In this paper we construct a Social Accounting Matrix (SAM) for Turkey with an emphasis on electricity sectors. For this purpose, we collect data from various sources and reorganize them into a balanced SAM. We specifically disaggregate the electricity sector into public generation and private generation sectors, and introduce four satellite accounts: public wholesale trading, private wholesale trading, distribution, and organized power market.

1. Introduction

Electric power is a vital source of energy for households and a key input for industries. The sector has traditionally been recognized as strategic by governments and large sunk costs give the industry features of a natural monopoly. This approach has mostly led to high inefficiencies and large burdens on state budgets. The trend has 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.

Power market reforms were launched in a number of countries and Turkey has been no exception. Various attempts in the past to unbundle the state-owned and vertically integrated electricity facilities resulted in a complex system of ownership. Since the start of the reforms in 2001, the Turkish electric power sector has undergone a comprehensive reform process. Organized markets, including day-ahead balancing and settlement, an intra-day market, and a power exchange, have been established recently in a bid to generate price signals for future investment. In this regard, the power sector has been an important component of competition policy.

In this paper, we introduce a Social Accounting Matrix (SAM) with an emphasis on electricity markets for 2010, which can be used to analyze the electricity market. SAM is “a comprehensive and disaggregated snapshot of the socio-economic system during a given year” (Thorbecke, 2000). We collect data from various institutions and reorganize them into a SAM which can be used for analysis of the power market and the power market reforms. In constructing the SAM, we make much use of Erten (2009) and Telli (2006) in some stages. We chose 2010 because data were available at a desired sectoral level for energy sectors.

2. The Social Accounting Matrix (SAM)

2.1. Structure of the SAM

SAM is a square matrix in the form of an extended Input-Output Table (IOT), mapping intersectoral transactions and interrelations among institutions (households, firms, government, capital, rest of the world) in an economy. It has been used for policy analysis (Sadoulet and de Janvry, 1995). Columns in a SAM represent payments and rows represent receipts. For the respective accounts, the sum of total spending equals total income. The aggregated matrix is presented in Table 1. “Activities” account refers to production entities that produce goods and services and “Commodities” account refers to the goods and services produced. There are three factors of production: labor, privately owned capital, and public capital. Institutions include households, enterprises, government, private savings, public savings, and the rest of the world.

Input-Output Tables: The core part of the micro-SAM is the IOT which reports transactions among production activities. We used the I-O coefficients in 2002 IOT and updated the monetary values of all intersectoral transactions to 2010. We reorganize and aggregate the sectoral classification of the IOT into 16 sectors before disaggregating the power sector. The number of sectors increases to 21 with the introduction of detailed power sectors. The IOT in Turkey are reported in basic prices, i.e., payments to producers net of taxes, trade and transport margins, inclusive of subsidies. In the SAM, the final demand columns are expressed in producers’ prices.

Output, Value-added, and Intermediate Demand: Sectoral distribution of value added is available in GDP (Gross Domestic Product) series. Disaggregated data at the sectoral level for exports and imports were obtained from Turkstat. However, data on final demand, i.e., private and public consumption and capital formation at NACE Rev. 3 disaggregation are not available and they are estimated. To estimate intermediate demand (inputs) data, we follow
Erten (2009) and estimate the ratios of intermediate input to gross output by each sector. The difference between gross output and value added yield total intermediate demand.

Foreign Trade: We reorganized export and import data which are published annually by Turkstat into 16 sectors. Trade data for services are taken from the balance of payments tables published by the Central Bank. To estimate natural gas imports, including LNG (liquefied natural gas) imports, volumes in 2010 are taken from the annual natural gas report published by EPDK (Turkish Energy Market Regulatory Authority). Since import prices vary with the countries of origin and are not officially announced we use price approximations in line with media reports for natural gas imported from Russia, Iran, and Azerbaijan. For LNG imports from Algeria and Nigeria we use average import prices paid by Germany which is available in a 2013 Statistical Review of BP. Average price in the UK is used for spot LNG imports. Finally, we also correct for the discrepancies regarding trade flows with Turkey’s free trade zones which are not included in GDP series as in Erten (2009).

Labor Compensation: To estimate labor compensation, we obtain data by sectors from the Social Security Institution of Turkey (SGK) on the basis of NACE (Statistical classification of economic activities in the European Community) Rev. 2 classification. We calculate annual labor compensation. We adjust the number of workers and labor compensation in the private sector by inflating the number of workers and labor compensation using the adjustment factors in Erten (2009). To avoid inconsistency with official statistics, we apply 2006 shares to calculate cost components of Turkey’s GDP in 2010, because they were the most recent ones available.

Operating Surplus: We separate public sector operating surplus from that of the private sector. Total operating surplus for state-owned companies is calculated as the sum of “factor income” from public sector general budget account as well as interest rate payments for social security institutions and State-owned Enterprises (SOEs) as in Erten (2009). Gross operating surplus is calculated as a residual.

Final Demand: Final demand block is composed of household consumption, government expenditures, private firms’ investments, and public firms’ investments. Aggregate figures for these accounts are taken from GDP series. Specifically, household consumption is calculated using the statistics in Household Budget Survey and sectoral household consumption shares computed from IOT and IEA (International Energy Agency) statistics for energy accounts. The relevant figures for electricity and gas-

oil sectors are estimated using EDAS and IEA statistics. Sectoral distribution of public sector fixed investments is based on data published by the Ministry of Development. Energy investments are disaggregated using data obtained from TEIAS.

Institutions: The remaining parts of activity and commodity accounts in the SAM are calculated as residual so as to ensure column sum and row sum balance.

2.2. Disaggregation of the Electricity Sector

In this section, we introduce the dynamics of intermediate demand interactions among different categories of power sector participants. This is followed by separation of generation into private and public sector and the introduction of four satellite accounts for the electricity industry. Intermediate power use by electricity sectors is strongly related to the market structure. The interaction among participants is complex. For instance, state-owned generator (EUAS) can sell power to the state-run wholesale company (TETAS) and distribution companies (EDAS) under universal service obligations or at the balancing and settlement market (PMUM). Also, TETAS can buy and sell from EUAS; PMUM buys all output of BO, BOT, and TOOR plants, and sells to distribution companies and eligible consumers. We simplify these transactions in Figure 1.

Figure 1. A simplified version of the structure of the Turkish electricity market. Note: Gen Pu – public sector power generation; GenPriv – private sector power generation; TETAS – state-run wholesale company TETAS; PMUM – balancing and settlement market; Whols – private sector wholesale trading companies; Dis.co – distribution companies; Tet.elg – TETAS eligible consumers; Eligible cons. – Eligible consumers.

The key characteristic of our SAM is the sectoral disaggregation which emphasizes the electricity sector. Electricity-related data are not available in the official IOT. We used data from IEA, grid operator (TEIAS), energy mar-
ket regulator (EPDK), state-run utility (EUAS), state-run wholesale company (TETAS), state-run retail company (TEDAS), state-owned natural gas company (BOTAS), and private power companies. We obtained detailed supply-side data from the grid operator to compute I-O coefficients for electricity sectors. Data availability was a major constraint as generation data are available by TEIAS but demand-side data were largely unavailable. Supply-side and demand-side data for the remaining energy sectors, i.e., gas-oil and coal, are estimated using IEA statistics and data published by regulator.

We first split the electricity account into public and private generation sectors. Then, we introduce four satellite accounts: (i) state-run wholesale trading (TETAS), (ii) private sector wholesale trading, (iii) distribution companies (EDAS), and (iv) organized power market (day-ahead market and the balancing and settlement market PMUM). Public sector generation includes power generated by EUAS and its affiliates as well as BOO, BOT, and TOOR plants. Private sector generation sector includes independent private generators and autoproducers. We include these plants in the public sector because their output is subject to price guarantees by the state for a certain period of time, usually 15-20 years. Therefore, they are not exposed to market risks in competitive markets. Most of the state-run utilities’ sales are also guaranteed via bilateral agreements with TETAS and distribution companies. We treat PMUM as a sector because it gathers buyers and sellers in an anonymous power trading setting.

Most average prices at which power is purchased and sold in various segments by market participants are available from the relevant institutions. However, unregulated prices which are determined through bilateral negotiations between counterparties are missing. We make some assumptions about unregulated power prices:

1. The price at which private sector producers sell to eligible consumers is 2.5% lower than the regulated price imposed on distribution companies.
2. The price at which wholesale companies sell to eligible consumers is the same as the price they charge to PMUM.
3. The prices IPPs and private wholesale companies sell to distribution companies are the same as respective average prices the former two sold to PMUM.
4. The price autoproducers bought power from IPPs and TETAS is the same as the price they bought from PMUM.
5. The price IPPs bought electricity from IPPs is the same as the price they paid to PMUM.
6. The price wholesale companies sold power to IPPs is the same as the price sold to PMUM.
7. The price private wholesale companies sold to other wholesale companies is the same as prices these firms sold to PMUM.
8. The price private wholesale companies bought power from IPPs and autoproducers is equal to the weighted average price IPPs and autoproducers bought from PMUM.
9. The average export price of private wholesale companies is calculated as follows: we take the difference between total power exports from Türkstat and TETAS in and then divide it by physical volumes in MW exported by wholesale companies.
10. The import price of private wholesale companies is the same as the import price of TETAS.

The cost of fuel used in generation is the most important intermediate input expenditure for electricity sectors. We calculate the generation mix of state-run and private utilities using TEIAS and TETAS data. We need to compute costs of generation in monetary terms. While no such data are available for state-run utilities, private sector generation costs by resources are available for 2013 in Aksa Enerji (2014). Once the costs of fuel are calculated for private generators, we subtract these from overall generation costs by each fuel type to compute fuel costs for public generators. We then calculate the shares of private and public sector generation sectors’ spending on fuels in total fuel cost by generators.

I-O data for satellite accounts, are presented in Table 2. Payments to services by TETAS, PMUM, and EDAS are estimated using data from reports published by TETAS, TEIAS, and TEDAS while payments to goods and services by satellite accounts to other sectors is assumed to be zero.

**Electricity - Demand Side:** Detailed information about the volume of power consumption by sectors is available in IEA (2012). Residential consumption of power was entirely from distribution companies. Before power sector reform was introduced in 2001, only distribution companies were eligible to deliver electricity to industrial and residential end-users. Information about which industries purchase power from which group of power market participants is not available. Therefore, we assume that these participants distribute power to all sectors in the same proportions as their shares in IEA data. An exception is TETAS sales to eligible consumers, which are available from the company’s reported sales.

**Oil, Natural Gas, and Coal - Demand Side:** For sectoral disaggregation of oil, natural gas, and coal at NACE Rev. 3 level of sectoral classification, we use physical quantities reported by IEA. Oil and oil product prices are not regulated so there is no single price for these commodities. We use oil indicative average respective producer prices in EPDK (2011: 90). Residential oil consumption is calculated using physical volumes from IEA data. Regulated natural gas prices are taken from official statistics to estimate gas consumption in monetary terms. We assume that industrial users, including in the electricity sector, purchase gas at...
the wholesale price of organized industrial zones. The gas price for residential consumers is taken from the subscribers category of regulated prices charged by distribution companies. To estimate the purchase price of household consumption of gas, we assume that 76.2% of total natural gas bill is the cost of gas and the remaining part is the distribution fee and indirect taxes.

2.3. Balancing the SAM

The constructed SAM ends up unbalanced owing to usage of data from different sources. However, row sums in a SAM must equal the columns sum for the respective accounts. We employ the RAS (Reliability, Availability and Serviceability) method as in United Nations (1999). The RAS method is an iterative method of bi-proportional adjustment of rows and columns and it is widely used to update and revise IOT when new information are available.

3. Conclusion

The aim of this paper was to construct a SAM for Turkey with a special focus on electricity market using data for the year 2010. The unavailability of electricity market aggregates in the IOT should be addressed. Significant discrepancies were observed in the data but we did our best to reconcile these data.

References


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Table 1. Macro-SAM for 2010 (unit: billion Turkish liras)

Table 2. Simplified Turkish power market structure in 2010 [unit: million TL] (Source: TEIAS/PMUM TEIAS/MYTM EUAS EDAS TETAS EPDK, author’s calculations.)
Should Turkey Change the Regulatory Model for Electricity Distribution?

Fuat Oğuz* and Koray Göksal**

The regulatory model in Turkey is not well suited for the changing market environment and a new model has to be designed in order to create necessary incentives for companies to increase customer satisfaction rather than following government intervention beyond regulation. Our aim is to discuss the actual and potential problems of the existing tariff model and show the need for a major revision in the regulatory framework, if the liberalization of the industry is expected to continue as planned.

1. Introduction

The regulatory model of electricity distribution was established in 2001 in Turkey. The lack of investments, vast inefficiencies in the industry and increasing demand contributed to the move toward liberalization (Cetin and Oguz, 2007). However, the model was not designed to push Distribution System Operators (DSOs) to follow the privatization agreements completely. The electricity industry evolved toward a more competitive structure, and companies began to see that electricity generation was not a risk-free market. The establishment of the energy exchange and the evolution of market transactions created problems for companies and put pressure on the downstream segments of the market.

During the design period of the tariff model, the infrastructure was not expected to change quickly. The natural monopoly characteristics of the industry assumed to remain intact for the foreseeable future. Thus, observing inputs and guaranteeing distribution companies some profit margin through regulatory processes were thought to be the right way to go. Another problem of incentive regulation model is the information asymmetry between the regulatory agency and the regulated firm. Since the regulatory agency depends on the firm for information, this creates tensions in the implementation process. Asymmetric information gives way to stricter regulations on DSO.

While there is a growing literature on different aspects of the Turkish electricity markets, the regulatory model and its assessment are usually ignored. The dearth of works that focus on the economic consequences of the tariff model provided the motivation for this paper. We believe to contribute to the literature by discussing the potential and actual problems with the existing model and address policy issues surrounding it.

2. Reasons for Reconsidering the Regulation of DSOs

The regulatory model of electricity distribution was designed during a period where the technology was relatively stable. When Stephen Littlechild and M. Beesley (1980) first developed incentive regulation, it was thought to be a method to eliminate the problems of the rate of return regulation. During the last decade the technology advanced and the natural monopoly model started to create inefficiencies in the tariff model.

In the traditional model, DSOs had the role of being ‘transporters’ of electricity. Thus, they have to provide some kind of universal access to electricity. They have to provide this service as efficiently as possible and transfer gains of efficiency to consumers. The regulatory model was designed under these conditions. However, the role of DSO changed substantially in the last decade. The following are major changes:

1. One fundamental change is in advances in distributed generation. The advances in wind and solar power and small scale hydro turbine change the structure of tariffs. Advances in small scale generation such as rooftop solar also changes the relationship between the DSO and consumer.

2. Another important development is advances in the storage technology and electric vehicles. The distribution tariffs started at a time when distribution meant using a resource that was not storable, and the use was not a substitute for other energy resources such as oil.

3. Technological advances have the tendency to decrease the DSO revenues (Pérez-Arriaga, 2010). The integration of distributed generation, energy conservation measures and other factors reduce electricity demand during the implementation periods.

4. The revenue-cap model does not encourage innovation as expected. Empirical studies show that the ratchet effect is more prominent in the industry. The model does not have any variable or component to reduce the ratchet effect.

In this changing environment, the role of DSOs also evolve. They become more than just a network operator.
Advances in financial and technological dimensions require changes in the tariff model as well. They create value as well by being the key player in the value chain of electricity industry.

3. The Outline of the Existing Tariff Model in Turkey

The Turkish regulatory model for electricity distribution follows European countries to some extent. In this model,

\[
\text{Allowed revenue} = \text{Authorized Opex} + \text{Depreciation} + \text{Opportunity Cost (WACC)} + \text{Tax Difference}
\]

And, the CAPEX is determined in the following way:

\[
\text{Authorized Capex} = \text{Base expenditures} + \text{Physical Growth} + \text{Productivity Parameter (X)}
\]

The fundamentals of the model is the same in many countries. Yet, small differences occur.

4. Shortcomings of the Existing Model

Now let us look at the problems of the existing model more closely.

1. A major issue with the existing tariff model is its assumption of constant technology. Since the model was designed in a period where the technology of distribution did not change substantially, the evolution of technical and economic aspects of tariffs was not part of model.

2. The existing tariff structure uses a revenue-cap model. It requires the national regulatory agency (Energy Market Regulatory Agency, EMRA) to follow DSOs very strictly in order to minimize the potential rent-extracting in the sector.

3. The way OPEX and CAPEX are defined, implemented and estimated creates problems for EMRA. A major reason is the problems with data. Official numbers and predictions, in some cases, did not fit with the realities of the industry. The problem with the data is reflected in the tariff models as well. The productivity variables calculated in the model do not reflect the realities of the industry.

4. EMRA corrects errors in the initial tariff decisions during the implementation period. This is usually done by postponing the problem to the next tariff period, in order not play with the existing tariffs a lot. Yet, this behavioral pattern creates wrong incentives in the industry and encourages firms not to take action to improve themselves.

5. A major issue in this context is about the productivity variable in the tariff model. The existing tariff structure is supposed to push companies to improve their productivity during the implementation period. They are expected to keep the gains of productivity. However, more productive firms are expected to have less room for improvement in the next period. Because of the difficulty of monitoring the sector, some DSOs prefer not to increase productivity as planned in the initial tariff decisions.

6. Most importantly, the methodology of EMRA on distribution tariffs is not clear. The reasoning and details of models are not made public. Thus, we try to understand it by guessing the logic of the regulator.

Regulators began to see that it is not easy to follow income tables and expenditures of DSOs, as theory expected. Being rational players, distribution companies used the system for profit-maximizing, which was not an assumption of the initial model. The model assumed that companies would act according to the rules of the model. This was also not realistic.

Recently, the government increased pressure over the DSO to improve customer satisfaction, their infrastructure, reduce costs and increase their investment activities. Yet, the current regulatory model is not appropriate for achieving these goals. It is time to look at alternative models rather than focusing on monitoring inputs in the revenue requirement tables of DSOs.

Conclusion

The incentive regulation model is used widely around the world. Its problems are also well documented. The problems with the price cap and revenue cap models in the distribution market led to a move toward a more output oriented tariff model. The problems of estimating, benchmarking and even defining CAPEX and OPEX push regulators toward observing output variables so that the need for investigating the expenditures of DSO is reduced. As a result, the output based, or result-based, regulatory models have become the subject of research.

A new model in this direction is introduced by the United Kingdom. The model is known as ‘the RIIO model’ (Revenue = Incentives+ Innovation + Outputs). In this model, the outputs such as consumer satisfaction, reliability and availability, safety, connectivity, environmental impact and social responsibilities are being considered. Each DSO submits an 8-year plan that specifies total expenditures rather than CAPEX and OPEX separately. The aim is to balance conflicting incentives for reducing costs and increasing investments. While this approach is new and its success is not certain, the need to modify the revenue cap model is clear. Turkey, in the face of the problems of the existing tariff model, should revise it and do it in a way to encourage productivity rather than manipulating the tariff model.
References

