

CHAPTER 5

Policy Analysis: Toward a Green Development Pathway for the Peripheral World

The key objectives of this chapter are to address the issues of duality and informalization as characterized by peripheral development. The main aim is to identify the set of viable environmental policies against climate change within general equilibrium analytics, constrained by peripheral development. The computable general equilibrium (CGE) apparatus will be utilized as a social laboratory device to provide “what if?” characterizations across various fiscal-cum-environmental instruments of abatement control, and as a comprehensive strategy toward a more equitable and sustained development pathway.

It should be noted that the framework consistently emphasizes on regional diversification and dual relations of production and accumulation along with fragmented labor markets; rather than treating the Turkish national economy as a whole homogeneous unit, it seeks to intervene in a heterogeneous structure both location and sector wise.

The first section investigates the basic characteristics of the business-as-usual (BAU) pathway for the Turkish economy under the given policy framework and historical trends into the 2040s. An alternative green development pathway is then invoked to identify the applicable instruments for emission abatement and improved social welfare within a more equitable framework. The chapter closes with an overall discussion, concluding comments, and an epilogue to attain lessons for the developing world at large.

5.1 INCEPTION OF THE BUSINESS-AS-USUAL

In the applied general equilibrium literature, the evaluation of alternative policies is generally portrayed and studied with reference to a base-run reference (BAU) scenario. This reference scenario is important for depicting a well-defined and coherent path of the economy and for reflecting its major underlying characteristics. In other words, to have a consistent framework

of benchmarking, long-term dynamics of the economy must be anchored to a baseline reference scenario fed by trends in global forecasts. Such a design is also crucial for reflecting the global nature of climate change and the mitigation efforts at large.

The BAU scenario design described here largely relies on global data and projections compiled by the Climate Equity Reference Project. This project combines historical GDP and CO₂ emission intensity growth rates with projected growth rates from the IMFs biannual World Economic Outlook and from the IPCC Reports¹. Thus the baseline scenario projected into 2018–40 takes into account the forecasts of the recently observed global productivity slowdown, and sets an average growth rate for the Turkish economy of 2.0%–2.5%.

Major assumptions followed in the framing of the BAU scenario include:

- The absence of any (additional) policy action to address the environmental concerns/responsibilities, or developmental concerns at a regional level.
- That Hicks-neutral productivity growth occurs at exogenous total factor productivity (TFP) growth rates, differentiated at sector and region levels in line with historical observations.
- Exogenous labor force growth rates and exogenous parameters of migration dynamics for both formal and informal labor.
- That wage rates are fixed across sectors for the formal labor category.
- Exogenously determined foreign capital inflows as ratios to the GDP.
- Exogenous domestic and foreign real interest rates.
- Endogenous real exchange rates under the constraint of the balance of payments.
- A fiscal policy in accordance with a policy rule of a targeted primary surplus. Domestic interest rates (net costs of domestic debt servicing) will reduce from their base-year values (8.0% in 2012) to an average of 5.0% by 2020 and 3.0% by 2030. The ratio of primary (noninterest) surplus is initially set at 0.04 (as a ratio to the GDP), then gradually reduced to 0.0 by 2021 and then kept at this level for the rest of the base path.

It should be noted that the purpose of the exercise is not to project into the future, but rather to make comparative assessments of alternative policy environments within the discipline of general equilibrium.

¹ See: <https://climateequityreference.org/calculator-information/gdp-and-emissions-baselines/> for details of data compilation.

The major source of growth in this analytical structure originates from the gains in TFP. Kolsuz and Yeldan (2013) estimated that the average rate of TFP growth during 2000–10 was in the order of 1.1% per annum. The World Bank (2013) estimates that the average TFP growth in 2010–30 will be 0.8%. Given the lack of detailed estimates, the average TFP growth in this analytical structure was set equally (0.8%) for all urban–industrial sectors. Agricultural TFP was set at 0.15% for “low-income Turkey” and at 0.90% for its “high-income” counterpart. For the regional urban–industrial TFP rates, the low-income region industrial sector TFP was assumed at 0.60%, while the high-income region TFP was assumed to be 0.85%.

Further assumptions were made including that the rural labor supply would expand by 1.0% during 2013–30, with a gradual reduction to 0.7% by 2040. Conversely, the urban labor supply was projected to expand by 0.5% over the entire horizon. The final source of growth for the model economy is the accumulation of physical capital, which is endogenously achieved through investments (by sector of destination). Aggregate investment funds are generated through domestic and foreign savings; domestic saving is the saving from private disposable incomes (the neoclassical closure), while foreign saving is the resolution of exogenously given net foreign inflows.

Finally, all of the existing policy rates and ratios were maintained at their given levels on this dynamic path, hence the idea of “business-as-usual.” Simulation of the 2012–40 period under these specifications yields the BAU trajectory. Relevant aspects of this trajectory are summarized in Table 5.1. With an average annual growth rate of around 2.5%, the economy is projected to reach a GDP level of approximately TRY 2,726.3 billion and 3,336.1 billion by 2030 and 2040, respectively (in fixed 2012 prices). However, the dualities still remain; for example, on this path the high-income region produced an average of 77.5% of the total added value, retaining around 83.8 and 69.4% of the formal and informal employment, respectively. The employment shares of the high-income region increased gradually over time due to the mild-operating migration dynamics from low- to high-income regions. The dynamics of growth fed by TFP growth and growth of the labor force led to declining unemployment rates in both regions. For example, the formal unemployment rate in high-income regions was 8.0% in 2017 and will decline to 7.0 and 6.0% by 2030 and 2040, respectively. Similarly, the formal unemployment rate in low-income region will decline to 8.9% by

Table 5.1 Macroeconomic results

	Base path					Scenario: green development pathway				
	2018	2020	2025	2030	2040	2018	2020	2025	2030	2040
High-income region total supply (billion TRYs, 2012 fixed prices)	3,065.8	3,239.3	3,651.9	4,124.0	5,184.4	3,042.2	3,137.9	3,655.3	4,089.7	5,229.9
Low-income region total supply (billion TRYs, 2012 fixed prices)	1,010.5	1,064.8	1,212.6	1,325.7	1,564.6	985.6	1,038.1	1,265.1	1,416.8	1,795.4
Total GDP (billion TRYs, 2012 fixed prices)	2,068.3	2,177.5	2,445.5	2,726.3	3,336.1	2,048.6	2,155.4	2,520.2	2,827.5	3,578.6
Real rate of GDP growth (%)	2.84	2.55	2.28	2.10	1.99	3.04	3.14	3.18	2.33	2.58
High-income region value added (billion TRYs, 2012 fixed prices)	1,321.2	1,389.0	1,553.8	1,732.2	2,127.1	1,309.5	1,358.7	1,581.0	1,752.7	2,209.1
Low-income region value added (billion TRYs, 2012 fixed prices)	386.2	406.3	457.3	505.6	610.8	381.8	397.1	469.2	519.6	653.9
Total labor employment in high-income regions (persons)	12,755,118.7	13,153,617.1	14,048,537.2	15,105,756.5	16,819,084.3	12,663,874.1	12,922,673.9	14,374,770.4	15,404,763.0	17,646,593.2
Formal labor employment in low-income regions (persons)	3,059,398.6	3,063,525.1	3,005,269.6	2,945,405.0	2,858,412.9	3,024,080.0	3,003,627.6	3,105,970.1	3,054,293.8	3,095,952.1
Total formal labor employment, (persons)	15,814,517.3	16,217,142.2	17,053,806.8	18,051,161.5	19,677,497.1	15,687,954.1	15,926,301.5	17,480,740.5	18,459,056.8	20,742,545.2
Informal labor employment in high-income regions (persons)	7,262,586.6	7,523,562.7	8,098,588.9	8,606,561.0	9,547,700.3	7,262,655.9	7,524,027.4	8,092,088.5	8,583,874.2	9,480,447.7

Informal labor employment in low-income regions (persons)	3,671,905.8	3,645,423.3	3,646,203.1	3,712,623.9	3,926,298.1	3,671,842.0	3,644,964.3	3,652,808.4	3,736,411.9	4,000,789.8
Total informal labor employment, (persons)	10,934,492.4	11,168,985.9	11,744,792.0	12,319,184.9	13,473,998.4	10,934,497.9	11,168,991.6	11,744,896.9	12,320,286.1	13,481,237.5
Total labor employment (persons)	26,749,009.7	27,386,128.1	28,798,598.8	30,370,346.4	33,151,495.5	26,622,452.0	27,095,293.1	29,225,637.4	30,779,343.0	34,223,782.7
Informal labor migration (1,000s)	107,161.4	90,331.0	66,345.5	55,657.2	43,972.7	107,141.0	90,865.3	63,950.2	52,319.6	39,026.3
Unemployment rate, high income (%)	8.0	8.0	8.0	7.0	6.0	8.4	8.9	6.6	5.9	3.3
Unemployment rate low income (%)	13.4	11.9	9.9	8.9	8.9	14.0	12.9	8.8	7.3	4.7
Average unemployment rate (%)	9.4	9.0	8.4	7.4	6.6	9.8	9.9	7.1	6.2	3.6
Private disposable income (billion TRYs, 2012 fixed prices)	1,494.9	1,564.5	1,744.1	1,936.2	2,361.5	1,480.9	1,531.5	1,781.3	1,970.5	2,478.0
Government revenues/GDP (%)	27.9	27.9	27.9	27.9	28.0	28.0	29.1	29.1	29.4	29.5
PSBR/GDP (%)	-1.7	-2.0	-0.1	-0.1	-0.1	-1.7	-1.9	-0.1	-0.1	-0.1
Aggregate investment (billion TRYs, 2012 fixed prices)	569.5	598.7	662.6	727.2	871.0	566.6	603.2	693.3	762.6	939.8
Aggregate consumption (billion TRYs, 2012 fixed prices)	1,269.2	1,329.1	1,484.6	1,650.0	2,009.7	1,254.4	1,293.7	1,504.8	1,679.6	2,119.2
Private foreign debt/GDP (%)	45.2	50.9	63.2	72.7	85.3	45.5	51.2	60.9	70.2	80.1
Government foreign debt/GDP (%)	9.7	9.3	8.3	7.4	6.0	9.8	9.3	8.0	7.2	5.7
Current account deficit/GDP (%)	4.2	4.0	3.9	3.8	3.1	4.2	4.0	3.4	3.1	2.4

2030 and might stay around this level throughout, having reduced from 13.9% in 2017. However, the wedge between formal-to-informal wage-rate ratios persisted in both regions; in high-income regions the ratio remained around 8.3-fold, whereas in the low-income regions it might slightly increase to 6.8-fold by 2040 from 6.3-fold in 2017. The difference in informal wage rates decreased slightly throughout the period due to migration dynamics that sustain continued informal labor into the high-income region.

The rate of consumption growth and investment expenditure followed roughly similar trends, with the ratio of consumption-to-GDP maintained at 63%–65%, and investment at 24%. The public sector borrowing requirement (PSBR) ran at a surplus of approximately -2% to the GDP until 2020, before it reduced to -0.1% . The hypothesis here highlights the fiscal discipline and austerity characterizations of public macroeconomic policies. It should be noted that in the current global conjuncture, this is not simply a “local or domestic” decision, but the main fiscal policy stance is typically dictated by the conditions of the international finance corporations and rating agencies in an open economy and free capital mobility world. Under these conditions, the foreign deficit (current account deficit) gradually declines from 4.5% to the GDP in 2012 to 3.8 and 3.1% by 2030 and 2040, respectively. The gap between exports and imports is expected to narrow significantly by 2040 as a consequence. This result significantly depends on the assumption of exogenously maintaining the external terms of trade, and endogenously adjusting the real exchange given the hypothesized exogenous flows of foreign capital.

Regarding environmental indicators, total greenhouse gas (GHG) emissions are envisaged to rise from 602.4 million tons of CO₂ eq. in 2017 to 789.4 and 936.5 million tons by 2030 and 2040, respectively (Table 5.2). Similarly, annual CO₂ emissions are predicted to increase to 644.0 and 760.9 million tons by 2030 and 2040, respectively.

An aggregate CO₂ eq. emission volume of 641.7 million tons by 2040 is calculated to be the end result of combusting fuels for energy generation, while 126.4 million tons occurs due to industrial processes. Emissions from agricultural processes and household consumption were 118.6 and 130.3 million tons, respectively. Carbon efficiency remained around 0.40 kg/\$GDP. Overall, carbonization of the Turkish economy is observed to closely follow the projected path of the real GDP. Therefore the warranted decoupling of carbonization from GDP activity is unlikely to be realized over the 2018–40 BAU path (Fig. 5.1).

Table 5.2 Environmental results

	Base path					Scenario: green development pathway ^a				
	2018	2020	2025	2030	2040	2018	2020	2025	2030	2040
Total CO ₂ (million tons)	490.0	521.4	590.7	644.0	760.9	460.6	414.4	493.0	509.7	614.7
Total CO ₂ eq. (million tons)	602.4	638.9	722.4	789.4	936.5	573.0	531.3	630.2	665.6	814.1
High income, CO ₂ emissions from coal burning for energy (million tons)	32.9	35.2	40.1	43.5	50.6	16.5	12.5	15.5	16.5	20.9
Low income, CO ₂ emissions from coal burning for energy (million tons)	8.1	8.8	10.4	11.9	15.2	4.1	3.1	3.9	4.3	6.0
High income, CO ₂ energy related (million tons)	267.4	283.8	316.7	336.9	378.5	250.4	219.4	255.9	254.8	290.1
Low income, CO ₂ energy related (million tons)	79.0	85.3	100.3	110.5	132.9	73.9	67.6	84.1	88.0	108.6
High income, CO ₂ industrial processes (million tons)	52.5	56.1	64.3	73.4	94.4	52.3	53.5	63.6	70.0	90.6
Low income, CO ₂ industrial processes (million tons)	15.9	16.8	19.2	21.0	24.8	15.3	15.9	19.7	21.6	27.6
High income, CO ₂ eq. agriculture (million tons)	37.0	38.3	42.6	47.9	60.4	36.6	37.7	42.5	48.2	61.3
Low income, CO ₂ eq. agriculture (million tons)	40.4	42.3	47.6	51.2	58.2	41.2	43.7	53.2	61.2	79.0
CO ₂ households (million tons)	75.2	79.4	90.3	102.2	130.3	68.7	58.0	69.8	75.3	97.7
Total CO ₂ energy related (million tons)	421.6	448.5	507.3	549.5	641.7	392.9	345.0	409.7	418.1	496.5
Total CO ₂ /GDP (kg/\$GDP)	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3
CO ₂ from energy/GDP (kg/\$GDP)	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2

(Continued)

Table 5.2 Environmental results (cont.)

	Base path					Scenario: green development pathway ^a				
	2018	2020	2025	2030	2040	2018	2020	2025	2030	2040
Intermediate demand coal in low income (billion TRYs, 2012 fixed prices)	2.8	3.0	3.4	4.0	5.4	1.3	0.9	1.2	1.3	2.0
Intermediate demand coal in high income (billion TRYs, 2012 fixed prices)	11.6	12.5	14.9	17.4	23.7	5.2	3.8	5.0	5.7	8.4
Intermediate demand petrol and gas in low income (billion TRYs, 2012 fixed prices)	24.4	26.1	30.4	35.0	45.8	24.0	18.1	22.8	23.1	31.8
Intermediate demand petrol and gas in high income (billion TRYs, 2012 fixed prices)	95.5	103.5	124.1	147.0	207.9	96.2	73.8	93.1	95.0	130.4
Intermediate demand ref. petrol in low income (billion TRYs, 2012 fixed prices)	21.5	22.7	26.2	28.9	34.5	20.9	21.6	26.6	29.7	38.0
Intermediate demand ref. petrol in high income (billion TRYs, 2012 fixed prices)	60.14	63.41	71.22	80.28	100.95	59.58	60.37	69.95	77.82	99.22

^a Green development pathway = remove coal subsidies + impose CO₂ taxes + earmark CO₂ tax revenues to expanded investments on renewables + increase the efficiency of aggregate energy composites.

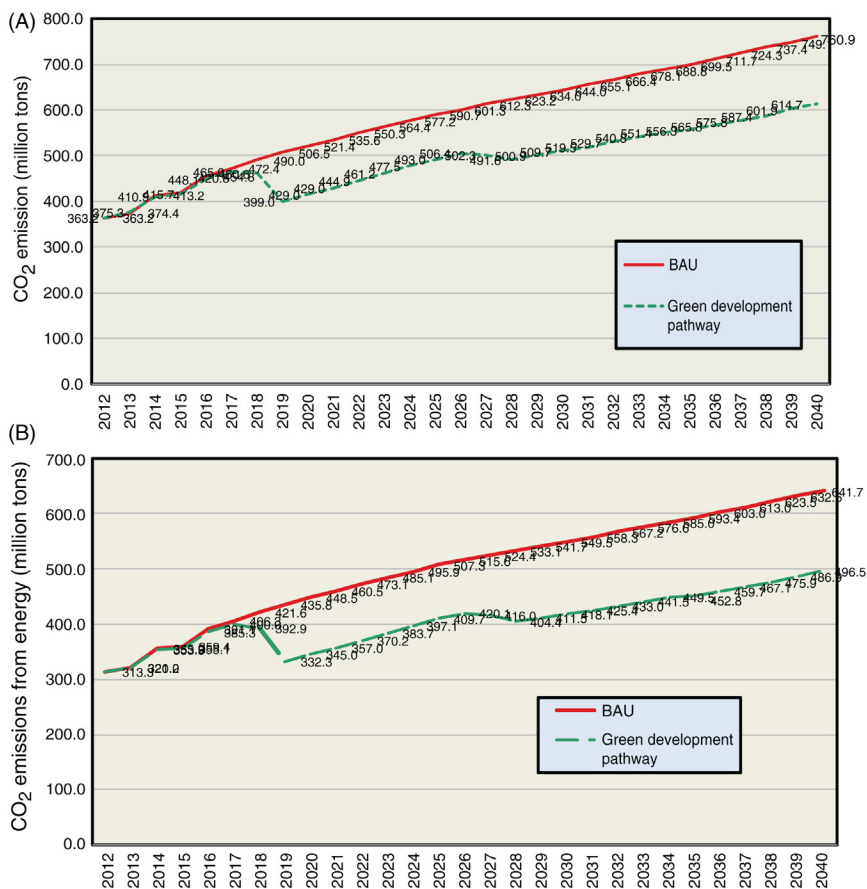


Figure 5.1 (A) CO₂ emission trajectories BAU and green development pathway (million tons). (B) CO₂ emission from energy (million tons).

5.2 INSTRUMENTS OF THE GREEN DEVELOPMENT PATHWAY

Next, the analytical model described in Chapter 4 was used to investigate the macroeconomic impacts of a policy package that aims to set a green development policy for a typical middle-income country. This policy package is fenced-in under the constraints of climate change mitigation and under the need to achieve balanced and sustained development.

The implementation of the policy package is comprised of four main instruments:

1. Elimination of coal subsidies: The first instrument comprises the elimination of coal production subsidies (which amount to approximately 0.1%

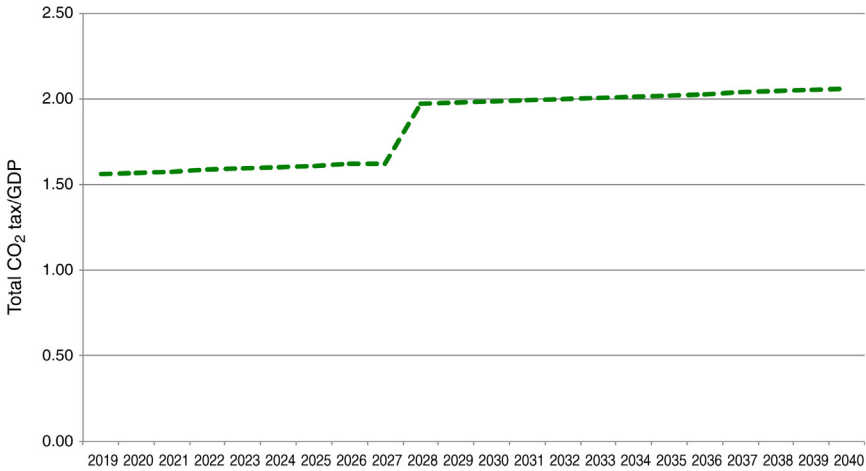


Figure 5.2 *Total CO₂ taxes/GDP under green development pathway.*

of GDP), as well as some regional investment subsidies on coal mining (which are supported by the central government to boost regional coal production). The existing scheme subsidizes the cost of investments by 30 and 35% in high- and low-income regions, respectively, via reduced income or corporate taxes (see [Acar and Yeldan \(2016\)](#) for further details).

2. Carbon taxation: This policy instrument is a dynamically-active and flexible taxation scheme on CO₂ polluters. In the model, this tax is imposed on an ad valorem basis as a ratio of the emissions of CO₂ as differentiated by the source of polluters, energy users, and households. The model foresees that this carbon tax will amount to 2.0 and 2.1% of the GDP by 2030 and 2040, respectively ([Fig. 5.2](#)).
3. Renewable energy investment fund: The third policy instrument is a fiscal policy intervention to earmark the total tax proceeds from carbon taxation to an investment fund for the expansion of renewables. Here, an asymmetrical treatment of the regions is assumed in order to associate this new investment prospect with the developmental needs of the low-income region. Thus 60% of the total funding is afforded to this relatively backward region.
4. Energy efficiency: The final policy instrument entails autonomous increase in energy efficiency (i.e., depending on technological advances and market conditions and not on any deliberate supporting efficiency policy). It is assumed that this policy instrument will gradually facilitate a higher per unit energy output (an annual increase from 0.5% to 1.5%) from primary and secondary energy sources.

5.2.1 Removal of Fossil Fuel Subsidies

Coal is still a widely used energy source in the international arena. Data from the International Energy Agency (IEA, 2014) revealed that the share of coal in world electricity production rose from 37.4% to 40.3% between 1990 and 2012. Some of this production was due to the availability of generous subsidies provided by governments to their coal sectors. These subsidies are usually designed to lower the cost of coal-fired electricity production, increase the price received by energy producers, or decrease the price paid by energy consumers. They take several forms including direct financial transfers, tax exemptions, market-price support, and the provision of services below market rates (i.e., the provision of land, water, infrastructure, or permissions) based on the WTO definition. The cost of global fossil fuel subsidies (FFS) (i.e., oil, gas, and coal subsidies) totaled USD 548 billion in 2013, which was 4 times more than renewable energy subsidies (IEA, 2014).

In 2009 the G20 leaders committed to “rationalize and phase out over the medium term inefficient FFS that encourage wasteful consumption.” This engagement has since been endorsed by the Asia-Pacific Economic Cooperation (APEC, 2009; Leaders’ Declaration). The topic of FFS is currently gaining momentum in a post-Rio+20 context, and the reform of “environmentally harmful subsidies” is also part of the Europe 2020 strategy. Withana et al. (2012) categorized such subsidies in the EU member states as on- and off-budget subsidies. Examples include direct financing for hard coal mining being phased out under state aid rules (e.g., in Denmark, Spain, Poland, and the United Kingdom); energy tax reductions for the manufacturing, agricultural, and forestry sectors; and tax exemptions for certain energy-intensive processes (e.g., in Denmark).

Studies that have investigated the possible socioeconomic and environmental impacts of FFS have mostly focused on scenarios to understand the impact of reduction, full elimination, or reformulation of subsidies. Ellis (2010) reviewed subsidy reduction scenarios in six different studies and found that reform would lead to a significant global increase in income and a decrease in CO₂ emissions². For instance, considering OECD and non-OECD countries in a multiregional dynamic general equilibrium study, Burniaux et al. (1992) estimated that full global FFS removal would lead to an 18% reduction in CO₂ emissions in 2050 compared to the base path. They also stated that annual real income increases from the removal of all

² For detailed findings of the six studies referred to by Ellis (2010) see: https://www.iisd.org/gsi/sites/default/files/effects_ffs.pdf.

consumer FFS would be 0.7% globally, 0.1% for OECD countries, and 1.6% for non-OECD countries over the 1990–2050 period (Ellis, 2010, p. 40).

Utilizing a CGE framework for the analysis of FFS in Vietnam, a UNDP (2012) study showed that the elimination of subsidies would increase actual GDP by 1% and significantly decrease GHG emissions. Moreover, a subsidy cut alongside a carbon tax scenario would bring about a 1.5% increase in GDP and considerably higher investment rates compared to the BAU scenario over the period to 2020. The CGE model used in the study assumed that revenue savings and increases were invested in the most productive sectors or in low-carbon activities (i.e., R&D).

Existing coal subsidies decrease the competitiveness of renewable energy technologies, jeopardize renewable energy investments, and ensure that energy systems are dependent on fossil fuel-based energy generation (i.e., “lock-in”) (Bridle and Kitson, 2014). A climate policy that aims to limit the global temperature increase to 2°C requires governments to completely abandon fossil fuels (i.e., coal, petrol, and natural gas). If the subsidies provided to such sectors are eliminated, most “polluting” projects would likely be abandoned and investments would shift to other sectors. Analyses conducted by CTI (2013) suggested that this sectoral transformation and renunciation of subsidies would lead to a gross loss of earnings of USD 28 trillion for the fossil fuel industry by 2035, and large volumes of fossil fuels would remain idle as stranded assets. Therefore even though they have not reached the end of their economic life span, existing coal and fossil fuels would become idle, as they would be unable to bring in income in a world that had transitioned to a low-carbon economy. The latest calculations indicate that 80% of the coal, petrol, and natural gas reserves held by large-scale companies have already been marked as “unburnable carbon” due to the threat of climate change (CTI, 2013).

FFS in Turkey mainly comprise of coal subsidies. Acar et al. (2015) recorded that the most substantial coal subsidies are direct transfers from the Undersecretariat of the treasury to the hard coal sector, usually in the form of capital and duty-loss payments. These transfers aim to subsidize local employment in the hard coal-mining regions and amounted to around USD 300 million in 2013. The government also supports the coal sector by providing R&D expenditure, funding the rehabilitation of hard coal mines and coal power stations, providing exploration budgets, funding new coal power plants, providing investment guarantees to some coal power plants, and distributing free coal to poor families as consumer support. The total

quantifiable coal subsidies in Turkey in 2013 amounted to USD 730 million; however, some of the support measures remain unquantifiable as they are not purely financial transfer mechanisms. For instance, exemptions from environmental regulations (including temporary exemptions for existing coal plants) and permissive environmental impact assessments enable most coal projects to be implemented even though they are harmful to the environment (Acar et al., 2015, pp. 8–11). In addition, Turkey introduced a new investment incentive scheme in 2012, which was composed of various instruments including VAT and customs duty exemption, income or corporate tax reduction, social security premium support to the employer, interest support, and land allocation. Defined as “priority areas,” new coal mining and power generation projects were subsidized within the regional investment incentive scheme with the most generous measures.

Using the data for quantifiable incentives in 2013, Acar et al. (2015) estimated that the producer subsidy for coal amounted to USD 0.01 per kWh, which increased to USD 0.02 per kWh when coal aid to the consumer was included. Needless to say, these figures serve as an underestimate of the total subsidy, as they do not cover incentives, such as investment guarantees, ease of credit access, exemption from value-added tax, exemption from import duties (within the regional investment incentive scheme), or any of the other identified subsidies.

Acar and Yeldan (2016) examined the macroeconomic and environmental impacts of coal subsidies in Turkey within a general equilibrium framework. They established that if the production and investment subsidies provided to coal are eliminated by 2030, CO₂ emissions will decrease significantly in both high- and low-income regions. In such a scenario, a national emission reduction of 5.4% would be realized in 2030 when compared to the base path. Given that the coal sector comprises only a small portion of the sectoral composition of the country, it is clear that eliminating the coal subsidies would be beneficial in terms of combating environmental damage and climate change.

Estimates from other scientific reports (Fraunhofer ISE, 2013) further confirm that coal power will remain a less-expensive technology than renewable energy, although renewable technologies are expected to get cheaper in the coming decades. However, taking advantage of these falling costs is likely to prove difficult if the energy sector has already configured its technical and institutional structure to support coal-fired generation and if financial support to the coal industry has become part of the status quo. This may lead to the danger of path dependence (i.e., firms becoming “locked”

in dirty technologies). Given the distorted prices, firms with a history of dirty innovations may be further led toward maintaining dirty technologies and creating path dependence in the long run (Aghion, 2014).

Thus the green development scenario exclusively aims to break away from the fossil fuel-based energy-production technologies, and it attempts to accommodate the warranted technological changes via making savings from the elimination of FFS and the (yet to be implemented) carbon tax monies.

5.2.2 Taxing Carbon

The second policy instrument is the taxation of carbon emissions to be imposed at the source. To make the issue explicit, the OECD definition will be utilized, which states that “carbon taxes is a form of explicit carbon pricing; referring to a tax directly linked to the level of carbon emissions, often expressed as a value per tonne CO₂ equivalent” (OECD, 2013). Carbon taxes have the advantage of being explicit and having defined coverage; however, one disadvantage is that the level of abatement (the expected rate of emission reduction) is not predefined. Nevertheless, carbon taxation is a significant part of the arsenal of environmental policy instruments in a number of countries. For example, Denmark and Finland adopted a form of a carbon tax as early as 1990. The Danish carbon tax encompasses the combustion of fossil fuels, with a partial exemption for sectors that participate in the EU Emission Trading System; the Finnish tax system mostly operates using a combination of carbon and energy tax. As of 2014 the Danish and Finnish tax rates were USD 31 and EUR 35 per ton of CO₂ eq. respectively (World Bank, 2014). Similar policies are seen in other countries, such as France, Ireland, Mexico, Norway, Sweden, and Switzerland, where the tax rates per ton of CO₂ eq. are USD 10, EUR 20, MXN 10–50, USD 4–69, USD 168, and USD 68, respectively (all 2014 levels).

Goulder (1995) analyzed the costs of carbon taxes via a model that entails interactions between the carbon tax and preexisting taxes in the US economy. It was determined that the costs of such carbon tax policies are significantly reduced when the proceeds of the carbon tax are utilized to finance income tax cuts. It was also acknowledged that the costs of carbon tax are sensitive to the level of preexisting taxes. Therefore any environmental tax policy should consider the feedback effects with regards to preexisting taxes in other sectors of the economy.

Devarajan et al. (2011) modeled the South African economy within the CGE framework to test the effects of several tax policy scenarios that would

produce a 15% decline in CO₂ emissions. They showed that a carbon tax would produce the lowest marginal cost of abatement. The authors concluded that the costs of such environmental taxation would be even lower if the labor market distortions in South Africa could be overcome.

Yahoo and Othman (2017) framed a CGE model that focused on the energy–emission relationship in Malaysia. Malaysia is a country that intends to reduce its CO₂ eq. emission intensity (% of GDP) by approximately 40% by 2020 (compared to its 2005 level). Their model aimed to assess the macroeconomic and welfare impacts of carbon and energy tax policies that are needed for the country to achieve such reductions. Their findings demonstrate that the negative economy-wide impact of carbon and energy taxes is negligible when the emission reduction is considered. Under the specified assumptions, implementation of a carbon tax appears to be the best choice, especially when the tax revenues are channeled to consumption subsidies on household purchases. The study also indicated that a carbon tax works better than an energy tax for handling emissions, as it leads to higher use of renewable energy in Malaysia.

A Turkish study by Kolsuz and Yeldan (2017) used an applied general equilibrium model to focus on the interrelationship between environmental abatement instruments and policies. It showed that Turkey can achieve a proemployment, eco-friendly, and sustained growth path by using an appropriate mix of environmental taxes and technological innovations. The authors channeled tax revenues to a wage fund, which was used to finance the so-called “green jobs” sector, therefore environmental abatement was achievable via eco-friendly employment. The effects of new carbon-mitigation technologies and endogenous technological innovations were also examined. This scenario projected a 19.7% reduction of total CO₂ eq. emissions by 2030 when compared to the base path. This analysis further proves that halving the existing labor taxes can help to successfully mitigate carbon emissions (Kolsuz and Yeldan, 2017).

These historical studies indicate that the introduction of a universal emissions tax for all polluters (enterprises as well as households) would be advantageous. As noted earlier, the tax should be imposed on an ad valorem basis as a ratio of the emissions of CO₂, as differentiated by the source of polluters, energy users, and households.

5.2.3 Investing in Renewables

In our model we distinguish 18 sectors, 17 of which are officially recognized in the official input–output (I/O) tables by TURKSTAT. The renewable

energy sources (RNW) sector is not recorded in the official I/O statistics in the framework described, therefore its inclusion relies on comparative data from aggregated energy supply–use tables, data on the levelized cost of energy (LCOE) from the World Energy Association, and [Bloomberg New Energy Finance \(BNEF\), 2014](#) material on energy balances ([Table 5.3](#)). From this an estimate of the market valuation of the RNW sector can be obtained.

The BNEF data suggests that 65,348.8 (GWh) of RNW were utilized in the production of electricity in Turkey in 2012 (the base year). This equates to 27.3% of the energy used for producing electricity ([Table 5.3](#)). The coal and petroleum–gas sectors used 28.4 and 44.3% of the total energy for electricity production, respectively. The LCOE estimates from the Bloomberg data were used to convert these energy balances into “market values.” The ratio of RNW to coal market value was then used to obtain a value item to be utilized in the social accounting matrix, 2012. This exercise yielded a value of TRY 2,247.1 million (in fixed 2012 prices) for the renewables sector.

This exercise also provided a series of conversion ratios (e) to convert energy units into market values (i.e., $\text{RNW}^{\text{TL}} [1/e] = \text{RNW}^{\text{JUL}}$). This revealed a coefficient of 0.034 (thousand TRY [2012 prices]/MWh) for the RNW sector.

Table 5.3 LCOE and top-down cost conversion coefficients in electricity production

	I/O data (2012, million TRY)	Power generation ^a (GWh)	LCOE ^b (Bloomberg data, USD/ MWh)	Total value implied by TEIAS and Bloomberg LCOE (million TRY)	Conversion coefficients (Σ) implied for I/O data ^c (million TRY/GWh)
Coal	2,892.9	68,013.1	92.39	11,310.7	0.04253
Petroleum and gas (and OM)	25,263.6	106,137.9	82.00	15,666.0	0.23803
Renewables (including hydro)	2,247.08	65,345.8	74.69	8,785.7	0.03439

Input–output value of renewables is estimated via
 $(11310.7/8785.7) \times 2,892.9 = \text{TRY } 2,247.08 \text{ million}$

^a Power generation taken from TEIAS data.

^b Levelized cost of energy (LCOE) is taken from Bloomberg data. For coal, the total production shares of lignite and hard coal are taken into account when calculating the weighted average. Likewise, the total renewables share of hydroelectricity and other RNW in power generation, along with the LCOE of each, are taken into account to calculate the weighted average.

^c Input–output data/power generation (GWh).

The RNW sector is thought to be utilized only in the production of electricity, and is “produced” as a factor of production via investments in renewables. In the long term, as more resources are diverted to renewables production, the available investment funds will be taken away from other sectors toward the RNW sector. This is an unavoidable trade-off between CO₂ mitigation and pure growth.

5.2.4 Improving Energy Efficiency

Mitigation of climate change will not be realized through fiscal measures alone. This fact is one of the stylized facts of climate change macroeconomics, and it is appropriate to accommodate for gains in energy efficiency within the green development package. Therefore a further hypothesis was implemented to state that the efficiency policies will gradually facilitate a higher per unit energy output (an annual increase from 0.5% to 1.5%) from primary and secondary energy sources.

5.3 FINDINGS AND POLICY DISCUSSION

The macroeconomic results of the green development pathway policy package are summarized and contrasted against the BAU pathway in [Table 5.1](#). Of prime importance is the evolution of the GDP during 2015–40. In contrast to the BAU, the green development scenario suffered a slight initial loss. The deceleration of GDP growth lasts for approximately 10 years, roughly until 2025. The GDP level in the green development scenario is 0.9% below that of BAU in 2018, and 1.01% below by 2020. The gap between the two scenarios quickly narrowed; however, the income-enhancing effects of the renewable sector allowed the green development scenario to catch up with the BAU in 2025. The green development scenario thereafter achieved rapid gains in national income due to the gains in renewables and energy efficiency that were earmarked by fiscal savings from the elimination of coal subsidization and the initiation of the carbon taxation programs. By the end of the planning horizon the green development pathway reported a real gross income of TRY 3,578.6 billion (in fixed 2012 prices), which was 7.2% greater than the BAU pathway. These gains materialize in the long term as a result of a consistent and coherent policy package simultaneously addressing both the fiscal balances and the regional equity objectives.

The gains in GDP were shared unevenly across the regions and favored the low-income regions. The value added of the low-income regions will accelerate after 2025 to achieve a regional value that was 7.1% higher under

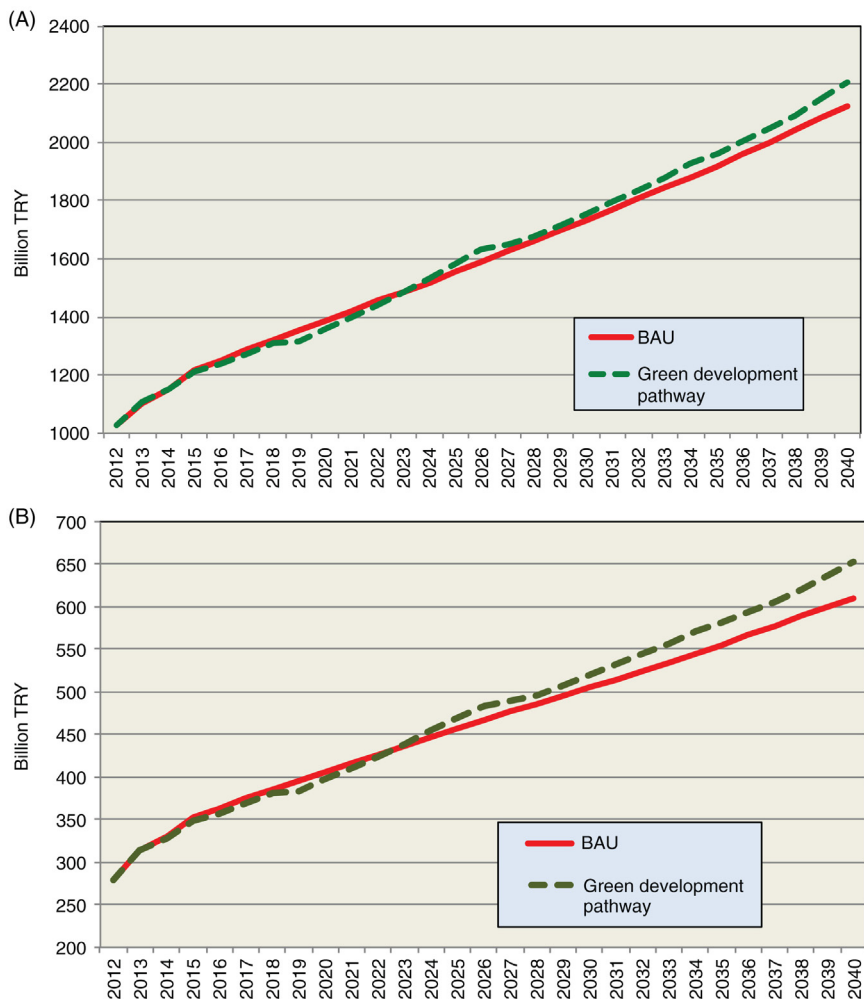


Figure 5.3 (A) *High-income region value added (bill TRY, fixed 2012 prices).* (B) *Low-income region value added (bill TRY, fixed 2012 prices).*

the green development policy than under the BAU scenario. Likewise, the value added in the high-income regions was 3.9% higher than under the BAU pathway (Fig. 5.3).

Of greater interest was the interregional gap. The modeling results suggest that the gap in aggregate GDP between the two regions narrowed down secularly over the green development trajectory. This achievement is partly due to the gains in formalization of the labor market in the low-income region. Formal employment in the low-income regions will rise

by 8.2% by 2040, which is supported by a 4.9% increase of formal labor employment in the high-income region compared with the BAU. Elevated formal employment levels in both regions will produced a total formal employment level, that will be 5.4% higher than the BAU scenario by 2040.

The rise in employment in the high-income region resulted to a reduction in the unemployment rate to 3.3% (compared to 6.0% in BAU), and to 4.7% in the low-income region (compared with 8.9% in BAU). Therefore the average unemployment rate fell to 3.6% in 2040 in contrast to 6.6% level under the BAU scenario.

Elimination of the coal production subsidies and invigoration of the carbon taxation program led to a rise of the state's fiscal revenues and helped to improve the budget balance of the public sector. Public foreign borrowing narrows down and, together with the rise in private incomes, is coupled with a similar fall of private debt. As a result of these two favorable outcomes, the account deficit narrows down to a 2.4% ratio to GDP by 2040 (in contrast to BAUs 3.1%). Thus the green development package not only achieved a rise in incomes and employment, but also sustained a fall in foreign debt and a fall in the foreign deficit of the overall domestic economy.

The environmental indicators are summarized in [Table 5.2](#) The evolution of the key abatement indicators are portrayed in [Figs 5.3–5.6](#). The results reveal that aggregate emissions of total GHGs and CO₂ decreased from the beginning of the planning phase under the green development pathway. Aggregate GHGs will fall from 936.5 million tons of CO₂ eq. under BAU, to 814.1 million tons by 2040. Likewise, CO₂ emissions reduced from 760.9 to 614.7 million tons by 2040. These amount to abatement gains of 13.1 and 19%, respectively. The biggest abatement gain was seen for energy utilization. Switching from fossil fuels to renewable sources of energy generation reduced the energy-related CO₂ emissions by 22% under the green development pathway, from 641.7 to 496.5 million tons by 2040 ([Fig. 5.1](#)).

The realization of increased GDP, together with the fall in emissions, led to a fall in the emission content of national income; in other words, a decline in CO₂ per unit of \$GDP. This is a direct indicator of a more efficient structure in terms of environmental abatement. CO₂ per unit of GDP decreased from 0.4 to 0.3 kg/\$GDP, whereas energy related emissions decreased from 0.3 to 0.2 kg/USD ([Fig. 5.4](#)).

It is interesting that emissions from agricultural and industrial processes increased in the low-income regions ([Table 5.2](#)). This is due to the invigoration of productivity in the region, both in sectoral production and employment. As we do not have any intervention in abatement control

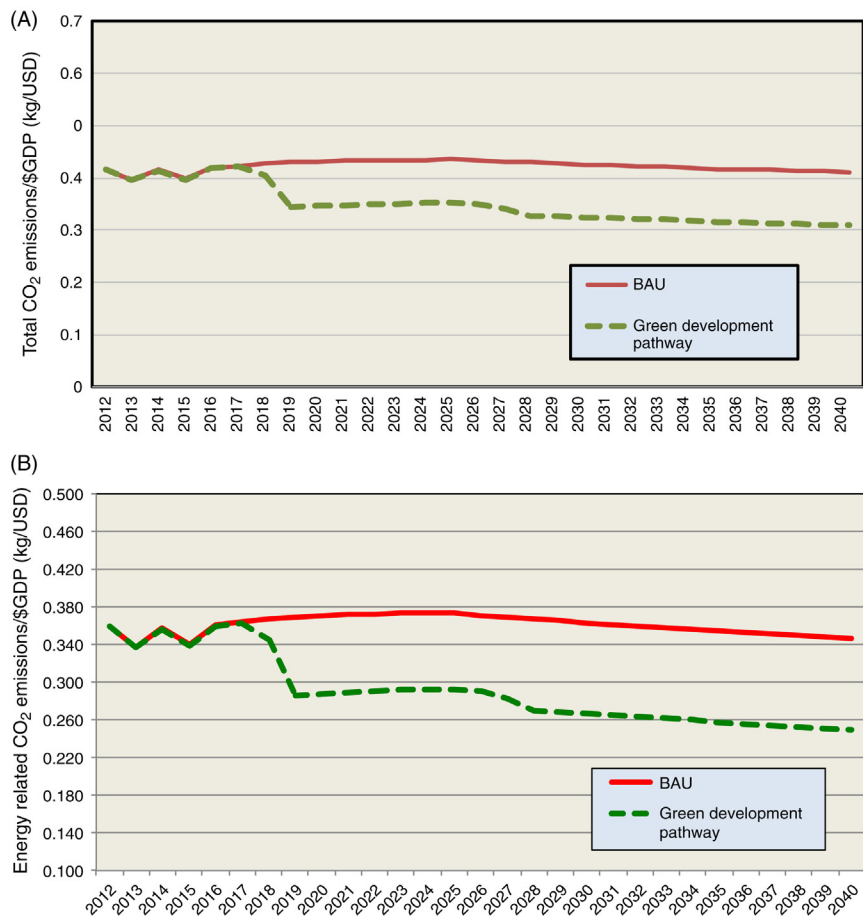


Figure 5.4 (A) Total CO₂ emissions per \$GDP (kg/USD) (2012 prices). (B) Energy-related CO₂ emissions per \$GDP (kg/USD) (2012 prices).

differentiated regionally, the rise in process activity should be regarded as normal. Nevertheless, decomposition of the aggregate CO₂ emissions (Fig. 5.5) showed that all sources of emissions fall under the green development pathway with respect to BAU, with the exception of industrial processes.

These gains in rationalization of abatement reveal themselves in the course of electricity generation. The green development intervention is leading to a rise of the share of renewables (solar and wind) in electricity generation from 4% in 2012 to 55% by 2040; and to a decline of coal's share from 28% to >10%. Likewise the share of petroleum and gas has been

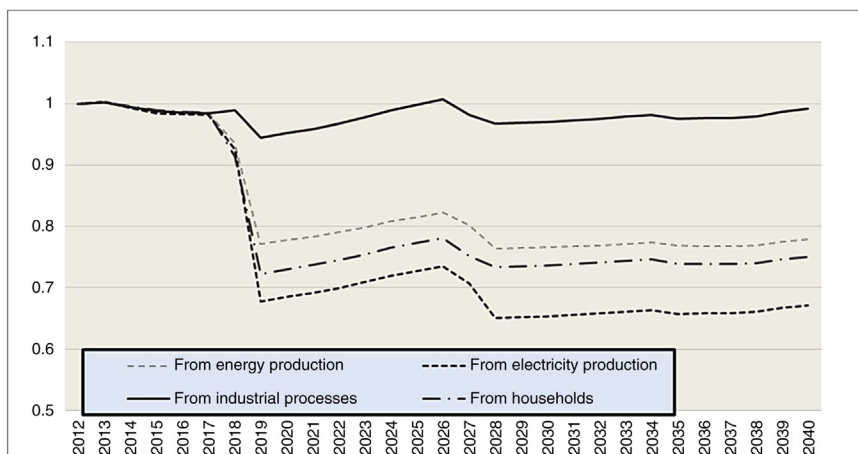


Figure 5.5 *Green development policy package: decomposition of CO₂ emissions (with respect to base path).*

declining from 44% in 2012 to 28% by 2040. In combination, the share of nonrenewable sources of electricity generation under the green development package is reducing from 72% in 2012 to 37% by 2040 (Fig. 5.6).

A critical instrument behind these gains is carbon taxation. These results indicate that with the implementation of the polluter-pays principle across producers and households, the carbon tax incidence (as a ratio to the aggregate GDP) is around 1.5% in the early periods of the green development pathway, and will secularly rise to 2.2% by 2040 (Fig. 5.2).

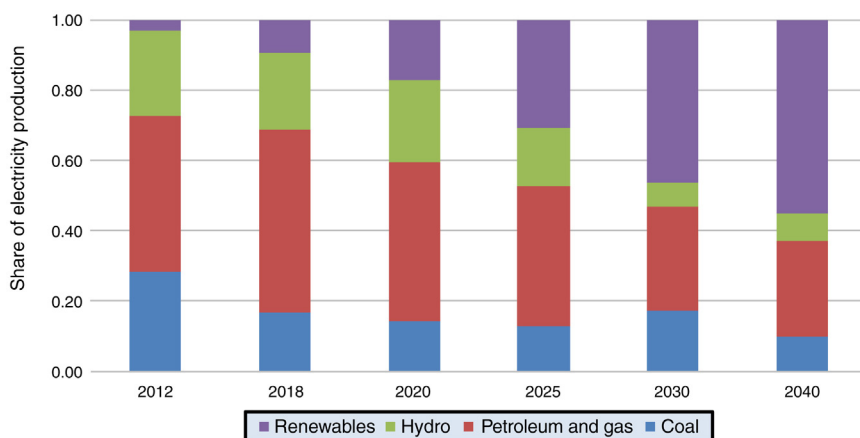


Figure 5.6 *Green development pathway: shares in electricity production.*

In contrast to the level of aggregate CO₂ emissions in 2040, this means a tax rate of 128 TRY/ton of CO₂ (in fixed 2012 prices), or 51.3 USD/ton (in real 2012 USD). Finally, in contrast to the gains in CO₂ emissions, carbon taxation results in marginal abatement costs of 540 TRY/ton of CO₂ mitigated in 2040, which is roughly 214 USD/ton of CO₂ mitigation (in constant 2012 USD).

5.4 EPILOGUE

The previous chapters have addressed the concept of development and its challenges in the 21st century, and the multilayered appearances of dualism, pertaining to and going beyond the classical dualism of the labor markets, including the heterogeneity of capital, regional technological diversity, access to knowledge capital, and integration of the world commodity and financial markets. Chapter 2 laid out how the functioning of the global economy and the trends of deindustrialization exacerbate existing challenges via stagnant wages, declining investment trends, and poor achievement of productivity growth. The issue of climate change in this picture seems to serve as yet another obstacle. On one hand, climate change creates serious development challenges; however, on the other hand, prioritizing economic growth and development have had major effects on climate change and vulnerability. Emission control and effective mitigation demand the transformation of production systems and energy systems, such as moving away from traditional high-carbon energy sources, deploying advanced renewable technologies, and increasing energy efficiency. In Chapter 3, evaluation of the current energy and environmental policy framework, and the potential implications of this framework for climate change in the Turkish economy, underlines how a lack of sufficient regional mitigation efforts and the ever increasing burden of climate responsibility relates and contributes to mounting spatial inequalities and dual economic structures within a national economy.

The model developed and presented in Chapter 4 aims to incorporate a regional general equilibrium model that accommodates the structure and dynamics of the dual traps embedded in the Turkish economy. Referred to as regional computable general equilibrium modeling, the most important contributions of this construction are the decomposition of the national economy into its observed regional differences, and the generation of a concrete impact analysis of the instruments of regional policy. Chapter 5 contained further analysis of a comprehensive package of the macroeconomic

development policies that are designed at the regional level, together with those that aim to abate environmental pollution and climate change.

In conclusion, these results indicate that by pursuing a coherent macroeconomic strategy to effectively tax fossil fuel use, remove coal subsidies, and earmark fiscal revenues for the expansion of the renewables sector within regional development programs, Turkey can mitigate gaseous emissions and expand its income and employment within a more equitable and sustained development pathway. This has serious implications for developing and developed economies, as it documents that with coherent programs, abatement policies can serve as viable sources of structural change and industrialization, rather than being mutually exclusive objectives, as is often alleged.

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