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Socioeconomic Impacts of Cross-Border Transport Infrastructure Development in South Asia

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Abstract

Although the overall economic performance of economies in South Asia in recent years has been impressive, there is concern that an aging and increasingly inadequate infrastructure may limit the potential for further growth and economic development. A critical infrastructure component is the transportation network, and there are currently several transportation infrastructure projects in the South Asia Subregional Economic Cooperation (SASEC) region, connecting Nepal, eastern India, Bangladesh, and Bhutan. This paper uses computable general equilibrium (CGE) methods to address how these infrastructure developments might affect the broader economy in SASEC, and in particular impact on income distribution and poverty. The paper describes a new CGE model for South Asia, covering India, Sri Lanka, Bangladesh, Nepal, and Pakistan, which incorporates modifications to household structure in order to capture the implications of reform for changes in intra-household income. The scenarios that are considered reflect proposed investments in land transport infrastructure in the SASEC region. These should result in reductions in the land transport component of international transport margins, which vary bilaterally by commodity. We found that all SASEC economies would benefit from the reductions in terms of aggregate welfare, with the largest gains accruing to India in absolute terms, but the largest relative gains to Nepal, followed by Bangladesh and Sri Lanka when the margin reduction is prorated to intra-South Asian trade rather than just SASEC. In terms of household level distribution, the picture was mixed, with clearly pro-poor outcomes in some countries, such as Nepal, but more ambiguous impacts in others. In terms of potential adjustment costs, examination of the extent of predicted structural changes suggests that these would be minor, although somewhat more significant for the smaller economies in the region.

JEL Classification: F14, F17, D58, O53

Contents

1. INTRODUCTION

The overall economic performance of economies in South Asia in recent years has been impressive. India has led the way with an 8–9% growth in gross domestic product (GDP) since 2003, followed by Bhutan with 7–8%, and Pakistan, Bangladesh, and Sri Lanka each with 6–7%. Only Nepal has experienced relatively slow growth. However, there is concern that an aging and increasingly inadequate infrastructure may limit the potential for further growth and economic development.

A critical infrastructure component is the transportation network. Although South Asia inherited an integrated transport infrastructure from the British, this infrastructure was fractured by the partition of India and its political aftermath, and now needs to be rebuilt within the context of greater political harmony in South Asia (Asian Development Bank [ADB] 2007: 1). Transport infrastructure in many areas has fallen into disuse, raising the cost of travel and trade. The ADB is financing several transportation infrastructure projects (in addition to projects on energy, tourism, and the environment) in the South Asia Subregional Economic Cooperation (SASEC) region, connecting Nepal, eastern India, Bangladesh, and Bhutan.

An important question is how these infrastructure developments might affect the broader economy in SASEC, and in particular impact on income distribution and poverty. South Asia is one of the poorest regions in the world. Table 1 reviews the poverty/income distribution statistics in the region. These have been drawn from the World Bank (2007), and we have extracted the latest available year for each economy in South Asia for which data are available.

The most basic measure of poverty is the headcount ratio, the proportion of the population that falls below a defined poverty line. Commonly used criteria are the international US$1/day and the US$2/day standards, with the higher standard more widely applied to countries with higher average incomes.[1] The overall percentage of the population under the poverty line in India has been falling since 1996. The depth and severity of poverty has also fallen over that period. Nonetheless, the proportion of the population living in poverty in India remains high, and there is also considerable variation in poverty levels between urban and rural populations. In Bangladesh, the poverty headcount is even higher, at 35%, while it is 25% in Nepal. In Pakistan and Sri Lanka, the rates are much lower, at 9% and 6%, respectively. Nonetheless, poverty remains an issue; at the US$2/day level the corresponding rates are 60% and 41%. Income distribution is also uneven throughout South Asia, especially in Sri Lanka and Nepal.

Two other measures are provided in Table 1, both of which attempt to address the issue of poverty depth. The poverty gap measure is the mean distance below the poverty line as a proportion of the poverty line. The squared poverty gap weights individual poverty gaps by the gaps themselves, and provides a measure of inequality among the poor. The areas with the greatest depth of poverty are again Bangladesh, rural India, and Nepal. Finally, the Gini coefficient is a commonly used measure of overall income inequality, with the greatest levels of inequality in Nepal and Sri Lanka.

[1] See Chen and Ravallion (2004) for more in-depth discussion of poverty measures and trends in global poverty.

Table 1: Poverty Profiles of South Asian Economies

	Year	Headcount (%)	Poverty Gap (%)	Squared Poverty Gap (%)	Gini (%)
US$1/day					
Bangladesh	2005	35.3	7.9	2.4	33.2
India — Rural	2005	40.2	9.4	3.1	30.5
India — Urban	2005	19.6	4.2	1.3	37.6
Nepal	2004	24.7	5.6	1.7	47.3
Pakistan	2005	9.0	1.4	0.4	31.2
Sri Lanka	2002	5.8	0.7	0.1	40.2
US$2/day					
Bangladesh	2005	81.5	35.6	18.5	33.2
India: Rural	2005	87.7	39.8	21.0	30.5
India: Urban	2005	61.5	23.1	11.1	37.6
Nepal	2004	64.8	26.4	13.2	47.3
Pakistan	2005	59.5	18.3	7.4	31.2
Sri Lanka	2002	41.5	12.1	4.6	40.2

Source: World Bank (2007).

The purpose of this study, as defined by the ADBI, was to try to quantify the impact of transportation infrastructure developments in the SASEC region by applying appropriate empirical methods to ascertain the economic outcomes from identified cross-border transportation projects in the region, and, as far as possible, by analyzing the socioeconomic implications. The impacts on households in the region, poverty, and income distribution are analyzed, as well as general economic conditions and impacts on sectors.

Given the desire to derive economy-wide and sector level impacts, computable general equilibrium (CGE) is the most appropriate methodological approach. CGE models are numerical simulation tools based on general equilibrium theory. Their objective is to turn the abstract models of theory into a practical tool for policy analysis. The typical applied model adds complexity to, but retains the basic structure of, textbook general equilibrium models. Since policy and other changes in an economic system often have repercussions beyond the sector in which they occur, by linking markets, CGE techniques are effective at capturing the relevant feedback and flow-through effects. CGE techniques have been widely used for ex ante trade policy analysis, and more recently for poverty analysis (for surveys see Scollay and Gilbert 2000; Gilbert and Wahl 2002; Robinson and Thierfelder 2002; and Lloyd and MacLaren 2004).

The primary objective of this draft paper is to describe the building of a new CGE model for South Asia constructed with the support of the study, and its applications for understanding the socioeconomic aspects of developments in cross-border transport infrastructure. The model covers India, Sri Lanka and Bangladesh, Nepal, and Pakistan. The model incorporates modifications to the household structure to capture implications of reform for intra-household income changes. It is general in purpose, with the possibility of future applications to related problems. It is also extensible, so that alternate datasets for other countries inside the region may be added in the future.

The paper is organized as follows. In Section 2, we outline the features of the proposed SASEC project, which involves a series of improvements in transportation network infrastructure between India, Bangladesh, Nepal, and Bhutan. In Section 3, we review the existing CGE studies of socioeconomic impacts of policy reforms in the SASEC region and

South Asia more generally. The majority of studies featuring household impacts have focused on trade liberalization. In Section 4, we then describe the regional model that we have built for this study. In Section 5, we consider the results of our simulations and the policy implications. Finally, in Section 6, we offer our concluding comments.

2. PROJECT BACKGROUND

The Regional Technical Assistance (RETA) Project No. 39454 (ADB 2007), which we briefly summarize here, lays out the background to the proposed project and the scope of the infrastructure developments that are being undertaken. Its central thesis is that while South Asia inherited an integrated transport infrastructure from the British, this infrastructure was fractured by the partition of India and its political aftermath and now needs to be rebuilt within the context of greater political harmony in South Asia (ADB 2007). Infrastructure in many areas has fallen into disuse, raising the cost of travel and trade.

Among the issues of particular concern that are highlighted in the RETA (which summarizes discussions from meetings in the SASEC region since 2001), is the landlocked or semi-isolated status of the regions under study; finding ways to integrate Nepal, Bhutan, and the northeastern region of India with the wider South Asian and world economy via improved access to the ports and economic centers of the region, and providing a choice of route and mode, are viewed as critical (ADB 2007).

In terms of physical infrastructure issues, the northeastern region of India is connected to the rest of India by a narrow and congested land corridor between Bangladesh and Nepal. This landlocked region trades with the rest of India and the world through this strip of land, and the costs of transporting goods to and from the northeastern region are consequently high. Third-country trade for both Nepal and Bhutan is also routed through this corridor, with associated delays and costs (ADB 2007).

The proposed solution is to allow the landlocked region of northeastern India, Bhutan, and Nepal access to Chittagong port through Bangladesh's eastern border, or to Mongla port through its northwestern border. Non-physical barriers are also an issue. Customs clearance procedures can add significant costs and delays, and can reduce transparency. In the SASEC region the key border-crossing points are at Benapole (Bangladesh) and Petrapole (India), through which more than 80% of trade between the two countries is routed. According to ADB (2007), severe congestion results in long queues of trucks on both sides of the border and waiting times of 1–5 days. More than 85% of the time spent waiting at the border is spent on queuing, customs clearance, and transferring cargo. To mitigate the congestion and improve the efficiency of border operation, the Government of India is in the process of developing an agreement for cross-border truck movement in consultation with the Government of Bangladesh.

The RETA lays out a plan addressing these physical and non-physical barrier issues for the promotion of subregional economic cooperation and integration between the SASEC economies. An investment project is proposed that will “facilitate the unhindered movement of goods, services, and people across SASEC countries through improved cross-border transport infrastructure and the introduction of modern cross-border management regimes.” The proposal involves improvements in road corridors, rail links, and cross-border procedures.

3. LITERATURE REVIEW

The linkages between economic reform and poverty, and the development of ways to quantitatively assess those linkages have been the subject of intense recent research.[2] Hertel and Reimer (2005) and Hertel and Winters (2005) reviewed ex ante studies and provided a method of classification by simulation type: partial equilibrium models; general equilibrium models; and micro/macro simulation models, which combine (not always with feedback) macro-level simulation with micro-level household models. They concluded that CGE techniques and micro/macro methods have the best potential to fully evaluate the complex web of determinants of changes in poverty ex ante.

Within the recent CGE literature there is a range of ways of addressing poverty impacts of policy reform. Aggregate results at the regional level, such as impacts on prices of staples or returns to unskilled labor, may be combined with ad hoc observations on potential effects on poverty. Other studies take results from a global model with a single representative household, and pass them through a sub-model to determine the poverty impact. The sub-model may be small, producing rough assessments of poverty impacts in the form of headcount indices that are calculated using established elasticities, as in Anderson and Martin (2005). Another approach at the country level is to build more sophisticated sub-models of household behavior, or to directly incorporate income distribution at the household level within a regional CGE model. Several studies of this type have been conducted recently for selected economies (Hertel and Winters 2006; OECD 2006).

The most straightforward method of dealing with income distribution and poverty impacts in a CGE framework is to abandon the single-representative consumer approach and to incorporate multiple representative household groups in the model. This allows the model to track inter-group income changes directly, but still leaves the issue of intra-group income changes external to the model. The greater the number of household groups, the better the model will be able to capture the pattern of income changes. Recent efforts typically feature between five and 10 household categories, although in some cases there are many more. The approach can be extended by incorporating any available information on the distribution of income within household categories.

Several recent CGE studies have used the multiple household approach to analyze the consequences of reform (mostly trade policy) in South Asia. Since the reduction in the cost of transportation has very similar theoretical implications to reductions in tax-based distortions, a review of the literature is worthwhile. These studies have tended to use single-economy models for the distribution analysis, often in combination with a global model to estimate the impacts of the proposed scenarios on world prices.

There are a number of studies of India. Gilbert (2007) considered the impact of the current proposed modalities for reform in agriculture under Doha at the household level in India, in addition to the effects of more comprehensive agricultural reform. The study used the Global Trade Analysis Project (GTAP) model to estimate the world market effects, after first modifying the underlying GTAP6 data to reflect the latest available applied protection levels, using the trade analysis and information system (TRAINS) database. The global results were then input into a single-economy CGE model of India, which is a competitive CGE of the Armington variety. Forty-three productive sectors and five factors of production were identified in that study, along with nine households (four rural and five urban with Stone-Geary preferences). Household data were obtained from Pradhan and Sahoo (2006) and matched to the GTAP data on aggregate consumption, production and trade using RAS

[2] Winters (2002) identified seven linkages between reform and poverty: Changes in i) consumer prices and availability of goods; ii) factor prices and quantities employed; iii) taxes and transfers influenced by shifts in government revenue; iv) the terms of trade and other external shocks; v) investment and innovation that affect the long-run growth path; vi) remittances; and vii) short-run risk and adjustment costs. While the primary reform scenario considered by Winters is trade reform, the same pathways exist for changes in transportation costs.

methods. The base year was 2001, although protection data was more recent, as noted above. The simulations were run as comparative statics, with two different adjustment time horizons (short and long run) represented by mobility/immobility of capital across productive sectors. Tax replacement was (implicitly) through lump sum transfers from the households.

In the Doha scenarios, the welfare of the poorest households (agricultural labor and other rural labor) fell in both the short and long run, whereas the welfare of the richest group (urban self-employed) rose. The income of the rural self-employed (landowners) also rose in the Doha scenarios, suggesting that ownership of land and capital helps to insulate this group from the effects of trade shifts. The result was similar to that of Annabi et al. (2006) for Bangladesh, but the change was not statistically robust. Under comprehensive reform the results were quite different. The aggregate welfare gains were several orders of magnitude larger, and the welfare of all households except the rural self-employed rose. The results were statistically significant, and suggest that India's landowning class is able to benefit from rising world prices under Doha reform when India does not engage in significant reforms of its own, but faces considerable drops in income if domestic prices are allowed to fall.

The results also indicate that, in the long run, income inequality improves in all scenarios except for comprehensive reform of agriculture. India would gain overall from agricultural reform, but a small increase in rural poverty is possible under the Doha agreement as it stands. On the other hand, comprehensive reform is likely to increase the incomes of the poorest groups, but at the expense of a slight increase in income inequality, and a substantial reduction in the incomes of landowners.

Pradhan and Sahoo (2006) used a similar CGE structure in their analysis of potential trade reform scenarios for India, although it was not connected to a global CGE framework, and obtained similar results.

Panda and Ganesh-Kumar (2008) specifically considered the issue of food security with changes in trade policy. Their modeling approach was very similar to that used in Gilbert (2007), with the exception that they used the modeling international relationships in applied general equilibrium (MIRAGE) model developed by the International Food Policy Research Institute (IFPRI) as the source of their global price changes rather than GTAP. They considered a Doha scenario and found that all households experienced a rise in welfare and a decline in poverty. However, they argued that this does not necessarily translate into increased food security as the poorest households decreased their consumption of protein and calories, while increasing their consumption of fats. These conclusions are based on an ex post assessment of the household consumption patterns which drive the CGE model.

Finally, Polaski et al. (2008) used a single-economy CGE of India, based on a very detailed social accounting matrix (SAM) for 1998–1999. The SAM included 115 commodities, 48 labor types, and 352 households (classified by social group, income class, region, and urban or rural). The model was a competitive Armington type, and varied from the standard model only in that the labor market for unskilled workers was closed by fixing the wage and allowing the supply to be endogenous (to capture potential underemployment of unskilled labor). They considered the impact of price changes in agricultural commodities, and found that a decrease in the price of rice could have a significant negative impact on Indian poverty levels.

Results for Bangladesh are available from Annabi et al. (2006) and Raihan (2008). Annabi et al. (2006) used the GTAP model to estimate the overall effect of trade reform under the Doha proposals (both agriculture and non-agriculture) at the world level, and then input the world market effects into a single-economy CGE model for Bangladesh. The single-country model was used to generate detailed results at the household level. In addition to the Doha agenda, the study also considered the potential impact of more comprehensive global reform, and of unilateral reform by Bangladesh.

The Bangladesh model was a standard, competitive CGE model of the Armington type. It identified 15 productive sectors, four factors of production, and nine households (five rural and four urban with Stone-Geary preferences), with 2000 as the base year. The simulation procedure is recursive dynamic, setting the growth of the labor stock and productivity at fixed levels, and making the capital stock growth path endogenous by applying a simple, sector-specific investment rule. Tax replacement is (implicitly) through lump sum transfers from the households. The simulations extend for a 20-year period, and are compared with a baseline growth path.

The results indicated aggregate welfare losses for Bangladesh in the Doha scenarios, along with small increases in the headcount ratio (diminishing somewhat but remaining negative in the long run). The negative aggregate welfare effect was driven by adverse terms of trade movements. These remain even in a scenario with complete liberalization in the rest of the world. The poverty effect was driven by increased prices, even though nominal unskilled wages rose slightly. When broken down to the household level, Annabi et al. (2006) found poverty increases for all household categories except large farms.

The study by Raihan (2008) used a single-economy model for Bangladesh. The SAM was based on 2005, with 26 sectors, nine production factors, and six households. Again, the model used the competitive Armington structure to analyze various unilateral liberalization scenarios under both a neoclassical labor market closure and an unemployment closure, where it is assumed that only a proportion of the workforce is able to change production activities. Raihan (2008) argued that the effects of unilateral reform in the aggregate are positive but small, suggesting that the export bias of the current regime is minimal. Unfortunately, the paper did not directly discuss poverty or income distribution impacts, although the model was clearly able to generate information on this aspect of adjustment to trade reforms.

Two recent studies are available for Nepal, Cockburn (2002) and Acharya and Cohen (2008). Cockburn (2002) constructed a CGE model of Nepal that explicitly models all households from a nationally representative household survey. The model was an archetype competitive CGE, but with a high degree of household disaggregation. The base year of the model was 1986, and the model incorporated 15 production activities. They considered a trade liberalization scenario and found that urban poverty decreased and rural poverty increased, as initial tariffs were highest for agriculture. Impacts increased with income level, resulting in rising income inequality.

Acharya and Cohen (2008) based their work on a 1996 SAM of Nepal, with four household groups. The model was very small scale, identifying only four production activities and two factors. The scenario considered is a 10% reduction in tariffs in the presence of both a fixed and a flexible exchange rate regime. They concluded that the results were not conclusively pro-poor, as one of the richer household groups benefited most, whereas the benefit to the poorest household group was only modest. Therefore, they suggested that complementary policies are required to make trade liberalization pro-poor in Nepal.

Although Sri Lanka is not part of the SASEC region, it is an important economy in South Asia and has been the focus of several CGE studies, many surveyed by Dasanayake (2000).[3] The most recent study was by Naranpanawa (2005), and used a 1995 SAM. The model identified 38 production activities, three factors, and five households. The poverty analysis was extended to intra-household groups (post simulation) by estimating the distributions of income within household groups and using these to estimate disaggregate poverty metrics. Naranpanawa considered a manufactured goods trade liberalization scenario, and found that the potential benefits accruing to low income rural groups were low relative to other groups in the model, a fact attributed to a reduction in transfer payments from the government to households following falls in government revenue. Long-term liberalization reduced absolute

[3] This study also briefly reviews some of the earlier CGE studies of India, Bangladesh, and Nepal.

poverty in all groups, with manufacturing reform being more pro-poor than agricultural reform, but might increase relative poverty, i.e., would not support a more even distribution of income.

Pakistan, while also not a member of SASEC, has been the subject of several recent CGE studies. Ahmed and O'Donoghue (2008) used a single-economy CGE to examine various macro-economic shocks. The SAM identified 44 sectors, 11 factors and 17 household categories, with 2001 as a base year. Although based on the standard competitive Armington framework, several modifications of the model were made to better represent the developing economy characteristics of Pakistan. In particular, the model incorporated household consumption of non-market commodities as well as market commodities and an explicit treatment of transaction costs for marketed commodities. Unlike many other CGE models (such as GTAP), the model also separated production activities and commodities (i.e., joint production was allowed). The CGE model was combined with a microsimulation model to generate poverty information. Prices, wages, and aggregate employment variables from the CGE model were used as input to a microsimulation model that generated changes in individual wages, self-employment incomes, and employment status. The microsimulation model was based on household and individual level data from the survey data for the year 1996 and simulated income generation mechanisms for 1150 households.

The model was used to simulate several international price shocks, both aggregate and sector-specific. Among the most important results, Ahmed and O'Donoghue (2008) found that external oil price shocks have the highest potential for socioeconomic impact. Poverty increased when the overall import price rose, but increases in the import price of petroleum had the greatest effect on inequality.

All of the preceding studies used single-economy models, sometimes in combination with a global model such as GTAP or LINKAGE, to analyze the socioeconomic impacts of policy changes on a single economy in the region. As far as we are aware, this is the first CGE study that attempts to deal with household income distribution issues in the context of the whole region simultaneously, using a disaggregated CGE model. Khan (2008) presented very preliminary results for a prototype model for South Asia. The model was an interesting approach, incorporating several non-standard features, including technological dualism and rural-urban migration of the Harris-Todaro type. Although the model included eight household groups, it had only three production activities, and was calibrated to a single country (India). Hence the results from Khan (2008) are relevant for other countries in the region only by extension in the model's current form, although the approach might be usefully adapted to other countries in the future.

4. METHODOLOGY

For this project we custom-built a CGE model of South Asia, with sub-economy models for key countries in the region, programmed using the general algebraic modeling system (GAMS) system. This section outlines key characteristics of the model structure and experimental design. The model is a multi-regional competitive CGE covering India, Bangladesh, Sri Lanka, Nepal, and Pakistan, as well as an incompletely modeled rest of the world (ROW) region. Overall, the structure of the model that we built for this study is a regional CGE similar in many respects to GTAP and other global models. Therefore we will keep our description brief.

4.1 Model

The model identified 16 production sectors. Each sector produced a joint product for domestic and foreign markets, with the allocation between the two based on a constant elasticity of transformation (CET) function. The production functions were nested constant elasticity of substitution (CES) functions with intermediate goods used in fixed proportions and all primary factors in variable proportions having a common elasticity. Intermediate inputs were composites of imported goods and domestic production, with variable proportions specified independently by industry. In this version of the model, the domestic transport sector was included in the services category, implying that changes in the output structure of all transportation services was in fixed proportions.

Competitive conditions hold, so firms paid market prices for all inputs, and made zero (economic) profit. Primary endowments were fixed, and could be treated as specific or mobile. The dataset contained five primary factors. In the default medium-run closure, we treated all factors except natural resources as mobile across economic activities.

The model identified several consumption agents: the government, investment, and multiple consumer households. The number of consumer households varied by region depending on available data, with between four and 19 categories in the various regions. Final consumption of each household was modeled using Stone-Geary utility functions, which generate linear expenditure systems (LES) characterizing demand for each household category. Changes in household welfare were measured by equivalent variation (EV).[4] The parameters of the functions varied by household to capture differences in consumption patterns. The quantity of government consumption and investment was held constant in the default closure. All agents consumed composites of imported goods and domestic production, with variable proportions specified independently by agent (sometimes called the SALTER specification). On the income side, factors were owned in varying proportions by the households, and we maintained fixed proportions in household savings, taxation, and government transfers.

The exportable produced by domestic firms was allocated over destination regions using a second-level CET function, hence the aggregate exportable was a composite of exports to the various regions (the elasticity of both CET functions was set such that export destinations are very close to being perfectly substitutable, with elasticities of 20 and 40 at the lower and upper levels, respectively). Similarly, on the import side, the imports of each country were a CES composite of regional imports (i.e., a second-level Armington function). In contrast to the first level, this function was common across all agents in the domestic economy. Demand for regional exports was derived from the Armington import structure for all regions that were explicitly modeled. For regions that were not explicitly modeled, here the ROW region, we reduced the computational complexity of the model by using constant elasticity of demand (CED) functions to represent demand responses. The prices of imports from the ROW region were fixed.

An international transportation sector accounted for the difference between the free on board (FOB) price of exports and the cost, insurance, and freight (CIF) price of imports. Transportation margins varied by commodity on all international routes. Unlike in the GTAP model, because of our focus on a single, relatively small (in global terms) region, we fixed the price of international transportation services.

The price normalization and closure rules were similar to those used in many single-country models. The current account balance was fixed and the nominal exchange rate was allowed to vary to maintain balance within each country. The numeraire in each country was the consumer price index. We also had to define a numeraire region for which the nominal exchange rate was fixed, which in this model was the ROW region.

The model included a full range of distortions in the form of taxes and subsidies on economic activities at all levels to ensure that the second-best implications of the policy scenarios were adequately accounted for.

[4] Equivalent variation is the monetary value of the increment in income that would have to be given to (or taken away from) a household at today's prices to make them as well off today as they would be under the proposed policy change.

4.2 Data

The CGE model required appropriate data in the form of a SAM for each country, trade flow matrices, and estimates of the model parameters and their distributions.[5] These were compiled from various sources, and were reconciled prior to model implementation.

The base data on trade, production, aggregate consumption, and employment were extracted from the GTAP7 (pre-release) database, which was made available by the ADBI for this project. GTAP7 has a base year of 2004. Information on sources of household income (ownership of primary factors and transfers/taxes) and variation in consumption patterns across households were obtained from Pradhan and Sahoo (2006) for India, Fontana and Wobst (2001) for Bangladesh, Naranpanawa (2005) for Sri Lanka, Roland-Holst (2008) for Pakistan, and Acharya (2007) for Nepal.[6] The household categories used in the model are listed in Table 2. The information in each study was aggregated/disaggregated and rebalanced where necessary to match the dimensions of our model and to be consistent with the aggregate GTAP7 household consumption data.[7]

Model elasticity parameters were obtained from the existing estimates in GTAP7. Armington elasticities have recently been estimated by Hertel et al. (2007). Base substitution elasticities in production were also obtained from GTAP7.

4.3 Experimental Design

The model is quite general in purpose, and can in principle be useful to examine a variety of developments in South Asia. For now, the shock magnitudes chosen to represent the effect of transport infrastructural developments are based on the original RETA (ADB 2007). This suggests a 20% reduction in transportation and processing time, which we assume is directly reflected in transportation margins.[8] Because the investment is in land networks, we used only the land transport component of international trade margins (see Table 3 for summary data from GTAP7). Transport margins and the primary mode of transport vary by product and route, and this information was taken into account when calculating the shock values.

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[5] The SAM is an account of all of the flows between economic agents at a given point in time.

[6] A newer SAM from Saluja and Yadav (2006) has a base year of 2003–2004, 73 productive sectors and 10 household categories, defined by expenditure level. We may update our model to include information from this SAM at a later date.

[7] The procedure we used was first to split the factor income proportions across skilled and unskilled labor using the aggregate level of factor use in GTAP7 and the allocation of labor to agricultural/non-agricultural activities. Once this mapping was complete, we were able to construct household incomes consistent with the GTAP7 data. These generally matched the proportions in the original data quite closely. We then matched the consumption categories to GTAP categories, and used the overall GTAP consumption proportions to split the individual household proportions where necessary. Finally, we used the RAS method (Bacharach 1970) to ensure that the household consumption shares were consistent with the household incomes and total expenditures in GTAP7. This process was undertaken for each country in the model.

[8] This is probably an upper bound of the impact for the first year, assuming that at least some costs are fixed. On the other hand, there are several reasons to expect the estimates of this type of model to be conservative, as discussed further below.

Table 2: Household Categories in the Model by Region

Category	Pakistan	Bangladesh	India	Sri Lanka	Nepal
H1	Large farm — Sindh	Agricultural landless	Rural self-employed agricultural	Urban low income	Small rural
H2	Large farm — Punjab	Agricultural marginal land	Rural agricultural labor	Rural low income	Large rural
H3	Large farm — other	Agricultural small land	Rural non-agricultural labor	Estate low income	Landless rural
H4	Medium farm — Sindh	Agricultural large land	Other rural	Urban high income	Urban
H5	Medium farm — Punjab	Non-agricultural poor	Urban agricultural	Rural high income	
H6	Medium farm — other	Non-agricultural rich	Urban self-employed non-agricultural		
H7	Small farm — Sindh	Urban illiterate	Urban salaried		
H8	Small farm — Punjab	Urban low educated	Urban casual labor		
H9	Small farm — other	Urban medium educated	Other urban		
H10	Landless farm — Sindh	Urban highly educated			
H11	Landless farm — Punjab				
H12	Landless farm — other				
H13	Rural landless — Sindh				
H14	Rural landless — Punjab				
H15	Rural landless — other				
H16	Rural non-poor				
H17	Rural non-farm poor				
H18	Urban non-poor				
H19	Urban poor				

Source: Pradhan and Sahoo (2006), Fontana and Wobst (2001), Naranpanawa (2005), Roland-Holst (2008), and Acharya (2007).

Table 3: Average Transportation Margins by Mode as Percentage of Total Export Value

Source	Destination					
	Bangladesh	India	Pakistan	Sri Lanka	Nepal	ROW
Air Transport						
Bangladesh	--	0.02	0.01	1.24	1.09	0.67
India	0.01	--	0.01	1.33	1.19	0.62
Pakistan	0.01	0.01	--	1.15	1.07	0.66
Sri Lanka	0.02	1.49	0.01	--	1.93	1.03
Nepal	0.01	0.04	0.01	1.38	--	0.46
ROW	0.01	0.77	0.01	1.17	1.03	0.51
Water Transport						
Bangladesh	--	0.02	24.28	4.78	5.30	3.98
India	13.88	--	7.86	4.79	5.48	3.42
Pakistan	8.65	0.07	-	4.74	8.10	4.86
Sri Lanka	7.15	2.87	14.92	--	5.67	4.21
Nepal	9.49	0.18	10.88	2.70	--	1.10
ROW	7.13	2.03	6.03	3.34	3.61	2.13
Land Transport						
Bangladesh	--	16.45	0.00	2.83	0.01	1.20
India	0.13	--	0.13	4.35	4.45	1.70
Pakistan	0.00	14.75	--	5.16	9.56	1.76
Sri Lanka	0.00	2.88	0.00	--	4.85	1.08
Nepal	0.00	9.54	0.55	3.64	--	0.42
ROW	0.00	1.50	0.02	2.24	0.96	1.01
Total Transport						
Bangladesh	--	16.49	24.29	8.85	6.40	5.85
India	14.03	--	8.00	10.48	11.11	5.74
Pakistan	8.66	14.82	--	11.06	18.72	7.28
Sri Lanka	7.17	7.24	14.93	--	12.45	6.31
Nepal	9.50	9.75	11.43	7.71	--	1.98
ROW	7.14	4.29	6.05	6.74	5.60	3.64

Source: GTAP7

We considered two alternative versions of the impact of the reduction in international transportation costs. In the first (Scenario 1), we assumed that the impact was only on the SASEC member economies in the model (i.e., India, Nepal, and Bangladesh). In Scenario 2, we assumed that the measures would also lower transportation costs of intra-regional trade for the other South Asian economies in the region (i.e., Pakistan and Sri Lanka). Again, the cuts were based only on the land transport costs, and were also adjusted downward to reflect the fact that only a part of the route is modernized under the proposal (i.e., the intra-SASEC component).

The simulations were run as comparative statics, so the results should be interpreted as representing how the economic system would have appeared in the base year had the proposed changes been implemented and the economic system given sufficient time to adjust to the new equilibrium. As noted above, the factor market closure allowed all factors except natural resources to be mobile across economic activities, implying that the simulation is medium run in nature.[9]

Sensitivity analysis was implemented within the simulations using an unconditional approach adopted in Gilbert and Wahl (2003). This approach improves the policy value of the simulations by highlighting results that are unlikely to be robust, and by providing an estimate of the range of potential outcomes rather than a point estimate. To undertake the analysis, key parameters (the trade elasticities) are treated as normally and independently distributed random variables.[10] Each simulation was run as a Monte-Carlo experiment, with a series of pseudo-random parameter values chosen from the underlying distributions. With a large number of iterations (we used 500) of the simulation we could approximate the mean predictions of the variables of interest, along with indicators of their susceptibility to parametric uncertainty (the standard deviations), and the accuracy of the simulation procedure (the standard errors).[11]

5. RESULTS

We first considered the impact of a reduction in regional transportation costs on overall economic welfare. The results of our simulations, using the household EV measure, are presented in Table 4. The overall welfare estimates are the sums in the row labeled “total”. This type of estimate of the benefit/cost of the proposed change is sometimes called a “one-off” gain/loss. However, this is somewhat misleading as the changes are permanent. Rather we can think of this (roughly) as a permanent increment to household incomes, at constant prices. In absolute terms, the biggest beneficiary in either scenario among the SASEC economies is India, followed by Nepal, then Bangladesh. The total welfare gain is positive, if modest, for all of the SASEC members.

When none of the benefits of transportation cost reductions is assumed to be passed on to other South Asian economies (Scenario 1), both Sri Lanka and Pakistan are estimated to suffer decreases in welfare. However, the losses are small. This suggests the non-SASEC economies in the region are likely to be affected only marginally, if at all, by investments in SASEC transport infrastructure should they be unable to utilize the networks. In the somewhat more reasonable case where some access benefit accrues to the other economies in the region (Scenario 2), the total welfare impact to both Pakistan and Sri Lanka becomes positive, although the benefits to Sri Lanka remain small in absolute terms.

In terms of a true “one-off” measure of benefit/cost, we need to discount the permanent income stream measured by the EV. If the discount rate is assumed to be a standard 2%, then the total estimated benefit is 50 times the annual increment; in Table 4 this row is labeled “cumulative”. We can think of this as the total benefit of the reduction in

[9] The implicit adjustment time frame in this type of simulation is roughly 10–12 years.

[10] We have followed Gilbert and Wahl (2003) and used a uniform margin, here a default standard deviation of 7.5% of the mean value from GTAP7, implying that almost all variation will occur within 25% of the mean. The results give us a measure of the underlying sensitivity of the outcomes.

[11] This general technique is valid for any type of model structure and the computational complexity does not increase with the number of parameters that are allowed to vary. It is, however, computationally expensive. Variance reduction techniques can therefore be usefully be applied here. The two techniques that we used are to run alternative simulations using common random numbers, and to adopt antithetic variates in the sampling. The former ensures that the same pseudo-random numbers are drawn for alternative simulations, and therefore that alternatives can be compared without the risk of a skewed draw. Antithetic variates use the mean of symmetric draws from the underlying distribution as the estimator for mean predictions. Since most of the variables of interest vary monotonically with the elasticities that we treated as random variables, this technique dramatically reduced the standard errors in our preliminary tests (i.e., improved the accuracy of the mean estimates). In simulations with 500 draws, the standard errors were roughly halved relative to 1000 fully random draws, a reduction that would require quadrupling the number of iterations under fully random draws. That is, simulations using 500 antithetic variates generate a level of accuracy equivalent to that of 4000 fully random draws.

transportation costs, and this is the figure with which the initial cost of the project needs to be compared to evaluate the net benefit.

It is important to note that while reduction in transportation margins is similar in many respects to lowering a tariff, a CGE simulation of the latter will include all of the costs and benefits, and hence the welfare impact can be directly interpreted as net benefit.

In the case of a reduction in transportation costs that comes via investment in infrastructure, the cost of the investment must also be considered. A CGE model is not designed to estimate the cost of investment, but rather to show how that investment might impact the economic system. Hence, we leave the question of what the proposals outlined in the RETA would cost to experts in project financing. However, we can say from a cost-benefit perspective, according to our topline results, that the project would be worthwhile for India in the aggregate if the investment costs for India do not exceed US$4.3 billion. However, for a variety of reasons, this estimate is likely to be very much a lower bound since the comparative static simulation technique used here does not capture any potential dynamic accumulation effects (i.e., some proportion of the increment to income might be invested, leading to a multiplier effect), and the competitive model used does not account for potential scale effects. Moreover, there could be internal transportation margin effects that a CGE model of this type is unable to capture.

In terms of relative benefits, we can evaluate the estimated welfare impact relative to a baseline metric, most commonly the initial GDP. The final row of Table 4 expresses the cumulative gain as a proportion of GDP. Viewed from this perspective, by far the biggest beneficiary of the reduction in transport margins in SASEC is not India but Nepal, with a cumulative gain of over 12% of GDP in both scenarios. Nepal is followed by Bangladesh, with the gains to India being quite small when expressed as a percentage of GDP. Overall, the results suggest that although the absolute benefits are relatively evenly spread across the members of SASEC, the poorer economies, especially Nepal, benefit disproportionately, relative to their economic size.

Table 4: Household Welfare Impact of Transport Cost Reductions (US$ millions, EV)

	Scenario 1					Scenario 2				
	Pakistan	Bangladesh	India	Sri Lanka	Nepal	Pakistan	Bangladesh	India	Sri Lanka	Nepal
H1	0.0	0.4	54.1	–0.1	12.3	0.4	0.6	92.3	3.5	11.3
H2	–0.1	4.3	–3.1	–0.2	8.9	0.9	6.8	–6.6	5.1	10.4
H3	0.0	–1.0	8.0	0.0	11.8	0.2	–1.2	14.6	1.6	14.2
H4	–0.1	–7.7	–1.3	–0.2	2.4	0.9	–11.7	–4.0	4.6	5.3
H5	–0.4	7.1	0.4	–0.1		2.6	10.7	0.8	3.8	
H6	–0.2	4.5	–1.1			0.9	6.6	–2.9		
H7	–0.1	2.6	0.3			0.8	4.1	–2.7		
H8	–0.5	3.0	–1.0			4.5	4.4	–2.0		
H9	–0.1	6.2	–1.4			1.5	8.7	–2.9		
H10	0.0	12.7				0.6	17.1			
H11	0.0					0.6				
H12	0.0					0.2				
H13	0.0					0.4				
H14	0.0					1.2				
H15	0.0					0.1				
H16	0.0					6.7				
H17	0.0					1.7				
H18	–2.2					24.7				
H19	0.0					3.2				
Total	–3.9	32.0	54.9	–0.6	35.4	52.0	45.9	86.6	18.7	41.1
Cumulative	–193.4	1599.8	2785.5	–30.4	1768.4	2600.8	2295.1	4330.3	933.8	2057.1
Cumulative as % of GDP	–0.2	2.9	0.4	–0.2	12.7	2.7	4.1	0.7	4.6	14.8

In summary, all SASEC member economies are estimated to benefit from the margin reductions, as are non-SASEC economies in the region under Scenario 2. The largest welfare gains in an absolute sense accrue to India, followed by Bangladesh (Pakistan in Scenario 2), and then Nepal. But, this is largely a reflection of the size of the economies in question. Measured relative to GDP, the biggest winner by a substantial margin is Nepal.

Before turning to the estimated impact on household welfare, it is useful to review the household categories in the model, as presented in Table 2.

In the Sri Lankan data, we have five household groups, broken down by location and income level into rural/urban and high income/low income groupings. For Nepal, we are limited to four groups, three rural groups organized by the size of their land holdings, and a single urban group.

The data for India, Pakistan and Bangladesh are grouped by archetype. In India, group H2 (rural agricultural labor) is the poorest group by a substantial margin, followed by H4 (other rural) and H3 (rural non-agricultural labor). The richest groups are H6 (urban self-employed) and H7 (urban salaried). The households differ substantially in their ownership of productive factors, with the richest rural group (H1, rural self-employed) being substantial owners of land and capital. On the other hand, the poorer households, especially H2, receive income almost exclusively from selling their own labor (a large fraction of which is unskilled). Comparing the poorest two groups (H2 and H4) with the richest two (H6 and H7), we observe significant differences in spending patterns as well, although the differences are not as great as in ownership of productive resources. In particular, the two poorest groups spend nearly 2.5 times as much of their income on basic food items (in particular processed rice), as the two richest groups. For textiles the pattern is less dramatic, but the poor groups spend about 30% more than the rich groups.

In Bangladesh, the poorest groups are H1 and H2, rural groups with only limited or no land holdings. They are followed by H7, H3, and to a lesser extent H8, that is, the urban illiterate and poorly educated, and rural households with small land holdings. The richest groups, by a substantial margin, are urban households with high or medium education (H9 and H10). The factor allocation pattern is similar to India, with the lower income groups having a much higher dependence on unskilled labor. Consumption differences are also similar, with the poorest households spending more than double the proportion of their budget on processed rice compared with the richest households.

In the Pakistan data, as with Sri Lanka, we have a combined archetype and income level classification. The data are very detailed, with a concentration on rural households. Households are grouped into multiple farm sizes based on land holdings, and three regions, in addition to the rural rich, and urban poor/rich. In total, our model tracks changes in the behavior of 47 household groups in the region.

The decomposition of the total welfare impacts on the various household groups is summarized in Table 4. Figures drawn in a box are not robust to changes in the underlying parameters of the model, i.e., we cannot be sure of the sign of the change. Other values are robust given the assumptions on the parameter distributions.[12]

Consider first the member economies of SASEC, which are our primary interest. In Nepal, the results indicate that all household groups would benefit, and the results for all households are robust. Of note is that the biggest gainers are small farm households and landless rural groups, while smaller gains accrue to large farm households and the urban group (which is richer on average). Hence, reduction of international transportation margins in SASEC would be pro-poor in Nepal in both an absolute and a relative sense, and also likely be relatively uncontroversial given the uniform benefits. The results follow a similar

[12] Roughly, a result can be considered robust to the assumed underlying parametric uncertainty if it retains the same sign within two standard deviations of the mean.

pattern, but are slightly larger when other economies in South Asia are included in the analysis (Scenario 2).

In Bangladesh, the reduction in transport margins has a positive impact on the welfare of all household groups except H3 and H4. H3 (small farmers) is one of the poorer groups in the country, but the negative impact is relatively small. On the other hand, the loss to relatively large (and relatively rich) farmers is more substantial. The poorest groups (H1, H2, and H7, corresponding to the rural landless, marginal farmers, and the urban illiterate) all experience income rises. This suggests that a reduction in SASEC transportation margins would be pro-poor in Bangladesh in an absolute sense. However, by far the largest gains accrue to H10, the urban highly educated. This is the richest group. Hence, it seems likely that the changes would not lower relative poverty (i.e., income inequality) in Bangladesh. As with Nepal, the pattern is unchanged, although the totals are larger in Scenario 2.

As noted above, the largest absolute gains are estimated for India in both our scenarios. However, India is also the country where the distributional consequences may be most severe. Welfare is estimated to fall in household groups H2, H4, H6, H7, H8, and H9, although the results for H6 and H7 are robust only in Scenario 2. This may be problematic as the poorest groups are H2 and H4. Of the three poorest archetypes, only H3 (rural non-agricultural labor) sees a modest income increase. By far the group that gains the most is H1, large farmers, who are middle income. This suggests that positive changes in the value of agricultural land is the primary driving factor of household income changes in India. Overall, the policy may be marginally pro-poor in a relative sense, as the welfare of the richest groups falls, but probably not in an absolute sense. In reality the reduction in transport margins is strongly pro-agricultural landowners. The same pattern exists and is more pronounced in Scenario 2.

Now consider the non-SASEC economies of South Asia. As noted above, in Scenario 1, the overall welfare impacts of the simulated changes in transport margins are small. The impacts at the household level are small also, and in many cases not robust. The only moderately large impact is a decline in welfare in Pakistan for group H18, the urban rich. In Scenario 2, however, the impacts on the households in Pakistan and Sri Lanka are much more pronounced, as we would expect. In Sri Lanka there are uniform gains across all household categories, although the result for H2 (rural low income) is sensitive to the parameters of the model. For Pakistan, the results are also uniformly positive, suggesting a fall in absolute poverty levels. By far the group that gains the most in Pakistan is H18, the urban rich. Hence, relative poverty may increase.

Overall, the impacts of the changes at the household level exhibit more variation than the aggregate results. While the policy appears to be pro-poor in an absolute sense in many cases (e.g., Nepal), income inequality also seems likely to rise in several cases (e.g., Bangladesh). Moreover, in some cases the poorest groups in society are disadvantaged (e.g., in India). Note, however, that the total welfare gains are positive for all regions in the model, hence it is possible to ensure that all household groups benefit. Our calculations are based on the assumption of invariant transfers, taxes, and factor ownership, but in principle these can be changed if the political will exists.

In addition to overall welfare effects, and their distribution across various groups in the societies in question, CGE simulation also generates information on sectors. Of particular interest are changes in the production structure, both because they indicate which sectors are most likely to be impacted by the proposed policy, and because they provide an indication of the potential degree of structural adjustment required. Estimates of the sector production changes are presented in Table 5. Again, results that are not considered robust under our sensitivity analysis are highlighted with a box.

Considering the SASEC economies first, in India, the production changes associated with the infrastructure scenario are very small (of course, regional variations may be hidden by the aggregation). The largest changes are in textiles and apparel, which experience very slight declines in both scenarios. The results suggest that for India overall, improvements to transport infrastructure of the magnitude considered here are not likely to cause any significant adjustment difficulties.

In Bangladesh, the production shifts are generally orders of magnitudes higher than in India, reflecting the larger impact of the simulated shocks on a smaller and less diversified economic system. They remain small, however. In Scenario 1 the largest drops in output are in the region of 0.5%. Contractions are observed in heavy manufacturing with the exception of chemicals and rubber, while expansions are observed in light manufacturing (textiles, apparel and leather products). The same broad patterns are observed in Scenario 2, but are more pronounced. However, no single sector expands or contracts more than 1% even in this expanded scenario. This suggests that adjustment issues are not likely to be significant in Bangladesh, either.

Table 5: Sector Impact of Transport Cost Reductions (Percent Change in Production)

	Scenario 1					Scenario 2				
	Pakistan	Bangladesh	India	Sri Lanka	Nepal	Pakistan	Bangladesh	India	Sri Lanka	Nepal
Food grains	0.01	0.02	0.00	0.00	–0.07	–0.06	0.03	0.00	0.04	–0.07
Other agriculture	0.00	–0.18	0.02	0.00	0.03	0.01	–0.28	0.03	–0.03	0.16
Forestry and fisheries	0.00	0.04	0.00	0.00	0.20	–0.07	0.03	0.02	0.05	0.23
Coal, oil, gas and other minerals	–0.01	–0.20	0.01	0.01	–0.41	–0.26	–0.61	0.00	–0.27	–0.33
Processed rice	0.02	0.04	0.01	0.00	–0.06	–0.22	0.06	0.01	0.14	–0.03
Other food products	–0.02	–0.03	0.01	0.00	0.22	0.10	–0.04	–0.01	–0.11	–0.46
Textiles	0.05	0.19	0.04	–0.05	1.06	0.10	0.21	–0.04	–0.17	–0.35
Wearing apparel	0.07	0.12	0.13	0.05	–1.00	–0.55	0.70	–0.30	0.45	–0.29
Leather	0.06	0.10	0.14	0.02	0.18	–0.50	0.26	–0.27	–0.12	0.17
Wood products	–0.01	–0.20	0.00	–0.03	0.66	–0.04	–0.24	0.02	0.67	–0.03
Chemicals, rubber, plastics	–0.02	0.06	0.00	–0.01	1.87	–0.21	–0.16	0.07	–0.14	–0.30
Metals and minerals	–0.08	–0.37	0.02	–0.07	–0.04	0.10	–0.39	–0.02	0.10	–1.50
Metal products	–0.28	–0.42	0.02	–0.03	0.22	–1.48	–0.47	0.01	0.11	0.72
Heavy manufacturing	0.01	–0.40	0.02	–0.02	–0.79	–0.16	–0.51	–0.05	0.11	–0.31
Not elsewhere classified (NEC) manufacturing	0.04	–0.11	0.09	0.05	0.04	–0.40	–0.08	–0.18	–0.66	0.20
Services	0.00	0.01	0.00	0.00	–0.05	0.00	0.01	0.00	–0.01	0.03

In Nepal, the production shifts are larger still, again reflecting the smaller economic system. The largest expansions/contractions exceed 1%. Nepal also seems to be more affected by the assumption of lowered transport costs for trade with Sri Lanka and Pakistan (i.e., comparing Scenarios 1 and 2) in terms of both the magnitude of impact and the pattern. In Scenario 1 we observe significant expansions in textiles, wood products and chemicals, and contractions in apparel and heavy manufacturing. By contrast, in Scenario 2 we observe contractions in textiles, but a smaller contraction in apparel. The contraction in heavy manufacturing is also modulated, but there is a relatively large contraction of metals and minerals. The difference in the outcomes presumably reflects much stronger trade ties between Nepal and Pakistan than between Pakistan and the other SASEC economies. The results suggest that Nepal is likely to face greater adjustment problems than the other SASEC economies, although the shifts remain relatively small overall.

For Pakistan and Sri Lanka the output changes are very small in Scenario 1, as we might expect given that they are impacted only indirectly. The only exception is a moderate decline in metal products in Pakistan. In Scenario 2 the changes are more significant in both economies. In Pakistan we project contractions in light manufacturing and metal products, with only the latter exceeding 1%. Minor expansions are predicted in food products, textiles, and metals and minerals. In Sri Lanka we project expansions in apparel and wood products, and contractions in general manufacturing. All shifts are less than 1%.

Overall, the output shifts tend to indicate that the reductions in international transportation margins would not have a major impact on production structures, and that adjustment costs would be minimal. As expected, the production shifts are more pronounced in the smaller economies in the region, and these areas may need some adjustment assistance, albeit probably minimal.

6. CONCLUDING COMMENTS

The main contribution of this study is to bring the multiple-representative household CGE approach to a model of the entire South Asian region, as opposed to the single-country models examined earlier in the paper, and to apply this model to changes in transportation infrastructure. The model that we have developed is a multi-country CGE with 16 production sectors and 47 regional households. In principle, the model should have applications for numerous policy questions concerning South Asia, especially in relation to international trade and economic integration.

The scenarios that we considered in this paper reflect the potential implications of proposed investments in land transport infrastructure in the SASEC region. These investments should result in reductions in the land transport component of international transport margins, which vary bilaterally by commodity. We found that all SASEC economies benefited from reductions in aggregate welfare, with the largest gains to India in absolute terms but the largest relative gains to Nepal, followed by Bangladesh, and Sri Lanka, when the margin reduction is prorated to intra-South Asian trade rather than just SASEC. Hence, in terms of overall impact, the largest gains are to the smallest economies in the region.

We used the discounted present value of the EV stream to provide a (lower bound) estimate of the total "one-off" benefit of the margin reductions, which is suitable for comparison with project cost estimates should these become available. In terms of household level distribution, the picture is mixed. While the outcomes are clearly pro-poor in some countries such as Nepal, the impacts are more ambiguous in other countries. Examination of the extent of predicted structural changes suggests that there would be only minor potential adjustment costs, although these would be somewhat more significant for the smaller economies in the region.

Ideally, we would like to allow for endogenous switching of mode of transportation and to incorporate internal transportation margin information within the model. The lack of these variables means that we are probably understating the potential gains from land transport infrastructure investment. Similarly, there is a question of what other pathways for impacts of the infrastructure developments can/should be implemented in the model and experimental design. As it stands, the model traces the impact of policies only through the price mechanism. Changes in transportation costs alter the costs of final goods. These affect households directly through their consumption and indirectly through their ownership of factors, the prices of which shift in response to output price changes. Changes in transfers such as tax revenues are also altered.

These are important forces, but there may be others. Improved transportation networks may lead to better access to education, for example, over time increasing the skilled/unskilled labor ratio. There are also potential costs that are difficult to quantify within a formal modeling framework. For example, the model only indirectly accounts for adjustment costs in production, and cannot account for dislocation impacts on household welfare. Transportation networks that connect the hinterland to more developed regions may result in substantial migration flows that strain urban resources. Exploring whether it is possible to bring this type of variable into the modeling process is an area for future research.

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