



Josef G. Knoll-Europäischer Wissenschaftspreissträger 2020

Josef G. Knoll-European-Science Award Winner 2020

Arndt Feuerbacher “Economy-wide modelling of seasonal labour and natural resource policies”, Humboldt-University of Berlin, 2019

Summary

In many developing economies, the largest part of the population still resides in rural areas and the agricultural sector absorbs the highest share of the labour force. In this context, rural livelihoods are dependent on the utilization of natural resources and with agriculture being a biological process, employment opportunities are largely determined by climatic seasonality. Against this background, policies related to the use of agricultural and other natural resources have a high relevance for efforts of rural development and poverty eradication. Natural resource policies often have implications for the whole economy, due to the agricultural sector's high absorption of employment and strongly established backward and forward linkages with the remaining sectors of the economy. For these cases, economy-wide models have generally proven to be effective tools for the ex-ante analysis of policies and exogenous shocks. Yet, in the context of developing agrarian countries and sustainable natural resource policies, these models have so far neglected the role of seasonality of labour markets.

Using an economy-wide modelling approach, this thesis investigates methodological and empirical research questions related to seasonal labour markets and natural resource policies in the broader context of rural development. The Kingdom of Bhutan, located in the south-eastern Himalayas, serves as a case study. The South Asian and landlocked country is a natural resource dependent economy and a detailed description of the country is provided in Chapter 2. More than 50% of Bhutan's population is employed within the agricultural sector, in which the patterns of seasonal labour demand are determined by Monsoon rains. The country is not only known for its unique development philosophy of Gross National Happiness, but also for its ambitious environmental conservation agenda, which entails many governance challenges balancing political priorities of sustainable resource management with objectives of rural development and food self-sufficiency.

The methodological research objective of this thesis is to gain an understanding of the relevance of seasonal labour markets in the context of economy-wide modelling. This objective is addressed in Chapter 3. The literature on economy-wide modelling has so far neglected the seasonal dimension of labour demand and supply. A social accounting matrix (SAM) for Bhutan is developed in Chapter 3, depicting seasonal labour market accounts and including satellite accounts with seasonal leisure and labour quantities. The SAM serves as the underlying database of a computable general equilibrium (CGE) model. Pursuing the methodological research objective, the model is extended in various ways. The multi-level production structure is extended in order to depict the activity specific characteristics of season labour demand. Moreover, a labour-leisure trade-off is integrated into the model's household demand system to model seasonal labour supply.

The depiction of seasonal labour markets at national scale using a seasonal SAM and CGE-model presents a novel development within the literature. It is demonstrated, that the absence of seasonal labour markets leads to systematic bias of model results. The bias originates from the common assumption in models with annualized labour markets that units of labour supplied in different seasons are perfect intertemporal substitutes. This assumption of homogeneity of labour units sidesteps the reality of farming, for which seasonal fluctuations of labour demand are considered inherent features. The consequences are distorted supply responses and biased welfare effects, underlining the pivotal implications of seasonality for economy-wide analysis in the context of agrarian economies, particularly for scenario analysis involving structural changes and agricultural policy interventions.

The empirical research objective addresses the interdependence of natural resource policies with the objectives of environmental conservation and rural development. Employing modelling techniques, three studies included in the Chapter 4 to 6 focus on specific questions of sustainable natural resource management related to agriculture and forest policies in Bhutan.

Chapter 4 analyses Bhutan's ambitious and unprecedented objective to convert to 100% organic agriculture. This study follows a two-step approach. Firstly, on-farm data are analysed revealing that organic crop yields are on average 24% lower than conventional yields. Secondly, a CGE model for Bhutan incorporating agroecological zones, crop nutrients, and field operations is employed to assess the economy-wide implications of a large-scale conversion policy. Methodologically, the study represents a novel approach by modelling field operations such as weeding and manuring explicitly in a CGE model. According to the model results, Bhutan's 100% organic policy is likely to result in substantial welfare losses and adverse impacts on food security, causing trade-offs with the objectives of rural development and food self-sufficiency. The analysis further finds that current organic-by-default farming practices in Bhutan are still underdeveloped, and that adopting the systems approach of organic farming as defined in the IFOAM organic farming standards could reduce the yield gap. Due to data limitations, the study could not account for the potential synergies stemming from increased eco-system services or potential price-premiums in export markets, which is an avenue for future research.

Chapter 5 and 6 focus on Bhutan's policies for forest conservation and utilization. Unlike many other countries, Bhutan has achieved an exceptional track record in forest conservation, with forests still covering more than 70% of the land area. However, because only about 5% of forest area is under commercial management, the country is highly dependent on wood-based imports from India, mainly in the form of charcoal, which faces high demand by metallurgical industries.

Chapter 5 examines how increasing the forest area under commercial management might allow for sustainable charcoal production in Bhutan, thereby reducing the country's dependence on charcoal imports. Using a transportation and investment model, cost efficient locations of charcoal production sites are identified at the subnational level. Simulation results show that charcoal production is profitable in 11 of the 19 districts with an aggregate potential to offset up to 61% of charcoal imports. The requirement in additional fuelwood supply would increase the commercially managed forest area from 5% to 15% of total forest area. Unlike earlier claims, the study finds that transportation cost and availability of labour do not present barriers for the economic viability of charcoal production. Monte Carlo simulations and sensitivity analyses confirm that using a decentralized approach, Bhutan

could increase commercial forest management without jeopardizing its highly acclaimed forest conservation agenda. However, further research is needed to address the limitations of the analysis, particularly with regards to estimating timber extraction cost from additionally managed commercial forest areas and potential cost of externalities stemming from increased forest utilization.

Lastly, the methodological contributions and empirical research objective are combined in the fourth and final study presented in Chapter 6. This study contributes to the literature on sustainable forest management in the rather rare context of forest underutilization. In addition, it analyses the economy-wide potential of forestry to provide seasonal employment during the lean season. Bhutan's current forest conservation framework has so far largely constrained households to utilize fuelwood for subsistence use only. Employing a CGE model that incorporates seasonal underemployment, three forest policies are simulated that link households to the commercial fuelwood value chain. Building on the findings of the study in Chapter 5, the model includes a domestic charcoal sector, which can absorb additional supply in fuelwood. The unutilized potential of forest resources is estimated using satellite data and spatial criteria for sustainable forest management.

All three forest policy scenarios increase rural households' welfare, mainly due to additional employment opportunities in the winter months and increases in forest utilization. The efficiency of fuelwood use is improved when its opportunity cost increases due to the opportunity of selling it, which is reflected by the increase in shadow prices. The estimated benefits for rural households are likely to be at the lower bound, since the study does not quantify the health co-benefits due to reduced indoor air pollution. However, the forest policy scenarios' success also hinges on the effectiveness of monitoring and governance systems that ensure compliance with sustainable forest management criteria. Furthermore, the study's scope is restricted as any potential adverse effects on ecosystem services are not included due to data limitations.

Livelihoods dependent on natural resources are inevitably linked to climatic seasonality and challenges of sustainable resource use. All four studies are related to these themes, although from different angles. Literature on modelling rural labour markets in economy-wide models is relatively scarce and the dissertation contributes to this literature by capturing the seasonal dimension of labour markets. This research area provides a large potential for further development. Methodologically, CGE models can, for instance, be extended to incorporate seasonal labour markets with technological trade-offs in agriculture, by integrating the field-operations approach as used in Chapter 4. Accounting for gender or age dimensions within the division of labour and time-use is of high relevance for future model extensions, which requires additional data. More data are also necessary for the incorporation of ecosystem services into economy-wide models, which this thesis likewise identifies as a key limitation and area of future research.