Welfare-Efficient Climate Policy in South and Southeast Asia: Synergies between Electricity Capacity Expansion and NDC Carbon Quotas

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Abstract

Developing economies of South and Southeast Asia face a double-edged challenge. With the increasing temperatures, the immediate efforts to curtail the carbon emissions are fundamentally essential; while the agenda of developing the economic welfare of a large base of population is also of equivalent importance. Political economy of focusing on curtailing the carbon emissions creates apprehensions about the loss of welfare. This paper attempts to quantify the least welfare cost solution by comparing the three emissions quota and with targeted capital-augmenting electricity investment policy.

The NDC scenarios from 2026 to 2037 have been calculated using the stated declarations by the countries in the South and Southeast Asia as per the Paris Agreement. This is simulated over and above a baseline scenario of staggered increasing energy efficiency, simulated using the IEA projections. In comparison to this, the projected increase in Energy infrastructure by the economies of South and Southeast Asia is documented from the planned investment declaration. This addition to capital in energy production is simulated as a capital augment technical change (AFE), which is used to project the energy production, energy efficiency, carbon emissions and welfare in the region.

The simulations results yield distinct outcomes. Under NDCs regional economies suffer welfare losses while the emissions fall in the range of 5 – 15%. The AFE policy improves production and welfare while causing slight increase in emission. The combined policy yield best balance. Emissions decrease substantially and welfare losses are marginally offset. No single policy in isolation yields the best outcome. The results indicate that pairing carbon pricing with the energy infrastructure expansion is the most cost-effective policy for the region.

Keywords: Climate Policy, South/Southeast Asia, CGE Modeling, GTAP-E-RD Model, Clean Energy Investment, Welfare Cost

JEL Classification: Q40, Q43, C68, Q54

1.1 Introduction

The trajectories of development in South and Southeast Asia are twice cursed; it needs to accommodate a vast population of the earth, nearly a third of total worlds population, ensure equitable distribution, modernise industry while facing significant challenges to trade from the developed world, and, it needs to do it in a way that ensures the carbon emissions and damage to the environment is minimal. While noble in its way, this situation is heavy constraining, given the uncertainities of trade policy and the headstart that the developed world has in terms of productive capacity, scale of operations, a long history of large-scale carbon emissions. In this sense, the challenge for the global south in general and South Asia and Southeast Asia in particular is to face the competition, and continue the growth-intensive policy while being sensitive towards the long-term sustainable and climate-sensitive targets.

This brings us to the Paris Agreement, where the parties to the Agreement communicate Nationally Determined Contributions (NDCs) to establish emissions reduction targets(Paris Agreement,2015). These targets are recorded by the UNFCCC secretariat (see UNFCCC, 2016). With the increasing demand for rapid growth coupled with concerns of equity and distribution, the developing economies face pressure for industrialisation and urbanisation. There is a clear shift of these economies from primary sector dependency to a move towards merchandise production and export. For these economies, the NDCs may prove a binding constraint upon their capacity and ambition for industrialisation. One of the most pivotal roles in Industrialisation is played by the energy sector. The energy sector is widely viewed as an instrument of growth and production. While the same sector is considered a significant player is carbon emissions. Thereby, for any agenda of decarbonisation, a focus on the energy sector is of utmost importance. Further, there is an increasing trend in the shift of energy production from carbon intensive methods to green energy production that includes hydro, solar, wind and nuclear power production proliferation. In this backdrop, the question of the economic consequences of the twin policy goals of higher production capacity and decarbonisation requires attention.

In this paper, the standard recursive-dynamic GTAP model (Hertel, 1997) is used to provide a robust framework to investigate the effects of the combination of energy capacity expansion and decarbonisation. Further, the energy variant GTAP-E-RD model (Burniax & Truong, 2002) is deployed to specifically study the variables of energy production, carbon emissions, and other related variables. The energy variant provides substitution possibilities and measures for detailed carbon accounting in the form of taxes and quotas. This framework uses the recursive dynamic structures and provides an energy-environment feature. With the help of this model, it is possible to study capital accumulation, investment response, price variation, and welfare measures over a long time period. In this paper, the GTAP 11c database (Aguiar et al., 2019) is used to run the simulations, which provide 2017 as the benchmark year for shocks. The model provides a systematic comparison of welfare implications of emissions quota restrictions versus planned electricity infrastructure investment.

The South Asian and Southeast Asian economies have an urgency to meet the energy requirements of an increasing population and diversifying production demands. The geography of these economies allows for significant improvements in clean energy infrastructure. Looking forward to prospective demands for electricity, these economies are all investing in energy infrastructure expansion. These plans include electricity production units, energy efficient technology and expansion of the electricity grid. The majority of these investments are clean energy sources, so much so that most new projects comply strictly with clean energy production targets (IRENA, 2023; ASEAN, 2023).

1.2 Regional Profile

The region of South Asia and Southeast Asia consists of 19 countries. The GTAP database is available for 16 of them. The aggregation in this paper consists of 17 regions in total. They are Bangladesh (BGD), Brunei Darussalam (BRU), Cambodia (CAM), Indonesia (IDN), India (IND), Lao People's Democratic Republic (LAO), Sri Lanka (LKA), Malaysia (MYS), Nepal (NPL), Pakistan (PAK), Philippines (PHI), Rest of the World (ROW), Singapore (SGP), Thailand (THA), Viet Nam (VNM), Rest of South Asia (XSA), and Rest of Southeast Asia (XSE). The regions of XSA include Afghanistan, Bhutan and the Maldives, while the XSE includes Timor-Leste. Since this is a general equilibrium setting, the rest of the world (ROW) is also a very important region to solve the model. While the data for Bhutan, Maldives and Timor-Leste is included in rest of the region as a standard setting, Afghanistan was removed from the standard and added to the XSA region, because Afghanistan has near zero base-year values in key energy and emissions variables. By aggregating it with the XSA the problem of division by zero and negative value artefacts in energy shares and carbon accounting equations were taken care of. Instead of additive smoothing, the aggregation was preferred as it maintains the integrity of the GTAP database and avoids introducing artificial distortions.

2.1 GTAP-E-RD Modelling Framework

The analytical framework used in this paper is based on the GTAP-E-RD model. This CGE model integrates representation of production, consumption, energy use by sector, emissions and welfare, to name a few, in a recursive dynamic setting. This model is an extension of the standard GTAP model and incorporates energy substitution and carbon emission. This unique substitutability within the model allows for analysing the climate policy, energy trade, emissions trade and welfare implications. Just like a standard GTAP-RD model, this model too assumes perfect competition, constant returns to scale and satisfaction of market clearing conditions. The production is divided between energy and non-energy input nests, which assume a CES production function.

The GTAP-E-RD model allows the firms to substitute energy for capital and vice versa when the relative prices change. The elasticity between energy bundle and capital is set exogenously at 0.5. This is a relatively low elasticity of substitution which ensures the real world replication of scenario where it is difficult to substitute capital with energy and vice versa. The energy bundle consists of coal, oil, gas and electricity. Within this bundle, there is relatively higher substitutability set exogenously at 1. A higher substitutability indicates higher possibilities of changes in demand for these energy sources based on the changes in relative prices and other policy triggers. All of these parameters are levied exogenously in a standard GTAP-E-RD setting and are widely used in such simulations (Burniaux and Truong, 2002).

2.2 Emissions Accounting

The GTAP-E-RD model captures carbon emission from burning fossil fuels such as coal, oil and gas by directly linking the amount of fuel used in production and consumption to emissions. Every type of fuel has emission factor that is a known amount of carbon dioxide it releases per unit of fuel being used. Through this, total emissions are calculated by summing the product of quantity of fuel type to its corresponding emissions factor.

$$E_r = \sum_i \theta_i \, . \, Q_{i,r}$$

Here θ_i is emissions factor and $Q_{i,r}$ is the quantity of fuel used in the region. This implies that emissions increase when either more fuel is used or more polluting fuel is used. The emissions factor will be higher for more polluting fuels such as coal, in comparison with gas. Further, the model distinguishes between target and actual emissions. They are identified as gco2t and gco2q, respectively. Under constraints or restrictions to emission the two are same. If the actual emissions rise over and above the target, the carbon prices rise, leading to reduced demand by firms and households and thereby encouraging them to shift to cleaner alternatives. If emissions are below the target, the carbon price falls, leading to more consumption of conventional fuel. By adjusting the carbon prices, the model simulates the caps on emissions. The carbon price rise increases the cost of using fossil fuels, which spreads through the economy. A rise in carbon price initiates multi-pronged responses by the firms and households. They either reduce the energy intensity of production or consumption, or they may find cleaner energy sources.

The wider economic effects of these adjustments can be seen in energy demand shifts particularly for carbon intensive fuels. Trade patterns shift, and sectors that rely heavily on energy become less competitive. There is a chance that clean energy using sectors may gain advantage.

2.3 Baseline Framework

Since the economic effects of reduction in carbon dioxide emission and increase in investment need to compared with the business-as-usual (BAU) scenario, a new baseline scenario to replicate the real-world projections is created. This baseline attempts to represent the pattern and trajectories that the global economy and emissions would follow, if the new climate sensitive and energy investment policies are not implemented. This baseline incorporates expected growth rates of population, labour, capital and technology. These, however, are the standard baseline, common for the standard GTAP-RD model. In addition to the above, in order to match the sector specific energy efficiency improvement, UNEP Emissions Gap report 2024 BAU pathways (UNEP, 2024) is used to create year on year energy efficiency changes in coal, oil, gas and electricity.

Table 01: Baseline Calibration

Variable	Exogenous Shock Variable(s)	Primary Source(s)
GDP growth rates (target)	qgdppc	Near- to medium-term: OECD, IMF, World Bank, national agencies

		Energy Group project specifically: World Energy Outlook (WEO) 2018 projections for 2011 - 2030 regional GDP growth rates
Population	pop	UN Population Division (medium variant) + IIASA/Wittgenstein Centre (age, gender, education)
Labour (skilled/unskilled)	qe(ENDWL,REG),	Derived from IIASA education-linked demographics (no separate external labour-force source)
Technology energy efficiency (AEEI)	aeei (year-on-year in aeei.har)	IEA WEO 2018 emission trajectories (residual calibration after macro shocks)
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The UNEP (2024) provided the historical (2017-2023) emission and projected (2024-2037) emissions of Green House Gases with approximate 1 – 3% annual growth rate for developing Asian regions. These projected rates were scaled to the SASEA aggregation, while using the 2017 base year as per the GTAP 11c database.

3.1 Policy Shock framework.

The simulation of the shock framework in GTAP-E-RD model consists of accurate translation of the real world government's plans for decarbonisation and investment in energy production, particularly electricity production. In addition to this, the NDCs are also calculated as per the UFCCC documentations. The following three scenarios are studied to find the effect on several outcome variables.

a. Scenario 1: NDC2°C Simulation

Although there are three possible scenarios with respect to NDCs, viz, Unconditional NDCs, Conditional NDCs and the NDCs required to be consistent with the global 2°C pathway (IEA, 2018). The previous two scenario are more practical but fall short of the stated objectives of 2°C pathway. They also have less distortionary and welfare effects upon the regional economies in comparison with the NDC2°C pathway. The 2°C pathway is the optimum policy measure determined at a global level. These targets are derived from the NDCs translated to 2030 levels relative to the baseline.

The model solves for the carbon prices, which are endogenous, to change so that the carbon emissions meet the fixed emissions path maintained through NDCs.

b. Scenario 2: Electricity Capacity Expansion

Countries in South Asia and Southeast Asia have been facing acute power shortages. The increasing demand for electricity both for firms and households is a driving the plans by these governments for capacity expansion. These capacity expansions particularly include, new power plants, turbines, grids etc. This expansion has a heavy leaning upon the renewable and clean energy projects (Please see Table 2). The time frame for these projects varies from 2014 to 2040. There is a difference between planned expansion and the actual translation of these plans into reality. Nevertheless, with the ongoing project, a lower limit of expansion can be assumed. Amongst the planned projects, Nepal particularly stands out with its more than 15 times increase in electricity production plans. There are ambitions to wield the hydro power potential within Nepal to become an exporter of electricity to the entire region, particularly India and Bangladesh. Pakistan too stands out in terms of its proliferation of Solar energy.

Table 2: Electricity Capacity Expansion Plans

Region	Key Target	Timeframe	Primary Source
Bangladesh	~74 524 MW added (total ~99 GW by 2041)	2017 - 2041	Power System Master Plan 2016, Power Division / SREDA, Government of Bangladesh
Brunei	200 MW renewables (30 % renewable share)	2025/2035	Brunei National Climate Change Policy (BNCCP) Strategy, official government targets via APEC EGNRET presentation
Cambodia	Installed capacity 5044 MW to 6044 MW; 70 % renewables	2024 - 2030	Power Development Plan 2022 - 2040, Ministry of Mines and Energy / Electricity Authority of Cambodia (official PDP document)
Indonesia	+69.5 GW total (76 % renewables)	2025 - 2034	Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) PLN 2025 - 2034, official

			PLN / Ministry of Energy and Mineral Resources
India	Installed capacity 415.5 GW to 777.1 GW	By 2029 - 30	Optimal Generation Capacity Mix for 2029-30, Central Electricity Authority, Government of India (official CEA reports, cea.nic.in)
Laos	Hydropower 13000 MW	By 2030	Lao PDR NDC and National Energy Strategy, Government of Lao PDR
Nepal	Installed capacity 3 400 MW â†' 28 500 MW	By 2035	Energy Development Roadmap 2081, Nepal Electricity Authority / Ministry of Energy, Water Resources and Irrigation (official NEA documents, nea.org.np)
Pakistan	+13 000 MW hydropower	By 2030	Indicative Generation Capacity Expansion Plan (IGCEP), National Transmission & Despatch Company / NEPRA, Government of Pakistan
Singapore	3 GWp solar PV	By 2030	Energy Market Authority official announcement, Government of Singapore
Thailand	37 % renewables (capacity basis)	By 2030	Alternative Energy Development Plan / Power Development Plan, Ministry of Energy, Government of Thailand
Vietnam	Total capacity 89.7 - 99.9 GW; hydropower 33294 to 34667 MW	By 2030	Power Development Plan VIII (PDP8, Decision 768/QD-TTg, revised 2025), Prime Minister / Ministry of Industry and Trade, Government of Vietnam
Prepared by Authors			

The table 2 provides the quantity of output of electricity. A direct shock to the quantity of output is a very mechanical shock to the model, resulting into increasing the production without increasing the cost and also without increasing the quantity and cost of intermediate goods. This increase will result in unrealistic projections. Thereby, the variable 'afe' is used, which is capital augmenting technological change for the production of electricity. This shock directly scales effective capital services in electricity production, in turn, replicating the planned MW addition.

By using data from the governments, and converting it for CAGR, the capital augmenting tech change shocks are calculated.

c. Scenario 3: Combined effect of NDC2°C and Electricity capacity Expansion

This scenario superimposes the carbon emissions targets set by NDC2°C upon the capacity expansion. Here, the data sets remain the same, but the joint effect of efforts of decarbonisation is studied in tandem with the increase in the productive capacity of electricity. This is a mix of policy that represents a complementarity of investment in electricity infrastructure that lowers the carbon prices required to meet the NDC2°C targets; all the while the carbon prices increase due to emissions target provide incentive for fuel efficient and clean energy sources.

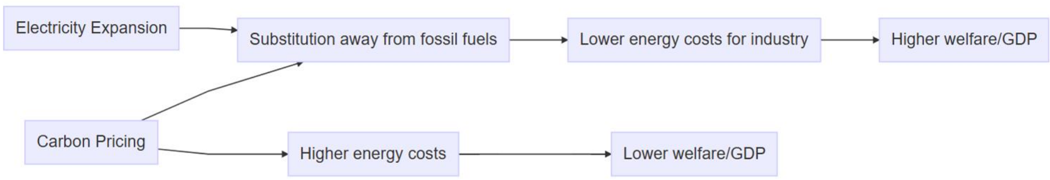
3.2 Shock Closure

For the three Scenarios, the shock closures are primarily the same, except for a small addition in scenario 3. The carbon tax or the price of carbon emissions is made endogenous, which allows it to adjust freely. However, in its place the power of emissions purchases at the bloc level are made exogenous. Further, the closure fixes the regional emissions quotas and allows for the power of emissions to adjust, which ensures that each region is able to meet its emissions constraint through the market-based adjustment mechanism. For the Scenario 3, closure is determined to ensure that 'afe' is exogenous, meaning that electricity sector capacity expansion is exogenous and can be shocked. So, when the planned capacity expansion increases, the model determines how the rest of the economy adjusts to accommodate the expansion.

4.1 Results and Analyses

The three scenarios produce distinct outcomes, for simplicity the are referred as NDC (Scenario 1), AFE (Scenario 2) and NDC + AFE (Scenario 3). Theoretically, NDCs tend to have high economic cost, and thereby simultaneous investment in capacity expansion for clean energy sources will have offsetting and complementary changes in the economy. The flow chart below (Figure 1) extends the prospective narrative in a nutshell.

Figure 1: Complementary Policies for Higher Welfare



For a detailed review of the impact of such policy measures, it is important to have a segregated view of the results. The results for each important target variable and important markers for economies are discussed below. The dynamic results indicate the changes at each year, however, most of the results indicate the results for 2037, that is the last year in the simulation.

I. Carbon Price

The NDC scenario imposes a gradual fall in emissions quota from 2026-37. This imposes large carbon taxes on the entire region. Albeit the carbon taxes (or prices) respond to the intensity of emissions cut under respective NDCs. For example, Bangladesh's carbon price jumps to 12.11% in 2037, India's by 6.26% (Table 03). Under AFE alone, the carbon tax is zero, because there are no restrictions to emissions. Thereby, the AFE scenario will continue to pollute the environment and there will be no reduction in the emissions. In the combined scenario, there is a slight offsetting effect of high carbon prices through an investment in electricity production. NDCs result in uniform rise in carbon prices indicating the penalties upon the fossil fuel. The fossil fuel reliant countries such as Bangladesh, Singapore, India and Thailand register largest increase. For AFE, on the other hand, prices fall slightly. In the combined case, taxes are offset by electricity production.

Higher carbon prices, although good for the cut on emissions, cause an increase in production cost. However, electricity expansion reduces the marginal abatement cost, thereby the combined policies require a smaller tax increase. This is identified as the synergy between the NDCs and AFEs to meet the target of clean growth.

Table: 03 real carbon tax rate (USD per tonne of CO_2) (Percent)

	NDC	AFE	AFE+NDC
BGD	12.10998	-0.37661	10.92263
BRN	5.433544	0.008548	5.369205
IDN	4.215563	-0.08209	3.954543
IND	6.262169	0.027354	6.095783
KHM	6.441526	-0.49024	5.432597
LAO	2.214954	0.519065	2.350814
LKA	6.430548	-0.03034	5.19839
MYS	4.313088	-0.00282	3.769143
NPL	8.104179	-0.51175	9.117051
PAK	4.125626	-0.2566	2.836017
PHL	5.055639	-0.0377	4.641271
ROW	4.666031	0.000987	4.346012
SGP	12.64695	-0.03063	12.89099
THA	2.664181	-0.01912	2.271343
VNM	3.791756	-0.15565	3.473437
XSA	4.745447	-0.04083	4.256935
XSE	4.168145	0.005811	0.876012

Source: Author's Calculations

II. Economic Growth & Energy Intensity

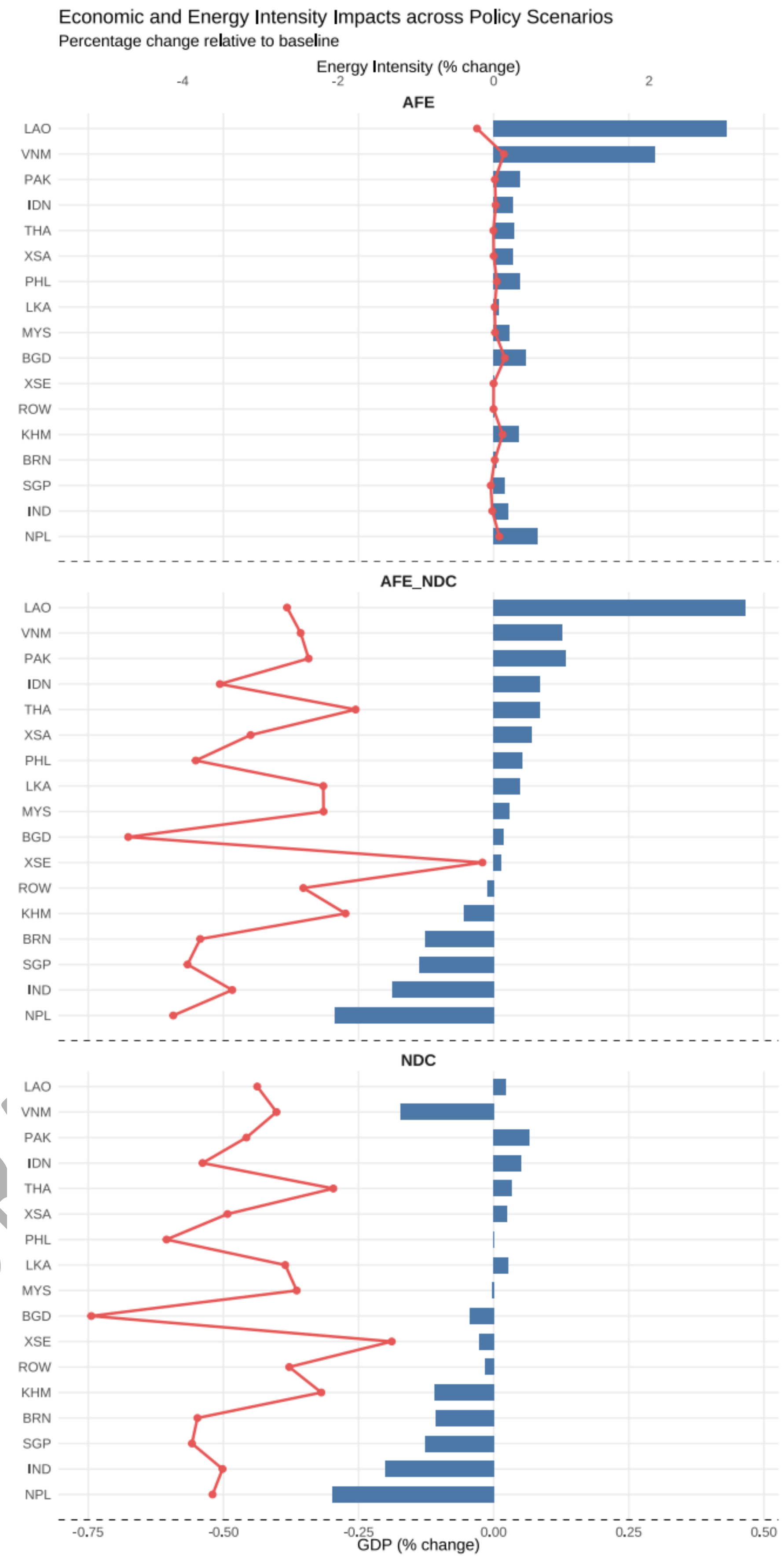
Responses to GDP diverge dramatically. Under NDC most countries see fall in their GDP, due to efforts of decarbonisation and increasing input costs. India, Nepal and Vietnam register a fall. While non carbon intensive countries predominantly from Southeast Asia show slight gain. On the other hand, under AFE, all the regions grow. The combined scenario generates mixed results, some regions break even, others lose but less than the NDC scenario alone. For example, Laos (0.46) and Pakistan (0.18) still gain, essentially due to the AFE effect, while India, Singapore and Nepal continue to have losses. (Figure 2, Table A1)

Energy intensity, that is, energy use per GDP, falls under the NDC scenario, as the emissions are cut. Bangladesh and Indonesia reduce intensity by 5 – 4 %. Under the AFE, intensity actually increase although it is a very slight rise, owing to a relatively higher rise in GDP than the energy consumption. In the combined scenario, energy intensity still drops substantially.

India suffers large GDP losses under decarbonisation, considering the impact on its coal-heavy industry. Even with power expansion, the fall is significant, but it registers a smaller loss. It is very clear that further expansion of electricity capacity may have significant offsetting effects of decarbonisation upon the Indian economy. Laos registers increase in growth in both NDCs and AFEs, primarily due to their focus on the renewable energy from the start, and due to the hydropower investment now.

These results suggest that electricity expansion in itself will not reduce energy intensity; a dedicated policy for decarbonisation is essential to drive efficiency. However, it is very clear that the loss of GDP growth due to NDCs is not even marginally covered by the increase in capacity expansion in electricity. In order to continue the growth path, the investment in infrastructure should increase multifold.

Figure 2



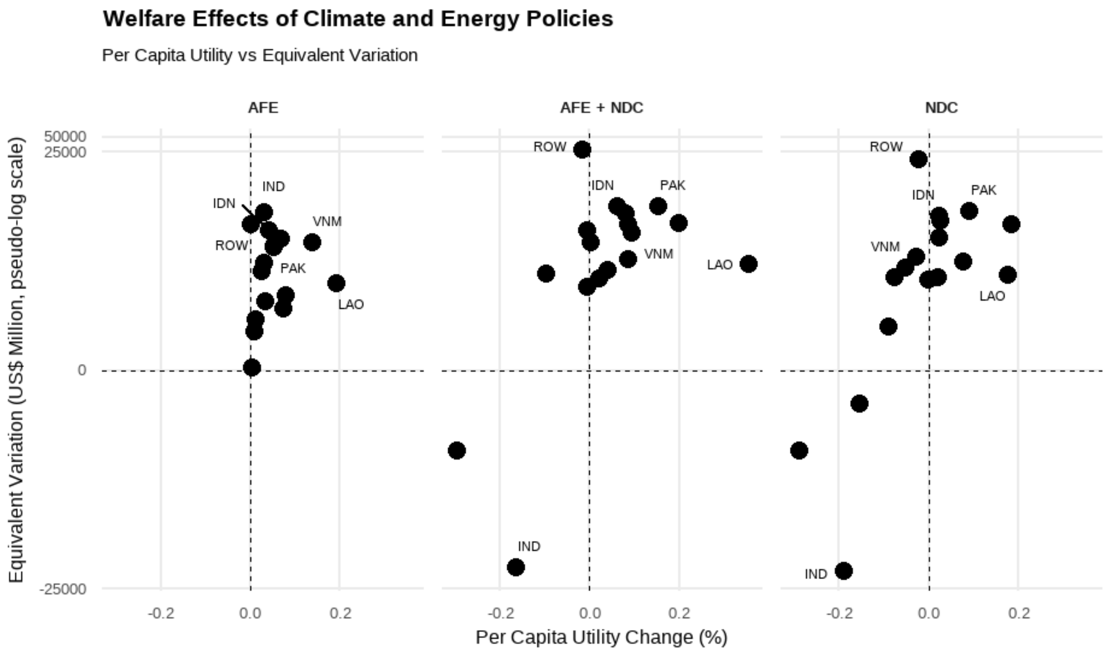
Source: Author's Calculations

III. Utility and Equivalent Variation

Other than GDP, utility for households is also an indicator of welfare. Decarbonisation tends to reduce welfare, while electricity capacity expansion tends to offset the losses. Welfare decline in terms of household utility is more in energy intensive economies. India, Nepal and Vietnam register the highest decline in the NDC scenario. While the AFE scenario broadly increases welfare as the energy expansion lowers costs and boosts real income. Laos and Vietnam see strong gains and Bangladesh shows slight decline. The combined NDC+AFE scenario is particularly significant, as it softens the welfare losses from the carbon price. For instance, Vietnam moves from welfare loss under NDC to gain in a combined scenario. Thereby for households, the carbon prices increase the costs and reduce purchasing power, electricity expansion tends to counterbalance it. There is variation in country experience, for example, India still faces welfare losses due to price increases, Laos benefits from electricity exports and Pakistan registers steady gains which reflects its energy restructuring capacity. (Figure 3, Table A2)

Equivalent variation is recorded as welfare in monetary terms. Under the NDC scenario, several economies experience welfare losses. India particularly sees extremely large losses, exceeding $10 billion. This is primarily due to rising prices and reduced output. Most of the economies nevertheless register gains, such as Indonesia, Pakistan, and Laos. In contrast, the AFE scenario generates positive welfare outcomes across all the economies. The combined scenario again provides a buffer, by reducing the welfare losses. India's loss are reduced and countries like Bangladesh, Vietnam and Pakistan see improvements in their welfare. Driven by hydropower exports and trade gains, Nepal and Laos benefit notably.

Figure 2



Source: Author's Calculations

IV. Sectoral Output

Coal, Oil, Gas: Under NDC, output of coal and oil falls down due to increasing carbon costs. Coal output registers the largest fall, across almost all the economies. The fall is sharp in Bangladesh, Malaysia, Thailand and Pakistan. Under the AFE scenario, larger electricity production substitutes the requirements of coal and oil; however, the magnitude of the expansion is not enough to completely meet the energy demands. Production of gas is more mixed, under NDCs, it registers the least fall as it is also a relatively cleaner source of energy.

Electricity: There are large swings in the electricity sector. Under NDC there is not much significant response but the AFE shock registers high out across the board. Nepal with its massive plans of investment in hyderopower electricity shows multifold increase in electricity output. Under the combined scenario, the electricity output remains high

Energy Intensive Sectors: The energy intensive sector, typically includes industries like metals, chemicals and machinery is hit hard in NDC due to higher energy costs, resulting in loss of output. When the electricity is cheaper, under AFE, their output expands. The combined scenario helps in recovering the losses due to NDC through electricity expansion.

V. Energy Prices and CO_2 Emissions

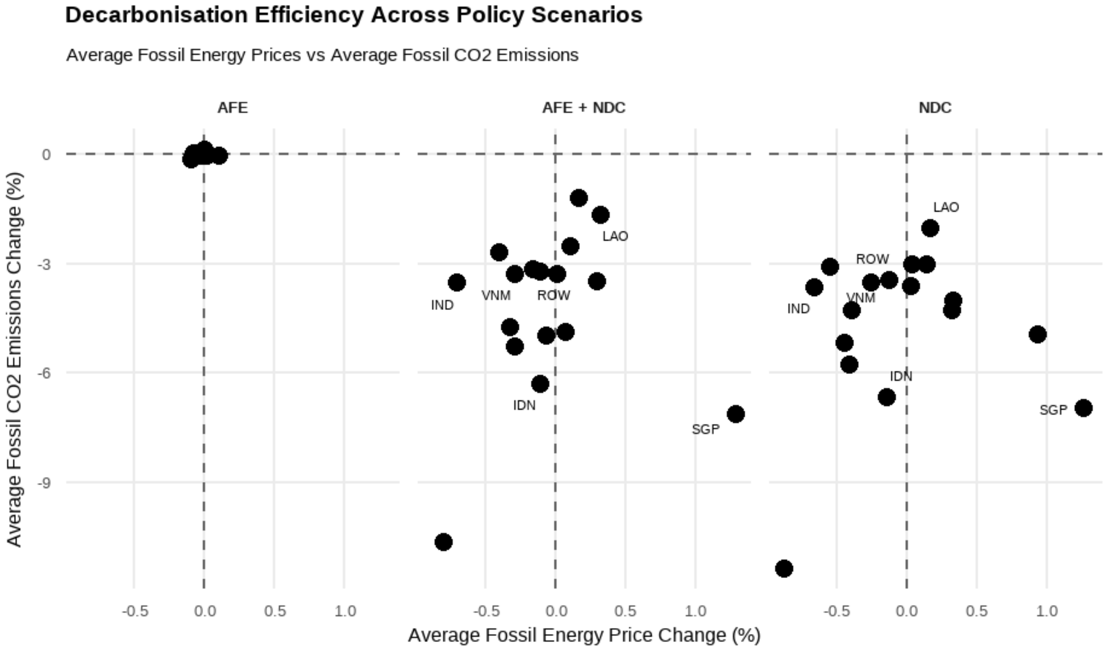
CO_2 emissions fall significantly in NDC, as is expected. At a regional level the fall is approximately 5 – 15%. Under AFE, emissions rise slightly, but the combined scenario the emissions reduction is actually very stable. Carbon price rise makes energy expensive, which is why, Electricity prices rise under NDC. And as expected, under AFE, the electricity becomes cheaper due to technology. In the combined scenario, electricity is cheaper than it would have been under NDC, making the process of decarbonization less painful economically.

The efficiency of emission reduction across the scenarios is measured using a Decarbonisation Efficiency Index[1] which is the ratio of emissions reduction to the changes in fossil energy prices. This measure captures the extent to which price changes translate into emissions reduction. The results reveal that, under NDC, all countries exhibit, increase in fossil energy price, with the fall in emissions, the average DEI being 21.1 and a median of 5.75. This indicates that decarbonization is achieved through cost increase of carbon intensive inputs. Valid uniform DEI observations across regions suggest price-dependent adjustment mechanism.

However, the AFE scenario fails to generate a decarbonization response, the average DEI being negative (-1.3). This reflects absence of stable connection between prices and emissions. With electricity expansion, without restrictions to emissions, the emissions continue to rise. The combined scenario yield the best results. It reports a DEI of 27.2 averaging across the region. Thereby, the emissions reductions take place at a lower price. The results suggest that electricity expansion provides a additional buffer and helps reduce the reliance on price based contraction of the fossil fuel use. Thereby the decarbonization is more effective and more efficient in combined scenario.

[1] The DEI is defined as, $DEI_r = \frac{-\Delta CO_{2,r}}{\Delta P_r}$, where ______ is the percent change in CO_2 emissions and _____ is the percent change in energy prices for the region. This is multiplied by – 1 so that higher values indicate larger reduction in emissions. The prices and emissions are averaged for all the fossil fuel sources. No interpretation is made for increasing emissions.

Figure 3



Source: Author's Calculations

VI. Trade Balance & Terms of Trade

The effect of policy shocks on external trade bear heterogenous outcomes. Under the NDC scenario, India and Singapore see improvement in trade balance while Pakistan, Philippines, etc., register deterioration (Table A3). This however is not a structural efficiency adjustment, but a form of redistribution of competitiveness due to rising carbon costs. For the same scenario, the terms of trade are relatively muted or negative, suggesting that the gains are registered due to the readjustment of competitiveness rather than productivity.

The AFE scenario is mostly muted, suggesting that the electricity expansion alone is not sufficient to change dynamics of external sector. The combined scenario retains the features of the NDC scenario, largely.

5 Conclusion

This paper attempted to examine the trade-off between the environmental and economic goals in South Asia and Southeast Asia. The policy shock reflected the efforts of decarbonization in the form of NDCs and the clean energy proliferation in the form of capacity expansion in electricity through capital augmenting technological change. A synergy of the two goals is designed as a combined policy shock.

The results indicate a clear trade-off between the economic ambition and environmental care, especially when the twin policies are implemented in isolation. The NDC scenario successfully exhibits reduction in carbon emission, by increasing the carbon prices and reducing production in fossil-fuel-intensive activities. However, the environmental gains are achieved at a high economic cost, reflected in falling GDP, reduced household utility and adverse impact on energy intensive sector. This mechanism leverages rising prices to increase cost and thereby yield the stated objectives. In contrast, electricity expansion presents a growth oriented path while ignoring the environmental impact due to the non-constrained emissions. It, however, does improve the production and welfare across the region.

The combined NDC + AFE scenario provides the most balanced outcomes. While emissions are reduced substantially, the economic losses are abated via increased electricity production. Electricity expansion reduces the marginal cost of abatement by providing more energy thereby weakening the reliance on contractionary pressure. This is reflected in improvements in welfare outcomes, reduction in GDP losses and over all stable sectoral performance. The Decarbonisation Efficiency Index further reinforces this finding, suggesting that emissions reduction is achieved more efficiently with electricity expansion rather than without it.

From the policy perspective, the results underline the need for coordinated strategies. The shock of energy expansion is relatively a small shock. At an intuitive level, it makes perfect sense that infrastructure at large, including, electricity, transport, trading efficiency are the key elements of effective policy to address the twin goals of decarbonization and economic growth. A singular policy measure to achieve a low carbon economy in South Asia and Southeast Asia is not suitable. Instead a careful calibration of a mix of policy measures will lead the region into a pathway of clean and growing economy.

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7 Annexure

Table A1						
	GDP (Percent Change)			Energy Intensity of GDP (Percent Change)		
	NDC	AFE	AFE+NDC	NDC	AFE	AFE+NDC
BGD	-0.04347	0.060776	0.017375	-5.17765	0.144791	-4.70195
BRN	-0.10724	0.005097	-0.12789	-3.81083	0.014476	-3.77538
IDN	0.050054	0.035952	0.086516	-3.74539	0.026528	-3.52264
IND	-0.20023	0.027753	-0.18712	-3.48805	-0.01778	-3.36287
KHM	-0.10908	0.047611	-0.05463	-2.21752	0.115779	-1.90594
LAO	0.022297	0.43156	0.466518	-3.04178	-0.21379	-2.65829
LKA	0.027393	0.010464	0.048995	-2.68183	0.012519	-2.19133
MYS	-0.00377	0.028805	0.028975	-2.53357	0.019139	-2.18838
NPL	-0.2988	0.081936	-0.29397	-3.61652	0.073938	-4.12241
PAK	0.066203	0.048128	0.133112	-3.18045	0.016741	-2.38068
PHL	-0.00181	0.04898	0.052641	-4.20933	0.041557	-3.8336
ROW	-0.01586	0.000606	-0.01139	-2.63034	-0.00134	-2.44899
SGP	-0.12794	0.020031	-0.1378	-3.88196	-0.03674	-3.93887
THA	0.034131	0.03873	0.085598	-2.06245	-0.00285	-1.77543
VNM	-0.17256	0.298671	0.126514	-2.79389	0.131799	-2.48281
XSA	0.025456	0.035238	0.070278	-3.42408	0.000953	-3.12683
XSE	-0.02724	0.000752	0.014668	-1.31078	-0.00054	-0.14401

Table A2						
	Per Capita Household Utility (Percent Change)			Equivalent Variation (US $ Million)		
	NDC	AFE	AFE+NDC	NDC	AFE	AFE+NDC
BGD	-0.0782	0.068011	-0.00748	73.6875	458.416	649.1719
BRN	-0.29083	0.003744	-0.29769	-40.2075	0.2761	-39.6208
IDN	0.021685	0.040131	0.061738	1308.797	662.2578	2082.125
IND	-0.19005	0.029897	-0.16572	-10553.6	1570.375	-9107.77
KHM	-0.09177	0.079124	-0.00571	7.725586	33.31946	49.05994
LAO	0.175482	0.191828	0.35418	84.91052	57.47052	140.9988
LKA	0.075287	0.011918	0.084404	157.9177	10.83154	171.1963
MYS	-0.02929	0.030302	0.000342	196.7842	145.6875	378.7988
NPL	-0.15463	0.072409	-0.09926	-4.39746	18.2052	88.44421

PAK	0.089282	0.051365	0.152712	1651.717	299.7109	2036.506
PHL	0.02523	0.052978	0.08078	1027.689	341.6738	1484.48
ROW	-0.02323	0.001375	-0.01799	17614.63	897.25	27987.5
SGP	0.183144	0.024788	0.197259	862.0406	102.7986	957.421
THA	0.021829	0.051864	0.084241	464.3252	318	888.9639
VNM	-0.05225	0.138221	0.093911	116.4277	380.0674	583.1045
XSA	-0.00239	0.032001	0.039123	67.01929	24.35547	105.4917
XSE	0.018025	0.007116	0.021675	76.09851	5.979065	71.56262

Table A3						
	change in trade balance X - M, $ US million (c)			trade terms for region r, computed from components (p)		
	NDC	AFE	NDC + AFE	NDC	AFE	NDC + AFE
BGD	479.6821	-36.2788	411.7334	-0.16313	-0.00729	-0.16139
BRN	31.76953	0.092379	32.91207	-0.35912	-0.00466	-0.34517
IDN	33.57104	40.13	90.71838	-0.16596	-0.00328	-0.17253
IND	10969.9	140.9185	10623.43	0.013533	-0.00799	0.020663
KHM	2.792262	1.008992	2.634135	0.008081	0.024654	0.030731
LAO	-4.84723	11.31463	4.590005	0.332905	-0.66421	-0.38146
LKA	-45.1085	4.256439	-36.5842	0.111022	-0.00664	0.067649
MYS	244.5762	10.78296	198.7335	-0.04188	-0.00078	-0.04686
NPL	118.1231	21.84525	168.2058	0.217655	-0.10658	0.165421
PAK	-532.376	-14.7244	-518.065	0.127004	-0.00353	0.090054
PHL	-482.255	-21.731	-478.965	0.061846	-0.00676	0.045139
ROW	-12487	-397.574	-12486.2	-0.0026	0.002903	0.000255
SGP	1416.512	-55.8297	1510.387	0.223836	0.001556	0.235935
THA	-58.0983	0.825928	-73.4144	-0.01277	0.018283	0.003856
VNM	409.498	299.6843	651.8286	0.043597	-0.11807	-0.07507
XSA	-101.961	-12.7814	-109.392	0.014582	-0.04638	-0.03613
XSE	4.054291	1.083862	3.976501	0.093483	0.012713	0.035128