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Impact of Electricity Sector Reform Implementation on Turkish Economy: A Social Accounting Matrix Analysis

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ABSTRACT

Turkey launched an extensive reform in electricity sector in 2001 aiming at liberalization of electricity markets and promotion of competition. Privatization of state-owned distribution companies was finalized in 2013, while the process goes on for a number of generating plants. A new electricity market law approved the same year, aiming to establish the electricity stock exchange, expanded the scope of reform. Private sector is expected to increase efficiency, provide better services at lower prices and make considerable investments to increase capacity for future increases in demand. This paper examines the impact of electricity reform implementation on the electricity sector and overall Turkish economy. We employ a social accounting matrix analysis to examine different scenarios when reform is successful or fails to deliver desired results. Empirical findings show that effects of a demand increase for electricity on gross domestic product are 10.5 percent lower when supply is limited due to failure of successful implementation of reform, compared to the case when supply is unlimited.

Keywords: social accounting matrix, electricity reform, constrained multipliers

Elektrik Sektörü Reformu Uygulamalarının Türk Ekonomisine Etkisi: Bir Sosyal Muhasebe Matrisi Analizi

ÖZ

Türkiye, elektrik sektörünü serbestleştirmek ve sektördeki rekabeti artırmak için 2001 yılında piyasa reformu yapmaya başlamıştır. 2013 yılına gelindiğinde kamuya ait elektrik dağıtım şirketlerinin özelleştirilme süreci tamamlanmışken, bir kısım üretim tesisi için bu süreç devam etmektedir. Ayrıca, elektrik borsasının kurulmasını da içerecek şekilde yeni yasa ile reformun kapsamı genişletilmiştir. Özel girişimin, verimliliği artırması, daha düşük fiyatlarla daha kaliteli hizmet sağlaması ve Türkiye'nin artan elektrik talebini karşılamaya yönelik olarak ciddi miktarlarda kapasite yatırımı yapması beklenmektedir. Bu çalışma elektrik sektöründe uygulanan reformun sektör çapındaki ve Türkiye ekonomisi için etkilerini incelemektedir. Sosyal Hesaplar Matrisi analizi kullanılarak reformun etkileri incelenmekte ve etkilerin beklentiler ile uyumlulukları araştırılmaktadır. Reformun sektörde beklenen etkileri yaratmaması durumunda ortaya çıkabilecek bir sorun arzın zaman içerisinde artan talebi karşılayamaması olabilir. Ampirik bulgulara göre, elektrik talebinde yaşanacak bir artışın gayri safi yurtiçi hasıla üzerindeki etkisi sınırlı arz varsayımı altında sınırsız arz varsayımına göre yüzde 10.5 oranında daha az olmaktadır.

Anahtar Kelimeler: sosyal hesaplar matrisi, elektrik sektörü reform, kısıtlanmış çarpan

Turkish economy has been growing at a fast pace in recent years. This, in turn, has translated in higher demand for electricity. Projections by the Turkish Electricity Transmission Company (TEIAS) show that electricity demand will increase at an average rate of 7.5 percent between 2011 and 2020 (TEIAS 2011). This rate is lower than Turkish economy's average annual growth rate of 5.12 percent between 2000 and 2012, which implies electricity sector has to grow at faster rates than economy growth rates to meet the ever-increasing demand.

TEIAS projections also show existing capacity will not match electricity demand as of 2016. Assuming that ongoing power plant projects will start generating electricity at scheduled time adding to existing capacity, the projections show electricity supply will not match demand as of 2018, unless additional investments are made.

In 2001, Turkey launched an extensive reform program in electricity sector. The vertically integrated state monopoly was unbundled into generation, transmission, distribution, wholesale and retail segments and an independent regulatory body was established. Parallel to these changes, plans for the privatization of 20 distribution companies owned by the state distribution company (TEDAS) and a considerable number of generating plants owned by the public generator (EUAS) were revealed in 2004 (MENR 2004). The privatization[1] of distribution companies was completed in September 2013, whereas the process goes on for generating plants.

The reform is expected to deliver higher efficiency in the sector and foster competition in electricity markets. The burden on public finances will decrease as a result of privatizations and the private sector is expected to provide better quality services at lower prices. Firms are also required to make serious amounts of investment to maintain capacity in place to meet electricity demand increases in the future.

The reform was extended further through a new electricity market law approved in 2013. Of the most essential changes are the legal separation of distribution and retail companies and the establishment of the Electricity Stock Exchange, where electricity will be traded like other commodities such as oil, natural gas on the bourse.

In this paper, we look at the impact of electricity reform implementation on the sector itself and overall the economy. We use social accounting matrix multiplier (SAM) models to compare possible reform outcomes. Results show that a one unit (Turkish liras) increase in the exogenous demand for electricity, say investments, will lead to a 1.15 unit increase in production of electricity and a 1.18 unit increase in the country's gross domestic product (GDP). Moreover, assuming that electricity supply becomes limited due to failure of reform in delivering desired results, the constrained SAM multipliers show the effects of a demand shock for electricity on the sector and overall economy will be smaller, compared to the case when supply is unlimited.

This article is organized as follows: the next section explains the methodology used in the paper. In section 3 we discuss policy scenarios, followed by reporting of empirical findings in section 4. In section 5 we conclude.

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[1] Through concessionary agreements, ownership is not transferred to the private sector.

METHODOLOGY

To evaluate the impact of electricity reform implementation on the Turkish economy we employ a SAM multiplier analysis. Thorbecke (2000:2) defines SAM as "a comprehensive and disaggregated snapshot of the socioeconomic system during a given year." The matrix maps inter-sectoral relations and relations among different institutions such as households, firms, government, as well as capital and rest of the world accounts for an economy, widely used by analysts and policy makers[2].

Electricity's output is a vital input for the other sectors of the economy and an important consumption good for households as well. Thus, we expect the sector to demonstrate strong multiplier effects, compared to the other sectors. Moreover, out of the main electricity market reform objectives, we expect successful implementation of reform to have a better effect on the economy, compared to the case when reform fails to deliver desired results.

The SAM multiplier model has advantages over input-output (IO) multiplier models. Direct effects of a shock are captured by both models. However, while IO multipliers capture indirect effects on other producing sectors through backward and forward production linkages, they fail to count for consumption linkages. This is an important drawback, given that research work suggests consumption linkage effects are larger than production linkage effects in developing economies (Breisinger et.al. 2009). SAM multipliers, on the other hand, capture all production and consumption linkage effects.

Accounts in a SAM are divided into 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. In the simple SAM setting below (Sadoulet and de Janvry 1995):

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

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 input coefficients corresponding to endogenous accounts. The elements of matrix M, input coefficients m_{ij} (i, j=1, 2, …, n, where n is the number of endogenous

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[2] See UN (1995), Thorbecke (1995, 2000), Breisinger et. al.(2009) for details on how a SAM is constructed.

accounts) for each endogenous account, express the ratio of the value of each cell in SAM to the corresponding column sum. These coefficients are kept unchanged in a SAM model. Finally, B is a rectangular matrix of coefficients with exogenous accounts as rows and endogenous accounts as columns.

Keeping the same matrix notation, the matrix of multipliers will be $(I-M)^{-1}$, where I is the identity matrix with ones in its diagonal and zeroes elsewhere[3]. 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 increase in production will in turn cause output in other sectors i uses as intermediate goods to increase as well. 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:

$$dX = (I-M)^{-1}\, dF$$

The leakages from this exogenous shock will be: $dL = B\, dX$.

Unconstrained SAM multiplier model assumes fixed price levels which requires an assumption for unlimited or 'unconstrained' supply. Thus, given that prices cannot respond to changes in demand, an increase in demand for some good will be met by an increase in supply.

In constrained SAM multiplier models, we drop the assumption of unlimited supply for certain sectors, assuming that the supply is fixed and any other final demand accounts previously kept fixed (in general, government expenditures, capital account and/or rest of the world) become endogenous in the model.

Turkey SAM for 2010

In this study, we use Turkey's SAM for 2010. Input-output tables published by the Turkish Statistical Institute (TÜİK) are used to construct SAM tables. The latest SAM published by TÜİK reflects Turkish economy for the year 2002. Thus, we had to use aggregate data and estimation methods developed in previous studies (Telli 2006, Erten 2009) in order to estimate the matrix for 2010.

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[3] For more on the derivation of the multiplier matrix see Defourny and Thorbecke (1984), Thorbecke (1995, 2000), Sadoulet and de Janvry (1995).

Data is collected by different official sources including TÜİK, Ministry of Finance, the Central Bank of the Republic of Turkey, the State Planning Department, Social Security Institute. We follow Erten (2009) in estimating the sectoral distribution of value added and intermediate inputs, using reports on Turkey's largest 500 industrial firms published by Istanbul Industrial Chamber (ISO 2010). The technology coefficients, which reflect inter-sectoral relations in the economy, are kept the same with those of year 2002, given lack of any other related data. The structure of macro-SAM used in this research is shown in Table 1 whereas the estimated macro-SAM for 2010 is presented in Table 2.

Activities and commodities in the SAM are partitioned into 20 sectors, namely: agriculture, transport, electricity, coal, oil and gas, metals, chemicals and petrochemicals, minerals, machinery, mining, food, paper, construction, textile, other industries and services.

As we use data from different sources, the estimated SAM was unbalanced, that is, the total row sum did not equal the total column sum for the same account. We use the RAS method to balance the SAM. It is "*an iterative method of bi-proportional adjustment of rows and columns*" (Ahmed and Preckel 2007:6), commonly used to update IO tables[4] and SAMs.

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

Table 1. Sturcture of Turkey SAM 2010

	Expenditures											
Incomes	1	2	3			4			5		6	7
			Factors			Institutions			Capital account			
	Activities	Commodities	Labor	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 investment		Domestic Demand
3.Factors												
Labor	Wages											GDP at factor cost
Private capital	Rent (pr.cap.)											
Public capital	Rent (pu.cap.)											
4.Institutions												
Households			Labor income				Transfers	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				Direct tax	Corporate 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	Labor costs	Private capital cost	Public capital cost	Household expenditures	Firms expenditures	Government expenditures	Private investment	Public investment	Rest of the world expenditures	

Table 2. Turkey SAM for 2010, Thousand TL

	Activities	Commodities	Labor	Private capital	Public capital	Household	Firms	Government	Private capital accumulat.	Public capital accumulat.	Rest of the world	Total
Activities	0	1 301 360 958	0	0	0	0	0	0	0	0	231 441 339	1 532 802 297
Commodities	459 365 334	0	0	0	0	751 987 860	0	85 733 649	359 167 910	61 378 831	0	1 717 633 585
Labor	388 939 534	0	0	0	0	0	0	0	0	0	0	388 939 534
Private capital	623 784 274	0	0	0	0	0	0	0	0	0	0	623 784 274
Public capital	20 249 557	0	0	0	0	0	0	0	0	0	0	20 249 557
Household	0	0	388 939 534	0	0	0	390 264 020	202 553 605	0	0	1 572 041	983 329 200
Firms	0	0	0	623 784 274	20 249 557	0	0	47 965 442	0	0	71 715 816	763 715 089
Government	40 463 598	97 208 070	0	0	0	69 265 115	190 928 772	0	0	0	989 494	398 855 050
Private capital accumulation	0	0	0	0	0	162 076 225	0	0	0	0	197 091 685	359 167 910
Public capital accumulation	0	0	0	0	0	0	0	56 620 451	0	0	4 758 380	61 378 831
Rest of the world	0	319 064 556	0	0	0	0	182 522 297	5 981 902	0	0	0	507 568 755
Total	1 532 802 297	1 717 633 585	388 939 534	623 784 274	20 249 557	983 329 200	763 715 089	398 855 050	359 167 910	61 378 831	507 568 755	7 357 424 081

PLACE OF ELECTRICITY IN ECONOMY AND POLICY SCENARIOS

To evaluate the weight of electricity sector in the Turkish economy, we first employ an unconstrained SAM multiplier model. Given that electricity is an important input for most sectors and is widely consumed by end users as well, we expect the multiplier effects on the economy from a shock to the electricity sector will be relatively large compared to those of other sectors. We compare the output, demand, gross domestic product (GDP) and income multipliers for each sector used in the study to compare their weight in the economy.

Then, we release the assumption that supply in the electricity sector is unlimited, that is, any increase in demand will be met by an increase in supply. In this case we adopt a more realistic scenario, where supply is kept exogenous and other accounts previously kept exogenous become endogenous.

Following, we compare both cases: the unconstrained SAM multiplier model, which reflects the case when reform implementation delivers desired results by increasing generation and distribution capacity for electricity to meet future increases in demand, to the constrained SAM multiplier model, where we assume electricity supply becomes limited and will not respond to increases in demand due to insufficient capacity. We expect the unconstrained SAM multipliers to be higher compared to the constrained ones.

The theoretical background of unconstrained and constrained SAM multiplier models and specifications of policy scenarios are discussed below.

Unconstrained SAM multiplier model

In the unconstrained SAM multiplier model, we assume the government, capital accumulation and rest of the world accounts as exogenous. Prices are fixed, thus, any changes in demand for producing sectors (activities) will be responded by changes in supply. This obviously requires an additional assumption that supply of all sectors is unlimited or 'unconstrained'. Lastly, the model assumes input coefficients for production and consumption are unaffected by exogenous demand shocks.

Let Z refer to the vector of final demands[5] for each sector (total sum of second row in Turkey's SAM introduced in the previous section). This includes endogenous final demand elements, namely demand for intermediate goods and household as well as exogenous accounts, namely government consumption, private and public investment and exports. If we denote the vector of exogenous final demand elements E, then we can express this identity in matrix notation as follows:

$$MZ + E = Z \tag{1}$$

where M is the input coefficient matrix for endogenous accounts as explained in previous section. Re-arranging we write:

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[5] Or supplies, given that demand equals supply in general equilibrium assumed by the SAM.

$$(I\text{-}M)Z = E \tag{2}$$

where *I* is the identity matrix with ones in its diagonal and zeroes elsewhere. From here we derive the multiplier formula:

$$Z = (I\text{-}M)^{-1}E \tag{3}$$

Equation (3) tells that the effect of a shock on exogenous demand E on final demand will be as large as Z, which reflects the sum of all rounds of direct and indirect effects. Information on linkage effects is embedded on coefficient matrix M and the magnitude of sectoral and overall effects is determined through multipliers embedded in the unconstrained SAM multiplier matrix $(I\text{-}M)^{-1}$.

Electricity supply in Turkish markets is mainly provided through domestic electricity generation, and a very small fraction of the overall electricity supplied to network comes from imports. In 2012, only 1.14 TWh or 0.6 percent of the total amount of electricity supplied to the network was imported. Moreover, electricity is a vital input for both industrial production and household consumption. Thus, it exhibits a high level of integration in economy structures, with strong forward and backward linkages. For these reasons, we expect unconstrained SAM multipliers corresponding to the electricity sector to be relatively large compared to other sectors.

Constrained SAM multiplier model

In the constrained SAM multiplier model we relax the assumption that supply is unlimited for all sectors. We divide sectors into two. For the first group of sectors supply is unconstrained, thus they behave identically as the sectors in the unconstrained SAM multiplier model. Meanwhile, for the second group of sectors supply is not unlimited anymore, due to the nature of the sector. Thus, we keep supply constant and in turn consider account(s) previously taken as exogenous to be endogenous.

We denote sectors that can change their production level by Z_1 and those with constrained supply as Z_2. Similarly, E_1 indicates exogenous accounts for sectors with unconstrained supply and E_2 the accounts corresponding to sectors with limited supply that used to be exogenous in the previous model but have now become endogenous. In matrix notation we get the constrained multiplier formula as follows:

$$\begin{pmatrix} Z_1 \\ E_2 \end{pmatrix} = (I - M^*)B \begin{pmatrix} E_1 \\ Z_2 \end{pmatrix} \tag{4}$$

where M* is the adjusted coefficient matrix and B is a new matrix, both of which result after re-arranging exogenous and endogenous accounts for sectors with limited supply (for details see Breisinger et. al. 2009).

The intuition behind equation (4) tells that an increase in the exogenous demand for unconstrained sectors of magnitude E1 will have an impact on the economy equal to Z_1. On the other hand, given that supply in constrained sectors is exogenous, it is accounts that were previously exogenous and have now become endogenous (E_2) that change as a response to a shock in demand (Z_2). In other words, an increase in demand (Z_2) will cause an increase of the endogenous account (E_2). It is crucial to make a rational assumption on which accounts previously treated as exogenous will become endogenous.

At this point, we can discuss how the constrained multiplier model relates to the electricity sector in Turkey. First, it is obvious that this model suits better to real conditions of the sector. Large investments are required in generation, transmission and distribution sectors to substantially increase electricity supply to meet respective increases in demand. These are generally sunk costs, and it might take years to complete the construction of a power plant. Thus, electricity supply is not elastic in the sense that it cannot be easily increased to meet a rise in demand.

Moreover, TEIAS forecasts through its capacity projections (TEIAS 2011) that given the existing capacity electricity demand will not be met by supply as of 2016. Assuming that ongoing power plant projects will start generating at the scheduled time in addition to existing capacity, the projections show electricity demand will not be met by supply as of 2018 unless additional investments are made.

The private sector is required to make investments in electricity distribution and generation companies transferred to them for management.

Should reform deliver desired results, the generation and distribution capacity will be increased sufficiently to meet increases in electricity demand in coming years. Thus, an unconstrained multiplier model would suit this scenario well. However, if reform fails to deliver desired results, supply of electricity will become limited, hence, a constrained multiplier model is more useful to examine what the impact on the economy will be in this case.

We develop four different cases with the constrained multiplier model: (1) electricity supply kept constant and private investments become endogenous; (2) electricity supply kept constant and government expenditures become endogenous; (3) electricity supply kept exogenous and exports set endogenous; (4) supply of electricity, coal & oil and natural gas sectors kept fixed and private investments set endogenous. The reason for limiting supply of other energy sectors in the fourth case is the same as for electricity. To illustrate with an example, a rise in exogenous demand for coal may not be followed by an increase in coal production if deposits do not exist or the industry does not possess the necessary technology to do the mining in new fields. Findings for each simulation are revealed in the following section.

EMPIRICAL FINDINGS

Results from the unconstrained multiplier model confirm our expectations of electricity's well integrated position in the economy and larger multipliers compared to most other industries. Table 3 summarizes results for each sector, showing the respective output, demand, GDP and income multipliers.

Figures corresponding to the electricity account tell that a one unit (Turkish liras, TL) increase in the exogenous demand (say, investments) will lead to a GDP increase by 1.18 TL. Given linearity of the model, we make the same interpretation for different magnitudes of the shock: a one-million TL increase in private investments in the electricity sector will be followed by a 1.18 million TL increase in GDP, and so on.

The output multiplier shows that an increase by one unit of exogenous demand in electricity will cause a 1.78 unit increase in the output of producing activities. Similarly, the unitary shock will lead to an increase in demand for all commodities by 2.12 units, whereas the household income will increase by 0.73 units.

The change in total demand as a result of the shock is obviously larger than the change in output, as shown by respective multipliers. This shows that not all the additional demand generated by the initial increase in electricity's exogenous demand is met by domestic production. This result indicates the high import dependence of electricity sector's intermediate goods, such as natural gas and coal.

Moreover, a unitary shock in exogenous demand for electricity will lead to a 1.15 unit increase in the production activities of the sector, as shown by multipliers at a sectoral basis in the first column of Table 4. The GDP multiplier is higher for capital than for labor, reflecting the higher capital-intensity nature of the electricity sector. The sum of all multipliers corresponding to electricity industry shows a unit change in exogenous demand in the sector will generate about seven folds of that amount of change in the overall production of the economy.

Table 3. Unconstrained SAM multipliers

Sector receiving the shock	Output multiplier	Demand multiplier	GDP multiplier	Income multiplier
Construction	1.9388	2.3144	1.2922	0.9457
Services	1.8703	2.2252	1.2868	0.8860
Electricity	1.7734	2.1234	1.1776	0.7289
Transport	1.7961	2.1426	1.1370	0.7370
Mining	1.6312	1.9739	1.1294	0.6693
Agriculture	1.7778	2.1334	1.1258	0.7307
Other industry	1.0219	1.6391	0.8092	0.5773
Paper	1.1791	1.8077	0.7409	0.5174
Textile	1.2546	1.8825	0.7301	0.5141
Food	1.2642	1.9287	0.6376	0.4593
Minerals	0.8986	1.5682	0.5817	0.3631
Coal	0.5499	1.3788	0.3536	0.2620
Chemicals	0.3124	1.2076	0.1983	0.1468
Machinery	0.2900	1.2013	0.1836	0.1311
Metals	0.2330	1.1683	0.1545	0.1250
Gas and oil	0.1711	1.1065	0.1178	0.0724

Although the overall effect might be too much exaggerated[6] due to strong assumptions of the model, unconstrained SAM multipliers are very helpful to indicate which sectors of the economy generate highest effects upon a shock. Table 3 shows electricity is one of the sectors that exhibit highest multipliers following a unitary shock to the exogenous demand. For example, we notice an increase by 1 million TL in private investments in the oil and gas industry would lead to 0.12 million TL increase in GDP, or only 10 percent the impact a shock in electricity sector would have had on GDP. This is due to high leakages in the oil and gas industry, whose primary intermediate demands are heavily supplied by imports, rather than domestic production (extraction).

One important conclusion from the comparison of multipliers among industries for policy makers is that priority could be given to sectors that generate highest effects on the economy, when deciding on how to distribute incentives in the framework of a growth and development strategy.

Findings from constrained multipliers model

Electricity sector differs from other sectors in the sense that production must occur at the moment the output (electricity energy) is consumed. Thus, the market is demand driven and some extra capacity over the operating generation capacity must exist for any abrupt increases in demand and peak loads.

TEIAS projections show that demand will exceed existing capacity as of 2016, and assuming that ongoing power plant construction projects are finalized in scheduled time, the supply will not be sufficient to meet increasing demand as of 2018, unless extra investments are made. This is likely to happen if reform in electricity sector fails to deliver desired results, particularly regarding requirements for additional investment by the private sector, in which case domestic electricity supply would become fixed or inelastic, in the sense that it would be insufficient unable to respond to increases in demand. Hence, in the constrained multiplier model, we assume domestic supply of electricity is fixed and set one of previous exogenous demand elements (investments, government expenditures, exports) as endogenous. The first three simulations show results when each of the three previous exogenous demand elements is set endogenous, separately.

Case 1 results show that the overall effects of a unitary increase in exogenous demand for electricity, when supply is kept fixed and private investments are set exogenous instead, are smaller than the effects caused by the same shock when supply is endogenous. Thus, comparing the GDP multiplier of the unconstrained model with that of the constrained model, we note effects of a shock to electricity demand on GDP would be 10.5 percent lower when supply is kept exogenous. Similarly, effects on output of a unit demand shock in electricity will be 10.9

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[6] For example, Haggblade, Hammer and Hazell (1991) find that unconstrained models overestimate agriculture sector multipliers by a factor between two and ten.

Table 4. Simulation results: unconstrained vs. constrained SAM multipliers

		Unconstrained multipliers	Constrained multipliers, electricity supply always fixed				
			Case 1	Case 2	Case 3	Case 4	
		Unconstrained, 1 unit shock in exogeneous demand for electricity	Private investments endogenous	Government expenditures endogenous	Exports endogenous	Gas&oil, coal supply also exog., private investments endogenous	
			Unitary supply shock to electricity				
Activities	Agriculture	0.0853	0.0793	0.1394	0.1119	0.0778	**Output multipliers**
	Transport	0.1164	0.1152	0.1799	0.1527	0.1129	
	Electricity	1.1521	0.9323	0.9323	0.9326	0.9323	
	Coal	0.0073	0.0064	0.0084	0.0071	0.0000	
	Gas and oil	0.0073	0.0062	0.0060	0.0062	0.0000	
	Metals	0.0012	0.0017	0.0015	0.0303	0.0016	
	Chemicals	0.0070	0.0069	0.0114	0.0309	0.0067	
	Minerals	0.0025	0.0038	0.0043	0.0095	0.0037	
	Machinery	0.0072	0.0066	0.0095	0.0282	0.0064	
	Mining	0.0007	0.0041	0.0012	0.0057	0.0040	
	Food	0.0213	0.0199	0.0344	0.0361	0.0195	
	Paper	0.0058	0.0060	0.0099	0.0107	0.0059	
	Construction	0.0034	0.0262	0.0082	0.0055	0.0257	
	Textile	0.0214	0.0210	0.0346	0.0629	0.0206	
	Other industry	0.0041	0.0248	0.0109	0.0383	0.0243	
	Services	0.3304	0.3193	0.6046	0.4305	0.3125	
Commodities	Agriculture	0.0938	0.0872	0.1532	0.1149	0.0856	**Demand multipliers**
	Transport	0.1278	0.1264	0.1975	0.1527	0.1239	
	Electricity	1.2357	0.1946	0.2017	0.1970	0.1938	
	Coal	0.0264	0.0233	0.0306	0.0256	0.0230	
	Gas and oil	0.0812	0.0689	0.0667	0.0677	0.0687	
	Metals	0.0101	0.0147	0.0129	0.0190	0.0141	
	Chemicals	0.0416	0.0413	0.0680	0.0570	0.0401	
	Minerals	0.0052	0.0079	0.0091	0.0077	0.0077	
	Machinery	0.0464	0.0424	0.0612	0.0508	0.0415	
	Mining	0.0007	0.0046	0.0013	0.0022	0.0045	
	Food	0.0390	0.0365	0.0630	0.0478	0.0358	
	Paper	0.0100	0.0102	0.0169	0.0136	0.0100	
	Construction	0.0034	0.0262	0.0082	0.0043	0.0257	
	Textile	0.0349	0.0342	0.0563	0.0502	0.0335	
	Other industry	0.0077	0.0465	0.0204	0.0105	0.0455	
	Services	0.3596	0.3475	0.6579	0.4273	0.3401	
Factors	Labor	0.2601	0.2501	0.3434	0.3355	0.2440	**GDP* multiplier**
	Private capital	0.8946	0.7837	0.9580	0.8980	0.7736	
	Public capital	0.0228	0.0203	0.0268	0.0243	0.0193	
Institutions	Households	0.7289	0.6610	1.1511	0.8426	0.6492	**Inc. mult.**
	Firms	0.9175	0.8040	1.0492	0.9896	0.7929	
	Government	0.4443	0.0000	0.5346	0.0000	0.0000	*
Capital Account	Priv. cap. accum.	0.1201	0.1089	0.0000	0.0000	0.1070	
	Pub. capital accum.	0.0000	0.0000	0.0000	0.0000	0.0000	
	Rest of the world	0.4356	0.0000	0.0000	0.4765	0.0000	
			Multipliers				
	Output	1.7734	1.5797	1.9965	1.8991	1.5540	
	Demand	2.1234	1.1123	1.6247	1.2484	1.0934	
	GDP	1.1776	1.0541	1.8629	1.2577	1.0369	
	Income	0.7289	0.6610	1.1511	0.8426	0.6492	

*GDP multiplier is the sum of factors and government multipliers.

percent lower and those on demand 9.3 percent lower if supply is inelastic, in the sense that it cannot respond to increases in demand. The effects of the shock on total demand in Case 1 will be 47.6 percent lower than the effects on overall demand when supply is endogenous. Obviously, the difference between demand multipliers in unconstrained and constrained models is even larger. The reason is due to the fact that supply for electricity cannot respond to the shock in exogenous demand (only investments for electricity can), thus no increases in the sector's intermediate demand will be exhibited.

The 0.93 multiplier corresponding to activities of electricity sector in Case 1 reveals the increase in private investments for electricity as a response to the demand shock, rather than in supply (which is kept fixed). The multiplier effects of other sectors in this case are also relatively lower, compared to their counterparts in the unconstrained model.

To conclude for Case 1, results indicate that the effects of a demand shock for electricity will be larger the more responsive domestic supply for the sector is. Thus, following changes in regulatory setup and privatization of all distribution companies as well as a considerable number of generating plants, authorities must make sure reform is properly implemented and private firms stay loyal to their investment commitments. Inability to build up capacity in electricity generation and distribution would lead not only to an outage crisis, but to a lower performance of all sectors in response to any demand shocks.

In Case 2, we look into the effects an electricity demand shock would have on sectors and the economy as a whole, when electricity supply is fixed and government expenditures to the electricity sector become endogenous. In this case, the increase in demand will be met by an increase in government expenditures in the sector, rather than in domestic supply. Interestingly, output, GDP and income multipliers are higher for this case, compared to those of the unconstrained SAM multipliers model. The demand multiplier, on the other hand, although larger than the respective multiplier in Case 1, is lower compared to the corresponding figure in the unconstrained model, for the same reasons mentioned in Case 1 above.

It is important to mention here that the multipliers are lower compared to the unconstrained model in which public expenditures are kept constant and only investments and rest of the world accounts are kept exogenous.

Although assuming government expenditures endogenous for either model seems appealing, this assumption hardly reflects the reality, since government expenditures allocated in different sectors of the economy are planned yearly and fixed and cannot be changed according to the needs of each sector.

Case 3, in which domestic supply is kept fixed and net exports are set endogenous, exhibits similar results to Case 2. Here, an increase in exogenous demand for electricity is met by imports, rather than domestic supply. Multipliers for this case are also lower compared to unconstrained multipliers in a model where rest of the world account is set endogenous and only investments and government accounts are kept exogenous.

Although assuming trade for electricity endogenous is not realistic for the current settlement in Turkish electricity markets, this may change in the future. Turkey is committed to expand its interconnection networks with all neighboring countries and once infrastructure is in place, electricity trade is expected to particularly increase after the electricity stock exchange starts functioning in 2014[7].

In Case 4 domestic supplies of electricity, gas and oil and coal sectors are kept exogenous and private investments to these sectors are set endogenous. The rationale for keeping the other energy sectors' supply fixed is similar to that used for the electricity sector: unless there is abundance of raw materials used in production of these sectors, namely oil, gas and coal, or the necessary investments to increase the production (extraction) capacity in these sectors are not made, domestic supply can hardly respond to increases of exogenous demand in these sectors. This is relevant for electricity, given that natural gas, oil and coal are key inputs to generation of electricity, hence an increase in supply of electricity as a response to a demand shock will only be possible if there is sufficient abundance of outputs of these sectors.

Multipliers for Case 4 are lower compared to both unconstrained SAM multipliers and multipliers for Case 1 of the constrained model. This implies that electricity sector and the economy as a whole will perform worse due to limitations in electricity sector domestic supply, but also due to limitations in domestic supply of other energy sectors such as gas, oil and coal. This implies that the economy as a whole would benefit more from successful implementation of reform in other energy sectors parallel to that in the electricity sector.

CONCLUSIONS

In this paper we have used constrained and unconstrained SAM models to compare possible outcomes of the implementation of reform in the electricity sector.

The unconstrained SAM multipliers confirm expectations on the key role electricity sector in the economy, as a vital input for both industrial production and household consumption. Electricity sector delivers much higher effects on the economy after a unitary positive shock in exogenous demand compared to other sectors. This implies electricity sector has strong direct and indirect linkages and the leakages from imports (and/or taxes) are smaller compared to other sectors.

The assumption of unlimited supply of electricity is released in the constrained SAM multiplier model, setting in turn previous exogenous demand elements such as investments, government and rest of the world accounts as endogenous. Results from simulations show that constraints to supply limit positive effects from an increase in exogenous demand for electricity, compared to the case when domestic supply

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[7] See "The electricity stock exchange will minimize extra profits" available at http://www.ekoayrinti.com/news_detail.php?id=135884 as of 22 Nov. 2013

is assumed unconstrained. This implies that authorities must make sure electricity sector reform delivers desired effects and private companies keep all their investment commitments after privatization of generation and distribution companies.

Lower constrained multipliers at a sectoral level imply limitations in electricity supply would affect not only performance of the electricity sector but that of other sectors as well.

When government expenditure for electricity is set endogenous as domestic supply of electricity is limited, the multipliers are larger compared to unconstrained SAM multipliers where government, investment and rest of the world are exogenous. However, the situation reverses if government account is also set endogenous and only investment and rest of the world accounts are kept fixed. Although appealing, this scenario is far from being real, as government expenditures are planned yearly and fixed, and do not change according to needs of sectors.

Setting rest of the world account endogenous reveals higher multipliers for both the unconstrained and constrained models. Although electricity trade volume is currently very low, Turkey is committed to expand its interconnection networks with neighbors. Results of this scenario will be meaningful once infrastructure is in place and trade volumes for electricity increase substantially, as is expected to happen after the electricity stock market starts functioning as of 2014.

Limiting domestic supply for other energy sectors that are key inputs for electricity generation also reveal lower multipliers compared to the unconstrained model. This implies in order for reform in electricity sector to be successful, it should go parallel with reform in other related sectors as well, such as natural gas and oil, and coal.

To sum up, our SAM multipliers analysis shows that if electricity reform fails to deliver desired results and supply is unable to meet ever increasing demand for electricity energy – as TEIAS forecasts will happen unless additional investments are made to increase capacity – this will translate not only to power outage crises, but also to a poorer performance of other sectors in the economy as well.

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