Title: **Poverty, Equity, and Growth in Developing and Transition Countries: Statistical Methods, Empirical Analyses, and Policy Issues**

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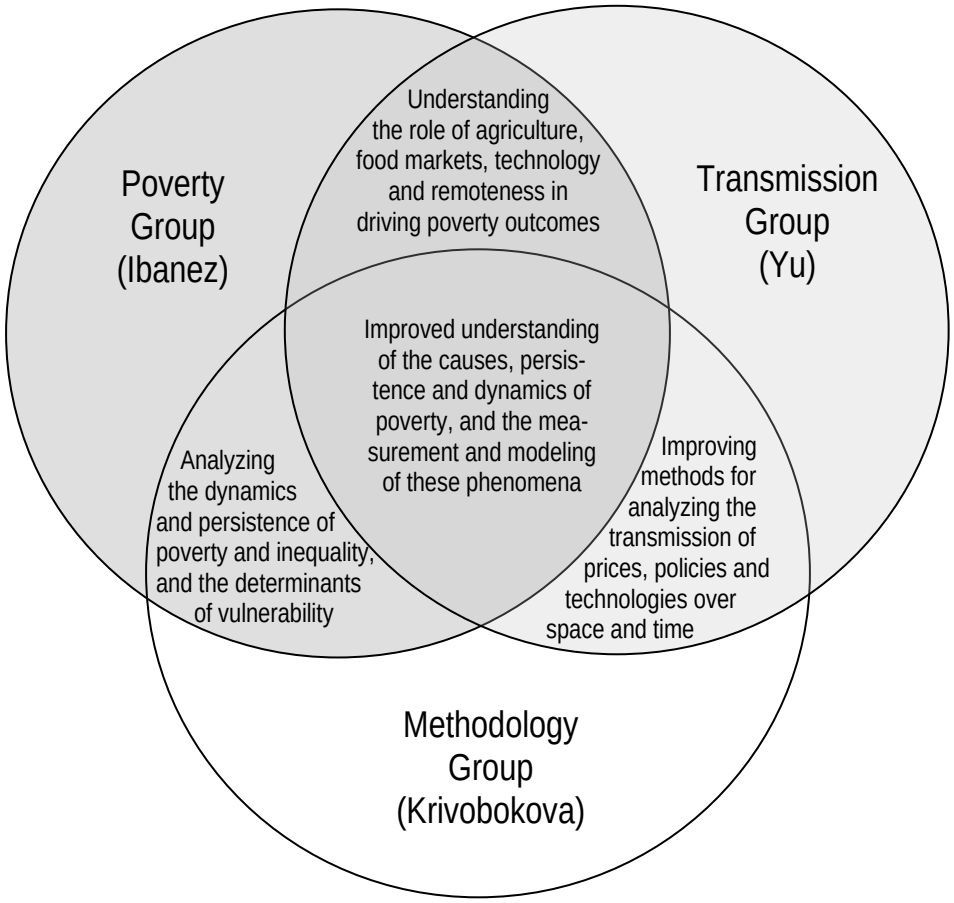

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I. Summary:

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1.4 billion people, or roughly 26% of the population of developing countries, live in extreme poverty. Three-quarters of the poor live in rural areas, making them directly or indirectly dependent on agriculture. At the Millennium Summit in 2000, the world community pledged to make poverty reduction the central goal of its development policy, but progress towards this goal has been very uneven with rising poverty and inequality in many countries.

Appropriate interventions to reduce poverty require a better understanding of the dynamics of poverty and inequality, and of the policy drivers affecting them. Among the critical research questions are measurement issues (e.g. definitions, dimensionality, and reference units), *ex ante* poverty risk and vulnerability analyses, determinants of poverty change across time and space (including assessments of spatial poverty traps, small-area poverty and inequality analyses, the role played by national and international policies), drivers of distributional change (including regional inequality), and determinants of improvements in agricultural productivity and income-earning opportunities in rural areas, where price and policy reforms as well as new technologies often fail to reach the poor. These issues pose substantial methodological challenges to model the spatial and temporal dynamics of poverty and inequality (ex ante and ex post and at high levels of spatial disaggregation), to analyze the transmission of prices, policies, and technologies, to deal with high dimensional data in space and time, and to address causality and measurement error issues, among others.

The Poverty Center combines a unique and recently established pool of development researchers (from the Faculties of Economics and Agriculture) with econometric and statistical researchers from the Economics and Mathematics Faculties. Most are members of the interdisciplinary Center for Statistics whose existing Georg-Lichtenberg Ph.D. program “Applied Statistics and Empirical Methods” would form the core of the teaching program.

The Poverty Center comprises three research groups, one focusing on measurement and determinants of poverty and inequality in a dynamic perspective, one focusing on market access and the transmission of prices, policies, and technologies to the (rural) poor along the supply chain and one focusing on methodological issues. It builds on existing collaborative work within the Center of Statistics, related poverty research undertaken as part of DFG Research Group

756 (“Impact of Shocks on Vulnerability to Poverty”), the international “Poverty, Equity, and Growth Research Network (PEGNet)”, methodological research as part of a DFG Research Group on ‘Statistical Regularisation’, as well as current involvement in 5 individual or joint DFG research grants.

The goal of the Poverty Center is to strengthen Göttingen’s international standing as a leading research location in this novel combination of methodologically sound and policy-relevant empirical research on poverty and inequality, its determinants, and policy options to overcome it, in developing and transition countries. To help achieve this goal, the Center plans to apply for a collaborative research center (SFB) to further develop this research agenda in the first years of its operation.

II. Major Research Focus for the Courant Research Center

1.4 billion people, or roughly 26% of the population in developing and transition countries, live in extreme poverty according to the World Bank’s definition (i.e. on less than 1.25 US$/capita/day) and more than 2.5 billion are forced to subsist on less than $2 a day. Three-quarters of the poor live in rural areas highlighting the importance of agricultural production and markets as determinants of poverty. Given this dire situation, the world community pledged at the Millennium Summit in 2000 to make poverty reduction the central goal of development policy and development cooperation. This is reflected in the Millennium Development Goals (MDGs) that were agreed, the first of which calls for a reduction of 50% of the share of the world’s population that lives on less than $1.25 a day (between 1990 and 2015). Other MDGs, such as those about promoting education and reducing ill health and mortality are also essentially about poverty reduction, when poverty is seen in a wider dimension.

Progress towards meeting the first MDG (and the related goals of reducing mortality and improving education) has been highly uneven. While some countries in East, South-East and South Asia have made rapid progress in reducing poverty, most of Sub-Saharan Africa, parts of South and West Asia, Latin America, and many transition countries are lagging seriously behind and are, on current trends, unlikely to meet the first (and most of the other) MDGs (World Bank, 2009). In addition, recently rising inequality in many countries (including fast growing ones), often linked to rising regional inequality, will make further poverty reduction more difficult. Hence the reduction of inequality is emerging as one of the critical emerging policy issues.

In order to analyze these developments and propose appropriate interventions to promote poverty reduction, a better understanding of poverty dynamics and the policy drivers affecting the key components of poverty reduction (growth and distributional change) is central. This in-

volves three critical issues. First, in order to understand the trends in poverty over time and between and within countries, measurement and definitional issues are important. These include questions of how to conceptualize and quantify poverty, whether to view it in the income or non-income dimensions, whether and how to treat it as a multidimensional concept, and how to deal with the fact that poverty is measured at the household level which may mask individual poverty. While many of these issues have been thoroughly analyzed in a static setting, their influence on changes in poverty across space and time has hardly been analyzed although this is ultimately most relevant for policy-makers who need to identify the drivers of poverty trends to design appropriate interventions. Another highly policy-relevant issue in this context is that all static (and even most dynamic) assessments of poverty have concentrated on *ex post* analyses and can say little about *ex ante* poverty risk or vulnerability to poverty. For the design of appropriate anti-poverty policies, however, such an *ex ante* assessment is vital to prevent poverty in the first place. A further important and closely related topic in this regard is the endogeneity of poverty (i.e. of poverty traps) and how it is affected by individual decisions and policies.

Second, moving to the policy determinants of poverty and inequality, there is now a very good understanding on the theoretical and empirical relationships between economic growth, inequality, and poverty reduction. *Ceteris paribus*, poverty reduction is fastest when there is high economic growth, initial inequality is low, and growth is accompanied by declining inequality. While there is a large literature examining the determinants of economic growth, there is much less work on understanding the drivers of inequality change (including regional inequality), and policy options to sustainably affect the income distribution and promote pro-poor growth (i.e. inequality-reducing growth).

Among the policy drivers of poverty and inequality change, a critical issue in the lagging countries and regions (particularly in Africa, but also in transition countries) appears to have been slow progress in improving agricultural productivity and income-earning opportunities in rural areas. Price liberalization and policy reforms of the 1980s or 1990s appear to have had little overall effect in these countries. Even where positive developments at the national level have been observed, it is questionable whether these reforms have actually reached and benefited the rural poor (particularly in remote areas). These issues are receiving new urgency due to the multilateral trade negotiations which are likely to affect agricultural prices, due to rapid (but uneven) technological progress in agriculture, and due to a renewed emphasis on agriculture in national governments and international organizations as the key sector determining poverty outcomes. Similarly, although there have been technological improvements in agriculture, often

they have not filtered down to poor farmers or were not adopted due to particular barriers they face.

With a view to supporting national and international policy initiatives aimed at reducing poverty, a number of critical methodological and empirical challenges emerge from the discussion above. First, it is critical to understand to what extent methodological choices in poverty measurement affect the dynamic assessment of poverty trends, to what extent dynamic poverty trends are driven by changes in household structure and composition or by household's productive decisions (and which factors, including gender and policy issues, affect those in turn), and how one can produce reliable approaches to estimating vulnerability to poverty and its determinants. Second, how can one adequately model and explain drivers of poverty and inequality change, particularly also increasing spatial inequality and possible spatial poverty traps? Third, how do individuals and groups adjust to deal with inequality? Fourth, how do policies at the national and international level (including aid policies) affect poverty and inequality in developing countries? Fifth, how can one understand processes of transmission of prices, policies, and technologies across space and time, particularly to remote and lagging regions?

To address these questions using sound methods to derive valid policy conclusions, it will be necessary to adapt existing statistical techniques, or to develop new ones. But they also call for the appropriate data to undertake such assessments. Fortunately, the availability of high quality data both at the macro and micro level (e.g. macro: data on aid, trade, institutions, micro data: so-called Living Standards Measurement Surveys, Demographic and Health Surveys, and regular Income or Expenditure Surveys as well as specialized households survey data generated in related research projects by the Principal Investigators) has improved dramatically in the past 10 years. For the first time it is possible to investigate the dynamic drivers of poverty using panel data, regularly repeated cross-section surveys, better data on prices and production, many of which allow significant spatial disaggregation. In addition, experimental approaches are increasingly being applied in such settings to study policy interventions using a controlled environment. Thus, for the first time, it is possible to empirically address these questions using advanced statistical tools in order to derive reliable advice to policy makers concerned with poverty reduction in developing and transition countries. This calls for collaborative interdisciplinary work combining researchers focusing on methodological and empirical issues as well as applied researchers focusing on the substantive measurement and policy issues.

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III. Research Topics

It is proposed that the Courant Research Center will focus on the following ten issues that are of particular importance in this overall research area:

1) Measurement choices in the measurement of poverty (role of income versus non income, multidimensionality, dynamic considerations)

There is a large literature on poverty measurement where measurement choices play a decisive role in affecting levels and trends of poverty. Particular issues under debate are absolute or relative conceptions of poverty (and relative poverty versus social exclusion), income versus non-income dimensions of poverty, uni-dimensional versus multi-dimensional views of poverty, subjective perceptions of poverty, valid international poverty comparisons, and the role of household heterogeneity. While these questions have been analyzed in great detail from a static perspective, addressing these questions in a dynamic perspective generates many new methodological challenges for measuring poverty trends and understanding what drives them. But it is this dynamic perspective that is crucial for devising appropriate policy interventions to reduce persistent (chronic), transitory poverty, and the overall vulnerability to poverty. For these analyses, the time dimension of poverty (how long a household has been poor, whether poverty, is transitory, recurrent, or chronic) needs to be explicitly considered. Only then can the determinants of entries into poverty, exits out of poverty, vulnerability to poverty, and chronic poverty be understood and linked to policy parameters. Static analyses usually only help to describe but not to explain poverty.

Investigating this issue (and the others outlined below) requires careful analyses of regional variations in initial conditions (such as geographical and institutional factors) and past growth processes. For instance analyzing the poverty change related to the Green Revolution in India might help to design policies to promote agricultural growth in Sub-Saharan Africa. Understanding the impact of climatic and financial market shocks on the vulnerability to poverty in South East Asia will help understand and model vulnerability to poverty also in other contexts where shocks play a large role. Likewise the analysis of safety nets (such as conditional cash

transfer programs) and labor market reforms in Latin America can help to elaborate appropriate poverty reduction strategies for South-Asia and Sub-Saharan Africa. Hence, comparative analyses across various countries will constitute a core element in the suggested research center.

A major challenge will be to develop the methodology to track the multidimensional manifestations of poverty in both space and time. How to adequately deal with stochastic components in a multi-dimensional setting over time? How to devise methodologically sound methods of robustness analysis of poverty dynamics using different measures and approaches? How to incorporate qualitative data into an assessment of poverty? How to empirically identify the key drivers of poverty change when poverty is viewed from a multidimensional perspective? How to model the interactions between different dimensions of poverty over time (and space)? What are the linkages between subjective perceptions of poverty, risk and vulnerability as well as ex ante and ex post coping mechanisms?

So far, the dimensionality problem in poverty measurement is concentrated on (classical) principal component and factor analysis. The main challenge here is the incorporation and treatment of cardinal (e.g. income), ordinal (e.g. literacy or status) and nominal variables (e.g. occupational status or location). As several of the indicators for poverty are described by qualitative variables (sometimes quantified using ordinal scales), this is clearly still an area requiring further research. A further step is the estimation of the joint distribution of these data to reach a better understanding of the multidimensional nature of the problem.

But our proposed approach clearly goes a step further: the principal component and factor analysis methods that are usually applied in this field provide “non-directed” principal components (respectively factors). This means that these methods just provide components (factors) which help to describe the variation of the variables which are believed to be relevant for poverty, but they do not provide us with components that explain poverty best. Therefore it would be desirable to construct “directed” principal components or factors that represent the largest variation in the data with respect to poverty prediction.

One approach is purely nonparametric and starts from a most general model and tries to identify a hyperspace that contains the main part of information. We could think here of a generalized PCA. Certainly, this is only of interest if no prior information on the model is available. Approaches that could be explored to this aim have been proposed e.g. by Yingcun Xia, Dennis Cook and Vladimir Spokoiny.

A second more natural approach in econometrics is to model poverty imposing shape constraints on how the potentially important variables affect the poverty status. If those constraints are given, the remaining question is how one can make use of them to overcome the

problem of dimensionality looking for an efficient estimator fulfilling these constraints. This approach, however, requires already a clear idea about the nature of poverty. If one tries to model poverty either in a regression or in a joint distribution context including also a time dimension, such techniques will be critical for mitigating or even overcoming the dimensionality problem.

The principle investigators in this research group have already worked in this research area, both on substantive as well as methodological issues. Klasen and co-authors have worked for several years on the measurement of poverty, and related concepts of social exclusion and pro-poor growth using non-income and multidimensional approaches, which also involved combining different data sets for such dynamic assessments. Klasen (jointly with Michael Grimm) has been awarded German Research Foundation (DFG) funding to investigate the impact of differential mortality between rich and poor people on the measurement of welfare, poverty, and inequality, and both are working for the United Nations Development Program on distribution-adjusted measures of human development. Presently, Sperlich is working with Spokoiny and others on feasible methods for generalized PCA in the mean regression context. Our newly developed methods seem to offer some natural though sophisticated extensions which would help to get what we have called “directed” PCA above. Moreover, in the last ten years several of Sperlich’s publications focus on dimension reduction through model restrictions, in particular for econometric models (see Sperlich, 2006 for typical examples). Munk has worked on shape constrained nonparametric estimation with potential application for poverty measurement; currently his focus is on shape constrained estimation in inverse models, as they occur in instrumental variable models.

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2) Modeling the endogeneity of households in poverty measurement and analysis

Ideally, one would want to measure poverty at the individual level as this is the basic unit of analysis when analyzing well-being. Unfortunately, income or consumption poverty is and can only usefully be measured at the household level due to the conceptual or practical inability to ascribe consumption flows to individual household members. Worse, intra-household allocation is then explicitly ignored and an equal distribution within households is assumed so that everyone or no one in a household is poor; also, assumptions must be made about differences in needs between households of different size and structure.

In measuring poverty and determining poverty trends at the household level, the household is then nearly always treated as an exogenous institution. This is clearly an invalid assumption as we know that households change as a result of shocks as well as decisions by individual members. Household size and composition change through mortality, fertility, migration, and household formation and dissolution decisions which are influenced by the economic circumstances of the household. For example, poor people face usually higher mortality, or they might react to poverty by migrating or by delaying or speeding up household formation and dissolution decisions. Households can also change as a result of policy incentives. Generous housing policies might encourage young people to leave home earlier, the absence of safety nets forces unemployed to stay with their parents, and targeted cash transfer programs can affect decisions such as setting up or dissolving households, leaving home, fertility, and marriage decisions. In each of these decisions, gender issues play an important role and gender inequality within households can affect these decisions greatly (e.g. fertility decisions, sex-specific mortality shocks, marriage decisions).

For the measurement of poverty and inequality at the national regional and global level, this endogeneity of the household has important implications. Poverty and inequality can change if household size and composition changes even if there has been no change in any person's individual incomes; this finding can also hold in most non-income and multidimensional approaches to poverty measurement. Worse, poverty can be artificially reduced just because the poor face higher mortality or if they decide to congregate in larger households. For the *ex ante* and *ex post* assessment of anti-poverty policies, similar problems may arise as policies can contribute to changes in household boundaries and these effects need to be taken into account when designing and implementing such policies.

The implications of this endogeneity for the measurement, analysis, and prediction of poverty dynamics at the regional, national, and global level (using income and non-income measures) have hardly been analyzed, although the data required for such assessments – repeated cross-sectional and panel household surveys – are now available in many developing countries.

Many of the methodological approaches to be used are challenging and have not been developed to a large extent. These will include decomposition methods to understand the contribution of endogenous household formation, simultaneous structural equations that estimate income functions and household formation decisions jointly, Instrumental Variable (IV) techniques to account for endogeneity, and making use of natural experiments. Here one focus will be on non- and – semiparametric approaches in order to deal with the trade off between flexibility and identification. Some non-parametric IV methods have been introduced, and semiparametric estimation of triangular systems has also been investigated. In particular they aim at identification and estimation of *shock models* with jump discontinuities in an IV model, as has been treated in Boysen et al. (2006) in the context of regression, and at using insights from the research on inverse problems to apply to IV methods, structural equations, and errors in variables problems. These approaches will be extended and applied to analyze past poverty dynamics, and to simulate future trends and policies using, among others, micro simulation techniques.

The principal investigators have been active in this field for some time. Woolard and Klasen analyze the impact of household changes on poverty and mobility in South Africa and investigate the role of endogenous household formation as a safety net against unemployment. Klasen and Grimm are currently working on the impact of differential mortality on the measurement of poverty, funded by the DFG. Munk's and Sperlich's work include estimation, modeling, and testing theory in non-parametric regression. Munk does further non-parametric analysis of covariance with high dimensional predictors and identification of jumps and shocks in regression models (*shock models*), as well as numerical implementation issues for large data sets (of the type we would be using)), while Sperlich and co-authors have worked on estimation issues in simultaneous equation systems (e.g. Rodriquez-Póo et al., 2005).

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3) Inequality change across space and time

Poverty is not only directly affected by inequality, but also indirectly via the impact of growth on poverty which, as stated above, depends on initial levels and changes in inequality. After decades of relative stability in the distribution of incomes in most developing countries, there have been pronounced increases in inequality in a number of countries in the 1990s and early 2000s, including transition countries, but also many of the faster growing developing countries. A considerable share of the rising national inequality is due to increasing regional inequality, particularly in economies that have experienced faster growth (e.g. China, India, Vietnam, Ghana, Brazil). Similarly, in many countries backward regions appear to be stuck in poverty traps, where poor initial conditions, poor institutions, and unfavorable economic dynamics (e.g. remoteness, brain drain, agglomeration tendencies draining economic opportunities from backward regions) conspire to make it nearly impossible to escape poverty. In some regions in sub-Saharan Africa, entire nations might be stuck in such poverty traps which might be reinforced by household behaviors that try to minimize risk but therefore enhance persistence of poverty traps.

To achieve poverty reduction in these unfavorable conditions requires careful analyses of the dynamics of inequality change across space and time that have generated rising regional inequality and spatial poverty traps. Furthermore, potential policy interventions need to be analyzed with respect to their likely spatial impact and how such spatial impacts will materialize over time. Ideally, such analyses will be based on highly disaggregated spatial data, involving small area statistical estimation techniques; moreover, the impact of inequality and poverty traps on behavior requires careful application of advanced statistical and experimental methods.

The quantitative and qualitative data available for such assessments for the space-time analysis of inequality and poverty traps has improved dramatically in recent years with the new household surveys, improved (and now publicly available) national censuses, and much improved regionally disaggregated administrative and economic data. Nevertheless, the different aggregation levels of these data as well as the differences in geographic or substantive detail of

the different data sources poses additional methodological challenges to combine them for assessment of poverty and inequality dynamics across space and time. Experimental methods could also be used to assess the impact of heterogeneous inequality changes on household behavior and cooperation, building on recent insights from behavioral economics.

The methodological challenge is to model the space-time dynamics of regional inequality and its determinants and to develop techniques for forecasting the evolution and persistence of spatial poverty traps at high levels of spatial disaggregation. In that context, an analysis of the contribution of 'remoteness' as a causal factor in causing poverty and inequality is especially important for determining appropriate interventions. Such analyses include assessments of which forms of 'remoteness' are particularly problematic (e.g. distance to markets, access to infrastructure and services, 'social' distance to economic centers). Among the approaches to be used are space-time models using Markov random field and latent Gaussian formulations, mixture models, small area statistical estimation techniques, and various decomposition techniques. In this area, both the methodological and substantial challenges are closely related to the work of transmission issues discussed below. To study the behavioral responses to inequality and poverty traps, it will be important to empirically link behavioral insights (e.g. on altruism, cooperation, reciprocity, and status-seeking) with the observed inequality dynamics.

For space or even space-time dynamics, many different methods are currently used, MCMC being maybe one of the most popular techniques. An also quite popular alternative, especially when looking at panel data, are the so called mixed effect models which are the mainly used models for the so called small area or small sample inference in official statistics (e.g. Elbers et al. 2004). The model then captures either the time or the space effect or both by a random factor, and the individual effects by deterministic coefficients.

To obtain a valuable instrument in our context we need to develop more realistic models, relaxing several of the presently typical model assumptions. Of particular relevance are the specification of the functional form, the error distribution (in particular the covariance structure over time and space), and assumptions on independence between individual and space or time effects. But also it will be essential to always offer instruments to construct valid prediction intervals to determine vulnerability to poverty.

A complementary starting point to the Hidden Markov models for modeling the spatio-temporal process of poverty and inequality is a non-parametric or semi-parametric spatio-temporal approach that stems from the general theory of random fields and stochastic geometry. Such an approach yields theoretical characteristics that can be used for model choice, gives a general understanding of the spectrum of possible behavior of the process of poverty, gives

guidance on the construction of indices for characterizing and assessing development of poverty, allows an investigation of the 'remoteness' issue by nearest neighbor characteristics and similar techniques, and provides models for the underlying spatial heterogeneity, which is critical for identifying possible areas of policy intervention.

In addition, various alternatives should be considered since remoteness usually cannot be measured in Euclidean distances. Hence, space transformations of random fields (Sampson and Guttorp, 1992) or random fields on graphs (Perez and Heitz, 1996) have to be taken into account. Both approaches assume that there is no relation between the existence of data at a certain spatial location and the values of the data. This is not obvious, and new tools to support such an assumption have to be developed within the theory of spatio-temporal marked point processes.

Here too, there exists considerable preliminary work by the principal investigators. Grün and Klasen have investigated changes in inequality and its impact on well-being across space and time. Bjørnskov, Dreher, Fischer and Schnellenbach revisit the association between happiness and inequality, focusing on the perceived fairness of the income generation process in the labor market and political beliefs. Klasen and Grimm were part of an international research consortium analyzing determinants of pro-poor growth in developing countries where inequality change was a central component; Klasen and co-authors have in the past collaborated with investigators of SFB386: Analysis of Discrete Structures in Munich (where Klasen was a member before coming to Göttingen) where the focus was on geo-additive modeling of undernutrition and child mortality in developing countries; this work is currently being extended as part of a DFG-funded research projects on sex-specific inequality in child mortality and health access in South Asia.

Sperlich has worked on semiparametric generalized mixed effect models, Schlather und Zucchini have worked extensively on various approaches to space-time modeling and Sperlich (see reference list) works on small area statistics which are of particular relevance e.g. when trying to identify local poverty traps or predicting economic indices. Sperlich and Klasen are currently jointly supervising two Ph.D.s which specifically address this topic. A collaboration between Sperlich and the junior research group "Econometrics and Statistical Methods" (Krivobokova) on the inferential problems in the context of small area statistics is planned. Ibanez is working, with Kocher, Kroll and Martinson, on the stability of preferences for cooperation under income inequality.

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4) Modeling the vulnerability to poverty ex ante and ex post

Much of the poverty literature has focused on static assessments or *ex post* dynamic assessments of poverty, inequality, and mobility, and it is unclear to what extent the observed dynamics are driven by measurement error and unobserved heterogeneity. For policy purposes, however, *ex ante* assessments of the vulnerability to poverty are needed to design appropriate policy interventions. The data for such assessments has improved recently with the increasing availability of panel household surveys in developing countries as well as better data on the nature and impact of covariate shocks (e.g. price and production-related) and idiosyncratic shocks (e.g. demographic and employment) on household welfare.

One of the key drivers of vulnerability at the household level is the ability of households to make best use of their available assets and inputs to produce high incomes. Here it is important to model jointly consumption and production decisions in rural households and to study how rural households behave close to the subsistence margin. Thus the vulnerability of a household will depend on initial assets and incomes as well as on the constraints imposed by production technology and market structure; it might also be directly related riskiness of different production choices which might have discontinuous effects above or below subsistence levels.

In addition, the ability to manage shocks *ex-ante* and to cope with them *ex-post* will be critical drivers of poverty risk of households. Such strategies comprise the diversification of income

streams to reduce risk, and in the case of adverse shocks, the depletion of assets, the reallocation and expansion of labor supply, the reliance on transfers from outside the household, and borrowing.

Thus, the ability of households to deal with such adverse shocks depends, among other things, on their asset base, their social capital and access to networks for borrowing and support, and thus their vulnerability to shocks depends on this. In addition, the (technical and allocative) efficiency of households in using their asset base to generate incomes can differ greatly between households and thus seriously affect their vulnerability as has been demonstrated for agrarian households in many contexts. Additionally, other productivity drivers such as changes in available technologies at the household level or adjustments with regard to scale and scope of production affect the household's exposure to poverty. Low productivities can be drivers of chronic poverty, and variations in productivity between households can be another source of vulnerability.

In order to understand this vulnerability, it is therefore necessary to ascertain the risk environment that potentially poor households face, their attitude towards risk, their ability to put their available assets and resources to the most productive use, as well as the potential coping mechanisms they have available, are critical. With the advent of panel surveys, better data on the agricultural production processes and the nature and type of shocks and coping mechanisms, such assessments are becoming possible but face a range of methodological hurdles. When examining the potential impact of policies on vulnerability, additional issues arise regarding the households' responses to such policy interventions. Among the approaches to be developed and used are panel-econometric techniques, IV approaches to address measurement error, data envelopment and stochastic frontier analyses to study the productivity (and variability) of asset and resource use at the household level. Finally, the analysis of the stochastic nature of incomes will be used to study vulnerability and its response to policies. Also here, experimental methods could contribute to analyze risk preferences and capture reference dependence.

Due to the complexity of the problem and the partial lack of data, the model used for the estimation of future risk of poverty must be based on idealized assumptions. Interdisciplinary knowledge is needed to determine which of these assumptions are plausible; the derived confidence bound for the risk of poverty needs to take account of uncertainties of the model assumptions and the data.

There also exists preliminary work in this regard. In particular, Klasen is part of a recently approved DFG-funded research group (Forschergruppe) on 'Vulnerability to Poverty in East and South-East Asia' where Klasen's project focuses on conceptual and empirical issues in vulnera-

bility measurement. Klasen and Zucchini are currently collaborating on modeling the time path of incomes using long panel data. Brümmer has worked extensively on efficiency and productivity issues in agrarian households, and Zucchini and Sperlich have worked on a range of modeling approaches that could be extended for the assessment of vulnerability. Ibanez modeled the effect of threats to fall below subsistence on the decision to participate in risky activities; currently she works on risk preferences from rural households and its effect on the adoption of a new technology.

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5) The impact of aid on growth including the impact of aid allocation on aid effectiveness

One of the policy options to tackle persistent poverty in developing countries has been aid from abroad which might arguably be one way to promote economic growth and thus overcome poverty. Previous research studying the effectiveness of aid in terms of promoting real GDP growth and poverty reduction in recipient countries get mixed results. While the now famous results by Burnside and Dollar (2000) suggested that aid promoted growth only in an environment of 'good policies', other authors point to a positive growth effect independent of economic policies in recipient countries, or dependent on certain features of recipient countries such as the share of a country's area that lies in the tropics, the level of democratization, institutional quality, political stability, the level of aid dependence, vulnerability to external shock sand absorptive capacity. Clearer evidence on this aspect of aid may, however, be impeded by adequate and long enough

time series on democratization, corruption, institutional quality, and indicators of economic policy. It is always difficult to draw conclusions over the long term without having sufficient time series data. Other empirical studies have even pointed to an even negative growth effect of aid in the long run (Svensson, 1999), maybe due due to weak institutions, increased corruption and a dwindling willingness to raise taxes (Rajan and Subramanian, 2007) and/or to real exchange-rate appreciation (Rajan and Subramanian, 2005) in the recipient economies. These issues remain largely unresolved.

Regarding aid allocation and aid effectiveness, surprisingly, only a handful of studies have examined the impact of donor behavior on aid effectiveness in detail. In large parts of the literature, it is still common to run panel regressions with aggregate aid flows as explanatory variable: However, donors have stressed repeatedly that they pursue multiple objectives when granting aid (e.g., Isenman and Ehrenpreis, 2003). These purposes tend to escape analyses narrowly focused on the nexus between overall aid and economic growth. Only recently, the paper by Clemens et al. (2004) on short-impact aid has initiated a shift towards using disaggregated aid data. Dreher et al. (2008a) and Williamson (2008) focus on the effect of aid given to specific sectors, and the outcome in these sectors. Przeworski and Vreeland (2000), Dreher (2006a) and Miniou and Reddy (2007) focus on specific donors rather than lumping them all together.

However, even aid given to a particular sector, by a particular donor, or aid that can reasonably be expected to affect growth in the short-run might arguably be driven by various motives. Depending on these motivations, the outcomes are likely to differ as well. We therefore intend to investigate the impact of donor motives on aid effectiveness. Past research on aid allocation identifies donor motives as a mix of humanitarian and self-interested economic or political motives (e.g. Alesina and Dollar (2000) Dreher et al. (2009, 2010).

There are several reasons why aid given to achieve foreign policy, strategic, or commercial goals may be less effective at promoting growth and poverty reduction within the recipient country. Thus, the effectiveness of aid may vary across donors if those with more of a humanitarian focus (rather than a self-interested focus) take actions to promote aid effectiveness by directing aid to high return activities or threatening to withdraw aid to governments that do not implement developmental policies. Even for a given donor, the development effectiveness of its aid may vary across recipients and over time as the donor's motive for providing aid varies across recipients and over time.

Among the methodological challenges of this literature are some of the classical problems of cross-country regressions (parameter stability, measurement error, non-linearitites, unobserved heterogeneity, and endogeneity). Some of these issues can be addressed using panel ap-

proaches, doing extensive robustness checks, carefully modeling non-linearities, and finding convincing instruments to deal with endogeneity. Here linking the issue of motivation with outcomes in a panel setting might be a one approach to address endogeneity issues. Moving from aggregate growth and poverty impacts to project impacts might also be able to tackle some of the methodological issues.

Klasen and Dreher have both worked on empirical growth determinants using cross-section, panel, and time series methods for an extended period of time. In addition, Dreher has worked extensively on the political determinants of aid allocation at the bilateral, multilateral, and non-governmental level; he has also studied aid effectiveness at the global, sector, or project level and Klasen and Dreher are currently investigating the impact of political motivations for granting World Bank projects on the outcome of these projects.

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6) Poverty and the transmission of prices and policy changes in space and time

Standard economic theory is based on the assumption that a single price for each good characterizes all exchange activity and that shocks that influence this price are immediately manifest to all market participants. In reality we observe that prices even for highly standardized and homogeneous goods vary widely over space, both in levels and in the dynamic patterns of their responses to shocks. This suggests that price formation is a much more complex, decentralized and dynamic process than is commonly assumed. Underlying this issue is the concept of price

transmission, both vertical (between different levels of the food chain) and spatial (across regions in space).

The transmission of prices of food in particular, but also prices of key inputs such as fertiliser and agricultural labour (which is itself an important source of income for many poor households) has profound implications for income levels and poverty outcomes in developing countries. Spatial price transmission determines whether a poor harvest in one region leads to local hardship and perhaps even famine, or whether the burden is shared across regions, and perhaps even dissipated by the blessing of a good harvest elsewhere. Similarly, spatial price transmission determines the extent to which food producers and consumers in developing countries are affected by changes in world market prices of food such as the major increases (and subsequent decreases) that took place in conjunction with the 2007/08 commodity price crisis. In a vertical setting, the transmission of prices between different levels of the food chain determines whether the price-reducing benefits of a good harvest or a reduction in state price support for farm products will be passed on to consumers or simply be absorbed as higher margins by traders, processors and retailers. This is of particular relevance for assessing the poverty effects of policy reforms and trade liberalisation in agriculture. In summary, poverty levels and in particular the genesis and persistence of variations in poverty over space and time will be strongly influenced by transmission of agricultural input and output prices. Developing concepts and empirical tools that enable us to understand and accurately measure price transmission is therefore of great importance.

The proposed research program aims at improving our understanding of price formation on food markets as a complex, decentralized and spatial process. The focus is on prices for agricultural inputs and outputs, because of their influence on poverty and because the availability of detailed, disaggregated price data for these products is exceptionally high worldwide for historical and intrinsic reasons (i.e. the above-mentioned importance of food prices for standards of living, the intensity of policy intervention on agricultural markets, the high frequency of repeated transactions).

Aided by this data availability, agricultural economists have been at the forefront of applied research on price formation and price transmission. However, this agricultural economic research is only beginning to take advantage of recent methodological advances in the areas of time series analysis, non-linear dynamics, and spatial econometrics. Interdisciplinary work involving agricultural economists, development economists, and statisticians and mathematicians, has the potential to accelerate the research agenda and generate significant innovations at an interface between fields that has hitherto largely been neglected.

The introduction of so-called cointegration methods in econometrics in the mid-1980s provided an impetus to the literature by enabling researchers to distinguish between spurious and non-spurious relationships between prices, and by providing a tool that under certain conditions can distinguish between co-movement that is due to market integration and co-movement that is due to other factors. By the late 1990s, however, research (e.g. McNew and Fackler, 1997) demonstrated that there are pitfalls associated with the application of cointegration methods to the analysis of price transmission. Specifically, the finding that prices on different markets do not co-move might be due to a lack of market integration, but it might also be caused by other factors such as non-constant transfer costs between markets (for example due to seasonally ice-bound waterways) or reversals of trade flows (due to harvests that fluctuate from year to year).

Two broad responses can be identified. First, one can study vertical price transmission between markets using Markov-switching and threshold cointegration models that allow the relationship between prices of different products in the production chain (e.g. wheat and flour) to switch between different regimes. Second, one can employ mixture distribution models that combine price data with information on transfer costs and trade flows to determine whether markets are integrated (e.g. the Parity Bounds Model (PBM) employed by Baulch, 1997).

While the PBM has the important advantage of explicitly incorporating data on transfer costs and trade flows between markets to avoid the pitfalls of the cointegration approach mentioned above, it does not account for the time series nature of the data (for example, the fact that the trade flows recorded in the current period may have been induced by prices in previous periods), and it can be highly sensitive to distributional assumptions. The first objective is therefore to explore the potential of methods that combine the advantages of mixture distribution models and Markov Switching models (MSM). A limitation of the MSM – and as well Hidden Markov models (HMM) – is that the underlying Markov assumption constrains the state sojourn duration to be geometrically distributed. However, empirical evidence suggests that the sojourn duration is more persistent than that associated with a geometric distribution. The statistical literature describes two approaches to deal with this problem. Hidden semi-Markov (HSMM) explicitly model the sojourn duration but their implementation is relatively demanding and far from fully developed. A second approach is to state-dependent duration HMMs. A recent and related approach is based on a latent-state model with feedback. A methodological challenge is that these approaches generally require longer time series than are available for most developing countries. Hence, it is very likely that special customized models will have to be developed. A final challenge will be to link these investigations of price transmission more directly to poverty outcomes

and policy reforms. This is an area where collaboration between the agricultural and development economics and methodological partners will prove particularly fruitful.

A second objective is to explore the application of recent developments in non-linear time series modelling to questions of price transmission. The time series models referred to above are all based on the assumption that prices on the markets in question are linked by a single long run relationship; non-linearity applies only to the error correction dynamics that describe reactions to departures from this long run relationship. In reality, we might expect that the long run relationship changes depending on the direction of trade between two markets (or in the absence of such trade). This could bias the results of common non-linear models used to estimate price transmission. Seo (2006) presents a test for the null of no cointegration in threshold vector error correction models, and Gonzalo and Pitarakis (2007) have recently designed a test for threshold effects in the cointegration relationship between two variables in this framework. An important task for the proposed research is to investigate the suitability of these new methods for the study of price transmission and market integration.

A third objective is to analyze the transmission between food prices and the non-farm sector. There are two different views on these macro-economic linkages in the current literature. On the one hand, the shares of food expenditure in total expenditure (Engel Index) are very high in developing countries. High food prices can be transmitted into non-food sector through raising wages of non-farm workers. On the other hand, Johnson and Song (1997) suggest that farmers can change their grain stocks by rationally expecting inflation so that price changes in non-food sectors can be transmitted into food sector. However, food and agriculture are main sources of income for farmers in developing countries. In order to protect both farmers and consumers, governments usually intervene in markets. Zhao et al. (2008) find that there is long-run equilibrium between food price and non-food prices in China due to government interventions.

The principal investigators have already worked on all of these fields in prior and on-going research. Brümmer et al. (2009) use Markov-switching methods to study vertical price transmission on wheat and flour markets in Ukraine. Dreher and Krieger (2008) focus on price convergence of different petroleum products in the EU, while von Cramon-Taubadel et al. (2006) study the impact of data aggregation on the empirical estimation of time series price transmission models. Yu has published on linkages between food and non-food prices (Zhao et al. 2008). Zucchini has worked on Hidden Markov models as well as latent-state models. Von Cramon-Taubadel et al. (2009) and Hernandez et al. (2009) study price transmission and the impact of the 2007/08 ‘price crisis’ in Eastern Africa (for the World Bank) and Latin America (for the CEPAL/United Nations), respectively, and ongoing work based on these studies is looking at the

influence of distance and international borders on price transmission relationships. Von Cramon-Taubadel is co-leader of a recently approved DFG Trilateral Project group with partners in Israel and Palestine that will, inter alia, study the influence on price transmission and household welfare of border closures and checkpoints between Israel and the West Bank and within the West Bank using switching methods.

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7) Improved estimation of threshold vector error correction models using multi-scale methods

Economists have devoted considerable attention to testing the Law of One Price (LOP) in a variety of settings. The LOP in its strong form states that a homogeneous good should sell for the same price everywhere. If prices are not the same, trade from low- to high-priced markets will take place until they are equalised. Since commodity prices typically display non-stationary behaviour, cointegration techniques are used in empirical analysis to determine whether there is a long-run equilibrium relationship between prices in different markets. If such a relationship exists, a vector error correction model (VECM) of the dynamic price transmission (PT) process can be estimated.

In the late 1990s, however, research demonstrated that there are pitfalls associated with the application of cointegration methods to the analysis of PT (Barrett, 2001; McNew and Fackler, 1997). Most important, Baulch (1994) and others, drawing on the spatial equilibrium theory formulated by Takayama and Judge (1971) pointed out that that prices will only be cointegrated if spatial arbitrage conditions are binding. This has lead to the development of the regime-dependent model, which allowed the prices move independently of one another if there is no incentive for trade. Such models are referred to as a threshold VECM (TVECM). Thresholds introduce nonlinearities into a system and determine its modes or regimes of operation. As a result of a threshold, the relationship between two or more variables may be locally linear within individual regimes, however globally it will exhibit nonlinear behaviour as it switches between regimes. Tong (1978) formally introduced the class of threshold models, and within this class the TVECM was first formulated by Balke and Fomby (1997).

The TVECM has been used extensively in PT analysis especially in agricultural economics (examples are Goodwin and Piggott, 2001; Meyer, 2004; Sephton, 2003). While the TVECM is appealing because of its theoretical foundations in spatial equilibrium theory, several unresolved problem remain. Own preliminary Monte Carlo evidence suggests that the grid search method systematically underestimates the true threshold. Furthermore, as Balcombe et al. (2007) point out, the criterion (SSE or log likelihood) is jagged function of the possible threshold values.

These problems may be related to the fact that the estimation procedure is inconsistent. In this project we are looking for the improved techniques for estimating TVECMs in the context of price transmission. Thereby two approaches are to be pursued. First, an explicit correction of the bias, which enters due to profiling the likelihood for the threshold parameter, should be found (e.g. in line with Severini, 1998). Second, a novel application of the multiscale method developed by Axel Munk should be pursued. Given its proximity to the price transmission question and the involved methodological challenges, this project will be pursued primarily by von Cramon, Munk, Krivobokova and Greb, the Ph.D. student who recently joined to work on this issue.

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8) Measuring asymmetric price transmission and its impacts on poverty

A frequent and important question on food markets is whether vertical price transmission is asymmetric, in other words whether price increases at one level of the chain are passed on to other levels at a different rate than price decreases. A currently topical case in point concerns the transmission of prices in the petroleum-gasoline chain. Another example, with direct relevance to poverty issues for rural consumers, relates to possibly asymmetric price transmission along the food chain: It is sometimes claimed that processors and retailers with market power pass reductions in consumer food prices on to farmers more rapidly than increases. Such asymmetries are often used to explain why market liberalization in developing and transition countries has produced fewer benefits for the poor than anticipated. Hence, asymmetry is also critical for an assessment of the poverty impact of reforms in international agricultural trade (such as those being discussed at the WTO Doha Round).

A variety of approaches using non-linear time series, structural and spectral modeling techniques have been developed to test for asymmetric transmission (Meyer and von Cramon-Taubadel, 2004; Frey and Manera, 2006). Several empirical studies have found asymmetric price transmission to be the rule rather than the exception (e.g. Peltzman, 2000). However, four main econometric methods for testing asymmetric price transmission coexist in the literature – along with a number of other methods that have only been employed in single studies. These methods do not produce identical results, and so far there has been no systematic attempt to compare them and determine which is most appropriate under which conditions. Moreover, at least as many theoretical explanations for asymmetric price transmission have been proposed in the literature as there are empirical methods for testing it. These explanations range from the abuse of market power by middlemen such as processors or retailers to inventory holding behaviour. None of the available empirical tests for asymmetric price transmission is able to distinguish conclusively between these different possible causes. In summary, it is not clear how robust the emprical finding of prevalent asymmetric price transmission is, and how serious its implications are.

One objective of the proposed research is therefore to systematically compare the strengths and weaknesses of existing tests for asymmetric price transmission. The existing plurality of often contradictory methods with their different propensities to identify asymmetry is a major weakness of the literature on asymmetric price transmission to date. Most new studies apply a new method to new data, generating two sources of variation that make meaningful comparison difficult. Additionally, virtually all empirical studies focus on the bivariate analysis of pairs of prices and do not explicitly account for the fact that prices are transmitted over networks of markets

in geographical space. Hence, there is the challenge of explicitly incorporating spatial effects in models of asymmetric price transmission, and of making appropriate use of corresponding new methods in spatial econometric modeling (Anselin and Florax, 1995). This can be especially relevant in developing country settings where transport costs are often very high and volatile. Furthermore, the aggregation of price series (for example calculating national averages from regional data) has a significant impact on the results of empirical price transmission analysis (von Cramon-Taubadel et al., 2006). Most published price transmission work uses price series that are highly aggregated over space and time, although disaggregated data is increasingly available. The literature describes a number of approaches to the spatial modeling of price transmission. It needs to be investigated in how far the currently available models lend themselves to different depths of disaggregation.

The objective of the proposed work is to develop new multivariate models for studying possibly asymmetric price transmission with spatially and temporally disaggregated micro-data to reveal a more detailed and rich picture of price transmission down to the local level where it directly influences individual households, enterprises and communities. Hidden Markov models (HMM) and Markov switching Models (MSM), which have been outlined earlier, also provide a flexible family of models for *multivariate* time series. They have been successfully applied in a variety of fields, e.g. hydrology and environmental studies among others. They provide one obvious starting point for the spatial temporal modeling of price transmission. However, multivariate HMMs and HSMs generally contain a large number of parameters and therefore require relatively long time series of observations, which are not always available. Thus a major methodological challenge is to construct special-purpose parameterizations that are parsimonious but that nevertheless capture the main features of asymmetric price transmission. In this respect a specific and potentially important advantage of HMMs in this application is the relative ease with which disaggregation can sometimes be modeled using constructions from the theory of graphical models. In particular, models based of the notion of contemporaneous conditional independence offer a promising approach to describing price transmission down to the local level.

Von Cramon-Taubadel has made several contributions on addressing methodological and empirical questions in asymmetric price transmission, including the first definitive review of this literature (Meyer and von Cramon-Taubadel, 2004), and the first use of the asymmetric error correction model to estimate asymmetric price transmission (von Cramon-Taubadel, 1998). He has also contributed to a study of the impact of data aggregation on the measurement of asymmetric price transmission (von Cramon-Taubadel et al., 2006). A paper that explores asymmetric price transmission between US and Mexican maize markets written by a PhD student in the

Courant Center (Araujo-Enciso, 2009) has recently been accepted for presentation at the upcoming August 2009 triennial Conference of the International Association of Agricultural Economists in Beijing. Zucchini and Guttorp (1991) have worked on space-time Hidden Markov-Models that could be extended and applied to this issue.

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9) Transmission and adoption of agricultural technologies and their poverty impacts

Agricultural technologies can play an important role for poverty reduction and rural development, but they need to be suitable for the small farm context, and an efficient institutional setup is required to ensure proper innovation access and implementation by the potential users. Experience shows that the transmission of technologies can be quite unequal across different regions of the world. For instance, while high-yielding varieties of rice, wheat and maize during the Green Revolution have been widely adopted in large parts of Asia and Latin America, the extent

and speed of diffusion was much lower in Sub-Saharan Africa. Similar trends are now also observable for biotechnology and genetically modified (GM) crops. Economics research suggests that the poverty reducing effects of agricultural technologies can be substantial under certain conditions. Therefore, knowledge on the determinants and constraints of adoption, and on the poverty impacts under different circumstances, is crucial for designing appropriate policies.

There are two main strands in adoption research: adoption and diffusion studies. Adoption studies mainly employ cross-sectional data in a discrete choice modeling framework to analyze why some farmers adopt (or disadopt) at a certain point in time and others do not. This static approach generally does not consider the timing of an adoption decision and the effect that time-varying variables may have. Including the timing of an adoption, however, can provide important information, if adoption is related to specific events that occurred in the past (e.g. a major reform) or if time is considered to be linked to phenomena like learning by doing and learning from others. Diffusion studies, which model aggregate diffusion rates, account for the timing of adoption by differentiating between early and late adopters, but they cannot address the specific factors behind the adoption decision. Hence, both research approaches as such do not seem to be suitable for analyzing *why* farmers adopt innovations at a particular point in time.

Duration models bridge the gap between adoption and diffusion studies by applying cross-sectional and time-series data jointly in a dynamic framework. Originating in the biomedical sciences, duration models found wide applications in economics, mainly in the analysis of unemployment spells. Yet, applications in agricultural and development contexts remain rare. The objective of the proposed work is to further develop such models and apply them to different examples of innovation adoption. Furthermore, the role of rural social networks will receive particular attention. Recent research shows that social interactions can be crucial determinants for the efficient transmission of technologies, which have been underrated in the past, partly also due to data constraints in capturing farmers' networks appropriately. Extending related approaches could significantly help to better understand the important dynamics in the technology diffusion process. Finally, the space-time dimension of the transmission and adoption processes of technologies and production efficiencies between agricultural households require the utilization of mark variograms and/or similar characterization of the stochastic processes.

In terms of the poverty impacts of agricultural technologies, productivity, efficiency, employment, income, and distribution effects play an important role. A large strand of the literature on productivity as a driver of growth analyzes developments at the aggregate (sectoral or national) level while it is clear from a theoretical viewpoint, that heterogeneity between households requires a microeconomic analysis. The available micro-based studies, on the other hand, usually

rely on cross-sectional data to model such impacts. However, in spite of sophisticated sampling techniques, a possible non-random selection bias can often not be ruled out completely. Instrumental variable approaches can be used to reduce the resulting endogeneity problem. Furthermore, panel data techniques can be employed to isolate the treatment effect even more precisely. Additionally, panel data allow to model heterogeneity in a more elaborate way, e.g. by using mixture models in order to take into account the differing access of households to various technology packages.

The data required for such technology adoption and impact studies are usually micro level data with a very specific focus, which have often never been collected or are not publicly available. Qaim and Brümmer have worked extensively on related aspects and, in doing so, have put together interesting data sets, including panel data on biotechnology adoption in India. Ibanez is currently working on adoption of organic coffee and plans to extend this analysis to panel settings. Grimm and Klasen are currently analyzing panel village surveys to study the impact of geography-induced institutional changes (esp. the institution of land rights) on the adoption of new technologies. Schlather has worked in depth on marked point processes, and explored their potential for applications. Additionally to new data to be collected in the framework of the proposed work, these existing data could be harnessed for further analyses with more advanced econometric techniques. Composing a set of studies for different technologies and environments, but using consistent methodologies, will eventually allows to derive broader conclusions about the role of technologies in driving poverty outcomes, which go beyond the previous lessons of traditional case study approaches.

Recently, Qaim and co-authors have made significant progress on various aspects within this research area. For instance, Matuschke and Qaim (2008) have developed duration models suitable to model the determinants of hybrid crop adoption among poor smallholder farmers over a long time horizon of several decades. In addition, Matuschke and Qaim (2009) have contributed to the analysis of the role of individual social networks for farmer technology adoption. In terms of impact analysis, Sadashivappa and Qaim (2009) have used panel data from India to show that GM cotton reduces pesticide use and increases crop yields and profits. Subramanian and Qaim (2009a, 2009b) have extended this analysis; building on a detailed village modeling framework they showed that GM cotton also contributes to poverty reduction and employment generation in rural India.

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10) Poverty, Smallholders and Dynamics of Food Supply Chain

Currently, agri-food systems are undergoing a rapid transformation towards high-value products, higher quality and food safety standards, and a higher degree of international and vertical integration, induced by the changes in consumer preferences. A challenging research topic is how smallholders adjust to, survive and grow in the changing global agri-food systems.

The evidence in many countries shows that food expenditure and calorie intake usually increase as income increases, though the share of food in total expenditure may decrease as Engel's Law predicts. With rising consumption of food quantity, the demand for food quality, food safety and convenience is growing. Understanding the transformation of consumer preferences is very important from both methodological and policy perspectives. On the one hand, ignoring the changes in food quality can cause severe biases in estimating income and price elasticities (Yu and Abler, 2009). On the other hand, understanding the transformation of consumer preferences can help to prepare smallholders for increased participation in high-value markets, which opens income opportunities and reduces market risks.

Transformation of consumer preferences has profound impacts on the whole food supply chain in developing countries. Food supply chains in developing countries are usually longer and more complicated than their counterparts in developed countries due to the active roles of a large number of traders. They connect smallholders with processors, retailers and consumers; so that they can help reduce transaction costs and share risks among the market players.

Studies for China and some African countries find that traders can improve marketing channels, optimize social search cots, stabilize the food supply chain and make markets work for the poor and small farmers, so as to increase farmer incomes and social welfare (Fafchamps and Minten 1999; Fafchamps et al. 2003; Yu et al. 2008; and Yu et al. 2009).The current literature emphasizes the role of social capital on the part of traders, which is found to facilitate access to information and trade finance, and improves risk sharing in the supply chain.

In practice, the food supply chain can be connected through either market purchases or contracts. In the case of contractual purchase, studies reveals that breaches of agricultural contracts are very prevalent in many developing and transition countries due to opportunistic behaviors, such as in some Eastern European transition countries (Gow and Swinnen 2001), in Madagascar (Fafchamps and Minten 1999), and in China (Yu et al. 2008, Yu et al. 2009).

Yu et al. (2008) find that in order to prevent opportunistic behaviors which may cause breaches of contracts and threaten the efficiency of contracts, the contractual design of simple price-quantity contracts in China has been evolving in two directions: organizational innovations and contractual innovations. Organizational innovations involve intermediate organizations, such as cooperatives or brokers, placed in between farmers and processors. Contractual innovations involve the evolution of price-quantity contracts into complex cooperation contracts to hold up the parties to a contract. Similarly, Wollni and Zeller (2007) show that institutional innovations – such as forming groups or cooperatives – can help smallholder participate in high-value markets.

Yu et al. (2009) also studied the contractual arrangements by traders using the survey data from China, and find that higher education on the part of traders can increase the propensity to observe contracts in markets and also can possibly reduce contract breaches. Following the study, Yu and Wollni are continuously working a project to study the food supply chains and roles of traders in China in particular for high-value products, such as mushrooms and bamboo shoots. Qaim has worked extensively on the transformation of agricultural supply chains in developing countries, with a special emphasis on high value tropical products, including studies on the supply side (Schipmann and Qaim 2009, Mergenthaler et al. 2009a) and demand side (Mergenthaler et al. 2009b, 2009c).

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IV. Research Areas for the Three Research Groups

The research issues identified are first and foremost the substantive questions associated with dynamic poverty analysis in developing and transition countries and the impact of policies and technologies on poverty outcomes. As discussed above, however, addressing these questions requires the development and application of new statistical methods and approaches that will be able to tackle the empirical complexities in these critical policy issues. Consequently, the development and application of new statistical methods will be a critical component of this research center and it is a particular strength of the center that it brings together people working on these substantive policy issues and people who can develop new approaches and methods to tackle them.

It is proposed that the ten substantive issues identified, alongside the methodological challenges will be tackled in three junior research groups, one concentrating on poverty and inequality dynamics as well as associated policy issues ('Poverty Group'), coordinated by Klasen where Ibanez-Diaz is the junior research group leader, one focusing on price, policy and technology transmission issues coordinated jointly by Brümmer and von Cramon-Taubadel ('Transmission Group'), and one addressing methodological questions coordinated by Munk ('Methods Group'). While each group will have its core research agenda, it is anticipated that major innovations will be generated at the interface between the groups. Thus we expect all senior and junior investigators to actively work on topics that are related to all groups, often in the form of co-authorships with members of the other groups. This is also reflected in our diagram below.

The Poverty Group will take the lead in the first five issues identified above and will be coordinated by Klasen. As far as principal investigators are concerned, it is composed of four development economists (Klasen, Grün, Dreher, Ibanez-Diaz) as well as Qaim, Sperlich and Seebens. In addition, Michael Grimm (former Junior Professor, now Professor of Development Economics at the Institute of Social Studies in The Hague, Netherlands) will continue to collaborate with the Center. Klasen (and the other development economists) will be particularly focused on the poverty measurement and policy issue. The researchers on this topic will collaborate closely

with Sperlich, particularly on the issue of multidimensionality of poverty. Regarding the endogeneity of households, Klasen, Grün, Grimm, Seebens will both work on these topics, this time in collaboration with Munk and Sperlich from the Methods Group. The inequality change topic will be an important focus of the work of all the development economists, in collaboration with Schlather, Zucchini, von Cramon, and Munk from the other two groups. The vulnerability topic will be coordinated by Klasen and Grimm and will work with Brümmer and Qaim on the productivity growth and efficiency issues (levels, variability, and determinants), and with Zucchini and Sperlich on methodological questions and with Ibanez on applying experimental methods. The aid issues will be tackled by Klasen and Dreher and seek input on methods from Sperlich.

The Transmission Group will be coordinated by Brümmer and von Cramon and will consist of Brümmer, Yu, von Cramon-Taubadel, Wollni, and Qaim. Substantively, it will focus on the topics of the transmission of prices, policies, and technologies as well as transforming agri-food systems. Also here, there will be close collaborations with other research groups. In particular, the space-time transmission of prices and policies will be led by Brümmer and von Cramon and will include collaboration with Zucchini, Schlather and Munk on time series and space-time modeling, and interaction with Klasen on empirical investigations of the poverty impact of remoteness. Questions of asymmetric transmissions will be analyzed by von Cramon, Sperlich, and Munk, and technology aspects will be addressed by Qaim and Brümmer, while transforming agri-food systems are analyzed by Wollni, Yu, Qaim, Brümmer, and Seebens

The Methods Group will be coordinated by Munk and will include Munk, Krivobokova, Sperlich, Schlather and Zucchini. Munk and Sperlich will work on IV methods (and related inverse problems) as well as structural equation models, and Sperlich, Grün, and Klasen will work on dimensionality issues. Krivobokova will work on issues of non-linear modeling. Munk, Zucchini and Sperlich will also focus on model selection issues, space-time modeling will be a particular focus of Zucchini, Schlather, von Cramon and Klasen, and Mixture models will be investigated by Munk, Klasen, and Sperlich.

The three junior research group leaders will actively participate in the research program of the Center. At the same time, given their varied own research interests which understandably does not overlap entirely with the proposed research program of the Center, we not only show how they will collaborate in the Center but also on describe their own research agenda below. The two descriptions are, of course, not mutually exclusive.

Table 1: Proposed Research Groups

Poverty Group (Klasen)	Transmission Group (Brümmer / von Cramon)	Methods Group (Munk)
-Poverty Measurement (Klasen, Sperlich, Grün) -Endogeneity of Households (Klasen, Sperlich, Munk, Seebens) -Vulnerability (Klasen, Zucchini, Sperlich, Brümmer, Qaim, Ibanez) -Inequality change across space and time (Klasen, Dreher, Grün Zucchini, von Cramon, Schlather) -Aid, Growth, and Poverty (Dreher, Klasen)	-Space-time transmission (von Cramon, Brümmer, Yu, Klasen, Schlather, Sperlich) -Estimating threshold models of price transmission (Krivobokova, Munk, von Cramon) -Asymmetric price transmission (von Cramon, Sperlich, Munk, Brümmer) -Transmission of technologies (Qaim, Brümmer, Schlather, Klasen, Ibanez) -Poverty and Food Supply Chains (Qaim, Brümmer, Yu, Wollni, Seebens)	-Dimensionality issues (Sperlich, Klasen, Grün) -IV methods (Munk, Sperlich) -Hidden Markov models (von Cramon, Munk, Zucchini) -Structural equation models (Munk, Sperlich) -Model selection (Munk, Zucchini, Krivobokova, Sperlich) -Space-time modelling (Zucchini, Klasen, Schlather, Krivobokova) -Mixture models (Munk, Klasen, Schlather) -Non-parametric techniques (Krivobokova)

Research Areas of the junior research groups

Junior Research Group 'Econometrics and Statistical Methods'

The main research focus of this group is on nonparametric techniques, especially on penalized splines, which are low-rank splines. Penalized splines have become very popular over the last decade. Small parameter dimension of this smoothing method allows handling large data sets described with sophisticated models. Links of penalized splines to mixed and Bayesian models enable employing the available estimation and inference machinery of these well-established techniques. In particular, handling correlated data, adaptive curve estimation and fitting of heteroscedastic data can be handled easily in the mixed model or Bayesian framework (see Krivobokova and Kauermann 2007, Krivobokova et al 2008).

In spite of the impressive development of penalized splines over the last years, their asymptotic properties remained less explored. Very few first results are available (Kauermann et al. 2009 and Claeskens et al. 2009) and one of the research topics of the group should be further work on the theoretical frame for penalized splines. Currently, Katsiaryna Saevich, a third-party funded PhD student, is working on Fourier analysis for penalized splines. Also the equivalent kernel for this smoothing technique is targeted. Another PhD student Manuel Wiesenfarth started the work on the asymptotic comparison of penalized spline estimators resulted from the standard and mixed model based framework. Construction of simultaneous confidence bands with penalized splines has been developed (Krivobokova et al 2009).

Penalized splines can be applied to many research problems of the Courant Center. For example, small area models employed in the research topic “Inequality across space and time” can be extended to more flexible versions in spirit of Opsomer et al. (2008) using the link between penalized splines and mixed models. Collaboration with Stefan Sperlich arises naturally. Manuel Wiesenfarth has already dealt with nonparametric mixed effects models. Duration models to be employed in the research topic “Transmission and adoption of agricultural technologies and their poverty impacts” can also make use of the nonparametric techniques, in line with Kauermann and Knomski (2009).

In addition to nonparametric modeling, some relevant econometric techniques complement the interests of the group. Friederike Greb, the third PhD student of the group, (co-advised with Munk and von Cramon-Taubadel) works on improved estimation in threshold vector error correction models, employed in the research topic “Poverty and the transmission of prices and policy changes in space and time“. This project in collaboration with Munk and von Cramon-Taubadel

aims to improve the parameter estimation in threshold vector error correction models, which is shown to be seriously biased for small samples.

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Junior Research Group 'Agricultural Economics'

Three out of every four poor people in developing countries live in rural areas, and most of their livelihoods depend directly or indirectly on agriculture. Agriculture is very important for spurring economic growth, reducing poverty and enhancing food security.

This group focuses on the broad issues in rural economies of developing countries, such as East Asian and African Countries. In particular, a strong emphasis is placed on the linkages between smallholders and consumer markets, and on the ongoing transformation of the food supply chain and the corresponding impacts on rural livelihoods (i.e., farmer income and consumer welfare) both from the theoretical and empirical perspectives.

The specific topics include:

1. The driving forces of the changes in the food supply chain, such as trade regulation changes and consumer preference transformation;
2. Traders' role in the supply chain;
3. Contract design between players in the supply chain, and the impacts on risk-sharing and contract enforcement;

4. Price transmissions along and beyond the supply chain and the impacts on rural livelihoods;
5. Transferablility of East Asian experience to African countries.

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Junior Research Group 'Development Economics'

The areas of research of this group are diverse, but nevertheless closely related with the ten mayor areas of research in the centre. One of the areas of research is on the determinants to adopt a new technology. We investigate whether the technological change is pro-poor in the sense that it reaches the less favored. To understand the dynamics of technological change we consider the effect of learning by doing and learning from others. The objective of this area of research is to construct a panel data that captures individual dimension across time. Eventually we would also like to implement a small scale natural field experiment. The second topic of our research is on the impact of technological change on well being. For example, we investigate whether technological change succeeds in generating higher income opportunities to adopters and in particular to poor farmers and the impact of new technologies on the environment.

The second area of research is on the linkages between poverty and illicit behavior. We focus on the theoretical and empirical investigation on the motivational factors behind participation in illegal activities. In particular, our research considers behavioral models of crime that take into account monetary and non-monetary factors that affect behavior. We investigate the effect of morality, religiosity, acceptance to the authorities and social networks on criminal participation. In addition, we consider how poverty or the impossibility to make a living out of a legal activity impacts behavior. We also investigate the effectiveness of different policies used to deal with crime or illegal behavior.

The investigation of attitudes towards risk is another area of research. The objective of this research area is to investigate risk preferences. In particular we are interested in comparing the validity of competing theories on behavior under risk. We use experimental methods to characterize attitude towards risk. The emphasis of our study is non-student population in developing countries who is confronted to risky situations in their daily life. This allows investigating how individual circumstances impact risk preferences.

Last but not least, we investigate preferences for income distribution using hypothetical experiments. In addition we study how cooperation changes as the societies become more uneven. We pay particular attention to the behavior of those who are relatively better off compared with those who are worse off. Differences in behavior of both groups are associated with redistributive preferences.

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