.14
Private savings	14.59	14.25	16.25	2.66	6.00
Unemployment	5.17	6.32	7.62	1.22	2.33
Exchange rate	1.74	0.04	0.04	0.00	0.01

All in all, the simulation results suggest that a change in the share in generation mix for gas and oil should be more costly than changes in the share of coal.

On renewable power generation technology, practice from other countries shows that increasing their share in generation mix has considerably weighed on power prices and shall benefit the economy overall. This is particularly true for Turkish economy, as it would substitute for other technologies highly dependent on supplies from abroad – i.e. natural gas and oil. In the meantime, it is important that the transition to a renewables-intensive energy sector is planned carefully and made gradually, keeping market participants well-informed on the impact this might have, as lower power prices could discourage investments.

6.6 Macro Policy Shocks

Lastly, I look into how power market is affected by macroeconomic policy shocks. World oil prices have experienced a significant fall in the past couple of years, also weighing on natural gas prices whose levels are in general kept indexed to oil prices in long-term supply contracts (usually between states).

Simulation results in Table 6.13 suggest that a 20% fall in domestic natural gas and oil prices[145] leads to a deviation of GDP 0.1% above its base level. While a fall in world

[145] This simulation is inspired by shocks given in the PwC study on Turkish energy market reforms which suggests gas prices are likely to fall by 20% after the gas market is liberalized.

gasoil prices by 25% has a negative impact on the GDP but encourages private consumption which turns around 1% above its base level.

While for coal, any reduction in the price of the commodity seems to have a positive impact on the economy – although small in magnitude.

The results are straightforward: natural gas, oil and coal are vital commodities for households, businesses and the government and are well connected not only to the electricity, but to other key sectors for Turkish economy, like the transportation sector. Therefore, a decline in their prices leads to higher demand for the commodities.

Table 6.13 Reduction in gas&oil and coal prices: impact on macro variables

	6.1	6.2	6.3	6.4
	Domestic gasoil price falls by 20%	World gasoil price falls 25%	Domestic coal price falls 20%	World coal prices fall 25%
GDP	0.10	(0.43)	0.02	0.02
Equivalent variation	0.16	0.13	0.04	0.06
Government consumption	0.10	(0.43)	0.02	0.02
Private consumption	0.97	0.81	0.23	0.40
Government investment	0.10	(0.43)	0.02	0.02
Private investment	3.79	4.51	2.03	0.55
Private Savings-Investment Gap	(6.25)	(7.15)	(3.03)	(2.57)
Government savings	1.70	4.38	1.05	1.60
Private savings	1.04	1.65	0.96	(0.43)
Unemployment	4.52	3.51	2.44	0.80
Exchange rate	1.20	0.00	(0.00)	(0.00)

Due to regulated gas prices, a fall in world gas prices is not necessarily reflected on domestic gas prices in Turkey's energy market. Therefore, the outcome of simulation 6.1 suggests reform in the gas market aimed at increasing competition in organized markets that generate clear and transparent price signals and where marginal-cost pricing is in place, shall be beneficiary for Turkey.

Table 6.14 Gas&oil and coal price cuts: impact on intermediate demand

	6.1	6.2	6.3	6.4
	Domestic gasoil price falls by 20%	World gasoil price falls 25%	Domestic coal price falls 20%	World coal prices fall 25%
AGR	0.00	(0.16)	0.29	0.38
TRAN	1.00	0.97	0.40	0.30
GENG	0.42	0.50	0.32	0.11
GENP	1.76	2.16	1.07	0.27
TETAS	0.41	0.52	0.33	0.11
PMUM	0.58	0.74	0.46	0.12
WHOLE	(0.91)	(0.74)	0.02	(0.12)
EDAS	0.47	0.57	0.34	0.12
COAL	1.18	1.24	(24.92)	(1.01)
GASOIL	(16.32)	(22.59)	0.23	0.20
MET	-	(0.00)	(0.00)	-
CHEM	(12.39)	(9.65)	(0.03)	0.02
MINR	0.97	1.08	0.44	0.14
MACH	(10.01)	(10.01)	(10.01)	(10.01)
MIN	(0.57)	(0.27)	(0.27)	(0.53)
FOOD	(7.28)	(7.68)	0.40	0.47
PAPR	0.99	1.08	0.55	0.31
CON	1.63	1.75	0.79	0.32
TEXT	(2.26)	(1.89)	0.32	0.28
OIND	(0.83)	(0.04)	0.01	0.01
SERV	0.88	0.79	0.31	0.29

When natural gas and oil is compared to coal, a cut in prices for the first two has a greater impact on the economy.

Intermediate use by GASOIL and COAL sectors after respective price cuts are introduced declines, pointing at efficiency improvements. Intermediate use by the machinery sector also falls considerably below base levels after oil and gas price cuts.

CONCLUSIONS

This dissertation focused on the impact power sector reform has had on the Turkish economy, employing a CGE model with 2010 as the base year. The hypothesis tested here was on whether delivery of power market reform's ultimate objectives set in the electricity market law (EML) has had or will have a positive impact on the economy. Objectives are set in EML's first article and include the development of a "*financially sound and transparent electricity market operating in a competitive environment under provisions of civil law and the delivery of sufficient, good quality, low cost and environment-friendly electricity to consumers* ...".

Major findings suggest that overall, electricity market reform has had a positive impact on the Turkish economy. Market liberalization, introduction and expansion of the day-ahead market, demand management and higher share of the private sector in power generation are the reform elements that have the largest impact on the GDP.

Liberalization is simulated by removing a monopolistic mark-up of 10% on prices for commodities produced by state-run utilities, namely, public-sector generation (GENP), state-run wholesale trading (TETAS) and the distribution segment (EDAS). GDP deviates by 0.35% above its baseline after the mark-up for all these three segments is removed. However, the impact on GDP turns negative when the monopolistic rent is removed for just one or two of the three sectors.

This suggests that market liberalization is effective when applied for all state-run monopolies at a time. The finding is particularly important for the Turkish power market given that GENP, TETAS and EDAS are three well-connected structures and liberalizing just one of them shall not necessarily lead to competitive pressure for the other companies, therefore optimal results may not be achieved.

Findings also suggest that a larger participation in the day-ahead electricity market has a positive impact on the economy. The impact is larger when state-run companies increase their participation in the market, due to their large market share and hence strong position in the sector. GDP settles 0.25% above its base level when sales of state-run generation (GENG) and state-owned wholesale company (TETAS) to the day-ahead market increase by four folds. While it deviates by around 0.1% above the baseline when sales of private-sector generators and power wholesale trading companies to the market increase by four folds.

Expansion of the organized day-ahead market also boosts savings and investments for both the public and priave sectors. One key lesson to be drawn here is that the presence of state-run companies is not necessarily "bad" for the sector, and that when exposed to competitive market pressure, these companies too are forced to increase efficiency and offer a better performance. One real example of this is the case of UK's state-run nuclear utilities which failed to be privatized in 1989 when the country first launched its power market reform due to lack of interest. Remaining in public-sector hands did not stop these utilities to increase efficiency in the years following the reform.

Larger private-sector shares in the generation segment also have a positive impact on the economy. An increase in private-sector generation by 108% and fall in state-run generation by 1.94% during the 2010-2012 period leads to a deviation of GDP to 0.18% above its baseline.

While the benefits of privatization and/or larger private-sector participation in network industries have been proven through decades since the liberalization wave started in the 1980s, another important point from this simulation is to realize that the impact of a rise in private-sector generation in the generation mix on GDP could be equivalent to the impact of stronger participation by generation and trading companies in the day-ahead and potentially, other organized markets.

Another important finding is the positive impact that stronger demand-side participation has on the power sector and overall on the economy. An increase in EDAS sales to eligible consumers – which are large power consumers eligible to choose their electricity provider – by 44 folds leads to a positive GDP deviation by 0.21% from the baseline. The impact on GDP is smaller but still positive when private wholesale companies fold their sales to eligible consumers.

The number of eligible consumers in Turkey has increased considerably in recent years as competition among providers pushes wholesale power prices on the downside. Moreover, the country mulls to fully eliminate the lower consumption limit for eligible consumers in coming years in a bid to reach 100% retail market openness. However, as experience in other countries shows, not all eligible consumers choose to switch providers. Therefore, policy makers should develop tools to promote a more active demand-side participation. Awareness campaigns and the launch of an online portal where verified tariffs offered by different suppliers can be compared are some examples.

A reduction in technical and theft losses of the power distribution segment combined with an increase in investment in the sector also exhibit a small, yet positive impact on GDP. Similarly, elimination of X-inefficiencies in electricity distribution leads to a positive deviation of the GDP from its baseline.

On the generation mix policy, an increase in renewable and oil and gas-fired generation generates a positive effect on value added. Meanwhile, simulation results for coal-fired power generation are somehow counter-intuitive, which could be due to discrepancies between actual and estimated input-output flows in SAM.

Overall, the reform has had a positive impact on Turkish economy. A simulation on all reform elements – namely, the removal of the 10% monopoly mark-up for all state-run power segments, increase in the private sector's share and reduction of the public sector's share in total generation as during the 2010-2012 period, a rise by four folds in sales of public and private generation and wholesale sectors to the day-ahead market, reduction of X-inefficiencies in the distribution segment and the reduction in technical and theft losses combined with a rise in investments – simultaneously, generates a deviation of GDP by 0.20% above its baseline.

This dissertation could be extended by differently modelling the power market production technology like for instance, introducing a CES production function for power segments, to tackle more flexibility offered in the sector in the post-reform period. Also, categorization of households into percentiles according to their levels of income and disaggregation of unemployment data could offer the possibility to conduct poverty analysis and a more detailed examination of the impact reform has had on the labour market. Introducing oligopolistic behaviour of certain power market actors – particularly state-run companies – in the model equations could also be another area for research in the future.

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ANNEX I INTERVIEW QUESTIONS

ERİSA DAUTAJ ŞENERDEM

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The purpose of the interview is to clarify certain points unclear to me regarding the present situation in Turkey's electricity sector. Anonimity will be kept strictly confidential.

TENTATIVE TITLE OF PLANNED DISSERTATION:

Evaluation of reform outcomes in Turkish electricity sector and projections for further reform and policies: a CGE analysis

KEY RESEARCH QUESTION AND OBJECTIVES:

Hypothesis: Reform in electricity sector in Turkey has helped to open the market to competition, make the sector more productive and efficient, hence lowering costs and making industries, households and the government better off.

Reform scenarios:

Privatize and restructure the transmission company TEIAS, i.e. abolish the single-buyer model.

Finalize privatization of distribution regional companies (only 10 privatized between 2009-2011, also measure effects of these privatizations).

100% market opening in retail.

Reduce carbon emissions originating from energy generation and/or use.

Eliminate licensing for generation and supply

Incentive regulation (no price distortion)

Policy scenarios:

Reduce natural gas dependency for generation and/or Promote renewable

Increase production efficiency

Promote green technologies

Incentivize buildings insulation

QUESTIONS

ELECTRICITY MARKET

1. How far is Turkey's electricity market from being competitive?
2. Regulated prices of distribution companies are lower than those of private generators. Do you find this anti-competitive? Does it pose any risks (eg. California crisis-like)
3. Day ahead market started functioning last year. Do you think it will function properly? How will it affect the electricity market in general?
4. The balancing and settlement market has been more profitable than bilateral contracts market. What are the reasons: there are hypotheses that firms have behaved strategically. Do you agree?

ELECTRICITY SECTOR – ALL SEGMENTS

1. Final objective is 100% openness of retail markets. Will this work in Turkey, taking into account that it has not been fully effective in the UK either?
2. What will then occur with distribution companies (and their exclusive monopoly rights)? What will become of TEDAŞ and its affiliates?
3. Does TEİAŞ provide non-discriminatory access? Does it execute investment plans fully and successfully?
4. Is it normal for TEİAŞ to be both TSO (transmission system operator) and market operator?
5. Why does TETAŞ keep its dominant position: due to insufficient private participation or entry barriers to the market?
6. There are not any retail sale companies except for distribution companies having retail sale licenses. Why so? What is the barrier to new retail firms to perform in Turkish electricity markets? Consequences?

7. Limit for eligible consumers decreased. How has this affected your (producers, etc) business?
8. Is infrastructure ready for 100% retail competition? What is the point if no retail firms for the time being?
9. Are EPDK/TEİAŞ really indepentent?
10. Environmental issues resulting from electricity production – could you mention some? How are these issues tackled? Is legilsation sufficient? What can be done further?

GENERAL ISSUES

1. The structure of Turkish electricity market (fig.1[146]) – Is it clear enough?
2. Could you assess the title, objective and hypotheses of my research?
3. Are there any extra issues I should cover? What are the key areas where academic studies lack, regarding current state and reform in electricity sector?

[146] See Figure 4.5 in Chapter 4.

ANNEX II REORGANIZATION OF IO TABLE ACCOUNTS

Turkey SAM		ISIC Rev.1		NACE Rev.1	
Account no.	**Account name**	**Account no.**	**Account name**	**Account no.**	**Account name**
1	Agriculture	1	Growing of cereals and other crops n.e.c.	01	Products of agriculture, hunting and related services
		2	Growing of vegetables, horticultural specialties and nursery products	02	Products of forestry, logging and related services
		3	Growing of fruit, nuts, beverage and spice crops	03	Fish and other fishing products; services incidental of fishing
		4	Farming of animals		
		5	Agricultural and animal husbandry service activities, except veterinary activities		
		6	Forestry, logging and related service activities		
		7	Fishing		
2	Transportation	73	Sale, maintenance and repair of motor vehicles, motorcycles; retail sale of fuel	35	Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel
		78	Transport via railways	39	Land transport; transport via pipeline services
		79	Land transport; transport via pipelines	40	Water transport services
		80	Water transport	41	Air transport services
		81	Air transport	42	Supporting and auxiliary transport services; travel agency services
3	Electricity	69	Production, collection and distribution of electricity	32	Electrical energy, gas, steam and hot water
		70	Manufacture of gas; distribution of gaseous fuels through mains		Electrical energy, gas, steam and hot water
4	Coal	8	Mining of coal and lignite	04	Coal and lignite; peat
5	Oil and gas	9	Extraction of crude petroleum and natural gas	05	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying
			Extraction of crude petroleum and natural gas		Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying
6	Metals	10	Mining of metal ores	21	Basic metals
		50	Manufacture of basic iron and steel	22	Fabricated metal products, except machinery and equipment
		51	Manufacture of basic precious and non-ferrous metals		
		52	Casting of metals		
		53	Manufacture of fabricated metal products, tanks, reservoirs &steam generators		
		54	Manufacture of other fabricated metal products; metal working service activities		
7	Chemicals	38	Manufacture of coke, refined petroleum products	17	Coke, refined petroleum products and nuclear fuels
		39	Manufacture of basic chemicals, plastics & synthetics rubber	18	Chemicals, chemical products and man-made fibres

		40 41 42 43 44 45	Manufacture of fertilizers and nitrogen compounds Manufacture of pesticides, other agro-chemicals and paints, varnishes Manufacture of pharmaceuticals, medicinal chemicals &botanical prod. Manufacture of cleaning materials, cosmetics & man-made fibres Manufacture of rubber products Manufacture of plastic products	19	Rubber and plastic products
8	Minerals	46 47 48 49	Manufacture of glass and glass products Manufacture of ceramic products Manufacture of cement, lime and plaster related articles these items Cutting and finishing of stone and man. of non-metallic mineral pro. n.e.c.	20	Other non-metallic mineral products Other non-metallic mineral products
9	Machinery	55 56 57 58 59	Manufacture of general purpose machinery Manufacture of special purpose machinery Manufacture of domestic appliances n.e.c. Manufacture of office, accounting and computing machinery Manufacture of electrical machinery and apparatus n.e.c.	23 24 25	Machinery and equipment n.e.c. Office machinery and computers Electrical machinery and apparatus n.e.c.
10	Mining	11 12	Quarrying of stone, sand and clay Mining and quarrying n.e.c.	07 08	Metal ores Other mining and quarrying products
11	Food	13 14 15 16 17 18 19 20 21 22	Production, processing and preserving of meat and meat products Processing and preserving of fish and fish products Processing and preserving of fruit and vegetables Manufacture of vegetable and animal oils and fats Manufacture of dairy products Manufacture of grain mill products, starches and starch products Manufacture of prepared animal feeds Manufacture of bakery products Manufacture of sugar Manufacture of cocoa, chocolate, sugar confert.& other food pro. n.e.c.	09 10	Food products and beverages Tobacco products

		23	Manufacture of alcoholic beverages		
		24	Manufacture of soft drinks; production of mineral waters		
		25	Manufacture of tobacco products		
12	Paper	33	Sawmilling and planing of wood	14	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials
		34	Manufacture of wood and of products of wood and cork	15	Pulp, paper and paper products
		35	Manufacture of paper and paper products	16	Printed matter and recorded media
		36	Publishing		
		37	Printing and service activities related to printing		
13	Contruction	72	Construction	34	Construction work
14	Textiles	26	Manufacture of textiles	11	Textiles
		27	Manufacture of other textiles	12	Wearing apparel; furs
		28	Manufacture of knitted and crocheted fabrics and articles	13	Leather and leather products
		29	Manufacture of wearing apparel, except fur apparel		
		30	Dressing and dyeing of fur; manufacture of articles of fur		
		31	Tanning and dressing of leather; man.of luggage, handbags, sad.& har.		
		32	Manufacture of footwear		
15	Other industries	60	Manufacture of radio, television and communication equipment and apparatus	26	Radio, television and communication equipment and apparatus
		61	Manufacture of medical, precision and optical instruments, watches and clocks	27	Medical, precision and optical instruments, watches and clocks
		62	Manufacture of motor vehicles, trailers and semi-trailers	28	Motor vehicles, trailers and semi-trailers
		63	Building and repairing of ships, pleasure and sporting boats	29	Other transport equipment
		64	Manufacture of railway and tramway locomotives and rolling stock	30	Furniture; other manufactured goods n.e.c.
		65	Manufacture of aircraft and spacecraft	31	Secondary raw materials
		66	Manufacture of transport equipment n.e.c.		
		67	Manufacture of furniture		
		68	Manufacturing n.e.c.		
16	Services	71	Collection, purification and distribution of water	33	Collected and purified water, distribution services of water

		74	Wholesale trade and commission trade, except of motor vehicles and motorcycles	36	Wholesale trade and commission trade services, except of motor vehicles and motorcycles
		75	Retail trade, except of motor vehicles and motorcycles;	37	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods
		76	Hotels; camping sites and other provision of short-stay accommodation	38	Hotel and restaurant services
		77	Restaurants, bars and canteens	43	Post and telecommunication services
		82	Supporting and auxiliary transport activities; activities of travel agencies	44	Financial intermediation services, except insurance and pension funding services
		83	Post and telecommunications	45	Insurance and pension funding services, except compulsory social security services
		84	Financial intermediation, except insurance and pension funding	46	Services auxiliary to financial intermediation
		85	Insurance and pension funding, except compulsory social security	47	Real estate services
		86	Real estate activities	48	Renting services of machinery and equipment without operator and of personal and household goods
		87	Renting of machinery and equip. without operator and of personal and hh. goods	49	Computer and related services
		88	Computer and related activities	50	Research and development services
		89	Research and development	51	Other business services
		90	Other business activities	52	Public administration and defence services; compulsory social security services
		91	Education	53	Education services
		92	Health and social work	54	Health and social work services
		93	Activities of membership organizations n.e.c auxiliary to financial intermediation	55	Sewage and refuse disposal services, sanitation and similar services
		94	Recreational, cultural and sporting activities	56	Membership organisation services n.e.c.
		95	Other service activities	57	Recreational, cultural and sporting services
		96	Public administration and defence; compulsory social security	58	Other services
		97	Ownership of dwelling	59	Private households with employed persons

ANNEX III EXTENDED SIMULATION RESULTS

Table AIII. 1 Market liberalization

	1.1	1.2	1.3	1.4	1.5	1.6
	mu reduced by 5% for GENG, TETAS, EDAS	*mu* reduced by 5% for GENG, TETAS, EDAS	mu reduced by 5% for GENG, TETAS	mu reduced by 5% for GENG, TETAS	mu reduced by 5% for EDAS	mu reduced by 10% for EDAS
GDP	0.35	0.35	(0.28)	(0.16)	(0.38)	(0.38)
Equivalent variation	0.03	0.03	(0.14)	0.05	0.10	0.10
Government consumption	0.35	0.35	(0.28)	(0.16)	(0.38)	(0.38)
Private consumption	0.19	0.19	(0.85)	0.29	0.64	0.64
Government investment	0.35	0.35	(0.28)	(0.16)	(0.38)	(0.38)
Private investment	(2.70)	(2.70)	(1.54)	1.14	(1.98)	(1.98)
Private Savings-Investment Gap	22.19	22.15	0.09	3.85	15.68	15.64
Government savings	1.64	1.38	(3.28)	2.20	3.19	3.07
Private savings	4.30	4.31	(1.26)	1.19	1.65	1.65
Unemployment	2.01	2.01	(3.01)	3.09	3.71	3.71

Exchange rate	(0.01)	(0.01)	0.01	1.75	1.76	1.76
Household expenditures	0.17	0.16	(0.77)	0.25	0.57	0.56
Firms transfers to hoh	(0.19)	(0.38)	(0.11)	(0.20)	(0.08)	(0.17)
Firms profit transfers abroad	(0.00)	(0.02)	(0.01)	(0.01)	0.00	(0.01)
Govt transfers to firms	0.39	0.36	(0.55)	0.18	0.18	0.17
Govt transfers to hoh	0.39	0.36	(0.55)	0.18	0.18	0.17
Corporate tax	(0.01)	(0.02)	(0.00)	(0.02)	(0.00)	(0.01)
Income tax	(0.13)	(0.24)	(0.00)	(0.20)	(0.16)	(0.21)
Unemp benefit payments	2.01	2.01	(3.01)	3.09	3.71	3.71
Firms income	(0.00)	(0.02)	(0.01)	(0.01)	0.00	(0.01)
Govt income	0.39	0.36	(0.55)	0.18	0.18	0.17
Household income	(0.13)	(0.24)	(0.00)	(0.20)	(0.16)	(0.21)

Table AIII.2 Privatization, Losses, X-inefficiency

	2.1	**2.2**	**2.3**	**2.4**
	GENP intermediate good sales up by 107.63%, GENG	Technical and theft losses reduced by	Eliminate chi for GENG, TETAS, EDAS	Eliminate chi for EDAS

	intermediate good sales down by 1.94%	33%, EDAS investments up by 5%		
GDP	0.18	0.01	0.00	0.01
Equivalent variation	0.12	0.07	0.07	0.07
Government consumption	0.18	0.01	0.00	0.01
Private consumption	0.76	0.41	0.41	0.41
Government investment	0.18	0.01	0.00	0.01
Private investment	2.38	0.48	0.49	0.48
Private Savings-Investment Gap	(4.33)	(1.03)	(2.57)	-
Government savings	12.28	9.74	1.64	1.63
Private savings	1.65	(0.86)	(0.49)	0.31
Unemployment	4.60	0.73	0.73	0.73
Exchange rate	(3.65)	(0.00)	(0.00)	(0.00)
Household expenditures	0.84	0.38	0.37	0.37
Firms transfers to hoh	(0.00)	0.01	0.00	0.00
Firms profit transfers abroad	(100.00)	0.01	0.00	0.00

Govt transfers to firms	1.01	1.18	0.20	0.20
Govt transfers to hoh	1.01	1.18	0.20	0.20
Corporate tax	-	(0.00)	-	(0.00)
Income tax	1.71	0.10	(0.01)	(0.01)
Unemp benefit payments	4.60	7.73	0.73	0.73
Firms income	(0.00)	0.01	0.00	0.00
Govt income	1.01	1.18	0.20	0.20
Household income	1.71	0.10	(0.01)	(0.01)

Table AIII.3 Establishment of day-ahead market

	3.1	3.2	3.3	3.4
	All sales to pmum as in 2010-2012	GENP and WHOLE sales to PMUM up by 400%	GENG and TETAS sales to PMUM up 400%	GENP, GENG, WHOLE and TETAS sales to PMUM up 400%
GDP	(0.03)	0.07	0.25	0.14
Equivalent variation	(0.48)	(0.58)	0.03	(0.00)
Government consumption	(0.03)	0.07	0.25	0.14
Private consumption	(2.94)	(3.55)	0.21	(0.03)
Government investment	(0.03)	0.07	0.25	0.14
Private investment	21.36	21.94	6.18	6.38
Private Savings-Investment Gap	(16.52)	(67.07)	(14.97)	(15.98)
Government savings	8.84	8.43	12.00	11.40
Private savings	15.87	1.65	1.65	1.65
Unemployment	8.61	2.11	2.28	4.74
Exchange rate	(1.35)	(3.65)	(2.74)	(2.90)
Household expenditures	(2.56)	(3.11)	0.35	0.10

Firms transfers to hoh	0.01	(0.01)	0.00	0.00
Firms profit transfers abroad	(100.00)	(100.00)	(100.00)	(100.00)
Govt transfers to firms	1.06	0.52	0.97	0.96
Govt transfers to hoh	1.06	0.52	0.97	0.96
Corporate tax	-	-	-	-
Income tax	1.45	1.64	1.90	1.46
Unemp benefit payments	8.61	2.11	2.28	4.74
Firms income	0.01	(0.01)	0.00	0.00
Govt income	1.06	0.52	0.97	0.96
Household income	1.45	1.64	1.90	1.46

Table AIII.4 Demand management

	4.1	**4.2**	**4.3**	**4.4**	**4.5**
	WHOLE sales to eligible consumers up 150%	EDAS sales to elig. cons up 43.7 times	WHOLE sales to elig. cons up 150% EDAS up 43.7 times	WHOLE sales up 24 times	EDAS sales up 24 times
GDP	(0.15)	0.21	0.16	0.02	(0.35)
Equivalent variation	(0.39)	0.19	0.40	(0.49)	(0.04)
Government consumption	(0.15)	0.21	0.16	0.02	(0.35)
Private consumption	(2.39)	1.17	2.44	(3.01)	(0.27)
Government investment	(0.15)	0.21	0.16	0.02	(0.35)
Private investment	14.55	0.56	(3.53)	21.94	4.74
Private Savings-Investment Gap	(21.69)	1.45	17.25	(61.77)	(9.31)
Government savings	1.48	12.56	7.87	13.08	16.08
Private savings	7.45	1.65	1.93	1.65	1.65
Unemployment	2.98	4.10	1.65	8.41	14.67
Exchange rate	0.02	(3.65)	(1.46)	(1.36)	(3.20)
Household expenditures	(2.20)	1.23	2.31	(2.59)	(0.16)
Firms transfers to hoh	0.00	0.00	0.00	0.01	0.00
Firms profit transfers abroad	0.00	(100.00)	(100.00)	(100.00)	(100.00)

Govt transfers to firms	0.10	1.03	0.74	1.03	1.23
Govt transfers to hoh	0.10	1.03	0.74	1.03	1.23
Corporate tax	-	-	-	(0.00)	-
Income tax	(0.10)	1.84	0.93	1.89	0.97
Unemp benefit payments	2.98	4.10	1.65	8.41	14.67
Firms income	0.00	0.00	0.00	0.01	0.00
Govt income	0.10	1.03	0.74	1.03	1.23
Household income	(0.10)	1.84	0.93	1.89	0.97

Table AIII.5 Generation mix: private sector

	5.1	5.2	5.3	5.4
	Generation mix changes in 2010-2012	Gas&oil use down 10%, renewb. up by 2 times	Coal use down 10%, renewb. up by 2 times	Renewables gen. up 200%
GDP	(0.16)	(0.14)	0.08	0.09
Equivalent variation	(0.84)	(0.00)	0.16	0.17
Government consumption	(0.16)	(0.14)	0.08	0.09
Private consumption	(5.20)	(0.02)	0.96	1.03
Government investment	(0.16)	(0.14)	0.08	0.09
Private investment	31.92	2.16	(1.83)	(2.12)
Private Savings-Investment Gap	(90.35)	(1.67)	(0.72)	(0.64)
Government savings	(2.03)	0.77	0.67	0.60
Private savings	2.48	0.60	(2.10)	(2.35)
Unemployment	(2.54)	0.55	(2.21)	(2.51)
Exchange rate	1.74	1.75	(0.01)	(0.01)
Household expenditures	(4.75)	(0.02)	0.89	0.95
Firms transfers to hoh	0.00	0.01	0.00	0.00

Firms profit transfers abroad	0.00	0.01	0.00	0.00
Govt transfers to firms	(0.33)	0.02	0.13	0.12
Govt transfers to hoh	(0.33)	0.02	0.13	0.12
Corporate tax	-	-	-	-
Income tax	0.06	(0.01)	0.10	0.11
Unemp benefit payments	(2.54)	0.55	(2.21)	(2.51)
Firms income	0.00	0.01	0.00	0.00
Govt income	(0.33)	0.02	0.13	0.12
Household income	0.06	(0.01)	0.10	0.11

Table AIII.6 Generation mix: public sector

	5.5	**5.6**	**5.7**	**5.8**	**5.9**
	Gas&oil use down 10%	Gas&oil use down 10%, renewb. up by 2 times	Coal use down by 10%	Coal use down 10%, renewb. up by 2 times	Renewables gen. up 200%
GDP	(0.59)	(0.20)	(0.28)	(0.03)	(0.08)
Equivalent variation	(0.85)	(0.85)	(0.86)	(0.04)	(0.31)
Government consumption	(0.59)	(0.20)	(0.28)	(0.03)	(0.08)
Private consumption	(5.24)	(5.27)	(5.30)	(0.24)	(1.90)
Government investment	(0.59)	(0.20)	(0.28)	(0.03)	(0.08)
Private investment	30.47	29.07	31.24	3.58	11.85
Private Savings-Investment Gap	(46.18)	(45.95)	(45.97)	(2.38)	(17.91)
Government savings	1.30	1.24	2.60	1.46	1.14
Private savings	14.59	14.25	16.25	2.66	6.00
Unemployment	5.17	6.32	7.62	1.22	2.33
Exchange rate	1.74	0.04	0.04	0.00	0.01
Household expenditures	(4.81)	(4.84)	(4.87)	(0.22)	(1.74)
Firms transfers to hoh	0.00	0.00	0.00	0.00	0.00

Firms profit transfers abroad	0.00	0.00	0.00	0.00	0.00
Govt transfers to firms	(0.16)	0.04	0.16	0.16	0.09
Govt transfers to hoh	(0.16)	0.04	0.16	0.16	0.09
Corporate tax	-	0.00	0.00	0.00	-
Income tax	(0.20)	(0.23)	(0.27)	(0.03)	(0.08)
Unemp benefit payments	5.17	6.32	7.62	1.22	2.33
Firms income	0.00	0.00	0.00	0.00	0.00
Govt income	(0.16)	0.04	0.16	0.16	0.09
Household income	(0.20)	(0.23)	(0.27)	(0.03)	(0.08)

Table AIII.7 Macro policy shocks.

	6.1	**6.2**	**6.3**	**6.4**
	Domestic gasoil price falls by 20%	World gasoil price falls 25%	Domestic coal price falls 20%	World coal prices fall 25%
GDP	0.10	(0.43)	0.02	0.02
Equivalent variation	0.16	0.13	0.04	0.06
Government consumption	0.10	(0.43)	0.02	0.02
Private consumption	0.97	0.81	0.23	0.40
Government investment	0.10	(0.43)	0.02	0.02
Private investment	3.79	4.51	2.03	0.55
Private Savings-Investment Gap	(6.25)	(7.15)	(3.03)	(2.57)
Government savings	1.70	4.38	1.05	1.60
Private savings	1.04	1.65	0.96	(0.43)
Unemployment	4.52	3.51	2.44	0.80
Exchange rate	1.20	0.00	(0.00)	(0.00)
Household expenditures	0.87	0.73	0.20	0.36
Firms transfers to hoh	0.01	0.00	0.00	0.00
Firms profit transfers abroad	0.01	0.00	0.00	0.00
Govt transfers to firms	0.29	0.30	0.24	0.21

Govt transfers to hoh	0.29	0.30	0.24	0.21
Corporate tax	-	(0.00)	0.00	(0.00)
Income tax	(0.13)	(0.10)	(0.07)	(0.01)
Unemp benefit payments	4.52	3.51	2.44	0.80
Firms income	0.01	0.00	0.00	0.00
Govt income	0.29	0.30	0.24	0.21
Household income	(0.13)	(0.10)	(0.07)	(0.01)

ANNEX IV SENSITIVITY TEST

Table AIV Sensitivity test[147]

	Baseline ($\rho_i^Q = 1.25$, $\rho_i^{CC} = -0.67$)	Test ($\rho_i^Q = 1.5$, $\rho_i^{CC} = -0.5$)
GDP	- 0.20	- 0.46
Equivalent variation	- 0.19	- 0.22
Government consumption	- 0.20	- 0.46
Private consumption	- 1.14	- 1.34
Government investment	- 0.20	- 0.46
Private investment	- 0.62	2.13
Government savings	- 13.43	- 64.08
Private savings	- 1.65	- 5.27
Unemployment	- 5.17	- 0.48
Exchange rate	3.65	3.11

147 Values show deviation from initial (database) values for two baseline models with different elasticity parameters.