ECONOMIC STUDIES

DEPARTMENT OF ECONOMICS
SCHOOL OF BUSINESS, ECONOMICS AND LAW
UNIVERSITY OF GOTHENBURG
179

Essays on Smallholder Diversification, Industry Location, Debt Relief, and Disability and Utility

Sven Tengstam

ISBN 91-85169-38-2
ISBN 978-91-85169-38-2
ISSN 1651-4289 print
ISSN 1651-4297 online

UNIVERSITY OF GOTHENBURG

ECONOMIC STUDIES

DEPARTMENT OF ECONOMICS
SCHOOL OF BUSINESS, ECONOMICS AND LAW
UNIVERSITY OF GOTHENBURG
179

Essays on Smallholder Diversification, Industry Location, Debt Relief, and Disability and Utility

Sven Tengstam

UNIVERSITY OF GOTHENBURG

ISBN 91-85169-38-2
ISBN 978-91-85169-38-2
ISSN 1651-4289 print
ISSN 1651-4297 online

Printed in Sweden
Geson Hylte Tryck, 2008

Abstract

Essay 1 Smallholder Income Diversification in Zambia: The Way Out of Poverty?
This paper investigates the relationship between income diversification (combinations of farm income, agricultural wage work, non-agricultural wage work, and own-business income) and income within Zambian smallholder households. Shifting to a higher degree of diversification is found to be associated with getting higher income per laborer. Households in more diversified and urbanized environments are found to be able to diversify more easily. Education opens up opportunities for non-agricultural wage work and, to a smaller extent, to own-business. Diversification into agricultural wage work depends on land shortage, which suggests that it is partly a distress diversification. Households with more market-oriented agricultural production are more likely than others to diversify into business but less likely to enter agricultural wage work. Female-headed households are less likely than others to combine farm income with non-farm wage work. Land, educational, gender and province influence income not only indirectly via choice of activity combination but also directly.

Essay 2 What Explains the International Location of Industry? –The Case of Clothing
The clothing sector has been a driver of diversification and growth for countries that have graduated into middle income. Using a partial adjustment panel data model for 61 countries 1975-2000, we investigate the global international location of clothing production by using a combination of variables suggested by the Heckscher-Ohlin theory and the New Economic Geography (NEG) theory. Our Blundell-Bond system estimator results confirm that the NEG variables do help explain the location of the clothing industry, and point to that convergence is not as inevitable as sometimes assumed. We find that closeness to various intermediates such as low-cost labor and textile production has strong effects on output. Factor endowments and closeness to the world market have inverted U-shaped effects. This is expected since above a certain level several other sectors benefit even more from closeness and factor endowments, driving resources away from the clothing industry.

Essay 3 Debt Relief and Adjustment Effort in a Multi-Period Model
This paper shows that if the period following the granting of debt relief is taken into account, debt relief increases adjustment effort (investment), irrespective of whether there is an initial debt overhang or not.

Essay 4 Disability and Marginal Utility of Income
It is often implicitly assumed that disability generally lowers the marginal utility of income. This paper questions this view. Individuals' marginal utility of income is estimated in two states – when paralyzed in both legs and when not mobility impaired at all – using experimental choices between hypothetical lotteries where the outcomes include both income and disability status. The median ratio of individuals' marginal utility of income when paralyzed to when not mobility impaired, R, is estimated at between 1.33 and 2. It is statistically significant higher than one. Individuals with personal experience of paralysis and voters for the Left Block or the Liberal Party are more likely than others to have an R over one. Our results imply that more than full insurance of income losses connected to being disabled is optimal. The results also suggest, in contrast to, e.g. Sen (1997), that given a utilitarian social welfare function, resources should be transferred to, rather than from, disabled people.

Keywords: Zambia, agriculture, income diversification, structural change, poverty, global clothing industry, new economic geography, comparative advantages, industrial agglomeration, HIPC, debt relief, debt overhang, investment, incentives, disability, mobility impairment, marginal utility, hypothetical lotteries, risk.

*JEL-classification***:** D10, D60, D63, F12, F13, F34, H63, I10, I30, L13, L67, O11, O13, O16, O55, Q10, R3, R11, R12

Populärvetenskaplig sammanfattning på svenska

Essä 1. Småbrukares inkomstdiversifiering i Zambia: Vägen ut ur fattigdom?
I denna artikel studeras relationen mellan diversifiering (breddning) av inkomstkällor (kombinationer av de fyra huvudsakliga inkomstkällorna – inkomster från den egna gården, lönearbete inom jordbruk, lönearbete utanför jordbruk, och inkomster som egenföretagare) och inkomst bland Zambiska småbrukarehushåll. Omkring 5000 hushåll med högst 20 hektar åkermark intervjuades 2001 och 2004.

Vi finner en positiv korrelation mellan hög grad av diversifiering och hög inkomst per arbetare. I linje med detta finner vi även att ett byte till mer diversifiering tycks leda till en ökning av inkomst per arbetare. I denna artikel undersöks även vilka faktorer som påverkar vilka inkomstkällor ett hushåll har. Hushåll i mer diversifierade och urbaniserade miljöer har lättare att diversifiera. Utbildning öppnar möjligheter för lönearbete utanför jordbruket och, i mindre utsträckning, för egenföretagande. Diversifiering till lönearbete inom jordbruk ökas av brist på åkermark, vilket tyder på att det delvis används som en nödlösning. De hushåll som har en mer marknadsorienterad jordbruksproduktion är oftare även egenföretagare, men har mer sällan inkomster från lönearbete inom jordbruket. De hushåll som leds av en kvinna har mer sällan inkomster från lönearbete utanför jordbruket. Ett hushålls tillgång till åkermark, utbildningsnivå och kön på familjeöverhuvudet, samt vilken provins hushållet finns i, påverkar inte bara inkomsten indirekt via val av inkomstkällor, utan också direkt.

Våra resultat pekar på att mer säker tillgång till jord, och tydliggjord äganderätt är viktigt. De perifera regionernas integrering i Zambias ekonomi bör underlättas via bl.a. infrastruktursatsningar. Tillgång till krediter är också viktigt.

Essä 2. Vad förklarar industrins internationella lokalisering? – Exemplet klädesindustri
Historiskt sett har klädesindustrin drivit på diversifiering och tillväxt för fattiga länder som har lyckats blir medelinkomstländer. Vi undersöker klädesindustrins internationella lokalisering med hjälp av variabler hämtade både från Heckscher-Ohlin-teorin (H-O-teorin) och från Ny Ekonomisk Geografi-teorin (NEG-teorin). Enligt H-O-teorin kommer ett land specialisera sig på sektorer där det har komparativa fördelar (dvs. fördelar i förhållande till andra länder) pga. sina tillgångar på faktorer såsom jord, arbetskraft och kapital. Industrier är emellertid ofta mer geografiskt koncentrerade än vad som kan förklaras av faktortillgångar. NEG-teorin (som grundlades av Paul Krugman) hävdar att industrier koncentreras geografiskt eftersom stordriftsfördelar och begränsad konkurrens gör det lönsamt.

En paneldatamodell med successiv anpassning för 61 länder 1975-2000 används i vår analys. Våra resultat bekräftar att de variabler som föreslås inom NEG-teorin verkligen bidrar till att förklara klädesindustrins lokalisering. Detta pekar på att ekonomisk utjämning mellan världens länder inte kommer av sig själv så självklart som man ibland antar inom den neoklassiska nationalekonomin. Vi finner att närhet till det som behövs för produktionen som textilproduktion och billig arbetskraft påverkar nivån på klädesproduktionen mycket. Tillgången på grundläggande faktorer som fysiskt kapital och humankapital, och närhet till världsmarknaden att sälja på, har omvänt U-formade effekter på produktionen. Detta är väntat eftersom att över en viss nivå på dessa variabler gynnas andra industrigrenar ännu mer. Dessa andra industrigrenar drar då till sig resurser på bekostad av klädesindustrin. Att en stor andel av befolkningen bor nära kusten har en positiv inverkan på klädesproduktionen, detta är i linje med att länder utan kust generellt sett är fattigare.

Våra resultat innebär att Afrika, den fattigaste regionen, har ganska goda möjligheter att dra till sig klädesindustri. Inverkan från att ha en stor kustbefolkning belyser hur viktigt det är med infrastruktur som krymper avstånden till hamnstäder. Vidare tycks det finnas en möjlighet för Afrikanska länder att konkurrera med låga löner när de asiatiska lönerna stiger med ökat välstånd.

Essä 3. Skuldavskrivning och investeringar i en flerperiodmodell
Hur är relationen mellan skuldavskrivning och investeringar (eller ansträngningar att förbättra det ekonomiska klimatet) i ett skuldtyngt land? Det har rått ganska stor enighet om två saker: Skuldavskrivning kan öka investeringarna om det finns ett skuldöverhäng, dvs. om skulden är så stor att den antagligen inte kommer att kunna betalas tillbaka fullt ut. Skuldavskrivning minskar investeringarna om det inte finns ett skuldöverhäng, eftersom en lägre skuld innebär mindre press på landet att öka sin produktion. Därför varnar många för skuldavskrivningar om det inte finns ett skuldöverhäng.

Denna artikel bidrar till den teoretiska förståelsen av dessa frågor genom att vidareutveckla den teoretiska modell av Jeffery Sachs och Max Corden som är den etablerade. Vi visar att om även tidsperioderna efter att skulden avskrivits tas med i analysen, ökar skuldavskrivning de totala investeringarna oavsett om det finns ett skuldöverhäng eller inte. Tidpunkten för investeringar skjuts framåt, men den totala volymen ökas. Den etablerade modellen beskriver korrekt vad som händer på kort sikt, men den missar vad som händer på lång sikt.

Essä 4. Funktionshinder och marginalnytta av inkomst
Det antas ofta, uttalat eller outtalat, att funktionshinder generellt sett gör det svårare att dra nytta av konsumtion. Eftersom inkomst möjliggör konsumtion betyder det att marginalnyttan av inkomst (dvs. den välfärdsökning som en ytterliggare krona ger) minskar. För att testa detta undersöker vi folks marginalnytta av inkomst i två lägen – när båda benen är förlamade och när man inte är rörelsehindrad alls – genom en experimentell studie.

354 universitetsstudenter fick göra nio hypotetiska val mellan tänkta lotterier där utfallen innehöll både inkomst och om man är funktionshindrad eller inte. De flesta som svarade föredrog mestadels lotterier som innebär att man tjänar mer om man är funktionshindrad än om man inte är funktionshindrad, framför lotterier som innebär att man tjänar minst om man är funktionshindrad. Vi noterade hur mycket extra inkomst som krävdes för att de svarande trots allt skulle föredra det lotteri som innebar att man tjänar minst om man är funktionshindrad. Därmed kunde vi beräkna kvoten mellan personers marginalnytta av inkomst om de är funktionshindrade och om de inte är funktionshindrade. Vi kallar kvoten *R*. Vi fann att medianen av *R* ligger mellan 1,33 och 2. Den är statistiskt säkerställd över ett. Vi fann även att personer som har personlig erfarenhet av rörelsehinder tenderar att ha ett högre *R*. De som stödjer Vänsterpartiet, Socialdemokraterna, Miljöpartiet eller Folkpartiet tenderar att ha ett högre *R* än de som stödjer Moderaterna.

Våra resultat innebär att mer än full försäkring för inkomstbortfall vid funktionshinder är optimalt. Resultaten tyder också på, i motsats till vad bl.a. Amartya Sen har hävdat, att utifrån en utilitaristisk social välfärdsfunktion ska resurser snarare transfereras till funktionshindrade, än från.

Preface

Yesterday I read in my morning paper: “Nairobi – the hub of the next big emerging market”. Five days ago I saw a son of Kenya and Kansas elected as president of the USA, and I saw the Democrats also win the Senate and the House. Maybe the world can change.

I would like to express my gratitude to all those who in various ways have supported me during my work with this thesis. Arne Bigsten and Olof Johansson-Stenman, my supervisors, thanks for your inspiration, for your help, and for all the time you spent. Dick Durevall, Fredrik Carlsson and Måns Söderbom, I do not know how many times I have disturbed you with my questions and thoughts, my thanks to you too. Three persons that I have disturbed a little bit less often, but still enough for you to have significantly contributed to the thesis’ development, are Lennart Flood, Bo Sandelin and Katarina Nordblom. From my licentiate seminar and final seminar, I am grateful for all the comments and suggestions from Ari Kokko and Jan Pettersson.

I am also very grateful to Eva-Lena Neth-Johansson and Elizabeth Földi. You always try to help whatever the problem is.

Big thanks to all my fellow Ph.D. candidates at the department for encouragement and friendship! I will remember the Thursday football at Hvitfeldtska gymnasiet, and I will remember the discussions within, and support from, Development Kids, the informal network for us Ph.D. candidates in the Development Economics field. The gang that I started the Ph.D. programme together with: it has been a pleasure to make this five year journey together with you.

I have tried to keep one foot in Malmö, and to my friends down there: Thanks for all the good times.

Mamma, pappa, Ola och Maria, tack för allt!

Göteborg, November 2008

Financial support to this Ph.D. project from the Swedish International Development Cooperation Agency (Sida)/The Department for Research Cooperation (SAREC), via the project “When will Africa take off?”, and from Jan Wallander’s and Tom Hedelius’ Foundation, via the project “ Geography, institutions, technology and economic convergence”, is gratefully acknowledged**.**

Contents

Abstract i

Populärvetenskaplig sammanfattning på svenska (Popular summary in Swedish) ii

Preface iv

Essay I: Smallholder Income Diversification in Zambia: The Way Out of Poverty?

1. Introduction 1

2. Theory review 2

3. Data and the income variable 4

   3.1. The data 4

   3.2. The income concept 4

      3.2.1. Farm income 5

      3.2.2. Off-farm income 5

4. Description of the pattern of income diversification 5

5. Explaining income diversification of smallholders 9

   5.1. Explanatory variables 9

   5.2. Selection into activity combinations 11

   5.3. Determination of level of income 12

   5.4. Income and changes for activity combinations 14

   5.5. Income growth within an activity combination 15

6. Policy conclusions 16

Appendix A. 18

Appendix B. 19

Appendix C. 21

Appendix D. 22

References 22

Essay II: What Explains the International Location of Industry? -The Case of Clothing

1. Introduction 1

2. Theory and earlier studies 4

3. Estimating equations and choice of variables 6

4. Econometric considerations 11

5. Discussion of results 13

   5.1. Partial adjustment 15

   5.2. Size variables 15

5.3. Closeness 15
5.4. Closeness to intermediate factors 15
5.5. Closeness to output markets 15
5.6. The comparative advantage variables 17
5.7. Robustness 17
6. Conclusions 17
Appendix 1. 18
Appendix 2. 20
References 22

Essay III: Debt Relief and Adjustment Effort in a Multi-period Model
1. Introduction 127
2. The model 128
3. Result 129
4. Conclusion 129
References 130

Essay IV: Disability and Marginal Utility of Income
1. Introduction 1
2. The model 2
3. The choice experiments 4
4. Results 6
4.1. Descriptive results of the choice experiments 6
4.2. Statistical analysis of the median *R* 8
4.3. Econometric analysis of the determinants of individual *R* 8
5. Ordering and design effects, and a robustness discussion 12
5.1. Ordering and design effects 12
5.2. Robustness discussion 12
6. Conclusions 14
Appendix 1. 15
Appendix 2. 19
Appendix 3. 29
References 33

Essay I

Smallholder Income Diversification in Zambia: The Way Out of Poverty?

Arne Bigsten and Sven Tengstam*

This paper investigates the relationship between income diversification (combinations of the four main income generating activities – farm income, agricultural wage work, non-agricultural wage work, and own-business income) and income within Zambian smallholder households, using a panel data set of roughly 5,000 smallholder farmer households interviewed in 2001 and 2004. A higher degree of diversification is found to be associated with higher income per laborer. Similar results are found when looking at how shifting from one activity combination to another influences income. The paper also studies the determinants of selection into activity combinations. Location matters a lot; households in more diversified and urbanized environments are able to diversify more easily. Education opens up opportunities for non-agricultural wage work and, to a smaller extent, for own-business. Diversification into agricultural wage work depends on land shortage, which suggests that it is partly a distress diversification. Households with more market-oriented agricultural production are more likely than others to diversify into business but less likely to enter agricultural wage work. Female-headed households are less likely than others to combine farm income with non-farm wage work. A household's area of land per laborer, educational level of the household head, gender of the household head, and province of residence influence income not only indirectly via choice of activity combination but also directly.

Keywords: Zambia, agriculture, income diversification, structural change, poverty.

*JEL-classification***:** O13, O55, Q10, R11.

1. Introduction

Zambia started out in 1964 as one of the richest of the newly independent developing countries. During the first decade of independence, Gross Domestic Product (GDP) per capita in Zambia changed little, but from the oil crisis in 1973-74 through the mid-1990s, per capita income fell by 45%. However, the country has since the late 1990s been experiencing a recovery, with an increasing per capita income. A very important question is to what extent this reversal of fortunes has implied a reduction in poverty. This depends on both the growth in the economic activities in which the poor are engaged and on the extent to which the poor can shift into other and more lucrative activities.

The income changes of poor households are thus the joint outcome of growth and structural change. The latter has been central in the theorizing about economic development typi-

* Department of Economics, University of Gothenburg, Box 640, SE 405 30 Gothenburg, Sweden, arne.bigsten@economics.gu.se and sven.tengstam@economics.gu.se. We are grateful to Jos Verbeek, Eva Lövgren, Måns Söderbom, Rick Wicks, and seminar participants at the University of Gothenburg and at the Nordic Conference in Development Economics 2008 in Stockholm for useful comments. We would also like to thank the Food Security Research Project, in particular Michael Weber and Antony Chapoto, for sharing their data on Zambian agriculture with us. We are also grateful for helpful discussions with officials of the Zambian government. Financial support from Sida/SAREC is gratefully acknowledged**.**

fied by the dual-economy model of Lewis (1954). Empirically, economic growth has been associated with a declining agricultural share of GDP and increasing shares for industry and services. This structural change can be seen as a macroeconomic phenomenon, but it also occurs within households. Smallholders in Africa (and elsewhere) were originally almost exclusively farmers, but have over time shifted into non-agricultural activities as well. In fact, some households have shifted completely out of agriculture, although the process is usually gradual with households maintaining a foothold in agriculture for an extended period of time. Hence, the income structure of households changes as the overall economic structure changes. This paper studies this aspect of structural change or income diversification at the household level in Zambia. It has been argued that the key challenge in poverty reduction efforts relates to inequality of opportunities (World Bank, 2006). The opportunity set we are particularly concerned with is therefore access to different types of income opportunities for smallholders.

In this paper we concentrate on the changes among smallholders, who make up the largest group of poor Zambians. We look specifically at the role of income diversification among smallholder households, and also investigate what the constraints on income diversification are in this group. Although the policy question we focus on is what interventions could make it easier for smallholder households to enter new types of income-generating activities, we also briefly discuss how they could earn more money in existing activities.

We use four different income-generating activities – farm income, agricultural wage work, non-agricultural wage work, and own-business income – and study the determinants of selection into different combinations of these. Households in a more diversified and urbanized environment are found to be able to diversify more easily. Education opens up opportunities for non-agricultural wage work. Diversification into agricultural wage work depends on land shortage, suggesting that it is partly distress related. Households with more market-oriented agricultural production (who are thereby less cash constrained) are more likely to diversify into business but less likely to enter agricultural wage work. Further, our panel data analysis indicates that a higher degree of diversification is associated with higher income per laborer. Similar results are found when looking at how shifting from one activity combination to another influences income. Changing from being a full-time farmer to a more diversified livelihood strategy seems to raise the per laborer income in the order of 35% to 140%. Our analysis shows that the variables land-per-laborer, education of household head, province of residence, and gender of household head influence income not only indirectly via choice of activity combination but also directly.

In conclusion, rural income growth does not come from agriculture alone. Hence, options to diversify income are very important and should be pursued. Attention must therefore be given both to endowment improvements and to reductions of the constraints faced by households when trying to improve agriculture directly and when trying to improve possibilities of income diversification away from agriculture. Land per laborer, education, and location (market access and infrastructure) are key dimensions in understanding and figuring out how to make improvements in this context.

The remainder of this paper is organized as follows. Section 2 presents a theory review, and Section 3 describes the data and the income variable. Section 4 reports and discusses the descriptive results regarding the pattern of income diversification, and Section 5 analyzes these results econometrically. Finally, Section 6 concludes the paper and discusses policy implications.

2. Theory review

Structural change is an integral part of economic development. Typically, the agricultural sector's share shrinks, while industry and services expand. As noted in the introduction, we

will investigate structural change, or income diversification, at the level of rural households. Income diversification is a result of households' allocation of their assets across different income-generating activities. Households seek to achieve an optimal balance between expected returns and risks in different activities, given the constraints they face (Doss, McPeak, and Barrett 2006).[1] Since households are different in many respects, income patterns vary according to assets and constraints. Moreover, not all households have access to the same set of income opportunities. There are spatial variations in transaction costs, market prices, etc., and there are variations among households in the quality of the factors that determine their allocation of resources across activities.

Doss, McPeak, and Barrett (2006) show how income sources and diversification vary among and within smallholders in Kenya, Cote d'Ivoire, and Rwanda. However, since they only had access to cross-section information, they were unable to analyze actual changes over time. The challenge of establishing causality in the analysis of diversification requires use of disaggregated panel data. We have panel data for Zambia covering two years, 2001 and 2004, which we use to analyze changes over time for individual households.

Constraints differ across households in terms of property rights, land and labor availability, and access to credit or other forms of liquidity. There are also considerable start-up costs involved in some activities; a household sometimes has to enter at a reasonably large scale to be able to enter at all.[2] This means that households that do not possess sufficient human and financial resources do not have access to some potentially lucrative activities.

Household endowments are of course a key determinant of smallholders' activity choices.[3] To be full-time farmers, they need reasonable access to land, and the bigger the labor force of the household, the more land required. Consequently, the labor/land ratio of the household is a key determinant of its desire to move into off-farm activities. The human-capital endowment (education) of household members is also a key determinant of activity choices. In addition, it is easier to diversify out of agriculture if a household has good access to a thriving off-farm sector, which means being close to an urban market or being located in a region with a diversified economy. So, overall, we would say that the main factors behind allocation choices are differences in endowments, differences in access to markets, and differences in access to finance.

It has also been observed that the character and impact of smallholder income diversification vary with the education of a household. The most common pattern seems to be that households gradually improve their lot through diversification. Reardon (1997) finds in his survey of the income-diversification literature that non-farm income is generally regressively distributed. This means that households with the highest farm income also have the highest level and share of income from non-farm activities. Doss, McPeak, and Barrett (2006) find that the poor are more likely to rely on income from their own farms. This suggests that diversification generally is a way up the income scale. However, there is also the opposite pat-

[1] Barrett et al. (2005) note that "households choose an activity allocation vector for asset endowments that yield an uncertain income return from among a feasible set defined by the intersection of a non-tradable inputs availability constraint equal to one's endowment level of the input (e.g., land) and a budget constraint equal to one's current cash income plus access to liquid capital through savings or credit. Because income is a function of activity choice, it is an endogenous function of the prevailing (shadow) price distributions for all factors, goods and services. So observed income patterns can be understood as a function of the constraints – including ex ante asset endowments – faced by the household and its preferences."

[2] Barrett et al. (2005) write that "entry into lower-return niches (e.g., petty commerce at weekly rural markets) is low cost and widespread, but movement within the sub-sector in the higher-return niches requiring partially irreversible investment in fixed capital is sharply limited by liquidity constraints, social networks necessary to stabilize, monitor, and enforce contracts, etc."

[3] Assets are of course endogenous variables, and to understand the dynamics one also needs to understand the process of factor accumulation.

tern, distress diversification, where poor households seek to add to their meager agricultural incomes (Barrett 1998).[4] Here we are interested in finding to what extent income diversification in Zambia is of one or the other of these two types.

Typically the poor tend to rely more on farm wage labor, while richer households rely more on cash crops, livestock income, and non-farm income. Most households pursue strategies with several income components, and we will try to identify the most common activity combinations to see whether there is a pattern of mobility among them, and whether some routes of diversification are more successful than others.

3. Data and the income variable

3.1. The data

The data comes from the first and second supplemental surveys to the nationally representative 1999/2000 Post-Harvest Survey (PHS). The PHS is also known as the Agricultural and Pastoral Production Survey (APPS). These supplemental surveys, carried out by the Central Statistical Office in conjunction with the Ministry of Agriculture, Food, and Fisheries and commissioned by the Food Security Research Project (FSRP), cover incomes and livelihoods of small and medium scale rural holdings and provide a more complete assessment of smallholder conditions.[5]

The surveys (details of which are presented in Republic of Zambia, 2001, 2004), carried out in April/May 2001 and June/July 2004 to collect data for the 1999/2000 and 2002/2003 cropping seasons and for the 2000/2001 and 2003/2004 marketing seasons, cover the same sample of roughly 7,000 households as the 1999/00 PHS (they represent the second and third visits to these households). A sampling-frame of smallholder farmers (cultivating less than 20 hectares) in the rural areas of Zambia was used, and a household has to have at least some land to be included in the PHS.

The Food Security Research Project reports that rural poverty has been falling (Jayne et al., 2007). Agricultural growth has been positive, and real staple-food consumer prices have declined by 20% over the past decade. The total gross value of agricultural output rose by over 50% from the mid-1990s to 2001-2004. The worst performers in terms of output-growth were staple grains and beans. As much as 90% of all fertilizer used by smallholders has been used on maize, which has been stagnant, while cassava, sweet potatoes, cotton, and groundnuts have performed well. One out of every five small farmers grew cotton in 2002/03, while 45% derived income from the sale of animal products and 17% from horticultural products (fresh fruits and vegetables, etc.). The value of animal products and horticulture sales was almost as high as for maize, and there has been export-led growth in cotton and tobacco.

Neither 2001 nor 2004 was exceptional in terms of the conditions for agricultural production (Jayne et al., 2007). We can therefore be reasonably confident that our data sets are representative of the long-term trend in rural incomes.

3.2. The income concept

The data collected on smallholder incomes is not quite complete. Smallholder income is broadly made up of on-farm (agricultural) income and off-farm income. While the latter is well measured, the former lacks some components on the income side, and also lacks some costs.

[4] Ethiopia, with a very undifferentiated countryside, would be a case of distress diversification. There the households that diversify out of agriculture tend to be poorer than the non-diversified (Bigsten et al., 2003).

[5] Policy-makers in Zambia have access to the Crop Forecast and the annual PHS when deciding how to promote small-farmer welfare (Zulu, Jayne, and Beaver, 2007).

The ideal income concept includes all current household income (revenues minus costs) plus asset-valuation changes. The latter component is difficult to gather, but for a smallholder household one would like to know at least stock-valuation changes (changes in the value of livestock assets). Since we do not have this information, we are confined to looking at current income in a year. However, this data also has some shortcomings (discussed below). It is difficult to judge whether the overall effect is an overestimation or an underestimation. The time gap between the cropping and marketing seasons is also a problem, though hopefully not a serious one.

3.2.1. Farm income

a. Own consumption of crops – This is gross output/income from crops produced less crops sold but without deduction of costs. Errors here will therefore lead to overestimation.

b. Crop sales – This is the value of the part of gross production that is sold. It is overestimated to the extent that there were input costs related to the production of crops sold that were not deducted.

c. Vegetable sales – This is the value of vegetables sold. This income is overestimated to the extent that there were input costs related to the production of vegetables that were not deducted, and underestimated to the extent that the household itself consumes vegetables.

d. Livestock income – This is total income from livestock, i.e., the value of sales of animals (live and slaughtered), milk, and eggs. We may underestimate this income by ignoring own consumption of livestock products, and overestimate it by ignoring the cost of livestock inputs.

3.2.2. Off-farm income

a. Own-business income – This is net income, i.e., gross income less costs, so here there are no conceptual problems. The precision in measurements is probably rather low, however, since it is difficult for people to remember all costs and revenues for a whole year. To compute annual income, the questionnaire therefore asks for data for a good month and data for a bad month, and then about the numbers of such months. Although this is an ingenious way of computing this difficult income category, it is still an approximation.

b. Agricultural wage income – This is the value of agricultural wage income.

c. Non-agricultural wage income – This is the value of non-farm labor wage income.

d. *Remittances* – This is remittances received by the household from non-household members or organizations. Households may of course also remit out, that is considered part of household expenditures and is therefore not deducted here.

All income variables are expressed in 2004 Kwacha. See Appendix A for further details about the variables. Appendix B presents summary statistics.

4. Description of the pattern of income diversification

The question discussed here concerns how patterns of diversification relate to incomes. We start by presenting our data in some descriptive tables designed to show how income diversification among Zambian smallholders changed from 2001 to 2004. We report estimates for the whole aggregate and by quintile. What is reported in these tables can be compared to some basic figures: In 2004, GDP per capita was 2.29 million Kwacha (1133 PPP-$ in 2005 prices), and the food poverty line was approximately 900,000 Kwacha per adult equivalent. The average smallholder per adult equivalent income was below the food poverty line (Table 1).

Table 1. 2001 and 2004 Overall Income Diversification, in Percent and in 2004 Kwacha

	Percent		Per adult equivalent (000')		Per capita (000')		Total (billions)	
Income Source	2001	2004	2001	2004	2001	2004	2001	2004
Farm income	49.1	56.3	211	296	163.2	245	1077	1829
Farm work	2.6	2.3	11.3	12.0	8.8	10.0	58	74
Non-farm work	19.7	16.4	84.5	86.3	65.3	71.5	431	534
Own-business income	26.5	23.8	113.8	125	88.0	104	581	773
Remittances	2.1	1.1	8.8	5.6	6.8	4.6	45.1	34.5
Sum	100	100	429.5	524.8	332.2	435	2190	3240

Note: The discount factor 1.7619 was used (IMF 2007a), based on CPI for April/May 2001 and June/July 2004.

Even if incomes may be underestimated and the poverty line may be too high (see Bigsten and Tengstam, 2008, for a discussion), this suggests that severe poverty is widespread among Zambian smallholders.[6]

Although incomes were exceedingly low, all income categories except remittances increased in absolute terms over the studied period. The percentage coming from farm income increased, while the off-farm percentage decreased. The dependence on self-subsistence income (not shown) declined slightly.

Tables 2-4 show how income diversification varied by quintile.[7] In general, the higher the quintile, the lower the farm-income share (Table 2). Subsistence dependence declined with income. Higher quintiles had higher sales of crops and vegetables, higher wage incomes (mostly for non-farm labor), and higher own-business income, but lower remittances.

Tables 3 and 4 show income per adult equivalent and income per capita by quintile. From a welfare perspective, income per adult equivalent is the most appropriate measure. The lower quintiles had strikingly low income per adult equivalent, but this does not necessarily mean that consumption levels were that low. Income per adult equivalent for the lowest quintile grew by only 6.5%. Crops harvested for this quintile developed less favorably, with only a modest increase in own consumption and sales of crops, and own-business income fell. Wage income almost doubled, which is in line with the notion that the wage-income option is mainly used by the poorest to supplement their income when other sources yield too little. The three middle quintiles saw their income grow by a bit more than 10%. Compared to the overall figures in Table 1, these households had a less favorable development of crops and own business. Finally, quintile 5 incomes per adult equivalent grew by 29%. This is mostly due to increases from crops sold and own-business income.

Bigsten and Tengstam (2008) study how consumption developed in rural Zambia 1998-2004 and find that moderate rural consumption poverty fell from 83.5% to 77.5% (the moderate poverty line includes food, health, shelter, and education). They decompose the change into one part due to per capita consumption growth and one part due to consumption inequality change.

[6] Even if incomes might be underestimated to some extent, they are mainly in line with the Living Conditions Monitoring Survey IV. The Central Statistical Office (2005 p. 86 and 91) reports that total smallholder farm-income in 2004 was 2,158 billion Kwacha, whereas Table 6 shows that total smallholder farm income was 1,829 billion Kwacha. Both income levels are expressed in June/July Kwacha. The smallholder farm income reported by CSO (2005) is reasonable in relation to the total smallholder income, smallholder consumption, household consumption, and GDP reported by CSO (2005 p. 86 and 99) and World Bank (2007).

[7] There are the same number of persons in each quintile, so for 2004 the poorest 1,500,000 persons (not adult equivalents) are in quintile 1. "Poor" means belonging to a household with low income per adult equivalent (not per capita).

Table 2. 2001 and 2004 Income Diversification Shares by Quintile

Quintile	1		2		3		4		5	
Year	2001	2004	2001	2004	2001	2004	2001	2004	2001	2004
Income Source	---------- percent ----------									
Farm income	85.8	89.1	81	86	79	81	65.9	74.4	34	44.3
Farm work	1.6	2.3	1.4	1.3	2.7	2.3	3.3	3.7	2.6	2.0
Non-farm work	1.1	2.1	2.5	3.1	2.8	4.2	10.4	6.6	28.0	22.6
Own-business income	6.5	4.0	10.3	8.1	12.1	11.0	17.7	14.0	34.3	30.4
Remittances	5.0	2.4	4.4	1.8	3.3	1.7	2.8	1.3	1.3	0.8
Sum (percent)	100	100	100	100	100	100	100	100	100	100

Table 3. 2001 and 2004 Income Diversification per Adult equivalent by Quintile

Quintile	1		2		3		4		5	
Year	2001	2004	2001	2004	2001	2004	2001	2004	2001	2004
Income Source	---------- 2004 Kwacha per adult equivalent (in 1000s) ----------									
Farm income	48,8	54	107	129	182,9	208	269	334	446	749
Farm work	0.9	1.4	1.9	1.9	6.5	6.0	13.6	16.7	33.7	33.9
Non-farm work	0.6	1.3	3.2	4.6	6.5	10.9	42.2	29.7	369.2	381.7
Own-business incom	3.7	2.4	13.6	12.2	28.1	28.3	72.0	62.8	450.9	514.5
Remittances	2.9	1.5	5.8	2.7	7.6	4.4	11.2	5.8	16.6	13.5
Sum	56.8	60.5	131.7	150.1	231.7	257.5	407.8	449.1	1316.4	1692.4

Table 4. 2001 and 2004 Income Diversification Per Capita by Quintile

Quintile	1		2		3		4		5	
Year	2001	2004	2001	2004	2001	2004	2001	2004	2001	2004
Income Source	---------- 2004 Kwacha per capita (in 1000s) ----------									
Farm income	37.7	44.5	82	106	141.6	172	209	277.5	345	625
Farm work	0.7	1.1	1.4	1.6	5.0	4.9	10.6	13.9	26.1	28.3
Non-farm work	0.5	1.1	2.5	3.8	5.1	9.0	32.8	24.6	285.8	318.6
Own-business income	2.9	2.0	10.4	10.1	21.7	23.4	56.0	52.2	349.1	429.4
Remittances	2.2	1.2	4.5	2.2	5.9	3.7	8.7	4.8	12.9	11.2
Sum	43.9	49.9	101.3	124.2	179.2	212.6	317.1	372.9	1019.1	1412.5

The growth is found to have contributed 6.5 percentage points of the fall, while inequality change reversed the fall by 0.2 percentage points. (There was also a 0.3 percentage point residual.) Their findings are in line with our findings for the development of the rural smallholders' incomes from 2001 to 2004. Incomes were generally higher in 2004, but inequality did not decrease.

To be able to identify livelihood strategies, we classify households according to their sources of income. To simplify, we do not take remittances into account (this is only 1-2% of total income). This leaves us with 15 potential activity combinations, if we do not include those for which no income at all was registered. We use the panel data set, i.e., the observations that exist for both years. A household that derived farm income but had no other income has the activity combination farming-only, denoted F. A household that derived income only from farming and agricultural wage work has the activity combination FA, and so on. Tables 5 and 6 present the activity combinations for 2001 and 2004, respectively.

The overall pattern changes little between Tables 5 and 6. Households engaged in non-agricultural wage work or own-business generally have higher incomes than others.

Table 5. Income by Activity Combination, 2001 (in 2004 Kwacha per Adult Equivalent, 1000s)

Activity combination	Farm income	Farm work	Non-farm work	Own business	Total income	Activity freq. %
F	235.36	0.00	0.00	0.00	235.36	50.94
FA	216.36	164.19	0.00	0.00	380.55	4.66
A	0.00	50.61	0.00	0.00	50.61	0.02
FN	201.20	0.00	562.28	0.00	765.91	9.11
N	0.00	0.00	505.37	0.00	505.37	0.10
FB	210.77	0.00	0.00	333.19	542.90	26.38
FAB	151.63	77.79	0.00	123.28	353.80	2.27
FNB	221.58	0.00	384.51	328.03	934.11	5.14
B	0.00	0.00	0.00	274.57	274.57	0.54
AB	0.00	333.08	0.00	158.26	491.34	0.04
NB	0.00	0.00	432.59	117.24	550.30	0.06
FAN	128.15	40.95	186.65	0.00	355.65	0.30
FANB	201.81	94.30	238.90	136.42	672.69	0.44
All	220.09	10.17	73.71	109.05	412.99	100.00

Notes: F = Farm income, A = Agricultural wage work, N = Non-agricultural work, B = Own-business income. Activity frequency is based on population and not households.

Table 6. Income by Activity Combination, 2004 (per Adult Equivalent, 1000s)

Activity combination	Farm income	Farm work	Non-Farm work	Own business	Total income	Activity freq.%
F	301.83	0.00	0.00	0.00	301.83	53.49
FA	199.11	155.32	0.00	0.00	353.92	5.09
A	0.00	83.05	0.00	0.00	83.05	0.17
FN	310.54	0.00	554.91	0.00	865.45	10.21
N	0.00	0.00	697.48	0.00	697.48	0.14
FB	345.62	0.00	0.00	368.34	713.97	22.08
FAB	206.21	94.62	0.00	180.94	482.18	2.58
FNB	312.90	0.00	417.55	405.00	1135.45	4.93
B	0.00	0.00	0.00	838.27	838.27	0.29
AB	0.00	14.93	0.00	11.64	26.65	0.02
NB	0.00	0.00	1137.88	436.07	1573.95	0.08
FAN	216.36	84.64	97.86	0.00	399.39	0.49
FANB	197.48	77.43	168.67	150.06	593.03	0.44
All	302.18	11.32	80.97	108.72	503.17	100.00

Notes: F = Farm income, A = Agricultural wage work, N = Non-agricultural wage work, B = Own-business income. Activity frequency is based on population and not households.

Comparing Tables 5 and 6 shows how the activity frequencies for the different activity combinations developed. The full-time farmer share increased in size. The shares that include own-business generally decreased, while the shares that include wage work increased. The poor development of own-business is somewhat surprising; to be able explain it further we would need to know more about the kinds of businesses generating the income. Generally, farmers were less diversified in 2004 than in 2001. Table 7 shows paths from one type of combination in 2001 to another in 2004. The entries in the table show where those who started in a certain activity combination in 2001 ended up in 2004.

Table 7. Percentage Moving from One Activity Combination to Another from 2001 to 2004

	F	FA	FN	FB	FAB	FNB	Rest	Sum	Freq. in 2001
F	**69.0**	4.1	5.5	16.8	1.7	2.2	0.8	100	50.9
FA	45.9	**23.8**	8.0	13.3	4.6	2.9	1.3	100	4.7
FN	27.9	4.8	**40.0**	9.0	0.9	13.2	4.1	100	9.1
FB	45.8	3.7	5.4	**36.6**	3.0	3.6	2.0	100	26.4
FAB	48.1	9.0	4.9	21.2	**8.8**	4.3	3.6	100	2.3
FNB	26.2	5.4	23.7	22.5	3.7	**15.3**	3.3	100	5.1
Rest	38.6	0.0	11.1	28.3	2.7	13.2	6.1	100	1.5

Notes: F = Farm income, A = Agricultural wage work, N = Non-agricultural work, B = Own-business income. Rest = A, N, B, AB, NB, FAN and FANB. Percentages are based on population and not households.

For example, the first row contains the households that had activity combination F in 2001. Of those, 69.0% still had F in 2004, while 4.1% had FA and 5.5% had FN. We see that 16.8% of the households that had the activity combination F in 2001 had diversified into FB by 2004.

70.1% (Table 7, Row 2, Columns 1, 3, 4, and 6) of those earning income from a combination of their own farm and agricultural wage work in 2001 did not receive any agricultural wage income in 2004. Thus, working on others' farms is not generally a permanent feature of smallholder income generation in Zambia. Most of the households that were full-time farmers in 2001 had the same activity combination in 2004, but 31% (Row 1, columns beyond F) had diversified further into wage work and/or business. Clearly, there are considerable fluctuations in incomes and income structures in rural Zambia.

Looking at the values on the diagonal in Table 7, we see that it is not a general pattern that households remained in the same activity combination. For example, only 40% of the households that started in FN had the same activity combination in 2004. However, it is at the same time clear that a household was much more likely to end up in FN if it started in FN than if it started with another activity combination. We see that 53.2% of those that started in FN remained in FN or had diversified further into FNB by 2004, and that 39.0% of those that were in FNB in 2001 were still in FNB or FN in 2004. This means that FNB includes numerous households that often change activity combination. We further note that of those that started in FB, 43.2% stayed in FB or diversified further, while 45.8% fell back to F.

These descriptive tables show that there is extensive income diversification among Zambian smallholders, and that increasing diversification seems to generally be associated with higher incomes. However, to be able to say something more substantive about causality and the driving forces we need econometric analysis.

5. Explaining income diversification of smallholders

In the econometric analysis we look at several related aspects of smallholder income diversification and incomes. Before we do the analysis, let us present the variables used in the regressions.

5.1. Explanatory variables

From the theoretical review we concluded that important determinants of household income are endowments, market access, and access to finance. From our data set we were able to extract variables that reflect the first two dimensions, while we do not have any direct measure of access to finance.

First we have data reflecting the assets of households. We include a variable for the age of the household head (*Age*) and its square (*Agesq*) to pick up potential life-cycle effects. We also include three dummy variables measuring the level of education of the household head: *primary* (grades 1-7), *secondary* (grades 8-12 or forms 1-5), and *tertiary* (form 6, college, or higher). The default category in the regressions is no education. We also include a dummy for female headship, and a measure of land per laborer; i.e., hectares of land per household member aged 15-64 (all the household's land and not only cultivated land). To pick up possible effects of indivisibility, we also include a variable for the absolute size of the household labor force.

We include market access in two ways. First, we include provincial dummies for eight provinces: Lusaka, Central, Copper Belt, Eastern, Luapula, Northern, North Western, and Western; Southern is the default. Three provinces – Lusaka, Copper Belt, and Central – stand out as the most urbanized. (Households in Lusaka and Copper Belt have by far the shortest distance to a market, Thurlow and Wobst, 2004.) One would therefore expect it to be much easier for smallholders in these three provinces to diversify. Table A3 and the map in Appendix C provide additional information about the provinces. We also include a second, more direct measure of market orientation: the fraction of agricultural output that a household sells in the market.

Access to credit may to some extent be picked up by the provincial dummies, which reflect different levels of economic integration, including development of a financial system. The market-orientation variable can also to some extent be taken to reflect access to cash that can be used, for example, for investment in alternative activities. Market orientation and size of labor force are used in the selection regressions but not in the income regressions.

We encountered some problems with the age and education variables: Individuals sometimes answered differently in the two waves. In fact, only 47% reported exactly the same year of birth in the two waves. For another 15%, the difference was not more than one year, while for about 10% the difference was more than ten years. In terms of education, 40% answered the same in 2004 as in 2001. For another 25%, the difference was not more than one year, while for about 10% the difference was more than four years. Although these differences are a concern, they do not seem to be systematic for either variable. Hence, we feel it is acceptable to use these two variables in most of our regressions. However, we do not include them in the fixed-effects panel estimates since these are more sensitive to measurement error.

In the econometric analysis undertaken to explain income diversification of smallholders, we use the panel data set, i.e., the observations that existed in both years. There were 6,922 households in the 2001 survey, of which 1,580 were not in the 2004 survey. Out of those that were not in the 2004 survey, 707 households had moved out of the Standard Enumeration Area (SEA), 390 had dissolved, and 362 had not been possible to contact (Republic of Zambia, 2004). Thus, the attrition rate was 22.8%. Households that left the survey had on average 95% of the income of the total 2001 sample; 26.7% were female-headed compared to 21.7% for the whole sample; and they were on average 1.8 years younger, yet with 0.14 more years of schooling. Overall, they were not very different from the households that remained in the sample.

Of the households that were included in both waves, some did not report any information about their household heads, or about how much land they had. Moreover, some households reported negative or zero incomes, and some had no labor force in the age bracket 15-64. After deleting these households, since they can not be used in the econometric analysis, the data set includes 4,819 households.

5.2. Selection into activity combinations

The first key issue is to understand the determinants of activity combinations, i.e., the factors and constraints that determine what activities households enter into. We base our analysis on the structure of activity combinations shown in the previous section. We only discuss the six most common activity combinations, since the other nine were very unusual. We first run a multinomial logit regression explaining selection into activity combinations in 2001. Market orientation and size of labor force are used in these regressions, but not in the income regressions. Market orientation likely matters for selection into activity combinations, since it can offer the cash needed to change activity. Size of labor force arguably matters since individuals cannot be in two different places at the same time. However, there are less clear reasons for these two variables to influence income level *per se*.

Table 8 shows the marginal effects. The most striking result is that location, i.e., province, mattered a lot. If a household resided in the most urbanized province, Lusaka, it was particularly likely to have an activity combination other than farming only (F). Households in Southern, the default, had a 44 percentage points higher probability than those in Lusaka of being in farming only, and they were less likely to be in FA or FN. Households in Western and Luapula were particularly likely to be in FB (21 and 17 percentage points more likely, respectively, than those in Eastern), FAB, or FNB. Households in some of the poorer regions where there is a limited market for agricultural wage work instead seemed to go into business on the side to supplement their farm incomes. Households in the provinces along the Line of Rail were more likely to be in FA. Also, the more market oriented the agricultural production of a household, the more likely it was to be in FB. Income from sale of agricultural output probably helped relieve the financial constraint on entering own-business. Overall, it seems clear that the character of diversification depends strongly on location and market access.

Households with high land/labor ratios were more likely to be in farming only; one extra hectare per laborer increased the probability by 1.6 percentage points. This means that households shift into agricultural wage work when they are short of own land. The absolute size of the labor force also has some effect, with smaller size associated with some activity in combination with farming. Small households may suffer from indivisibility problems when trying to allocate their labor time across activities. Households with better educated heads were much more likely than others to diversify into FN or FNB. Secondary education increased the probability of being in the FN category by 11 percentage points, while tertiary education increased it by 64 percentage points. Thus, education can take a household out of agriculture, although the combination farmer and own-business is less likely if the head has tertiary education. Tertiary education opens up primarily for non-agricultural wage work. The probability of being a full-time farmer is progressively reduced by education: by 8 percentage points for *primary*, 19 percentage points for *secondary*, and 57 percentage points for *tertiary*. Clearly, education opens up the market for much better paid non-agricultural wage work, which of course is a way out of poverty, as was suggested by the descriptive tables in the previous section.

Households with more market-oriented agricultural production were more likely to diversify into business (FB), while their probability of also engaging in agricultural wage work (FA), or non farm wage income (FN), was reduced. A possible interpretation of this is that the cash generated by market-oriented agriculture helps lift the cash constraint on entering business. Female-headed households were less likely than others to be in FN, which may reflect the combination of females often being less geographically mobile (because of traditional household or family duties) than males and non-farm wage work often requiring long-distance travel. Finally, if the household head was young, the household was a bit more likely to be in FB, although this effect was quite weak.

Table 8. Marginal Effects for Selection into Activity Combination, 2001

Activity combination	F	FA	FN	FB	FAB	FNB
Age01	0.002	-0.001	0.00604**	0.00828***	-0.000	0.001
Agesq01	0.000	0.000	-0.00007**	0.00006***	-0.000	-0.000
Primary01*	-0.084***	-0.002	0.018	0.055***	0.000	0.012*
Secondary01*	-0.191***	-0.011	0.112***	0.048**	0.000	0.040***
Tertiary01*	-0.567***	-0.033***	0.637***	-0.140***	-0.003	0.103***
Female01*	0.026	-0.002	-0.029***	0.009	0.003	-0.005
Landplabor01	0.016***	-0.015***	-0.007**	0.006***	-0.000	0.001
Lusaka*	-0.440***	0.121***	0.060*	0.095**	0.070**	0.051**
Copperbelt*	-0.207***	0.124***	0.016	-0.001	0.056***	0.014
Central*	-0.082***	0.043**	0.009	0.023	0.013*	-0.004
Eastern*	-0.008	0.018	0.012	-0.031*	0.013**	-0.003
Luapula*	-0.272***	0.035**	0.005	0.142***	0.045***	0.034**
Northern*	-0.018	-0.011	0.001	0.026	0.002	-0.001
Nwestern*	-0.065*	0.002	0.020	0.039	0.000	-0.001
Western*	-0.295***	0.022	-0.007	0.183***	0.054***	0.035**
Market orientation01	0.014	-0.024*	-0.031**	0.048**	-0.001	-0.007
Laborforce01	-0.012***	0.001	0.002	0.006**	0.000	0.003**
Frequency	52.0%	4.7%	8.0%	27.1%	2.5%	4.5%

Notes: F = Farm income, A = Agricultural wage work, N = Non-agricultural work, B = Own-business income. Marginal effects from a multinomial logit. The marginal effects are for discrete changes of dummy variables (*) from 0 to 1 and for other variables for changes at the mean. Robust standard errors, * significant at the 10% level, ** at the 5% level, and *** at the 1% level.

In conclusion, the first result that emerges from this stage of our analysis is that location matters a lot. If a household operates in a more diversified and urbanized environment, it is able to diversify more easily. Primary and secondary education open up opportunities for non-agricultural wage work, and to some extent for business. Diversification into agricultural wage work depends especially on land shortage, which suggests that it is partly distress oriented.

5. 3. Determination of level of income

Next we look at the determinants of the logarithm of the level of real income. We need to somehow normalize for household size, and the most appropriate way to do this if we want to explain incomes is to do it per laborer (members of the household in the age bracket 15-64 years). We checked for specification with a Hausman test, which suggested that we use fixed-effects estimation. We therefore run FE panel regressions with two waves of observations. A time dummy is added.

We run two different panel regressions. We start with one on the activity combinations chosen and the control variables (but dropping education and age of head as discussed earlier); see Table 9, Column 1. The activity combinations are obviously endogenous, so we go on to estimate a second equation with only the other determinants (Col. 2), which in this case includes both the direct effect on income and the indirect effect via activity choice.

Looking at the first panel regression (Col. 1) where we control for gender and land per laborer, we see that FA is associated with 42% higher income than F. Since the left-hand variable is the logarithm of income and the estimate of the FA dummy is 0.351, we carry out $e^{0.351}-1=0.42$ to get the effect on income level. We use this method throughout the paper, except when the parameter estimate is smaller than 25% so the parameter estimate is a good approximation.

Table 9. Fixed-Effects Regressions (Col. 1-2) and Pooled OLS Regressions (Col. 3-6) for Log Level of Income, 2001 and 2004

	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Female	-0.138*	-0.168**	-0.437***	-0.520***	-0.287***	-0.316***
Landplabor	0.134***	0.131***	0.063***	0.057***	0.061***	0.058***
FA	0.351***		0.268***		0.277***	
FN	0.714***		1.022***		0.779***	
FB	0.711***		0.684***		0.729***	
FAB	0.748***		0.562***		0.619***	
FNB	1.086***		1.214***		1.095***	
t04	0.168***	0.143***	0.168***	0.148***	0.179***	0.158***
Age					-0.021***	-0.021***
Agesq					0.000***	0.000***
Primary					0.179***	0.246***
Secondary					0.444***	0.601***
Tertiary					1.304***	1.780***
Lusaka					0.263***	0.476***
Copperbelt					0.135***	0.191***
Central					0.148***	0.174***
Eastern					0.146***	0.091**
Luapula					-0.410***	-0.276***
Northern					-0.152***	-0.117***
Nwestern					-0.222***	-0.212***
Western					-0.540***	-0.381***
Constant	12.408***	12.756***	12.547***	12.921***	12.924***	13.202***
Observations	9638	9638	9638	9638	9638	9638

Notes: Robust standard errors; * significant at the 10%; ** at the 5% level; *** at the 1% level.

FN, FB, and FAB are associated with approximately 100% and FNB with 200% higher income than F. Hence, we see a very clear pattern of incomes going up with diversification, although the regression suffers from some endogeneity problems. When we consider the total effect of the deeper variables (Col. 2), we see that the total negative effect of having a female household head on income is about 17%, while the land/labor ratio has a strong positive effect: 13% per hectare/laborer. With the FE model, we do not get any estimates of time invariant variables such as province.[8]

OLS estimates of the pooled sample are shown for comparison and as an attempt to get some estimates of the impact of education, age, and location. Columns 3 and 4 repeat the regressions in Columns 1 and 2, while Columns 5 and 6 show the results for regressions with all variables included. The first set of results (Col.3-4) are similar to those in the fixed-effects regressions. The second set of regressions (Col. 5-6) are also broadly consistent for the variables included in the fixed-effects regressions, although we here also pick up the effects of education, age, and province. Even with all these controls included, the estimates for the effect of activity combination (Col. 5) are about the same as in the panel estimation (Col. 1). Looking at the controls in Column 5, we see that Luapula and Western, the two provinces with high degrees of diversification despite being remote, had a strongly negative effect on income levels.

[8] We have tested the effect of a dependency ratio (people aged 0-14 and 65 and older divided by the labor force aged 15-64). It turns out that the effect on output per laborer is positive. This reflects the fact that the dependents after all do contribute something to output. When we ran the regression on income per adult equivalent instead, we found a strongly negative effect. This shows that dependents indeed add something to output, but much less than proportionately.

Table 10. Log Income Per Laborer 2004; Separate Regressions by Activity Combination, 2001

	F01	FA01	FN01	FB01	FAB01	FNB01
Lnincomeplabor01	-1.476***	-0.147	-2.624***	-0.417	0.979	-0.090
Lnincomeplabor012	0.075***	0.023	0.118***	0.028	-0.017	0.020
Age01	-0.024***	0.015	-0.011	-0.010	-0.035	-0.092**
Age012	0.000**	-0.000	-0.000	0.000	0.000	0.001**
Primary01	-0.017	-0.111	-0.027	0.037	-0.256	0.223
Secondary01	0.035	-0.085	0.376*	0.216**	-0.191	0.239
Tertiary01	0.085	-0.567**	0.621***	0.443*	0.000	0.960***
Female01	-0.190***	-0.102	-0.337*	-0.170**	0.180	-0.581**
Landplabor01	0.035***	-0.021	0.015	0.026***	0.047	0.082***
Central	0.085	-0.122	0.195	0.263**	-0.436	0.468*
Copperbelt	0.146	0.012	0.362*	0.526***	-0.220	0.481**
Eastern	0.330***	0.109	0.518***	0.574***	0.291	0.591**
Luapula	0.027	-0.457*	-0.064	0.127	-0.244	0.285
Lusaka	0.547***	-0.012	0.563***	0.028	-0.201	0.386
Northern	0.062	0.392	0.298*	0.215**	0.092	0.215
Nwestern	0.289***	0.084	0.340*	0.240	-1.564*	0.705***
Western	-0.349***	-0.154	-0.110	-0.030	-0.844	0.310
F04		-0.715***	-0.957***	-0.770***	-1.204***	-1.477***
FA04	0.303***		-0.386**	-0.590***	-0.806**	-0.876***
FN04	0.581***	0.194		-0.264**	0.603	-0.374**
FB04	0.664***	0.240	-0.176		-0.233	-0.780***
FAB04	0.723***	0.193	-0.338**	-0.087		-0.407*
FNB04	0.891***	-0.167	0.310**	0.127	0.893*	
Rest04	0.029	-0.315	-0.344	-0.403*	-1.562*	-0.740*
Constant	19.983***	11.427	27.650***	14.099***	5.418	13.134
R-squared	0.293	0.454	0.613	0.313	0.581	0.571
Observations	2504	224	386	1307	118	215

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Column 6 shows that the total effect of the deeper variables is considerable, and that education and living in the Lusaka province had a strong positive effect. We also see that the total effect of living in Luapula or Western was negative. This means that the indirect positive effect of the high probability of diversification is more than cancelled out by the direct negative effect. Column 5 shows that activity combination matters very much, even when controlling for education and province, etc.

5.4. Income and changes for activity combinations

In this section we split the sample into subsamples, based on activity combination in 2001. Within each subsample we look at how shifting from one activity combination to another influences income. By controlling for initial income, we can hopefully significantly reduce reverse causality. However, we still cannot avoid endogeneity completely. It could be that, e.g., unemployment led to both return to F and lower income in 2004. The six regressions, one for each initial activity combination, are presented in Table 10. The first regression includes only households that had the activity combination F in 2001, and the second includes only those that had the activity combination FA in 2001, etc. The dummy FN04 captures households that had changed to FN by 2004, etc. Having the same activity combination both years is the default. In both regressions, we control for initial income, i.e., income per laborer

in 2001. In addition, we use the same controls as in the previous two regressions. To capture potential non-linear effects we add the squared value of initial income.

Let us first consider the households that started in F. This is the intuitively most appealing regression. If you start in F, does it pay to diversify? The effect of changing to any other activity combination was statistically significantly positive. In fact, the magnitude was huge: Changing to FA gave an approximately 35% higher income, and changing to FN, FB, or FAB resulted in an approximately 80-100% increase. Yet, changing to FNB seems to be the most lucrative alternative, since it gave about a 140% higher income compared to staying in F. Next we look at those that started in FB. For these households it was statistically significantly negative to revert back to F, since it lowered income levels by 54%. It was also negative to change to FA and FN. These changes are associated with a decrease in income by 45% and 23% respectively. The other dummy estimates are not statistically significant.

Looking at the other four regressions, one should keep in mind that these subsamples are quite small, and these estimations therefore have less power. Nevertheless, the overall picture is that it generally pays to switch from a less diversified to a more diversified activity state. Starting in any activity combination other than F, changing to F was connected with a lower income in 2004. This means that it was negative to revert from FA back to F, although we considered FA to partly exemplify distress diversification, based on our earlier selection regressions. If a household was in FN, it paid to diversify into business as well. If a household starts out as mixed (FAB and FNB), it should stay mixed, and the best option is to be fully diversified (FNB), albeit without participating in agricultural wage work.

5.5. Income growth within an activity combination

So far we have analyzed the impact of activity combinations, changes in activity combinations, and deeper determinants of income. What remains to investigate are the deeper determinants of income growth within activity combinations. We thus estimate income growth per category according to activity combination in 2001. We correct for sample-selection bias by using the results from the multinomial selection estimates presented in Table 8.[9] The results for our six income categories using the Lee (1983) sample selection correction method are reported in Table 11.[10] Since there are statistically significant correlations between the residuals in the income growth regression and the residuals from the multinomial logit model, the selection correction model should be used.

The estimates for all activity combinations except F have very high standard errors. This is due to both the small samples and the estimation method, and results in low power for these regressions. Very few estimates are therefore statistically significant. However, the estimates are in line with our expectations; education matters the most for FN and FNB, and female-headed households are punished the most within FN and FNB. As expected, the land-per-laborer ratio has a positive effect for full-time farming households, but the stronger and positive effect for FNB is more difficult to explain. Looking at the influence of province, we see that it mattered for full-time farming households in 2001. Living in the Lusaka province is associated with a 56% higher annual growth than living in Southern. Households engaged in FN or FNB benefited from living in Lusaka (where there are more well-paid jobs available), and those engaged in FB or FNB benefited from living in Copperbelt.

[9] In regressions like these there is always a risk of selection bias. We first ran a Heckman estimation with two states, F vs. all others. This showed that we had significant selection bias. Therefore we use a selection-correction model.

[10] For comparison we ran an OLS regression on each activity combination without sample selection correction. The estimates are shown in Table A4 in Appendix E. Except for the province parameters the estimates are similar to our Lee (1983) estimates. The OLS province estimates for F are much weaker than the Lee (1983) estimates.

Table 11. Income Growth 2001-2004 by Activity Combination in 2001
(Selection bias correction based on the multinomial logit model, the Lee (1983) correction method)

	F	FA	FN	FB	FAB	FNB
Lnincomeplabor01	-0.806***	-0.462	-1.202***	-0.526***	0.310	-0.564
Lnincomeplaborsq01	0.024***	0.011	0.040***	0.012**	-0.018	0.014
Age01	-0.012***	0.010	-0.007	0.006	-0.032*	-0.007
Agesq01	0.000**	-0.000	0.000	-0.000	0.000	0.000
Primary01	0.062***	-0.040	-0.004	-0.052	-0.070	0.148
Secondary01	0.166***	-0.107	0.186	0.022	-0.081	0.301*
Tertiary01	0.484***	-0.422	0.239	0.510***	Dropped	0.800***
Female01	-0.082***	-0.091	-0.136	-0.069***	0.316	-0.302***
Landplabor01	0.008***	-0.038	0.004	0.004	-0.088	0.022**
Lusaka	0.561***	0.161	0.168*	-0.038	1.095	0.431***
Copperbelt	0.173***	0.082	0.091	0.186***	1.050	0.294**
Central	0.076***	0.046	0.082	0.063	0.431	0.123
Eastern	0.078***	-0.003	0.107*	0.200***	0.476	0.096
Luapula	0.227***	-0.109	0.007	-0.058	0.846	0.141
Northern	0.042*	0.124	0.116**	0.062	0.283	0.055
Nwestern	0.114***	-0.024	0.076	0.041	-0.743	0.133
Western	0.130**	-0.043	-0.019	-0.141**	0.820	0.186
_mF	0.476***					
_mFA		-0.129				
_mFN			0.046			
_mFB				0.443***		
_mFAB					-1.003	
_mFNB						-0.384
Sigma2	0.212	0.215	0.102	0.521	8.427	1.135
Rho	1.034	-0.278	0.143	0.613	-0.345	-0.360
Constant	7.085***	3.876	8.942***	5.308***	-2.927	4.109
Observations	2504	224	386	1307	118	215

Note: F = Farm income, A = Agricultural wage work, N = Non-agricultural work, B = Own-business income. The variables labeled _m are consistent estimators of conditional expected values of the residuals derived from the multinomial logit model. The coefficients on these variables are functions of the covariance between the residual in the regression and the residuals (or some function of the residuals) from the multinomial logit model.

6. Policy conclusions

The analysis in the previous sections showed that smallholders in Zambia are dependent on a range of off-farm income sources. Our analysis showed that greater diversification is associated with higher income per laborer. It is therefore important not to look at rural policies as only those concerning agriculture. Paving the way for diversification is a key ingredient in a package of poverty-reducing policies, although measures that facilitates income-generating activities other than agriculture will also be beneficial for agriculture. The diversification route to higher income for rural households requires a well-functioning economic environment and general policies that make it possible for new income-generating activities to emerge. Of course, poverty may also be reduced by households leaving agriculture altogether and migrating to town. In fact, this is expected to be the long-term pattern, but at the present stage in the development of Zambia this type of migration is only realistic for a minority of people.

We identified three main sets of determinants of diversification that can be affected by policy interventions, namely factors related to endowments, markets and transaction costs, and finance.

The most basic endowment of a smallholder household is land. There is high variation within districts in terms of land ownership. In areas under traditional tenure (94% of the land), the local chief decides on land allocation. Although everyone is supposed to have land according to capability, this is of course a flexible concept; in reality, influence seems to matter a lot as well. Therefore, local allocation of land in more fair ways seems highly important. Insecurity of tenure may have substantial effects on the willingness of farmers to invest and on their ability to use land as collateral for loans to finance investment. It is also a problem that some cultivable Zambian land is not cultivated. So improved and more secure access to land is important both for investment and productivity in agriculture, and to create a basis for diversification out of agriculture.

Human capital is another key endowment of smallholder households. Farmers with better skills can improve productivity on the farm, but education also opens up opportunities for non-agricultural wage work. It also opens up the route to own-business income, although to a lower degree.

The second set of determinants of diversification relates to market access. Our most striking finding is that location, i.e., province of residence, matters a lot. A household in a more diversified and urbanized environment is able to diversify more easily. Farmers that are in more developed economic regions are able to exploit their assets and diversify much more effectively than those in the periphery. Location is a very important determinant of income differences in Zambia. Thus, to help households in regions with poor integration into the economic network there is need for measures that reduce their costs of transactions and interactions. Hence, resources should be used to improve infrastructure such as roads and electricity, extension services, and education. This is probably a more efficient way of helping households in the poor locations, than the subsidy schemes that at present dominate the Ministry of Agriculture budget.

In the 1980s, up to 17% of the national budget was devoted to maize and fertilizer policies, but these expenditures were later scaled back. However, in recent years as much as 70% of the Ministry of Agriculture budget has gone to fertilizer subsidies and maize marketing, plus stockholding programs. Despite these efforts, only 20% of small farmers in Zambia currently use fertilizers. Farmers' effective demand for fertilizer must be built up by making fertilizer use profitable. This could be done by developing output markets and regional trade. Jayne et al. (2007) argue that "sustained investment in crop science, effective extension programs, physical infrastructure, and a stable and supportive policy environment" is where public sector resources could be best used. The recent government subsidy policies have also undermined the emerging private input supply industry. Private sellers of fertilizer are in trouble; many do not even hold fertilizer in stock any more, since the market has been taken away. Local traders and network sellers need a predictable environment in order to consider long-term engagement in the sector.

Thirdly, we noted that the lack of finance is a serious constraint on income diversification and growth in rural Zambia. We noted in our analysis that households that were more market oriented in terms of agricultural production, also diversified more out of agriculture. A possible interpretation of this is that the cash income generated by market-oriented agriculture helps lift the cash-constraint on entering business. Cash constraints hinder diversification into both business and new crops. It is therefore crucial to give more households access to credit. This can be accomplished via direct measures, but also by strengthening the overall economic environment.

Policy-makers should thus keep in mind that rural household incomes are not derived from agriculture alone. A strong focus should therefore be placed on measures to facilitate smallholder income diversification. Typically, these are policies aimed at building up the small-

holder households' assets, to develop the economic environment so that smallholders get better market access, and to develop credit facilities that are accessible for smallholders.

Appendix A. The Variables

Activity combinations:

F	Farm income
A	Agricultural wage income (or "Farm work")
N	Non-agricultural wage income (or "Non-farm work")
B	Own-business income
FA	Farm income and agricultural wage income
FN	Farm income and non-agricultural wage income
Etc…	
FAB	Farm income, agricultural wage income, and own-business income
Etc…	

Other variables

Land	land in hectares
Laborforce	labor force aged 15-64
LandpLaborer	land/labor force
Age, Education	referring to the household head
Female	female-headed household
Market orientation	the fraction of agricultural output that a household sells in the market
Total income	total real income in June/July 2004 Kwacha
Incomeplaborer	real income/labor force
Incomeplaborer-growth	annual percentage change of income per laborer

District

Southern is the default

Education

Primary	Grades 1-7
Secondary	Grades 8-12 (forms 1-5)
Tertiary	Form 6, college, or higher
Default	No education

Appendix B. Summary Statistics for the Panel Data Set

Table A1. The Variables

Variable	Obs	Mean	Std. dev.	Min	Max
LncomepLaborer01	4819	776220	1489086	1019.518	5.64e+07
LncomepLaborer04	4819	930026	1844360	1818.182	5.72e+07
LncomepLaborerGrowth	4819	0.0457	0.4041	-2.224043	2.473509
Totalincome01	4819	2424640	5003368	5209.096	1.38e+08
Totalincome04	4819	2916466	6935249	10000	1.85e+08
Farmincome01	4819	761857	1211612	0	2.44e+07
Agricultural wage income 01	4819	30538	206146	0	3600000
Non agric. wage income01	4819	214393	914397	0	1.64e+07
Own business income01	4819	369360	2109611	0	7.08e+07
Remittances01	4819	24268	95300	0	1945000
Farmincome04	4819	1817569	4958687	0	1.83e+08
Agricultural wage income 04	4819	60086	415558	0	9455000
Non agric. wage income04	4819	431948	2122798	0	4.86e+07
Own business income04	4819	606862	3607145	0	1.20e+08
Remittances04	4819	31451	189738	0	5000000
Landplabor01	4819	1.355	3.106	0.0144643	139
Landplabor04	4819	1.338	3.203	0.015625	139
Laborforce01	4819	3.245	1.868	1	22
Laborforce04	4819	3.356	1.968	1	26
Land	4819	3.810	7.429	0.06	240.8725
Age01	4819	45.19	14.16	15	91
Agesq01	4819	2243	1388	225	8281
Age04	4819	47.70	14.10	16	94
Agesc04	4819	2474	1448	256	8836
Primary01	4819	0.6032	0.4892	0	1
Secondary01	4819	0.2056	0.4042	0	1
Tertiary01	4819	0.0269	0.1620	0	1
Primary04	4819	0.6051	0.4888	0	1
Secondary04	4819	0.2014	0.4011	0	1
Tertiary04	4819	0.0292	0.1685	0	1
Female01	4819	0.1851	0.3884	0	1
Female04	4819	0.2029	0.4022	0	1
Market orientation01	4786	0.2709	0.2694	0	1
Market orientation04	4777	0.3116	0.2867	0	1
Adult equivalts01	4819	5.051	2.642	0.1733333	32.58
Household size01	4819	6.500	3.378	0.6666667	41
Adult equivalts04	4819	5.199	2.619	0.0833333	32.53833
Household size04	4819	6.259	3.123	0.0833333	40.66667
Central	4819	0.1093	0.3121	0	1
Copperbelt	4819	0.0576	0.2331	0	1
Eastern	4819	0.2129	0.4094	0	1
Luapula	4819	0.1110	0.3141	0	1
Lusaka	4819	0.0298	0.1702	0	1
Northern	4819	0.1873	0.3902	0	1
Nwestern	4819	0.0589	0.2355	0	1
Southern	4819	0.1263	0.3323	0	1
Western	4819	0.1064	0.3084	0	1
F01	4819	0.5196	0.4996	0	1
A01	4819	0.000415	0.02037	0	1
B01	4819	0.004150	0.06429	0	1

Variable	Obs	Mean	Std. dev.	Min	Max
N01	4819	0.001245	0.03526	0	1
FA01	4819	0.04648	0.2105	0	1
FB01	4819	0.2712	0.4446	0	1
FN01	4819	0.08009	0.2714	0	1
AB01	4819	0.000415	0.02037	0	1
AN01	4819	0	0	0	0
NB01	4819	0.0006225	0.02494	0	1
FAB01	4819	0.02448	0.1545	0	1
FAN01	4819	0.002905	0.05382	0	1
FNB01	4819	0.04461	0.2064	0	1
ANB01	4819	0	0	0	0
FANB01	4819	0.003735	0.06100	0	1
F04	4819	0.5490	0.4976	0	1
A04	4819	0.001452	0.03808	0	1
B04	4819	0.004150	0.06429	0	1
N04	4819	0.002075	0.04551	0	1
FA04	4819	0.05084	0.2196	0	1
FB04	4819	0.2236	0.4167	0	1
FN04	4819	0.09317	0.2907	0	1
AB04	4819	0.000415	0.02037	0	1
AN04	4819	0	0	0	0
NB04	4819	0.0006225	0.02494	0	1
FAB04	4819	0.02365	0.1519	0	1
FAN04	4819	0.004357	0.06587	0	1
FNB04	4819	0.042539	0.2018	0	1
ANB04	4819	0	0	0	0
FANB04	4819	0.003942	0.06267	0	1

Table A2. Trajectories, Frequencies

paths from one type of combination to another	frequency	paths from one type of combination to another	frequency
FtoF	0.3552	FNtoF	0.0217
FtoFA	0.0211	FNtoFA	0.0039
FtoFB	0.0906	FNtoFB	0.0070
FtoFN	0.0282	FNtoFN	0.0327
FtoFAB	0.0089	FNtoFAB	0.0006
FtoFNB	0.0112	FNtoFNB	0.0105
FAtoF	0.0205	FABtoF	0.0116
FAtoFA	0.0116	FABtoFA	0.0020
FAtoFB	0.0062	FABtoFB	0.0051
FAtoFN	0.0035	FABtoFN	0.0012
FAtoFAB	0.0022	FABtoFAB	0.0024
FAtoFNB	0.0014	FABtoFNB	0.0010
FBtoF	0.1236	FNBtoF	0.0114
FBtoFA	0.0097	FNBtoFA	0.0022
FBtoFB	0.1004	FNBtoFB	0.0105
FBtoFN	0.0155	FNBtoFN	0.0103
FBtoFAB	0.0070	FNBtoFAB	0.0016
FBtoFNB	0.0093	FNBtoFNB	0.0068

Appendix C. Descriptive Tables

Table A3. The Provinces

Province	Capital	Average income per hh and month, 000'	Population	Density (people /km²)	Line of Rail	Distance to market (km)[11]
Lusaka	Lusaka	734	1,391,329	63.5	X	4.2
Copperbelt	Ndola	665	1,581,221	50.5	X	3.9
Central	Kabwe	443	1,012,257	10.7	X	17.6
Southern	Livingstone	474	1,212,124	14.2	X	16.4
Eastern	Chipata	490	1,306,173	18.9		20.0
Luapula	Mansa	318	775,353	15.3		18.6
Northern	Kasama	378	1,258,696	8.5		25.0
North-Western	Solwezi	427	583,350	4.6		19.7
Western (Barotseland)	Mongu	356	765,088	6.1		23.0
Zambia	Lusaka	502	9,885,591	13.1		14.8

Note: Income from CSO (2005). Pop. (for 2000) and pop. density from Administrative Divisions of Countries by Gwillim Law. Distance to markets from Thurlow and Wobst (2004).

Map A1.

[11] Dist. to markets = Average distance from household to food and input markets.

Appendix D. Regressions

Table A4. Log Income Growth 2001-2004 by Activity Combination Without Sample Selection Correction

	F	FA	FN	FB	FAB	FNB
Lnincomeplabor01	-0.831***	-0.476	-1.205***	-0.527***	0.554	-0.528
Lnincomeplabor012	0.025***	0.012	0.040***	0.012	-0.027	0.013
Age01	-0.010***	0.011	-0.004	-0.004	-0.036**	-0.021*
Age012	0.000***	-0.000	0.000	0.000	0.000*	0.000
Primary01	0.003	-0.037	0.002	0.020	-0.094	0.088
Secondary01	0.037	-0.083	0.210***	0.085**	-0.071	0.136
Tertiary01	0.098	-0.342***	0.306***	0.194**	0.000	0.455***
Female01	-0.062***	-0.089	-0.150**	-0.065**	0.033	-0.273***
Landplabor01	0.010***	-0.021	0.001	0.007**	-0.022	0.022***
Lusaka	0.217***	0.087	0.179**	0.045	-0.092	0.271**
Copperbelt	0.051	0.011	0.095	0.186***	-0.073	0.228***
Central	0.021	0.012	0.085	0.100**	-0.186	0.179**
Eastern	0.088***	-0.015	0.111*	0.156***	-0.091	0.121
Luapula	0.033	-0.132	0.006	0.075*	-0.148	0.025
Northern	0.041	0.146	0.117*	0.097***	0.143	0.083
Nwestern	0.077**	-0.021	0.083	0.085	-0.722*	0.182*
Western	-0.084**	-0.057	-0.025	0.022	-0.246	0.074
Constant	6.849***	4.178	8.822***	4.895***	-1.530	4.961
R-squared	0.330	0.328	0.217	0.289	0.218	0.295
Observations	2504	224	386	1307	118	215

References

Barrett, C. B. 1998. Immiserized Growth in Liberalized Agriculture, *World Development* 26.5: 743-53.

Barrett, Christopher B., Mesfin Bezuneh, Daniel C. Clay, and Thomas Reardon. 2005. Heterogeneous Constraints, Incentives and Income Diversification Strategies in Rural Africa. *Quarterly Journal of International Agriculture* 44.1: 37-60.

Bigsten, A., B. Kebede, and T. Mekkonen. 2003. Growth and Poverty Reduction in Ethiopia: Evidence from Household Panel Surveys. *World Development* 31.1.

Bigsten, A., and S. Tengstam. 2008. *Growth, Rural Diversification and Poverty Reduction in Zambia.* Sida Country Economic Report No 2008:4. Stockholm: Sida.

Central Statistical Office. Republic of Zambia. 2005. *Living Conditions Monitoring Survey Report 2004*.

Doss, Cheryl, John McPeak, and Christopher Barrett. 2006. *Interpersonal, Intertemporal, and Spatial Variation in Risk Perceptions: Evidence from East Africa*. Yale University Working Paper 948. New Haven: Yale University, Economic Growth Center.

Food Security Research Project. 2005. Second Supplemental Survey to the 1999/2000 PHS. Lusaka, Zambia: FSRP and MSU.

IMF. 2007a. *International Financial Statistics.* May. Washington D.C.; International Monetary Fund.

Jayne, T. S., J. Govereh, P. Chilonda, N. Mason, A. Chapoto, and H. Haantuba. 2007. *Trends in Agricultural and Rural Development Indicators in Zambia.* FSRP Working Paper No. 24. Lusaka: Food Security Research Project.

Law, G. 2008. *Administrative Divisions of Countries.* Statoids website. http://www.statoids.com/

Lee, L.F. 1983. Generalized Economic Methods with Selectivity. *Econometrica* 51.2: 507-12.

Lewis, W. A. 1954. Economic Development with Unlimited Supplies of Labor. *The Manchester School of Economic and Social Studies* 22: 139-91.

Megill, D. J. 2005. *Recommendations for Adjusting Weights for Zambia Post-harvest Survey Data Series and Improving Estimation Methodology for Future Surveys.* FSRP Working Paper No. 13. Lusaka: Food Security Research Project.

National Food and Nutrition Commission. 1993. An Update on Minimum Monthly Food Requirements for an Average Zambian Family.

Reardon, T. 1997. Using Evidence on Household Income Diversification to Inform Study of the Rural Non-farm Labor Market in Africa, *World Development* 25.5: 735-48.

Republic of Zambia, 2001. Supplemental survey to the 1999/00 post harvest survey. Interviewers' instruction manual, Central Statistical Office.

Republic of Zambia, 2004. Rural income and livelihoods survey 2004. Second supplemental survey to the 1999/00 post harvest survey. Interviewers' instruction manual, Central Statistical Office.

Republic of Zambia. 2006a. *Economic Report 2005.* Lusaka: Ministry of Finance and National Planning.

Republic of Zambia. 2006b. *Economic Report 2006.* Lusaka: Ministry of Finance and National Planning.

Thurlow, J., and P. Wobst. 2004. The Road to Pro-poor Growth in Zambia: Past Lessons and Future Challenges. Washington, D.C.: IFPRI. mimeo.

Venables, T. 2006. Notes on The Zambian Economic Situation. London: DFID. mimeo.

World Bank. 2006. World Development Report 2006: Poverty, Washington DC.

World Bank. 2007. *World Development Indicators.* New York: World Bank. Online at http://web.worldbank.org.ezproxy.ub.gu.se/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20398986~menuPK:64133163~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html

Zulu, B., T. S. Jayne, and M. Beaver. 2007. *Smallholder Household Maize Production and Marketing Behaviour in Zambia and its Implications for Policy.* FSRP Working Paper No. 22. Lusaka: Food Security Research Project.

Essay II

What Explains the International Location of Industry? -The Case of Clothing

Sven Tengstam*

The clothing sector has been a driver of diversification and growth for countries that have graduated into middle income. Using a partial adjustment panel data model for 61 countries 1975-2000, we investigate the global international location of clothing production by using a combination of variables suggested by the Heckscher-Ohlin theory and the New Economic Geography (NEG) theory. Our Blundell-Bond system estimator results confirm that the NEG variables do help explain the location of the clothing industry, and point to that convergence is not as inevitable as sometimes assumed. We find that closeness to various intermediates such as low-cost labor and textile production has strong effects on output. Factor endowments and closeness to the world market have inverted U-shaped effects. This is expected since above a certain level several other sectors benefit even more from closeness and factor endowments, driving resources away from the clothing industry.

Keywords: global clothing industry, new economic geography, comparative advantages, industrial agglomeration.

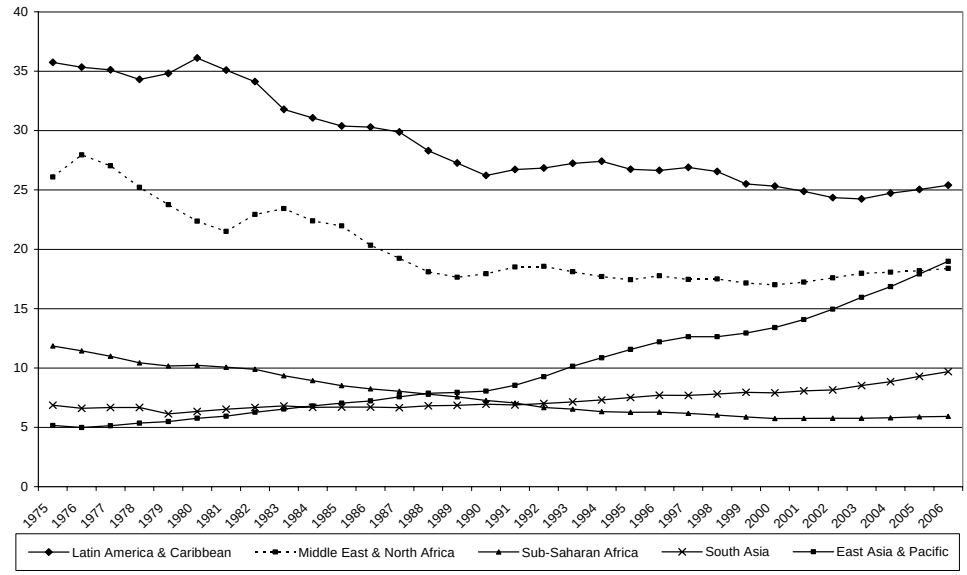
JEL classification: F12, F13, L13, L67, R3, R12.

1. Introduction

This article examines one aspect of the globalization process: the determinants of the international location of the clothing industry. While it is an in-depth study of the clothing industry per se, it should also be seen as a study of industry location in general, where clothing is used as a case. Clothing is especially important from a development perspective since it has played a major role in the early stages of development in many countries. This has been possible since it is labor intensive and prone to relocation as wages increase. For low-income countries, the clothing industry still provides an opportunity for expansion of the manufacturing industry (Brenton and Hoppe, 2007). The main contribution of this study is that it includes both New Economic Geography (NEG) variables and Heckscher-Ohlin variables in an empirical test of the determinants of the location of the international clothing industry. This has to our knowledge not been done before. We find that the NEG variables do help explain the location of the clothing industry.

* Department of Economics, University of Gothenburg, Box 640, SE 405 30 Göteborg, Sweden, Tel.: +46-31-7861000, e-mail: sven.tengstam@economics.gu.se. I wish to thank Arne Bigsten, Måns Söderbom, Gustav Hansson, Annika Lindskog, and Ann-Sofie Isaksson for very useful comments. I also wish to thank the participants at the "Geography, Institutions, Technology and Economic Convergence" conference in Särö, Sweden, 2006, at the Nordic Conference in Development Economics in Oslo, 2006, and at the CSAE Conference in Oxford, 2007. Financial support from Jan Wallander's and Tom Hedelius' Foundation is gratefully acknowledged. All remaining errors are my own.

Figure 1. GDP per capita, PPP (% of OECD)



Source: World Bank (2007).

Gaining a better understanding of what drives the international location of industry sectors could be an essential contribution to the convergence-divergence discussion, and to the general understanding of the globalization process. This is an urgent topic since globalization has had such different impacts in different parts of the world.

The global economic development has until recently been a disappointment for large parts of the world. For example, Easterly and Levine (2001) find that national income levels have diverged over the long run. Figure 1 shows the big picture: East Asia has converged fast and steadily toward rich country income levels during the last 30 years, while South Asia has converged since the late 1980s, and at a slower pace. At the same time, the other developing regions have been diverging more or less throughout and, compared to OECD, Sub-Saharan Africa has reduced its relative income since 1975 by half. This is alarming since poverty is much more widespread and incomes are much lower in Africa than in any other region. The relationship between international economic integration and growth in less developed countries does not seem to follow one common pattern. The fact that not all countries benefit from globalization is in contrast to the convergence predicted by standard neoclassical theory (e.g., Lucas, 2000).

According to the Heckscher-Ohlin theory, a country will specialize in the sectors in which it has a comparative advantage due to factor endowments such as land, labor, and capital. Although factor endowments can explain a lot of the basic patterns in the industry location in the world, there is considerably more to it. For example, there has been an increasing focus on the importance of institutions. In fact, a common explanation of the East-Asian miracle relates to good institutions and policy (see, e.g., World Bank, 1993). However, while there is no doubt that a lack of good institutions can help explain why some regions are less successful, we have also

seen examples of the opposite: One is parts of East Asia, which come out as badly as Africa on many measures of institutional quality (e.g., corruption), yet show much better development over the last 30-40 years.

Two patterns observed in several sectors are the existence of agglomeration and that industrialization happens in waves. This agglomeration is somewhat surprising since the concentration of an industrial sector in one geographical area should boost wages and hence induce firms to move to other regions. What we instead often observe is that firms cluster more than what can be motivated by factor endowments. And when reallocation from the core to the periphery does occur, this process is not uniform. The NEG literature[1] has tried to tackle these questions by considering second-nature geography, i.e., the geography of distance between economic agents. By assuming increasing returns to scale and imperfectly competitive markets, agglomeration is possible in this framework. But what drives agglomeration? The core in NEG is that industries are linked in an input-output structure, which creates forward and backward linkages. A straightforward example is a textile industry plant that moves to a town and thereby makes the demand for cotton in the area go up. It also creates forward linkage to the clothing industry.

The main purpose of this article is to test empirically whether NEG can add something to traditional Heckscher-Ohlin theory in explaining the location of the clothing industry; i.e., are factor endowments all that matter or does closeness to markets and suppliers of intermediate goods also play a role? Crafts and Mulatu (2004) and Antweiler and Trefler (2002), among others, find empirical support for including NEG variables together with Hechscher-Ohlin variables.[2] Our study is to our knowledge the first to do this for the international clothing industry.

We use a partial adjustment panel data model, and the empirical strategy is inspired by the study of industry location in Europe by Tony Venables and others (Midelfart-Knarvik et al., 2000). Our framework uses more detailed variables to capture proximity to suppliers, and adds variables for trade restrictions. The clothing industry has been strongly affected by trade restrictions (see, e.g., Spinanger 1999).[3] In the decades following the Second World War, world trade was liberalized and grew tremendously. Due to growing low-price competition from developing countries in labor-intensive industry sectors, especially in the clothing industry, trade in clothing has been regulated in different ways since 1955 to protect jobs and production in the OECD countries. The most important agreement has been the Multi-Fiber Agreement (MFA) from 1974, which included quantitative restrictions on textile exports from developing countries, and was discriminatory by country of origin; the exporting countries captured the quota rents from the export constraints. While the agreement stipulated a 6 % annual growth of export from developing countries, the growth rates of quotas were frequently lower than that (Yang et al., 1997). MFA was phased out 1995-2005, although very little happened before the last year. Textiles and clothing are now (almost) fully deregulated, and a new agreement, the Agreement on

[1] This literature is said to have started with Krugman (1991a and 1991b). Its roots go back to Samuelson (1952), Dixit and Stiglitz (1977), Krugman (1979), and Krugman (1980). It was further explored in, e.g., Fujita and Krugman (1995) and Krugman and Venables (1995). Fujita et al. (1999) is a synthesized presentation of the field. Geographers such as J. H. von Thünen have been working with related models for a long time (Fujita, 2000). NEG is also related to gravity models, and already Harris (1954) argued that the potential demand for goods produced in one location depends on the distance-weighted GDP of all locations.

[2] Antweiler and Trefler (2002), among others, claim that scale economies are an important source of comparative advantage in general. Craft and Mulatu (2004) find that NEG does matter, although it was mainly factor endowments that determined the location of the pre-1931 British industry.

[3] Trade barriers have a strong effect on the geographical distribution of industries. E.g., Sanguinetti and Martincus (2005) present empirical evidence of this.

Textiles and Clothing (ATC), is in place. Since it is notoriously difficult to find good data on MFA quotas, we use dummies for facing the risk of quotas. Adjustment costs (lagged dependent variable) are used as well. The available data allows us to study 61 countries 1975-2000.

Our Blundell-Bond system estimator results confirm that the NEG variables do help explain the location of the clothing industry, and suggests that the standard neoclassical view (e.g., Lucas, 2000), which sees convergence as inevitable, is too narrow-minded. We find that closeness to intermediates (low-cost labor and textile production) has positive effects on output. However, closeness to high technology suppliers is negative; it benefits other more sophisticated industries and thereby drives resources away from the clothing industry. Access to markets via low transport costs due to a high fraction of the population living close to the coast has a positive effect. Factor endowments and closeness to the world market have inverted U-shaped effects. This is expected since above a certain level several other sectors benefit even more from closeness, and as factor proportions change, comparative advantages change as well. Consequently, resources shift to other sectors.

The remainder of this paper is organized as follows. Section 2 presents theory and earlier studies, Section 3 describes the estimating equations and choice of variables, and Section 4 discusses econometric considerations. Section 5 reports the results and, finally, Section 6 concludes the paper.

2. Theory and earlier studies

NEG starts from an analytical model of monopolistic competition including economies of scale a la Dixit and Stiglitz (1977) and transport costs (Samuelson, 1952). We follow Puga and Venables (1996) when presenting the NEG framework. Like many other trade theories, it is a very simplified model, giving us broad suggestions about what to consider. The model assumes that countries have identical technology and endowments, and contains two sectors: agriculture and industry. Firms in the industrial sector are linked by an input-output structure, which creates forward and backward linkages. The interaction of these forces creates externalities, encouraging agglomeration of industry. In fact, if these forces are strong enough, industry will become concentrated to one single country.[4] Since exogenous overall growth increases the size of the industry relative to agriculture, wages will increase in this country relative to wages elsewhere. Eventually it will be profitable for firms to move out of this country, but since all countries are assumed to be identical in technology and endowments, it is random to which peripheral country the firms will move. And so it continues: as one country gets one step ahead of the others in the periphery, agglomeration forces strengthen the process. As predicted, Barrios et al. (2003) find some empirical support for convergence as total market size increases.

Puga and Venables (1996) try to establish circumstances under which industrialization takes this form. The process of growth is captured in a simple way by assuming an exogenous increase in the labor endowment (in efficiency units). We can think of it as a process of technical change, raising the productivity of labor in both agriculture and industry. The model is a general equilibrium model and has a structure similar to Krugman and Venables (1995) and Dixit and Stiglitz (1977). However, Puga and Venables (1996) expand these models by having *s* industry sectors instead of two. The model includes N countries, and for the *i*th of them we have (all exogenous) labor force L_i and arable land K_i. Agriculture is perfectly competitive and has constant returns

[4] Brakman et al. (2005) argue that agglomeration effects are so strong that it is very hard to carry out regional policy.

to scale. The production function for agriculture is Cobb-Douglas in land and labor, with a labor share of θ. The industrial sector produces a number of varieties of differentiated products, and $\sigma > 1$ is the elasticity of demand for a single variety. The input-output matrix consists of η^s, the share of agriculture inputs in the industry sector *s*, and $\mu^{r,s}$, the share of industry sector *r* in industry sector *s*. $\tau_{i,j}$ is the iceberg transport cost from country *i* to country *j* (the fraction of any shipment that "melts away" in transit). The consumer preferences are such that the consumers have a linear expenditure system. The subsistence level of agriculture consumption is e^0, and a proportion γ^s of income above this level is spent on industry *s* products. Raw materials are not included.

We do not present all the details of the model here, but given the production functions, consumer preferences, and the parameters, the model predicts the equilibrium output $y^*_{i,u,t}$ of each industry sector *u* in each country *i* at each point in time *t*:

$$y^*_{i,u,t} = f_u(\{\tau_{j,k}\}_t, \{L_j\}_t, \{\mu^{r,s}\}, \{\eta^s\}; \sigma, \theta, e^0, \{\gamma^s\}). \quad (1)$$

This means that the variables explaining the size of an industry sector are all transport costs (even those between two other countries), labor in every country, and the full input-output matrix. σ, θ, e^0 and $\{\gamma^s\}$ are parameters.

$f_u(\{\tau_{j,k}\}_t, \{L_j\}_t; \sigma, \theta, e^0, \{\gamma^s\}, \{\mu^{r,s}\}, \{\eta^s\})$ is not necessarily linear. This kind of complex general equilibrium model seldom has a simple solution. As a general equilibrium model it only predicts how the equilibrium responds to, for example, exogenous overall growth, but says nothing about the speed of this transition. By expanding the model to a dynamic model we make it more realistic.

Puga and Venables (1996) ask which industries relocate first when the world economy grows and transport costs decrease, and doing simulations they find that the answer depends largely on the strength of the linkages among industries, which involve the structure of the input-output matrix (the elements in this matrix are $\{\mu^{r,s}\}$ and $\{\eta^s\}$). They find three basic aspects: First, when industries differ in labor intensity, the prediction is that labor-intensive industries move first. Second, when we can rank industries from upstream to downstream, there is no clear prediction. Third, when some industries are strongly linked to the rest and some are weakly linked, the weakly linked move first. Since the clothing industry is labor intensive and quite weakly linked, it should be one of the first to move. This is also what we observe.

The conclusion of the NEG theory is that the agglomeration forces act both through closeness to intermediate suppliers and through closeness to output markets. The clothing industry benefits from such closeness, *ceteris paribus*, but since other sectors might also benefit from the closeness, and thereby drive away resources from the clothing industry, the total effect might be the opposite: the clothing industry might actually lose from being close to, e.g., suppliers of advanced capital and technology. An industry sector might also benefit from closeness up to a certain level, and then lose; i.e., there might be an inverted U-shaped effect of closeness. This could happen if the effect of other sectors driving away resources from the clothing industry is weak at low levels of closeness and stronger at high levels of closeness. The impact of the closeness variables is tested together with the comparative advantage in the form of physical capital, human

capital, and arable land. These factor endowments might have negative or inverted U-shaped effects, since the arguments used regarding closeness also apply to factor endowments.

A lot of theoretical work has been done in the NEG tradition; recent papers include Holmes and Stevens (2005) and Gallo (2005). However, there is less empirical work focusing strictly on NEG. One implication of the NEG approach that can be tested is the "home market effects." Davis and Weinstein (1998) find strong such effects. On a sub-national level there are studies suggesting that clustering does exist. However, there are few empirical studies of clustering at the international level (see Overman et al., 2001, for an overview of the field). Very few empirical studies have been done on geography and the clothing industry. Elbadawi et al. (2001) analyze empirically the export performance of textile and clothing manufacturers in six Sub-Saharan African countries, and find that geography is important and that domestic transport costs are even more influential than international transport costs.

3. Estimating equations and choice of variables

We put the variables from equation (1) and the variables suggested by Heckscher-Ohlin theory in the same estimating equation, and use a partial adjustment panel data model. Our model is in line with Midelfart-Knarvik et al. (2000), whose econometric analysis includes 13 EU countries and 33 industries. They construct a very general simulation model, and use the simulation output to inform their choice of functional form. The model is estimated for several industries simultaneously, but if we express the estimating equation for only the clothing industry we get:

$$\ln s_i^{clothing^*} = c + \alpha \ln pop_i + \beta \ln man_i + \sum_j \beta^j (x_i^j - \gamma^j)(z^{j,clothing} - \kappa^j) . \quad (2)$$

The share of country *i* in the total activity of the clothing industry is denoted $s_i^{clothing^*}$, which is the equilibrium value; c is a constant; pop_i is the share of the EU population living in country *i*; man_i is the share of the total EU manufacturing located in country *i*; x_i^j is the level of the *j*th country characteristic (the country characteristics are closeness variables and factor endowments) in country *i*; $z^{j,clothing}$ is the clothing industry value of the industry characteristic (e.g., capital intensity) paired with country characteristic *j*; and, finally, $\alpha, \beta, \beta^j, \kappa^j$, and γ^j are coefficients. γ^j is the "normal" level of the *j*th country characteristic, and κ^j is the "normal" level of the industry characteristic paired with country characteristic *j*. Dropping the superscript *clothing* and rearranging we can write equation (2) as:

$$\ln s_i^* = \hat{c} + \alpha \ln pop_i + \beta \ln man_i + \sum_j \hat{\beta}^j x_i^j . \quad (3)$$

In equation (3), $\hat{c} = c - \sum_j \beta^j \gamma^j (z^j - \kappa^j)$ and $\hat{\beta}^j = \beta^j (z^j - \kappa^j)$. $\hat{\beta}^j$ measures the sensitivity of the clothing industry to variations in country characteristics, and is a combination of β^j, which measures the general sensitivity of all industries to country characteristic *j*, and $(z^j - \kappa^j)$, which measures how important characteristic *j* is for the clothing industry specifically.

Equation (3) can be seen as a special case of equation (1). We estimate a partial adjustment equation where equation (3) is considered the desired (or equilibrium) value. The country characteristics x_i^j are the factor endowments, closeness to markets, and intermediate suppliers. There are also a couple of differences compared to Midelfart-Knarvik et al. (2000). We focus on one industry sector, but go further in trying to capture forward and backward linkages. Instead of using market potential as a country characteristic that captures all NEG aspects, we use the relevant factors (textile output, etc.). We also expand the model by making it dynamic. Our model is linear in the parameters, but in contrast to Midelfart-Knarvik et al. (2000) we allow the variables to be nonlinear.

When the equation is expanded and includes partial adjustment, we have a dynamic linear model. The adjustment equation is:

$$\ln s_{i,t} - \ln s_{i,t-1} = (1-\lambda)(\ln s_{i,t}^{*} - \ln s_{i,t-1}) . \tag{4}$$

$(1-\lambda)$ is the coefficient of adjustment. This is rewritten as:

$$\ln s_{i,t} = \lambda \ln s_{i,t-1} + (1-\lambda) \ln s_{i,t}^{*} ; \tag{5}$$

that is:

$$\ln s_{i,t} = \lambda \ln s_{i,t-1} + (1-\lambda)(\hat{c} + \alpha \ln pop_{i,t} + \beta \ln man_{i,t} + \sum_j \hat{\beta}^j x_{i,t}^j) . \tag{6}$$

Equation (6) is our estimating equation, and the variables described below are included as country characteristics $x_{i,t}^j$ (the details concerning the variables are discussed in Appendix 1). Closeness to intermediate suppliers is represented by manufacturing wage, textile industry output, and distance to advanced technology (airdist). Manufacturing wage is used instead of size of the labor force,[5] since labor force is strongly correlated with the already included population ($pop_{i,t}$); i.e. having labor force and population in the same regression would give severe multicolinearity. When interpreting the results for manufacturing wage one should be aware that this variable might capture more than intended. The textile industry output is included as the share of total world output. Distance to advanced technology (airdist) is measured as the shortest distance to the closest city of Tokyo, Rotterdam, and New York. This variable was first used in Gallup et al. (1999), and is assumed to be a proxy for international transport cost of advanced capital goods that are unavailable in local or regional markets.

Closeness to output markets is represented by the distance-weighted world GDP (GDP-dist),[6] coastal population, tariffs, and infrastructure. GDP-dist captures how well located a country is with respect to markets, or in other words how close it is to the world market. It is calculated as the sum of the GDPs of all countries divided by the distance to that particular country. Coastal

[5] There is not always a clear distinction between NEG variables and comparative advantage variables. Labor force can also be seen as a comparative advantage variable.

[6] Measures like this are often used in empirical NEG work, but usually not as one of many variables. Breinlich (2005), for example, uses a "transport cost weighted sum of the surrounding locations' GDP" and relates it to income levels.

population is calculated as the percentage of the population living less that 100 km from the coast or a navigable river. This variable was first used in Gallup et al. (1999). Tariffs on clothing exports is the most difficult variable to find a good measure of; Appendix 2 provides a deeper discussion on this. A dummy indicating being under the risk of Multi-Fiber Agreement (MFA) quotas is to our knowledge the best available alternative and is therefore used. Unfortunately, this dummy is quite rough, and there might be a risk of endogeneity. A country might be classified as an LDC and thereby avoid quotas because it has been less successful in expanding its industry. Two alternative measures, import duty (in percent of imports) and a developing country dummy, are used as robustness test. The developing country dummy refers to all countries except those that were OECD countries before 1994 (plus Turkey).[7] There is therefore no risk of endogeneity in this dummy. Telephone connections per 1,000 people is used as a proxy for infrastructure.

The comparative advantage effects are represented in the regressions by capital per worker, human capital, and arable land per worker. Capital per worker is based on the Bosworth and Collins (2003) estimate of capital stocks, human capital is represented by average years of schooling in the total adult population (older than 15) from the Barro and Lee (2000) dataset, and arable land per person is measured as hectares per person.

As mentioned earlier, the total effect of closeness and factor endowments might not be linear and positive, but could be inverted U-shaped or negative, since other sectors may benefit even more from the closeness and factor endowments and thereby attract resources away from the clothing industry. In the estimating equation, manufacturing output as a share of world manufacturing output is controlled for. Therefore the effects of the right hand variables, given the level of manufacturing, are estimated. This makes it even more likely that we will find a negative or inverted U-shaped effect of closeness and factor endowments. What the effect is expected to be depends on the importance of the variables for the clothing industry and for other industry sectors. Among the other industries we find many that are advanced, but also ones that are less advanced than clothing.

The size of the textile industry is expected to have a positive effect on clothing production, while being under the risk of MFA quotas is expected to have a negative effect. For most of the other closeness variables we expect a mostly positive, but perhaps inverted U-shaped, effect. Physical and human capital, as well as distance to advanced technology, are expected to have inverted U-shaped, mostly negative, effects. Arable land per person is expected to have a negative but probably small effect.

Based on the simulation results of Midelfart-Knarvik et al. (2000), we use the logarithms of all but four variables: Schooling is included without logarithms in line with the Mincer equation (Mincer, 1974), which relates the logarithm of earnings linearly to years of education. Coastal population can not exceed 100 % and airdist can not exceed approximately 10,000 km, and often when a variable has an upper limit it is more realistic to include it without logarithms. Including the logarithm of coastal population would be based on the assumption that going from 2 to 4 percent has the same effect as going from 20 to 40 percent, which is implausible. The same reasoning can be applied to airdist. MFA is a dummy.

[7] The developed countries are in other words defined as Western Europe, USA, Canada, Australia, New Zealand, and Japan.

Table 1. Countries in the dataset, with year of gaining LDC and/or Lomé country status (when appropriate).

Developed countries	Developing countries	LDC status	Lomé status	Developing countries, cont.	LDC status	Lomé status
Australia	Algeria			Kenya		1969
Austria	Argentina			Korea, Rep.		
Canada	Bangladesh	1975		Malawi	yes	1975
Denmark	Bolivia			Malaysia		
Finland	Brazil			Mauritius		1975
France	Cameroon		1963	Mexico		
Greece	Chile			Mozambique	1988	1984
Ireland	China			Nicaragua		
Italy	Colombia			Pakistan		
Japan	Costa Rica			Panama		
Netherlands	Dominican		1984	Peru		
N. Zealand	Ecuador			Philippines		
Norway	Egypt			Senegal	2000	1963
Portugal	El.Salvador			Singapore		
Spain	Ghana		1975	South Africa		1995
Sweden	Guatemala			Sri Lanka		
UK	Honduras			Thailand		
USA	India			Trinid. & To.		1975
	Indonesia			Tunisia		
	Iran			Turkey		
	Israel			Tanzania	yes	1969
	Jordan					

Notes: A country is considered to have Lomé status if it is included in the Yaoundé or Lomé agreement. Developed country refers to all OECD countries before 1994 except Turkey.
Source: UN (2005), European Commission (2007).

Table 2. Summary statistics

Variable	Obs.	Mean	S.D.	Min	Max
Lnclothshare	1220	-6.12	2.14	-13.16	-0.93
Lnpopshare	1220	-5.81	1.57	-9.94	-1.48
Lnmanshare	1220	-6.01	2.02	-11.28	-1.00
Lntextshare	1220	-5.99	2.14	-11.37	-1.34
Airdist	1172	3.69	2.63	0.14	9.59
Lnmanwage	1220	8.91	1.14	5.39	10.73
Lngdpdist	1220	22.28	0.61	21.00	23.92
Coastal population	1172	70.10	31.61	0.00	100.00
Lninfrastructure	1220	4.24	1.78	-0.20	6.63
MFA	1220	0.52	0.50	0.00	1.00
Impduty	1034	9.27	9.36	0.00	73.71
Lnkapworker	1220	9.88	1.56	6.48	12.44
Schoolyears	1220	6.33	2.61	0.95	11.89
Lnarable	1210	-1.76	1.27	-8.30	1.12
Institutions	1141	5.90	3.61	2.00	13.00

Table 3. Regression analysis of the determinants of clothing production with successively fewer quadratic terms included (using Blundell-Bond system estimator, dependent variable: ln Clothing Share)

	1.	2.	3.	4.	5.	6.
Lagged lnclothshare	0.537***	0.550***	0.550***	0.458***	0.453***	0.444***
	(0.114)	(0.111)	(0.107)	(0.116)	(0.119)	(0.110)
Lnpopshare	-0.277**	-0.293**	-0.279**	-0.306**	-0.298**	-0.276**
	(0.132)	(0.133)	(0.121)	(0.123)	(0.118)	(0.119)
Lnmanshare	0.554***	0.549***	0.528***	0.646***	0.640***	0.620***
	(0.155)	(0.148)	(0.144)	(0.154)	(0.151)	(0.146)
Lntextshare	0.153**	0.157**	0.162**	0.171***	0.175***	0.183***
	(0.063)	(0.062)	(0.063)	(0.063)	(0.064)	(0.065)
Airdist	-0.033	-0.019	-0.023	0.099***	0.101***	0.090***
	(0.131)	(0.127)	(0.124)	(0.032)	(0.031)	(0.030)
Airdist2	0.012	0.011	0.011			
	(0.013)	(0.013)	(0.012)			
Lnmanwage	-0.659	-0.735	-0.682	-0.910	-0.869	-0.167**
	(0.470)	(0.488)	(0.501)	(0.545)	(0.526)	(0.083)
Lnmanwage2	0.031	0.036	0.033	0.044	0.041	
	(0.026)	(0.027)	(0.028)	(0.030)	(0.029)	
Lngdpdist	14.426**	13.791**	13.105**	12.953**	12.866**	12.730**
	(5.758)	(5.586)	(5.459)	(5.303)	(5.100)	(5.007)
Lngdpdist2	-0.319**	-0.303**	-0.288**	-0.283**	-0.281**	-0.279**
	(0.129)	(0.125)	(0.122)	(0.118)	(0.114)	(0.112)
Coastal population	0.000	0.001	0.004	0.005*	0.004*	0.004*
	(0.009)	(0.009)	(0.003)	(0.003)	(0.002)	(0.002)
Coastal population2	0.000	0.000				
	(0.000)	(0.000)				
Lninfrastructure	-0.139	-0.103	-0.087	-0.102	-0.160*	-0.144
	(0.231)	(0.216)	(0.223)	(0.231)	(0.089)	(0.088)
Lninfrastructure2	0.002	-0.004	-0.005	-0.008		
	(0.031)	(0.028)	(0.029)	(0.028)		
MFA	-0.041	-0.056	-0.075	-0.213	-0.218	-0.239
	(0.180)	(0.169)	(0.159)	(0.191)	(0.188)	(0.162)
Lnkapworker	1.343*	1.360**	1.324**	1.903**	2.035***	1.865***
	(0.680)	(0.670)	(0.658)	(0.777)	(0.695)	(0.626)
Lnkapworker2	-0.073**	-0.076**	-0.074**	-0.103**	-0.109***	-0.100***
	(0.035)	(0.034)	(0.033)	(0.039)	(0.035)	(0.032)
Schoolyears	0.157	0.141	0.136	0.143	0.168*	0.167*
	(0.111)	(0.104)	(0.100)	(0.088)	(0.095)	(0.088)
Schoolyears2	-0.011	-0.010	-0.009	-0.009	-0.011*	-0.010*
	(0.009)	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Lnarable	0.029	0.047	0.031	0.042	0.042	0.029
	(0.099)	(0.057)	(0.046)	(0.046)	(0.044)	(0.046)
Lnarable2	-0.000					
	(0.011)					
Constant	-166.028**	-159.511**	-151.749**	-152.630**	-152.467**	-152.651***
	(64.393)	(62.601)	(61.406)	(60.323)	(58.201)	(57.071)
Observations	1128	1128	1128	1128	1128	1128
Number of countries	61	61	61	61	61	61

Note: Robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%.

The data used for clothing, textile, and manufacturing is from the Industrial Statistical Database from UNIDO (2005). It is mostly the data availability in this database, and in the capital stock estimates by Bosworth and Collins (2003), that has limited our study to 61 countries 1975-2000. The countries are presented in Table 1, and summary statistics for the variables are presented in Table 2. We use yearly data. Doing the regressions with five year averages instead gives similar estimates, but lower statistical significance due to smaller sample size. Using yearly data forced us to interpolate years of schooling between the reported values for every five years (see Appendix 1 for a presentation of the variables). We believe that the benefit of not having to throw away information by averaging variables over time outweighs that we have to interpolate one variable.

The effects might be diminishing, which can be captured by a quadratic term. We test this successively (see Table 3) and find that only GDPdist, capital per laborer, and years of schooling have a statistically significant quadratic term. This, finally, gives us the following estimating equation:

$$\begin{aligned}\ln clothingshare_{i,t} = {} & \lambda \ln clothingshare_{i,t-1} + (1-\lambda)(const + \beta_1 \ln popshare_{i,t} + \\ & \beta_2 \ln manshare_{i,t} + \beta_3 \ln textshare_{i,t} + \beta_4 airdist_i + \beta_5 \ln manwage_{i,t} + \\ & \beta_6 \ln gdpdist_{i,t} + \beta_7 (\ln gdpdist_{i,t})^2 + \beta_8 \ln pop100cr_i + \beta_9 \ln \inf rastructure_{i,t} \\ & + \beta_{10} MFA_{i,t} + \beta_{11} \ln kaplabor_{i,t} + \beta_{12} (\ln kaplabor_{i,t})^2 + \beta_{13} schoolyears_{i,t} + \\ & \beta_{14} (schoolyears_{i,t})^2 + \beta_{15} \ln arable_{i,t})\end{aligned} \quad (6')$$

4. Econometric considerations

We use a panel model since we want to control for unobserved heterogeneity in the form of time-invariant country-specific effects. When estimating a dynamic panel data model the lagged dependent variable is correlated with the compound disturbance, which makes it necessary to take some extra steps. The general approach relies on IV estimators. We use the Blundell-Bond (1998) system estimator (Bond, 2002, is a good introduction), which is based on the Arellano-Bond (1991) estimator – sometimes called "the difference GMM estimator." Consider the model

$$y_{it} = \alpha y_{i,t-1} + \beta x_{it} + (\eta_i + \upsilon_{it}), \quad (7)$$

where x_{it} is a vector of explanatory variables that might be strictly exogenous, predetermined, or endogenous; η_i are unobserved group-level effects; and υ_{it} is a disturbance term. First-differencing (7) gives:

$$\Delta y_{it} = \alpha \Delta y_{i,t-1} + \beta \Delta x_{it} + \Delta \upsilon_{it}. \quad (8)$$

Now $\Delta \upsilon_{it}$ is correlated with $\Delta y_{i,t-1}$, so we need an instrument. $\Delta y_{i,t-1}$ is instrumented with lagged $y_{i,t-2}$. Endogenous and predetermined (lagged) variables in first differences are instrumented with two time lags of their own levels.

The difference GMM estimator can be expanded to a system estimator (Arellano and Bover, 1995; Blundell and Bond, 1998). A system uses both difference equations and level equations.

The level equations include a random effect.[8] The system has two advantages: The estimations are more efficient than when only using differences, since lagged levels are often poor instruments for first differences, and we can estimate the parameters of the time-invariant variables. In the level equations, predetermined (lagged) and endogenous variables are instrumented with lags of their differences.

The instruments we use in the instrument matrix are standard 2SLS and not GMM instruments, since GMM instruments are highly biased in small panels. We use the two step estimator with the Windmeijer (2000) correlations of the robust standard errors. The Arellano-Bond (1991) test for serial correlation is applied to the first-difference equation residuals, $\Delta\upsilon_{it}$. First order serial correlation is expected, but higher order serial correlation indicates that υ_{it} is serially correlated. If υ_{it} itself is MA(1) , then $\Delta\upsilon_{it}$ is MA(2); hence $y_{i,t-2}$ is not a valid instrument for $\Delta y_{i,t-1}$, while $y_{i,t-3}$ remains available as an instrument. If υ_{it} is AR(1), then no lags are valid as instruments.[9] The Arellano-Bond test for serial correlation is applied in our regressions to the difference-equation residuals. These residuals are found to be first order serial correlation as expected in most regressions, but the test does not indicate second order serial correlation in any of them. All our system regressions pass the Difference-in-Hansen tests of exogeneity of instrument subsets.[10]

Looking at the correlation matrix in Table 4, we see that schoolyears, lninfrastructure, and lnkapworker mainly have correlation coefficients of 0.8 and higher between each other. This is also true for lnclothshare, lnmanshare, and lntextshare. This indicates multicolinearity and leads to lower power with higher standard errors and lower statistical significance, since our system estimator includes level equations.

In this type of regression there is always a risk of spurious regression. The left hand variable is most likely stationary. On the right hand we have five non-stationary variables: schoolyears, capital per worker, GDPdist, manufacturing wage, and infrastructure, plus the squared terms of the first three of these. Since we have more than one non-stationary variable on the right hand side, the regression might still be legitimate, even if the left hand variable is stationary. At the end of the day the question is whether our model is correctly specified or misspecified; can these explanatory variables that are growing over time have a constant effect on the stationary variable on the left hand side? During this limited time period (1975-2000) and in the nearest future, it is not unreasonable to assume that the variables included with a quadratic term are correctly included in the model. This would mean that the "optimal level" of these variables is constant during this period, which in turn means that nothing indicates that our model is misspecified or that we have a problem with spurious regression. Still, one should be cautious. A Multivariate Augmented Dickey-Fuller panel unit root test cannot be done since the panel is not balanced.

[8] The level equations work as an extension of the Hausman and Taylor (1981) formulation of the random effects model, which utilizes instrumentation. Time-invariant variables correlated with the country effect are instrumented with time-varying variables uncorrelated with the country effect. However, we have no reason to suspect such a correlation in our model.

[9] If we suspect that υ_{it} is serially correlated, a Hansen J-test can be carried out to determine whether υ_{it} is MA or AR.

[10] This is used instead of a Difference-in-Sargan test since the Sargan statistic is not robust to heteroskedasticity or autocorrelation.

Table 4. Pairwise correlation coefficients for the independent variables

	Lnclo	Lnpop	Lnman	Lntex	Airdi	Lnmanw	Lngdp	Coast	Ininf	MFA	Lnkap	School
Lnclothshare	1.00											
Lnpopshare	0.50	1.00										
Lnmanshare	0.89	0.67	1.00									
Lntextshare	0.80	0.76	0.90	1.00								
Airdist	-0.47	-0.13	-0.52	-0.43	1.00							
Lnmanwage	0.48	-0.16	0.48	0.25	-0.38	1.00						
Lngdpdist	0.48	0.12	0.48	0.38	-0.70	0.42	1.00					
Coastal population	0.39	-0.04	0.39	0.21	-0.46	0.37	0.34	1.00				
Lninfrastructure	0.52	-0.19	0.48	0.30	-0.51	0.65	0.64	0.49	1.00			
MFA	-0.03	-0.12	-0.10	-0.10	-0.11	-0.16	0.21	0.08	0.29	1.00		
Lnkapworker	0.63	-0.19	0.60	0.37	-0.48	0.87	0.61	0.48	0.95	-0.01	1.00	
Schoolyears	0.60	0.02	0.59	0.40	-0.38	0.68	0.55	0.48	0.87	0.16	0.81	1.00
Lnarable	0.07	0.41	0.12	0.26	0.06	-0.05	-0.16	-0.33	-0.20	-0.21	-0.03	-0.05

Using time dummies will make the potential problem of non-stationary variables smaller. We use time dummies as a robustness test, and the statistical significance falls as expected. However, the parameter estimates change only slightly (see Table 6).

5. Discussion of results

Table 3 reports regressions where we successively exclude the quadratic terms that are not statistically significant. As can be seen in Column 6, only GDPdist, capital per laborer, and schoolyears have statistically significant quadratic terms. This finally gives us the estimating equation (6') as reported earlier. Table 5 reports the main regressions and Table 6 reports regressions for robustness tests. Heteroskedasticity-consistent asymptotic standard errors are used in all estimations.

The first two columns in Table 5 report OLS level estimates and within-group estimates. As discussed earlier, these are strongly biased and are only reported for comparison. The Arellano-Bond difference estimates reported in the third column are unbiased but less efficient than the Blundell-Bond system estimates reported in the fourth column. We have reason to believe there is causality in both directions between clothing and textile, which if so will bias our parameter estimate for textile upwards. We therefore instrument textile with lagged values in Column 5. However, this makes the parameter estimate go up and not down as expected, indicating that something is wrong. When using arable land per person as an instrument, the same problem arises (as can be seen in Table 6, Column 5). While both instrumenting approaches pass the Hansen test, neither gives reasonable results.[11] We therefore do not instrument for textile. Columns 3-5 reveal that the difference estimation and the two systems produce very similar results.

[11] The Difference-in-Hansen test gives chi2(14) = 11.91 (p = 0.615) in the first approach and chi2(13) = 11.41 (p = 0.577) in the second.

Table 5. Main regression analysis of the determinants of clothing production (using various estimators, dependent variable: ln Clothing Share)

	OLS levels	Within groups	Arellano-Bond difference	Blundell-Bond system	Blundell-Bond system IV: lagged
Lagged lnclothshare	0.912***	0.813***	0.722	0.445***	0.381***
	(0.021)	(0.040)	(2.661)	(0.110)	(0.100)
Lnpopshare	-0.100***	-0.498***	-0.437	-0.276**	-0.533***
	(0.029)	(0.183)	(0.451)	(0.119)	(0.185)
Lnmanshare	0.131***	0.348***	0.783***	0.620***	0.422**
	(0.030)	(0.075)	(0.183)	(0.146)	(0.170)
Lntextshare	0.059***	0.106*	0.167	0.183***	0.576***
	(0.015)	(0.054)	(0.126)	(0.065)	(0.176)
Airdist	0.016			0.090***	0.092**
	(0.010)			(0.030)	(0.036)
Lnmanwage	-0.093**	-0.027	-0.076	-0.168**	-0.161
	(0.038)	(0.042)	(0.252)	(0.083)	(0.114)
Lngdpdist	1.570	3.876**	12.680	12.556**	13.268***
	(1.501)	(1.890)	(20.030)	(4.961)	(4.579)
Lngdpdist2	-0.034	-0.079*	-0.264	-0.275**	-0.290***
	(0.033)	(0.043)	(0.425)	(0.111)	(0.102)
Coastal population	0.001**			0.004*	0.003
	(0.001)			(0.002)	(0.003)
Lninfrastructure	-0.038	-0.069	-0.260	-0.143	-0.166*
	(0.032)	(0.054)	(0.759)	(0.088)	(0.092)
MFA	0.024	-0.272***	0.000	-0.239	-0.068
	(0.049)	(0.059)	(0.000)	(0.162)	(0.259)
Lnkapworker	0.355*	0.342	0.114	1.863***	1.480
	(0.191)	(0.515)	(20.075)	(0.626)	(0.992)
Lnkapworker2	-0.020**	-0.034	-0.042	-0.100***	-0.084
	(0.009)	(0.025)	(0.936)	(0.032)	(0.052)
Schoolyears	0.032	0.215***	-0.224	0.167*	0.262**
	(0.024)	(0.079)	(1.034)	(0.088)	(0.123)
Schoolyears2	-0.002	-0.013***	0.014	-0.010*	-0.013*
	(0.001)	(0.004)	(0.084)	(0.006)	(0.007)
Lnarable	0.013	0.175**	0.029	0.029	-0.018
	(0.010)	(0.079)	(0.631)	(0.046)	(0.040)
Constant	-19.025	-47.936**		-150.688***	-158.130***
	(17.800)	(21.159)		(56.530)	(51.656)
Observations	1162	1162	1073	1128	1128
R-squared	0.980	0.824			
Number of countries		61	61	61	61

Note: Robust standard errors * significant at 10%; ** significant at 5%; *** significant at 1%.

As expected, the standard errors are much higher in the difference estimation, giving us lower statistical significance, although the estimates are similar. Looking carefully at the preferred fourth regression (the Blundell-Bond system estimation without instruments), we see what follows below.

5.1. Partial adjustment

Regression 4 in Table 5 shows that the parameter of the lagged clothing output is estimated at around 0.44, which means that 56 % of the desired adjustment is completed after one year. A permanent rise in an independent variable has not only a direct effect but also an indirect effect via lagged clothing output. The total effect is the long-run effect. Since we are estimating eq. (6'), the estimates we get from our regression are estimates of $(1-\lambda)\beta_i$. However, we are primarily interested in eq. 3 and the long-run effects, β_i. Therefore we should divide our parameter estimates by (1-0.44) = 0.56, the estimate of $(1-\lambda)$, to get the estimates of the long-run parameters. These long-run parameters are what we discuss from here on.

5.2. Size variables

Population and manufacturing are control variables, but if the estimates of their parameters are unreasonable we should be worried. The parameter of manufacturing has a statistically significant positive point estimate and a long-run elasticity of approximately one, which is reasonable. The estimated parameter of population is negative and statistically significant. Since we control for manufacturing, one could expect population to have no effect at all. However, it is not unreasonable that smaller countries on average have more clothing production, since smaller countries generally are more export oriented and being export oriented could support expansion of the clothing industry.

5.3. Closeness

In our regressions we control for the manufacturing industry, so if we find that one of our explanatory variables has a positive parameter,[12] the interpretation is that it has a more positive effect on the clothing industry than on other industries.

5.4. Closeness to intermediate factors

Textile output has a positive and statistically significant effect. The elasticity is estimated to 33 %. A one standard deviation (see Table 2 for summary statistics) change makes the *clothoutshare*, and thereby the clothing output, approximately 100% larger. As mentioned earlier, we suspect reversed causality here, although we have not been able to find any strong and valid instruments. This parameter estimate is therefore probably biased upwards. As expected, closeness to advanced technology has a statistically significant negative effect; a one standard deviation rise changes the clothing output by about 50%. The parameter estimate of manufacturing wage is negative and statistically significant; the elasticity is estimated to 0.30.

5.5. Closeness to output markets

Distance-weighted world GDP has a statistically significant inverted U-shaped effect. The effect turns negative quite close to the mean value of the variable in our dataset. Hence, the clothing industry benefits from being close to output markets, but only to a certain point. Other industries probably benefit more from being very close to markets. As predicted, coastal population has a positive effect, with an elasticity of 0.70. However, infrastructure has no statistically significant effect.

---

[12] In the case with a squared term included, e.g., $\beta_1 X + \beta_2 X^2$, the marginal effect is given by $\beta_1 + 2X\beta_2$. We focus on this linear combination of the two parameters instead of on the parameters separately.

Table 6. Robustness test of the regression analysis of the determinants of clothing production (using Blundell-Bond system estimator, dependent variable: ln Clothing Share)

	Institutions	Developing	Impduty	Time dummies	IV: Arable land
Lagged lnclothshare	0.507***	0.457***	0.594***	0.689***	0.378***
	(0.128)	(0.097)	(0.123)	(0.084)	(0.098)
Lnpopshare	-0.273**	-0.336**	-0.308**	-0.232**	-0.529**
	(0.109)	(0.133)	(0.129)	(0.103)	(0.217)
Lnmanshare	0.584***	0.653***	0.513***	0.428***	0.480**
	(0.153)	(0.146)	(0.142)	(0.124)	(0.198)
Lntextshare	0.165**	0.189***	0.169***	0.130**	0.527**
	(0.074)	(0.067)	(0.063)	(0.059)	(0.240)
Airdist	0.086***	0.095***	0.081**	0.097	0.099**
	(0.031)	(0.034)	(0.032)	(0.066)	(0.038)
Lnmanwage	-0.165**	-0.203**	-0.139	-0.128	-0.162
	(0.080)	(0.092)	(0.087)	(0.092)	(0.122)
Lngdpdist	12.742**	11.349**	9.715**	16.930	13.407***
	(5.061)	(4.400)	(3.974)	(13.111)	(4.777)
Lngdpdist2	-0.279**	-0.246**	-0.211**	-0.372	-0.292***
	(0.112)	(0.098)	(0.088)	(0.288)	(0.107)
Coastal population	0.003*	0.004	0.004*	0.003**	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Lninfrastructure	-0.167	-0.150	-0.064	-0.161	-0.165
	(0.103)	(0.090)	(0.082)	(0.105)	(0.106)
MFA	-0.237			-0.178	-0.081
	(0.154)			(0.124)	(0.318)
Developing		-0.001			
		(0.168)			
Impduty			-0.002		
			(0.003)		
Lnkapworker	1.895***	1.393***	0.891**	1.224**	1.575
	(0.637)	(0.517)	(0.436)	(0.498)	(1.053)
Lnkapworker2	-0.100***	-0.075***	-0.054**	-0.066***	-0.090
	(0.032)	(0.027)	(0.021)	(0.024)	(0.057)
Schoolyears	0.132	0.143	0.098	0.094	0.243*
	(0.088)	(0.086)	(0.085)	(0.075)	(0.125)
Schoolyears2	-0.007	-0.008	-0.006	-0.005	-0.012
	(0.006)	(0.005)	(0.006)	(0.005)	(0.007)
Lnarable	0.032	0.073	0.055**	0.019	
	(0.043)	(0.044)	(0.026)	(0.035)	
Institutions	0.003				
	(0.016)				
Constant	-152.924**	-135.457***	-114.293**	-196.914	-160.426***
	(58.146)	(50.068)	(45.061)	(149.805)	(53.923)
Observations	1079	1128	963	1128	1128
Number of countries	61	61	57	61	61

Note: Robust standard errors * significant at 10%; ** significant at 5%; *** significant at 1%.

Since we use telephone connections as a proxy, this should be interpreted carefully; the result might not hold for infrastructure in general, for example in terms of roads. The MFA dummy is not statistically significantly different from zero (p = 0.14), but the point estimate is negative and substantial.

5.6. The comparative advantage variables

Both capital per worker and years of schooling seem to have the expected effects; positive to start with but negative for higher values. If the parameter estimates are true, then one extra year of schooling is associated with a 25 % higher clothing production at low levels of schooling. Then the effect declines, and when a country is at an educational level of 8 years, the effect disappears. One should not take these computations too literally, but rather see them as hints of what the results say. For low levels of capital per worker the effect might be huge, with an elasticity of 0.85. The effect disappears at a capital per worker level around 10,000 USD, which is quite close to the mean value of the variable in our dataset. The parameter of arable land per person is far from statistically significant, and the economic effect is, if any, very low.

5.7. Robustness

Our results seem to be robust to several changes: Including the variable institutions,[13] using import duty (in percent of imports) instead of the MFA dummy, or using a developing country dummy instead of the MFA dummy does not change anything substantially, as seen in Table 6, Columns 1-3. When using time dummies (Column 4) we see that the results are very similar, although a bit less statistically significant. Column 5 reports the results when instrumenting textile with arable land per person, as discussed earlier. The Arellano-Bond test for serial correlation is applied to the difference equation residuals, and we get the same result in all regressions. First order serial correlation is expected, but there is no indication of second order serial correlation. All regressions pass the Hansen J test.

6. Conclusions

The clothing sector has been a driver of diversification and growth for countries that have graduated into middle income. This study tries to explain the international location of clothing production by using a partial adjustment panel data model and a combination of variables suggested by the Heckscher-Ohlin theory and the New Economic Geography theory. While it is an in-depth study of the clothing industry per se, it should also be seen as a study of industry location in general, where clothing is used as a case. The global economic development has until recently been a disappointment for large parts of the developing world. Several regions have been diverging more or less constantly. The worst performer, Sub-Saharan Africa, is half as rich today as in 1975 compared to OECD, which is alarming. It appears puzzling why all countries have not benefited from globalization. In fact, we have even been witnessing the opposite of the convergence predicted by standard neoclassical theory.

Our results confirm that the New Economic Geography variables do help explain the location of the clothing industry, and suggest that the standard neoclassical view (e.g., Lucas, 2000), which sees convergence as inevitable, is too narrow-minded. The results further point to the critical importance of being close to intermediate suppliers of textile and low wage labor. How-

[13] We include institutions as a robustness test and use the Freedom House dataset since it covers the entire period. The data used is discussed in more detail in Appendix 1.

ever, being close to high technology suppliers is negative, probably since such closeness primarily benefits other more sophisticated industries and thereby drives resources away from the clothing industry. Being close to output markets is also positive, but under a certain distance other sectors seem to benefit even more. Access to markets via low transport costs from a high fraction of the population living close to the coast has a positive effect. The comparative advantage variables have the expected effect. The effects of physical and human capital are initially strongly positive, but then inverted U-shaped. This is expected since above a certain level several other sectors benefit even more from an abundance of capital, attracting resources away from the clothing industry.

Given our results, can we expect Africa, the region most in need of attracting investments and production, to increase its market share in the clothing industry? Given the relative lack of both physical and human capital in African countries, one would expect them to have their comparative advantages in a low-tech sector like clothing. Nevertheless, our results indicate that too little physical and human capital can indeed be a disadvantage, even in the clothing industry. However, the fact that African countries are located far from high technology providers does not seem to constrain the expansion of their clothing industry. The result concerning the coastal population highlights the importance of physical infrastructure; hence, African economies need to improve this to become better connected to the world market. That low wage levels have an effect is good news for Africa, since the rising wages in Asia should make African wages relatively lower. However, it is worrisome that African wages have been surprisingly high in some formal sectors compared to the informal sector. In conclusion, while the prospects for expansion of the African clothing industry seem to be good, certain preconditions have to be further improved to make it actually happen.

Appendix 1. Data

GDP, industry output, and all other variables that indicate a monetary value of something, are expressed as constant 2000 US dollars.

Clothing industry, ln(clothshare) UNIDO (2005)
ISIC category 322 “wearing apparel, except footwear”
The share of the world clothing production located in country *i* is calculated as

$$clothingshare_{i,t} = \frac{clothingproduction_{i,t}}{worldclothingproduction_{t}}. \quad (9)$$

In this calculation we use output and not value added. The same goes for everything from Unido. To make the denominator worldclothingproduction more correct we fill in the missing values for the biggest countries by interpolating linearly US 1996 and Italy 1995, and extrapolating linearly China 1974-76. In the nominator these are still missing values.

Textile industry, ln(textshare) UNIDO (2005)
The share of the world textile production located in country *i* is calculated in line with (9). To make the denominator worldtextileproduction more correct we fill in the missing values for the biggest countries by interpolating linearly US 1996 and Italy 1995, and extrapolating linearly China 1974-76. In the nominator these are still missing values.

Manufacturing industry, ln(manshare) UNIDO (2005)
The share of the world manufacturing production located in country *i* is calculated in line with (9). To make the denominator worldmanufacturingproduction more correct we fill in the missing values for the biggest countries by interpolating linearly Italy 1995, and extrapolating linearly US 1996-2000, China 1974-76, and UK 1996-2000. In the nominator these are still missing values.

Population, ln(popshare) World Bank (2004)
The share of the world population living in country *i* is calculated.

Distance to advanced technology, airdist Gallup et. al. (1999)
The distance, in 1,000 km, from the country's capital to the nearest city of Tokyo, Rotterdam, and New York.

Wage, ln(manwage) UNIDO (2005)
Wages and salaries / employees for total manufacturing.

The distance weighted world GDP, ln(gdpdist) Subramanian and Wei (2003) and World Bank (2004)

We use the following definition:

(10) $GDPdist_i = \sum_j (GDP_j / dist_{i,j})$; $dist_{i,j}$ is distance between capitals when $i \neq j$,

where the own distance $dist_{i,i}$ (when $i = j$) is calculated as ((area / pi)^0.5) / (3/2).

Coastal population, Coastal population Gallup et al. (1999)
The share of the population living within 100 km of the coast or a navigable river.

Infrastructure, ln(infrastructure) World Bank (2004)
Telephone connections (per 1,000 people) is used as a proxy.

Capital per worker, ln(kapworker) Bosworth and Collins (2003) and World Bank (2002)
Bosworth and Collins (2003) estimate the capital stock with a perpetural inventory model,

(11) $K_t = K_{t-1}(1-d) + I_t$,

where the depreciation rate, *d*, equals 5%. 1950 is the first year. This can be compared to Weil (2005) who uses the capital stock from Bernanke and Gurkaynak (2001), who in turn assume a depreciation rate of 6%, following Hall and Jones (1999).[14] Their calculated capital stocks include both residential and nonresidential capital.

[14] Initial capital stocks are found by the assumption that capital and output grow at the same rate. If 1949 is the initial year, then the capital stock is
$K_{1949} = I_{1950} / (g + \delta)$,
where *g* is the ten-year average growth rate of output and δ is the assumed rate of depreciation.

Education, schoolyears Barro and Lee (2000)
Barro and Lee provide a further update of educational attainment up to 1995, and also construct projections to 2000. Average years of schooling for the total adult population (older than 15) is used. However, since this is only given for every fifth year (1970, 1975, 1980 etc. up to 2000), we interpolate linearly between these years.

Arable land per person, ln(arable) World Bank (2004)
Hectares per person

Rule of law, institutions Freedom House (2004)
As a proxy for Rule of Law we use Political Rights and Civil Liberties from Freedom House since we want numbers for 1975-2000 and most alternative measures do not cover such a long period. Political Rights and Civil Liberties are measured on a one-to-seven scale, with one representing the highest degree of freedom and seven the lowest. Freedom House only gives numbers for every fifth year, so we give all years in for example the interval 1963-1967 the 1965 value. We use the sum of these, and call it "bad institutions," since a high score means lack of Political Rights and Civil Liberties. We are aware of the fact that this proxy is far from perfect, and we only use it as a robustness test. The dataset includes some figures that clearly show that it is a shaky proxy for good institutions. For example, both Chile and Uruguay have had a perfect score in the 00s. In the 90s China and Vietnam scored 14, the worst, yet the business climate was obviously not that bad.

Trade barriers, MFA dummy and import duty World Bank (2002)
The MFA dummy indicates that a country is in the position where it can potentially be the object of quotas. Although it would have been better to have information on actual quotas, this has not been possible.[15] Therefore we simply use dummies for being under the MFA system. A developing country dummy is also used. How these dummies are constructed is discussed in detail in Appendix 2. Import duties, in percent of imports, is used as an additional robustness test. Import duties comprise all levies collected on goods at the point of entry into the country. The levies may be imposed for revenue or protection purposes and may be determined on a specific or ad valorem basis, as long as they are restricted to imported products. However, this seems to be an imprecise proxy: 228 of 2,548 observations are under 0.1 %.

Appendix 2. Trade restrictions for the clothing industry

To understand how trade restrictions in the clothing industry have evolved, one has to look back in history. In the decades following the Second World War, world trade was liberalized and grew considerably. The rich countries started to see growing low-price competition from developing countries in labor intensive industry sectors, especially in the clothing industry. To protect jobs and production in the OECD countries, trade in clothing became regulated in different ways starting in 1955 when Japan unilaterally restrained exports to the US (Francois et al., 2000). The Multi-Fiber Agreement (MFA) from 1974, which used the route of quantitative restrictions on textile exports from developing countries, provided rules for the imposition of quotas. The agreement was discriminatory by country of origin. Voluntary export restraints (VERs) were

[15] This is discussed in more detail in Appendix 2.

used, and thereby the exporting countries captured the quota rents. The MFA stipulated a 6 % annual growth of export from developing counties, but the growth rates of quotas were frequently below this (Yang et al., 1997). OECD (2003:9) notes that "Whenever textiles and clothing quotas became binding in one country under the MFA, investment was directed to initially unconstrained exporting countries, who then later became constrained also, with investment flowing yet elsewhere." The Uruguay Round Agreement on Textiles and Clothing (ATC) required a gradual phasing out of the quota restrictions during 1995-2005. Textiles and clothing were as of 2007 (almost) fully deregulated.

The developed countries did not face the risk of quotas ("developed country" refers to all OECD countries before 1994 except Turkey),[16] while most other countries did. However, there were a few exceptions, of which two in particular need to be mentioned. The Yaoundé and Lomé agreements, which started in 1963 and were then successively expanded, gave the African, Caribbean, and Pacific (ACP) countries the possibility to export to the EU under better terms than the MFA countries (Curran, 2007). The other very important exception was made for the LDCs (the Least Developed Countries) when the EU implemented the Generalized Scheme of Tariff Preferences (GSP) in 1971. Market access for products from the LDCs has gradually become fully liberalized. The LDCs and the ACP countries are presented in Table 1.

Measuring trade restrictions is a difficult task. As Milanovic and Squire (2005) put it, "All of the various ways of specifying variables representing trade liberalization are useful and answer interesting questions." In other words, there are a lot of measures out there that measure things that for most purposes are irrelevant. One has to choose carefully. We want to specify our variable representing trade restrictions in a way that answers the question we are asking. We are interested in the effect of tariffs and quotas. For example, what export tariffs does Tanzania impose on Tanzanian firms, and what import tariffs does the country face when it tries to reach, say, the EU market? And what are the effects of quotas? Ideally one would use a measure of the total yearly effect of tariffs and quotas on clothing by exporting country. This exists by importing region, but not by exporting region.[17] We therefore try to use a measure of only the MFA quotas, which have been the most important trade restrictions for clothing.

Since to our knowledge there is no detailed information available on the actual quotas, we are forced to use a dummy for facing the risk of quotas.[18] The dummy has the value 0 for developed countries, LDCs, and ACP countries, and the value 1 for all other countries. Tariff equivalents could be an alternative, but it appears that tariff equivalents are only available for one or two years in the late 1990s. Even if actual quotas were available, there would be problems: The MFA system was not transparent and had effect even when not binding (Linkins and Arce, 2002). For example, Francois et al. (2000:11) state that Japan and Switzerland did not impose MFA quotas, but "did send signals."

It can be argued that all developing countries in one way faced risk of quotas – even the LDCs ACP countries – since if these countries were to become very successful they might lose their preferences. Botswana actually did graduate from LDC status in 1994. Therefore we also use a developing country dummy as an alternative measure. As an additional robustness test we would

[16] Western Europe, USA, Canada, Australia, New Zealand, and Japan.

[17] Francois and Strutt (1999) offer average tariff rates by importing region, and Lankes (2002) offers export tax equivalents of MFA quotas also by importing region.

[18] Several papers deal with these quotas, but do not have the data we are looking for. These include: Francois and Wörz (2006), who deal with only the period from 1996 and forward; Trela and Whalley (1990) who deal with only two years; OECD (2003), which is a survey of studies that gives no fruitful suggestions about where to find the needed data; and Harrison et al. (1997), who report for only one year.

have liked to use a more general trade restrictiveness index. Kee et al. (2005) offer trade restrictiveness indices for 91 countries, the World Bank Overall Trade Restiveness Indices, but unfortunately only for one year. The IMF's overall trade restrictiveness indices (IMF-OTRI) were calculated on an annual basis for the period 1990-96 for 178 countries, but the IMF generally discourages the use of cross-country comparisons with the IMF-OTRI due to shortcomings in its methodology and data. Cline (2003) discusses these shortcomings. Market Access Maps did not start until 1999 and do not include any information on nontariff measures.

IMF (2005) discusses supplemental indicators and mentions that "collection rates," the amount of duties collected divided by imports, do provide useful information on the "effective" tariff rate. This value captures the effect of tariff rates and preferential arrangements etc. A problem discussed by IMF (2005) is that there is only a very weak correlation between the different trade policy indicators. Had they been strongly correlated one might have been able to argue that any of them could be used as a proxy for another, making the result robust to the choice of indicator. However, we cannot use that argument. Still, collection rates (as described above) are the only thing we are left with as an additional robustness test. Import duties from World Bank (2002) is used as this additional robustness test.

References

Arellano, M. and S. R. Bond (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, 58, 277-297

Antweiler W. and D. Trefler (2002). Increasing returns and all that: a view from trade. *American Economic Review* 92:1 (March)

Barrios, S., H. Görg and E. Strobl (2003). Multinational enterprises and new trade theory: evidence for the convergence hypothesis. *Open Economics Review* 14:397-418

Barro, R. and J. W. Lee (2000). International Data on Educational Attainment: Updates and Implications (CID Working Paper No. 42, April 2000) – Human capital updated files, February 2000

Bernanke, B. S. and R. S. Gurkaynak (2001). Is growth exogenous? Taking Mankiw, Romer, and Weil seriously. NBER working paper series 8365

Blundell, R. and S. Bond (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87 (1998) 115-143

Bond, S. (2002). Dynamic panel data models: a guide to micro data methods and practice. Cemmap Working Paper CWP09/02

Bosworth, B. P. and S. M. Collins (2003). The Empirics of Growth: An update. *Brookings Papers on Economic Activity*, 2:2003, 113-206

Brakman S., H. Garretsen, J. Gorter, A. van der Horst and M. Schramm (2005). New Economic Geography, empirics, and regional policy. CPB Special Publications:56

Breinlich H. (2005) The spatial income structure in the European Union – what role for economic geography? LSE, march 2005

Brenton, P. and M. Hoppe (2007). Clothing and export diversification: still a route to growth for low-income countries? The World Bank, Policy Research working Paper 4343

Cline, W. R. (2003). Enhancing the IMF's Index of Trade Restrictiveness. Washington: Center for Global Development, mimeo

Crafts, N. and A. J. Venables (2003). Globalization in History: A Geographical Perspective. In (eds.) Bordo, M., A. Taylor and J. Williamson, *Globalization in Historical Perspective*, Chicago/NBER

Crafts, N. and A. Mulatu (2004). What explains the location of industry in Britain, 1871-1931? CEPR discussion paper 4356

Curran, L. (2007). Clothing's big bang: the impact of the end of the ATC on developing country suppliers. *Journal of fashion marketing and management*, 11(1) 122-134

Davis, D. R. and D. E. Weinstein (1998). Market access, economic geography, and comparative advantage: An empirical assessment. NBER working paper 6787

Dixit, A. K. and J. E. Stiglitz (1977). Monopolistic Competition and Optimal Product Diversity. *American Economic Review* 67(3), 297-308

Easterly, W. and R. Levine (2001). It's not factor accumulation: stylized facts and growth models. *World Bank Economic Review*, 15:2, 177-219

Elbadawi I., T. Mengistae and A. Zeufack (2001). Geography, supplier access, foreign market potential, and manufacturing exports in Africa: an analysis of firm level data. the CSAE and UNIDO conference, 2001, Oxford

European Commission (2007). Home page

Francois, J., H. H. Glismann and D. Spinanger (2000). The cost of EU trade protection in textiles and clothing. Kiel Institute of World Economics working paper 997

Francois J. and A. Strutt (1999). Post Uruguay round tariff vectors for GTAP version 4. Erasmus University Rotterdam

Frankel, J. A. and D. Romer (1999). Does trade cause growth? *American Economic Review* 89(3): 379-399

Freedom House (2004). Freedom in the world country ratings 1972-2004. Freedom House home page

Fujita, M. (2000). Thünen and the new economic geography. Kyoto University, September 14, 2000

Fujita, M. and P. Krugman (1995). When is the economy monocentric? von Thunen and Chamberlin unified. *Regional Science and Urban Economics* 25: 505-528

Fujita, M., P. Krugman and A. J. Venables (1999). The spatial economy: Cities, regions and international trade. MIT Press, Cambridge MA

Gallo, F. (2005). Determining the level of transportation costs in the core-periphery model: a majority voting approach. Department of Economics, Lund University, working paper 32

Gallup J. L., J. D. Sachs and A. Mellinger (1999). Geography and Economic Development. CID working paper 1999:1

Hall, R. E. and C. I. Jones (1999). Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics*, 114(1)

Harris, C. (1954). The market as a factor in the localization of industry in the United States. *Annals of the Association of American Geographers*, 64: 315-348

Harrison, G. W., T. F. Rutherford and G. D. Tarr (1997). Quantifying the Uruguay round. *The Economic Journal*, 107 (September) , 1405-1430

Holmes, T. J. and J. J. Stevens (2005). Does home market size matter for the pattern of trade? *Journal of International Economics* 65 (2005) 489-505

IMF (2005). Review of the IMF's Trade Restrictiveness Index. The Policy Development and Review Department

Kee, H. L., A. Nicita and M. Olarreaga (2005). Estimating Trade Restrictiveness Indices. World Bank Policy Research Working Paper Series 3840
Krugman, P. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9: 469-479
Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *American Economic Review*, 1980: 950-959
Krugman, P. (1991a). Increasing returns and economic geography. *Journal of Political Economy* 99: 483-499
Krugman, P. (1991b) Geography and trade. MIT Press, Cambridge MA
Krugman, P and A. J. Venables (1995) Globalization and the Inequality of Nations. *Quarterly Journal of Economics*, 1995:857-880
Lankes H. P. (2002). Market access for developing countries. *Finance and Development* 2002/09
Linkins, L. A. and H. M. Arce (2002). Estimating tariff equivalents of nontariff barriers. Office of Economics working paper 94-06-A(r)
Lucas, R. E. (2000). Some macroeconomics for the 21st century. *Journal of Economics Perspectives*, 14(1): 159-168
Midelfart-Knarvik, K. H., H. G. Overman, S. J. Redding and A. J. Venables (2000). The Location of European Industry. Report prepared for the DG for Economic and Financial Affairs, EC
Milanovic B. and L. Squire (2005). Does tariff liberalization increase wage inequality? Some empirical evidence. NBER working paper series 11046
Mincer J. (1974). Schooling, experience and earnings. Colombia University Press, New York
Nordås H. K. (2004). The global textile and clothing industry post the agreement on textiles and clothing. WTO discussion paper 5
OECD (2003). Liberalizing trade in textiles and clothing: a survey of quantitative studies. Trade committee, TD/TC/WP(2003)2/final
Overman H. G., S. Redding, A. J. Venables (2001). The Economic Geography of Trade, Production, and Income: A Survey of Empirics. The Centre for Economic Performance, LSE
Puga, D. and A. J. Venables (1996). The Spread of Industry: Spatial Agglomeration in Economic Development. *Journal of the Japanese and International Economies* 10, 440-464
Sanguinetti, P. and C. V. Martincus (2005). Does trade liberalization favor spatial deconcentration of industry? Presentation at 5th spring school in economic geography, Center for economic policy research, May 2005
Subramanian, A and S-J Wei (2003). The WTO promotes trade, strongly but unevenly. NBER working paper series 10024, Dataset 1
Trela, I. and J. Whalley (1990). Global effects of developed country trade restrictions on textiles and apparel. *The Economic Journal*, 100 (December), 1190-1205
UN (2005). Home page
UNIDO (2005). Industrial Statistical Database
Weil, D. N. (2005). Economic Growth. Pearson Education
World Bank (1993). The East Asian Miracle: Growth and Public Policy. Oxford University Press, Oxford and New York
World Bank (2002). World Development Indicators
World Bank (2004). World Development Indicators
World Bank (2007). World Development Indicators Online

Yang, Y., W. Martin and K. Yanagishima (1997). Evaluating the benefits of abolishing the MFA in the Uruguay Round package. In (eds.) Hertel, T. W. *Global trade analysis: Modeling and applications*

Essay III

Available online at www.sciencedirect.com
SCIENCE DIRECT
Economics Letters 91 (2006) 127–130
economics letters
www.elsevier.com/locate/econbase

Debt relief and adjustment effort in a multi-period model

Sven Tengstam *

Department of Economics, Göteborg University, Box 640, SE 405 30 Göteborg, Sweden

Received 6 May 2005; received in revised form 24 August 2005; accepted 10 November 2005

Abstract

This paper shows that if the period following the granting of debt relief is taken into account, debt relief increases adjustment effort (investment), irrespective of whether there is an initial debt overhang or not.

Keywords: HIPC; Debt relief; Debt overhang; Investment; Incentives

JEL classification: F34; H63; O11; O16

1. Introduction

What is the relation between external debt relief and adjustment effort or investment? Much of the literature seems to agree on two conclusions. First, debt relief can increase investment if initially there is a debt overhang. There are several reasons for this, although the one emphasized by many authors is that investment depends on expected tax rates which, in turn, depends on the face value of the debt (Helpman, 1989). A debt overhang means that the probability of full repayment of the debt is less than unity, so while expected debt repayments may increase following a debt reduction, the face value falls. Hence—and this is particularly valid for debt owed to commercial banks—debt relief may be in the interest of the debtor as well as the creditor (see Sachs, 1989, for the original argument).

The second conclusion is that one reason why governments engage in adjustment is because of the existence of a large external debt. To facilitate repayment, governments try to increase growth by resorting

* Tel.: +46 31 7731000; fax: +46 31 7731326.
E-mail address: sven.tengstam@economics.gu.se.

0165-1765/$ - see front matter
doi:10.1016/j.econlet.2005.11.009

to measures such as liberalization, stimulation of the tradable sectors and fighting corruption. In the absence of a debt overhang, debt relief decreases the pressure to adjust and thus represents a disincentive to invest (Corden, 1989; see also Callier, 1989, for an extension). Based on these two conclusions it can be argued that debt relief only promotes investment in the presence of a debt overhang. This argument is used in the HIPC debate today (e.g., Arslanalp and Henry, 2004; IMF and IDA, 2004).

The purpose of this paper is to argue that the second conclusion is valid only under rather restrictive assumptions. In particular, we show that if the situation after the actual granting of debt relief is taken into account, total adjustment effort increases irrespective of whether there is an initial debt overhang or not—a conclusion that runs contrary to much of the literature.

2. The model

Following Corden (1989), which is very similar to Sachs (1989),[1] we treat adjustment effort and investment as equivalent, and assume the existence of a government that attempts to maximize an intertemporal utility function with present and future national consumption as arguments. Consumption in each period is normal. Part of each period's output, a function of the size of the capital stock, is consumed and the reminder is added to next period's capital stock. We are now at the end of period 1. At some time in the past, the government incurred a debt which is supposed to be serviced (or repaid) in period 3. Period 2, then, may be interpreted as a grace period. There is no debt overhang, i.e., the government is able and willing to service or repay the debt. The issue in Corden's three-period model is the effect of debt relief on the pattern and volume of consumption, and hence on investment. At the end of period 1, the government decides on a consumption plan $C=\{C_2, C_3\}$ that maximizes discounted utility. Denoting with an asterisk variables when debt relief is given, the issue is whether and how $C^*=\{C_2^*, C_3^*\}$ differs from $C=\{C_2, C_3\}$. It is quite clear that $C_2^*>C_2$ and consequently that $S_2^*<S_2$, where S denotes savings, since income in period 2 has not changed, but debt relief is granted in period 3, and period 2 consumption is a normal good. Since savings in a given period is identically equal to investment, or $S_2=I_2$, debt relief reduces the pressure to adjust:

> "...debt service obligations in the future would increase investment now, and this can be interpreted to mean that current 'adjustment effort' is increased... It follows that debt relief would reduce investment and adjustment effort... This is the *disincentive effect* of debt relief." (Corden, 1989: 245)

While the Corden analysis is correct, it ignores some important aspects of debt relief. For one thing, it is quite possible that the investment effect in the relief period is different from that in the pre-relief period, so the net result need not be the one found by Corden.

To explore that possibility we extend the analysis by incorporating one additional period, period 4, which follows after the granting of debt relief. Thereby we can capture the behavior of agents in the period of the actual granting of relief. We now allow for savings in period 3 (but period 4 output will be

[1] Sachs (1989) assumes the existence of a one period utility function which is additive and strictly concave and a production function which is concave, and hence that consumption in all periods are normal, and his model turns out to be a special case of the more general Corden (1989).

consumed in its entirety). Writing Y for output and R for debt repayment, we have in the absence of debt relief that $C_2 = Y_2 - S_2$, $C_3 = Y_3 - S_3 - R$, and $C_4 = Y_4$. As before, relief is announced at the end of period 1 and granted in period 3. The government, at the end of period 1, decides on a consumption plan $C = \{C_2, C_3, C_4\}$ that maximizes discounted utility. Similar to the reasoning above, the issue is whether and how $C^* = \{C_2^*, C_3^*, C_4^*\}$ differs from $C = \{C_2, C_3, C_4\}$.

3. Result

As in the Corden analysis, $C_2^* > C_2$ because income has increased and period 2 consumption is a normal good, and therefore $S_2^* < S_2$ and $I_2^* < I_2$. However, if the behavior of agents in the period of the actual granting of relief is taken into consideration, the initial fall in investment observed by Corden might be counteracted by a subsequent increase in investment. Is it possible to say anything about the relative size of these two investment effects: what is the net effect of debt relief?

As it turns out, the net effect is that total investment unambiguously increases as a result of debt relief. The reason is simple: period 4 consumption is higher if debt relief is granted, since period 4 consumption is also a normal good. Consequently, period 4 output is higher. Since output depends on the size of the capital stock, the capital stock in period 4 is higher if debt relief is given. Since we start at the end of period 1 with a capital stock of a given size, the difference in period 4 consumption reflects differences in investment in periods 2 and 3. Hence, since $Y_4^* > Y_4$ we know that $(I_2^* + I_3^*) > (I_2 + I_3)$. We have now shown that the investment effect in the relief period is stronger than the investment effect in the pre-relief period, and the net effect is the opposite of the one found by Corden. It is easy to show that adding even more time periods to our model does not change this result.[2] Our conclusion is empirically supported by Cohen (1993) who investigates the impact of debt service on investment for 81 developing countries 1982–1987. His analysis takes the behavior of agents in the period of the actual debt service into account. He finds a negative correlation, as we predict, irrespective of whether there is an initial debt overhang or not.[3]

4. Conclusion

While the analysis by Corden (1989) and others is correct insofar as the behavior of investment prior to the actual granting of debt relief is concerned, an important point is missed when the period immediately following debt relief is ignored. Since the relief period increase in investment is higher than the pre-relief decrease, the net effect of debt relief in an economy with no initial debt overhang is to increase, not decrease, total investment. Adding even more time periods to our model does not change this result. The time path of investment may change as a result of relief (specifically, investment are delayed), but the volume increases. Hence, debt relief stimulates adjustment, even in the absence of a

[2] Allowing for n time periods and savings in all periods except the last, we get that $C_4, C_5, \ldots C_n$ are all higher if debt relief is granted, since they are all normal. This requires entering period 4 in a better position, i.e. that the capital stock in period 4 is higher if debt relief is given. Hence, we know that $(I_2^* + I_3^*) > (I_2 + I_3)$. The same kind of reasoning tells us that $(I_2^* + \ldots + I_t^*) > (I_2 + \ldots + I_t)$ for any $2 < t < n$ since $C_{t+1}, \ldots C_n$ are all normal.

[3] He uses actual debt service instead of debt stock in his analysis, but we are primary interested in his results for the case with no debt overhang, and the two measurements are close in this case. Hofman and Reisen (1990) get similar results.

debt overhang. Our analysis shows that the worries aired by Corden (1989: 251) regarding the possibility of debt relief being either too generous, or being given when no debt overhang actually exists, and that this might reduce the economy's adjustment efforts, only is relevant if one ignores the behavior of agents in the period of the actual granting of relief.

Acknowledgements

First special thanks to Anders Danielson. I also thank Arne Bigsten and Gustav Hansson for comments, and Rick Wicks for editorial suggestions. I am of course solely responsible for any errors.

References

Arslanalp, S., Henry, P.B., 2004. Helping the Poor to Help Themselves: Debt Relief or Aid, NBER Working Paper 10230.
Callier, P., 1989. Debt relief and adjustment incentives in a financially open economy. IMF Staff Papers 36 (2), 514–522.
Cohen, D., 1993. Low Investment and Large LDC Debt in the 1980s. American Economic Review 83, 437–449.
Corden, W.M., 1989. Debt relief and adjustment incentives. In: Frenkel, J.A., Dooley, M.P., Wickham, P. (Eds.), Analytical Issues in Debt. IMF, Washington, pp. 242–257.
Helpman, E., 1989. Voluntary debt reductions. Incentives and welfare. IMF Staff Papers 36 (3), 580–611.
Hofman, B., Reisen, H., 1990. Debt Overhang, Liquidity Constraints and Adjustment Incentives, OECD Development Centre Working 32.
IMF, IDA, 2004. Debt Sustainability in Low-Income Countries- Proposal for an Operational Framework and Policy Implications. http://siteresources.worldbank.org/INTDEBTDEPT/PolicyPapers/20270815/debtSust-completepaper.pdf.
Sachs, J., 1989. The debt overhang of developing countries. In: Calvo, G., Fidlay, R., Kouri, P., de Macedo, J.B. (Eds.), Debt, Stabilization and Development. Essays in Honor of Carlos Dìaz-Alejandro. Blackwell, London.

Essay IV

Disability and Marginal Utility of Income

Sven Tengstam*

It is often implicitly assumed that disability generally lowers the marginal utility of income. This paper questions this view. Individuals' marginal utility (measured by a von Neumann-Morgenstern utility function) of income is estimated in two states – when paralyzed in both legs and when not mobility impaired at all – using experimental choices between imagined lotteries where the outcomes include both income and disability status. This allows for estimation of the ratio of individuals' marginal utility of income when paralyzed to when not mobility impaired, R. The median R for average incomes is estimated at between 1.33 and 2. It is statistically significant (at the 0.005 % level) higher than one. Individuals with personal experience of paralysis and voters for the Left Block or the Liberal Party are more likely than others to have an R over one. Our results imply that more than full insurance of income losses connected to being disabled is optimal. The results also suggest, in contrast to, e.g. Sen (1997), that given a utilitarian social welfare function, resources should be transferred to, rather than from, disabled people.

Keywords: disability, mobility impairment, marginal utility, hypothetical lotteries, risk.

JEL classification: D10, D60, D63, I10, I30.

1. Introduction

It is often implicitly assumed that disability generally makes it more difficult to benefit from consumption, or in other words, that disability lowers the marginal utility of income. This view is theoretically justified by assuming that disability makes an individual less efficient in transforming income into utility (see, e.g., Sen, 1997, and Moreno-Ternero and Roemer, 2005). Sloan et al. (1998) and Viscusi and Evans (1990) are two frequently referred to empirical studies that support this line of reasoning. While both are really about health, it could be argued that their results should hold for disability as well. One potential weakness in these studies is that their results to a large extent rely on the authors' assumptions on the functional form of the utility function.[1]

* Department of Economics, University of Gothenburg, Box 640, SE 405 30 Göteborg, Sweden, Tel.: +46-31-7861000, e-mail: sven.tengstam@economics.gu.se. I am grateful to John Roemer, Marc Fleurbaey, Olof Johansson-Stenman, Peter Martinsson, Fredrik Carlsson, Elina Lampi, Mark S. Stein, and seminar participants at the Norwegian School of Economics and Business Administration in Bergen and at the 2nd Nordic Workshop in Behavior and Experimental Economics in Göteborg for helpful comments, to Matilda Orth, Niklas Jakobsson, Gustav Hansson, and Anna Widerberg for research assistance, and to Emma Isinika for initial discussions. All mistakes are my own.

[1] Sloan et al. (1998) assume that the utility function is a state-dependent logarithmic function in income; i.e., the functional form is $u = \beta \ln y$, where β varies between the states. This means that they more or less have assumed what they intend to show (if utility is lower when disabled, then marginal utility also must be lower, given the logarithmic form). Viscusi and Evans (1990) make a first-order Taylor approximation and thereby neglect the second and higher order terms. We discuss the effect of this negligence in Appendix 1.

There is also a large literature were it is assumed that the shape of the utility function does not vary with health or disability.[2]

In this paper we try to test the relationship between disability and marginal utility of income, and find that the former actually increases the latter. Individuals' marginal utility (measured by a von Neumann-Morgenstern, 1947, utility function) of income in two states is measured through experimental choices between imagined lotteries behind a so-called "veil of ignorance" (this term was introduced by Rawls, 1971). The two states are (1) paralyzed in both legs from birth and (2) not mobility impaired at all. Early empirical studies that utilize a veil of ignorance to measure the shape of the utility function include Johannesson and Gerdtham (1995; 1996) and Johansson-Stenman et al. (2002), which both deal with risk aversion in income. Our study is to our knowledge the first to utilize a veil of ignorance to measure how disability affects marginal utility.

Following the basic experimental design in Johansson-Stenman et al. (2002), we design and perform a new choice experiment. The respondents are asked to choose what is best for their hypothetical grandchild (or another close person living two generations into the future). They choose between hypothetical lotteries, where the outcomes include both income and disability status. This allows for estimation of *R*, the ratio of the individual's marginal utility of income when paralyzed to the individual's marginal utility of income when not mobility impaired at all; i.e., the relative marginal utility of income when disabled. This ratio is interesting for many reasons; for example, when maximizing the utilitarian social welfare function in, e.g., cost-benefit analysis, it is not the level of individuals' utility or marginal utility that matters, but rather the relative marginal utility.

We estimate the median *R* to be in the 1.33–2 range for a monthly net income of 17,000 SEK. This should be interpreted as the marginal utility of income being between 33 % and 100 % higher for a physically disabled person than for a person with no physical disability. The median *R(y)* is statistically significantly (at the 0.005 % level) higher than one.

The remainder of this paper is organized as follows. Section 2 presents the model and Section 3 describes the choice experiment. Section 4 reports the descriptive and econometric results, and also includes a robustness discussion. Section 5 discusses welfare implications, and Section 6 concludes the paper.

2. The model

We assume that individuals' preferences (over choices including risk) satisfy the von Neumann-Morgenstern (VNM) axioms, and therefore can be represented by a VNM utility function (i.e., a utility function with the expected utility property). This means that everybody is an expected utility maximizer. Following the state-dependent utility approach, we let $u(y)$ denote the utility function when not mobility impaired and $v(y)$ the utility function when paralyzed. Now let $R(y)$ be the relative marginal utility of income when disabled:

$$(1) \qquad R(y) = \frac{v'(y)}{u'(y)}.$$

[2] Finkelstein et al., 2008:1.

Since VNM utility functions are unique up to positive affine transformations (i.e., cardinal),[3] this ratio is uniquely determined.

The interpretation of the experimental results is based on individuals' preferences satisfying the VNM axioms and individuals acting in line with their preferences. Two outcomes are possible in each lottery, both with a probability of 50 %. We use 50-50 since it is generally found to be difficult to communicate small probabilities (see, e.g., Kahneman and Tversky, 2000). In one of the outcomes the hypothetical grandchild ends up paralyzed in both legs, and in the other outcome she ends up not mobility impaired at all. She earns income y_p if she is born paralyzed and income y_{np} if she is not. The expected utility of a lottery is given by:

$$(2) \qquad E(U) = 0.5u(y_{np}) + 0.5v(y_p).$$

Let us now consider two lotteries, A and B. The income she gets in lottery *l* if she is born paralyzed is denoted $y_{p,l}$, and the income she gets in lottery *l* if she is not born mobility impaired is denoted $y_{np,l}$. An individual is indifferent between lotteries A and B if:

$$(3) \qquad 0.5u(y_{np,A}) + 0.5v(y_{p,A}) = 0.5u(y_{np,B}) + 0.5v(y_{p,B}).$$

This can be rearranged to:

$$(4) \qquad u(y_{np,A}) - u(y_{np,B}) = v(y_{p,B}) - v(y_{p,A}).$$

To be able to solve for *R(y)*, we construct first-order Taylor approximation of the utility functions *u(y)* and *v(y)*. The center of each difference is used as point of expansion.[4]

$$(5) \qquad (y_{np,A} - y_{np,B})u'(\frac{y_{np,A} + y_{np,B}}{2}) \approx (y_{p,B} - y_{p,A})v'(\frac{y_{p,A} + y_{p,B}}{2}).$$

This can be rearranged to:

$$(6) \qquad \frac{v'(\frac{y_{p,A} + y_{p,B}}{2})}{u'(\frac{y_{np,A} + y_{np,B}}{2})} \approx \frac{(y_{np,A} - y_{np,B})}{(y_{p,B} - y_{p,A})}.$$

---

[3] The VNM utility functions u_1 and u_2 represent the same preferences if and only if for some *a* and *b* > 0, $u_2(y) = a + bu_1(y)$, for all outcomes *y*. This implies that $u_2'(y_a)/u_2'(y_b) = u_1'(y_a)/u_1'(y_b)$ for all outcomes y_a and y_b.

[4] Neglecting the second order Taylor series terms does not give much bias if $\frac{u''(y)}{u'(y)}$ is close to $\frac{v''(y)}{v'(y)}$, which is reasonable to assume. For a more careful discussion of these approximations, see Appendix 1.

The experiments are designed so that the two differences have approximately the same center, y^*, or in algebraic terms: $\frac{y_{np,A} + y_{np,B}}{2} \approx \frac{y_{p,A} + y_{p,B}}{2} \approx y^*$. Then, using the notation from expression (1), we have:

$$(7) \qquad R(y^*) \approx \frac{(y_{np,A} - y_{np,B})}{(y_{p,B} - y_{p,A})}.$$

3. The choice experiments

A total of 354 respondents, all intermediate level undergraduate students from the University of Gothenburg and Chalmers University of Technology, participated in the choice experiments. The respondents were evenly distributed among the engineering, law, social work, and education programs. The choice experiments were conducted at the end of a lecture. Participation was voluntary and there was no show-up pay. The approximate participation rates were as follows: 90% for engineering students, law students and social work students, and 75% for education students. The questionnaire consisted of two parts to be answered by all respondents: the lottery experiment and questions about socioeconomic status (summary statistics are presented in Table 1, and the questionnaire is presented in Appendix 2). The respondents were only given information and instructions in writing (included in the questionnaire). The total time for answering the questionnaire was 15 minutes.

Following Johansson-Stenman et al. (2002), the respondents made pair-wise choices between hypothetical lotteries characterized by income and disability outcome. The respondents were asked to consider the well-being of an imaginary grandchild or another close person two generations into the future. In line with Johansson-Stenman et al. (2002:369), we motivate this with the assumption that asking about hypothetical grandchildren is a way to avoid the risk that respondents are not "able to disregard her personal circumstances and environment in the experiment" The hypothesis is that the respondents really end up using their own preferences, since they have no information suggesting that their grandchildren's preferences should be any different than their own. What we intend to measure is each respondent's utility function. We interpret our estimates of *R(y)* as estimates of the respondents' *R(y)*. If the respondents rather than stating their own preferences state what they think people in general prefer, then this is what we actually get an estimate of, which might grind down extreme values.

The respondents were told that the grandchild would have a predisposition giving her a 50% probability of being born with both legs irreparably paralyzed, and a 50 % probability of being born without any mobility impairment at all. They were further told to imagine that this was decided in a lottery, and that the grandchild's monthly net income was determined in the same lottery. If paralyzed, there would not exist any device able to give the grandchild her mobility back.

It was stated that: "Society pays all extra economic costs (e.g., for special trips and for adjusting her house) that arise due to being mobility impaired. The income differences thereby are actually differences in the amounts of goods and services she can buy and consume." We can picture this (compared to a situation with no welfare state whatsoever) as that society gives a transfer to paralyzed persons. This transfer gives them a lower marginal utility of income (than without the transfer) due to the marginal utility of income being diminishing in income. The society generally transfers less to non-paralyzed persons.

Table 1. Summary statistics

Variable	Description	Obs.	Min	Max	Mean	S.D.
Male	1 = male	290	0	1	0.345	
Age		291	20	49	26.5	5.8
Siblings	1 = having at least one sibling	291	0	1	0.938	
Middle income	1= did grow up in a middle income family	291	0	1	0.646	
High income	1= did grow up in a high income family	291	0	1	0.168	
Experienced	1 = "I (or a family member/close friend) am paralyzed in one or two legs"	291	0	1	0.089	
Married	1 = married or cohabiting	291	0	1	0.395	
Credits	University credits, one semester = 20 credits	288	30	260	104.7	41.8
Law	1 = law student	292	0	1	0.257	
Social	1 = social work student	292	0	1	0.216	
Teacher	1 = education student	292	0	1	0.288	
Engineering	1 = engineering student	292	0	1	0.240	
Left	1 = supports the Left Party	270	0	1	0.115	
Social Dem.	1 = supports the Social Democratic Party	270	0	1	0.307	
Green	1 = supports the Green Party	270	0	1	0.159	
Liberal	1 = supports the Liberal Party	270	0	1	0.093	
Centre	1 = supports the Centre Party	270	0	1	0.044	
Christian Dem.	1 = supports the Christian Democrats	270	0	1	0.052	
Moderaterna	1 = supports Moderaterna (a liberal-conservative party)	270	0	1	0.159	
Other party	1 = supports a party not today represented in the Swedish parliament	270	0	1	0.070	
Religious	1 = visits church / mosque / synagogue / equivalent once a month or more often	291	0	1	0.117	
Aanchor	corrects for a potential anchor effect, see Section 5.2 for a discussion	292	0	1	0.616	

This means that for most people, *R(y)* would be even higher without than with a welfare state. Therefore, had we stated the question without a welfare state, then our estimate of *R(y)* would probably have been higher.

The respondents were also told that the outcome of the lotteries would not influence their grandchild's job satisfaction or how hard she would have to work. They were also informed that society as a whole would not be affected by their choices or by the outcome of the lotteries, and that the grandchild's monthly net income would have the same percentage growth as incomes in society in general. After being presented with two lotteries, they were asked to choose the lottery they thought would be best for the imaginary grandchild. After making the selection, the procedure was repeated several times (there were nine rounds – see below), but with different sets of lotteries in each round.

We used four slightly different versions of the questionnaire. Let us first look at Version 1. For all choices, lottery A remained unchanged and had two possible 50-50 outcomes. Outcome 1 was a 20,000 SEK (approx. PPP US$ 2,000) monthly net income and no disability, and Outcome 2 was a 14,000 SEK monthly net income and both legs paralyzed. Nine different B lotteries were presented; thus, the respondents made nine pair-wise choices. All B lotteries had two 50-50 outcomes as well. Each lottery B corresponded to a certain *R(y)* at which the respondents were indifferent between the lotteries (A and B). The lotteries are presented in Table 2, along with the implicit *R(y)*. This is calculated with expression (7) and $\frac{y_{p,A}+y_{p,B}}{2} \approx \frac{y_{np,A}+y_{np,B}}{2} = 17000SEK$.

Table 2. Lotteries

	Income if not mobility impaired	Income if paralyzed	*R* if indifferent between A and B
Lottery A	20,000	14,000	
Lottery B1	14,000	15,000	6.00
Lottery B2	14,000	17,000	2.00
Lottery B3	14,000	18,500	1.33
Lottery B4	14,000	19,500	1.09
Lottery B5	14,000	20,000	1.00
Lottery B6	14,000	20,500	0.92
Lottery B7	14,000	21,500	0.80
Lottery B8	14,000	23,000	0.67
Lottery B9	14,000	25,000	0.55

It should be noted that *R(y)* is a function of income and that we estimate it for a monthly net income of 17,000 SEK. From hereon we denote $R = R(17000)$. These implicit *R*:s are approximations, but our results are not driven by them. For a discussion, see Appendix 1.

Version 1 is presented in Table 2. Using four different versions served as a robustness test (all versions are presented in Appendix 3). Versions 2-4 were used to see whether shifting A and B or shifting the ordering of the answer alternatives (starting at 25,000 SEK instead of at 15,000 SEK if paralyzed) made any difference. We also changed the name of the hypothetical person from the female Anna to the male Erik in half of the questionnaires to see whether the gender used had any influence. No effects were found of gender or of the ordering of the answer alternatives. However, shifting A and B so that lottery B stayed the same and lottery A changed did have an anchor effect. In our analysis we use the pooled sample. The anchor effect might have made our estimate of R downward biased, meaning that our result would have been even stronger without it. In the econometric analysis we control for the anchor effect by adding a dummy for the questionnaires with this anchor effect. These robustness tests are discussed further in Section 5.1.

4. Results

4.1. Descriptive results of the choice experiments

Of the 354 respondents, three did not answer the lottery question and 59 gave inconsistent answers,[5] leaving us with 292 valid (consistent) respondents in the choice experiments. Summary statistics are presented in Table 1, and the results are shown in Table 3. The median *R* is in the interval $1.33 < R < 2$.

[5] The 59 gave inconsistent answers in the sense that they switched from choosing one lottery to the other and then switched back again, or in the sense that their answers imply negative marginal utility of income.

Table 3. Results of the choice experiment

R	No.	Cumulative no.	Frequency	Cumulative freq.
R < 0.545	68	68	0.233	0.233
0.545 < *R* < 0.667	4	72	0.014	0.247
0.667 < *R* < 0.8	10	82	0.034	0.281
0.8 < *R* < 0.923	5	87	0.017	0.298
0.923 < *R* < 1	19	106	0.065	0.363
1 < *R* < 1.09	29	135	0.099	0.462
1.09 < *R* < 1.33	10	145	0.034	0.497
1.33 < *R* < 2	27	172	0.092	0.589
2 < *R* < 6	70	242	0.240	0.829
R > 6	50	292	0.171	1.000

Table 4. Results by subgroup

Subgroup	Obs.	Mean	S.D.	Median	Percentage with *R*>1
Male	100	2.29	2.20	1 < *R* < 1.09	60%
Female	190	3.13	2.87	1.33 < *R* < 2	65.8%
Has siblings	273	2.87	2.69	1.33 < *R* < 2	64.1%
Has no siblings	18	2.76	2.76	1.09	61.1%
Low income	54	2.97	2.98	1 < *R* < 1.09	55.6%
Middle income	188	2.98	2.71	1.33 < *R* < 2	67.6%
High income	49	2.25	2.21	1 < *R* < 1.09	59.2%
Experienced	26	4.15	3.10	2 < *R* < 6	84.6%
Not experienced	265	2.73	2.62	1.09 < *R* < 1.33	61.9%
Married	115	3.05	2.87	1.33 < *R* < 2	64.3%
Not married	176	2.74	2.57	1.33 < *R* < 2	63.6%
Law	75	2.81	2.66	1.33 < *R* < 2	62.7%
Social	63	3.58	2.87	2 < *R* < 6	71.4%
Teacher	84	3.29	2.89	1.33 < *R* < 2	67.9%
Engineering	70	1.71	1.87	1 < *R* < 1.09	52.9%
Left	31	3.65	2.93	2 < *R* < 6	74.2%
Social dem.	83	2.63	2.58	1 < *R* < 1.09	66.3%
Green	43	3.39	3.00	1.33 < *R* < 2	69.8%
Liberal	25	2.66	2.45	1.33 < *R* < 2	68%
Centre	12	2.49	2.86	0.923 < *R* < 1	41.7%
Christian dem.	14	3.71	2.75	2 < *R* < 6	71.4%
Moderaterna	43	2.15	2.44	0.923 < *R* < 1	48.8%
Other party	19	2.34	2.11	1.33 < *R* < 2	52.6%
Religious	34	3.46	2.91	2 < *R* < 6	64.7%
Not religious	257	2.77	2.66	1.09 < *R* < 1.33	63.4%
All	292	2.85	2.69	1.33 < *R* < 2	63.7%

Notes: Mean was calculated using the middle point within each interval, e.g. for the observations with 1 < R < 1.09, we used R = 1.045 in the calculations. When R < 0.545 we used R = 0.484, and when R > 6 we used R = 8.

4.2. Statistical analysis of the median R

125 of the 190 women and 60 of the 100 men had an *R* higher than one.[6] The estimator of the percentage of the population with an *R* higher than one is the average of the female and male estimators. The estimate is (60% + 65.79%) / 2 = 62.90%. This estimator is the average of two estimators with binomial distributions. The estimator has approximately a normal distribution with a standard deviation not higher than 3.09 percentage points.[7] The null hypothesis is that the median *R* equals one. The z-value is 4.17 and the null is rejected at the 0.005% level when making a two sided test (the p-value is 0.000030). The median *R* is statistically significantly (at the 0.005% level) higher than one.

One could argue that the respondents who made choices that imply an *R* just under or just over one did not clearly state their preferences. We could instead treat these respondents as if they were simply maximizing the expected income and flipping a coin when indifferent, and only look at the respondents with strong preferences. Since 157 had an *R* clearly over one and 87 had the opposite, we can no doubt reject the hypothesis that these groups have the same size; a larger fraction of the population has an *R* clearly over one than clearly under one.

4.3. Econometric analysis of the determinants of individual R

Econometric analysis was undertaken to gain insights into the determinants of individual *R*. An interval regression model is estimated (see Table 5) to describe what determines the level of *R*. In this regression, *R* is the dependent variable. Also, a probit model is estimated (see Table 6) to describe what determines whether a person's *R* is over one, but not what determines its level. A dummy equal to one if $R > 1$ serves as the dependent variable in this regression.[8] First we discuss the interval regression and then compare it with the probit regression. In Table 4 descriptive statistics for each subgroup is presented as comparison.

The first estimation (Table 5, Column 1) only includes the background variables as explanatory variables. The total effect (both the direct and the indirect via, e.g., political ideology and educational choice) is estimated here. We see no significant gender effect on *R*. This can be compared to findings that women tend to be more risk-averse (Jianakoplos and Bernaser, 1998; Hartog et al., 2002). Older persons are weakly statistically significantly found to have a higher *R*; every year of age adds 0.06 to *R*. Respondents with (or who have a family member/close friend with) one or two paralyzed legs appear to have a higher *R*. This effect is strong; in fact, it gives an *R* that is 1.31 higher. However, number of siblings and family income[9] do not affect *R*.

[6] Two respondents did not state their gender.

[7] Note that we do not use the standard error (an estimate of the standard deviation of the estimator), but instead the standard deviation of the estimator. The standard deviation for the female estimator is not higher than (0.5*0.5/190)^0.5 = 3.63 %, and for the male estimator it is not higher than (0.5*0.5/100)^0.5 = 5 %. Therefore, the standard deviation of the population estimator is not higher than ((0.5*0.5/190 + 0.5*0.5/100) ^ 0.5) / 2 = 3.09 %.

[8] As a robustness test we repeated both regressions with quadratic terms included, but none of these terms was statistically significant.

[9] However, if we break down the material we see that those who reported that they grew up in a family whose income was "much lower" than average appear to have a higher R, and the opposite goes for those who reported "much higher". While both these effects are strong, it is worth noting that only 3 % of the respondents belonged to one of these groups. Therefore we use more aggregated variables.

Table 5. Interval regressions

	1	2	3	4	5
Male	-0.333		-0.436		-0.349
	(0.292)		(0.296)		(0.344)
Age	0.059*		0.057*		0.040
	(0.031)		(0.032)		(0.035)
Siblings	0.262		0.139		0.187
	(0.574)		(0.613)		(0.584)
Middle income	0.041		0.028		-0.020
	(0.400)		(0.408)		(0.407)
High income	-0.524		-0.320		-0.306
	(0.460)		(0.503)		(0.499)
Experienced	1.309**		1.234**		1.258**
	(0.612)		(0.594)		(0.569)
Left		1.396**	0.829		0.474
		(0.605)	(0.653)		(0.662)
Social Dem.		0.453	0.279		0.185
		(0.416)	(0.431)		(0.436)
Green		1.024*	0.546		0.389
		(0.544)	(0.555)		(0.563)
Liberal		0.616	0.676		0.643
		(0.574)	(0.574)		(0.580)
Centre		0.623	0.407		0.433
		(0.842)	(0.765)		(0.744)
Christian Dem.		0.902	0.959		1.193
		(0.940)	(0.881)		(0.978)
Other party		0.097	-0.245		-0.332
		(0.581)	(0.601)		(0.625)
Religious		0.615	0.489		0.293
		(0.576)	(0.608)		(0.672)
Law				0.346	0.044
				(0.402)	(0.432)
Social				0.685	0.009
				(0.551)	(0.626)
Teacher				0.725*	0.216
				(0.437)	(0.495)
Credits				0.008	0.007
				(0.005)	(0.005)
Married				-0.191	-0.078
				(0.322)	(0.344)
Aanchor	-1.093***	-1.261***	-1.030***	-0.994***	-0.981***
	(0.333)	(0.341)	(0.337)	(0.372)	(0.363)
Constant	1.536	2.669***	1.201	1.982***	0.899
	(1.141)	(0.449)	(1.246)	(0.580)	(1.260)
Observations	289	270	267	288	264

Notes: Moderaterna is the default party. Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Estimation 2 includes variables capturing political preferences and religiousness. Left Party and Green Party voters have a higher *R* than those who sympathize with Moderaterna (the default). However, religiousness (how frequent one visits a church/mosque/synagogue/equivalent) does not seem to have any effect. In Estimation 3 we control for the background variables, and now the estimates of the effect of political preferences fall and none of them is statistically significant. This can be interpreted as the higher *R* among Left Party and Green Party voters than among voters for Moderaterna being mostly due to different backgrounds.

When looking at Estimation 4, which includes the variables that capture life situation, we see that whether or not a person is married does not seem to be correlated with *R*. Education students have a higher *R* than engineering students, who are the default in the regression. In Estimation 5 we control for the background variables, and also for political ideology and religion. These "value variables" are included in Estimation 5 since political preferences and religiousness to large extent precede educational choice and the decision to get married. In Estimation 5 the estimates of the effect of type of subjects fall: education students no longer have a statistically significantly higher *R* than engineering students. This can be interpreted as the higher *R* among education students than among engineering students being mostly due different backgrounds, political preferences and religiousness.

The interval regressions might to some extent suffer from the fact that the distribution of *R* is far from normal; the tails are thicker than the middle. Our explanatory variables can not explain this, implying that the error term is non-normal. The probit model is less sensitive to this problem. Looking at the probit regressions in Table 6, we see that the overall picture is similar to the interval regression, but there are some notable differences. The total effect (both the direct and the indirect via, e.g., political ideology and educational choice) of the background variables is estimated in Estimation 1. In Estimation 1 the age parameter has a small, not statistically significant point estimate. Individuals from a middle-income family have a 13.4 percentage point higher probability than those from a low-income family (the default) to have an *R* over one, which is weakly statistically significant. The experience dummy still has a strong effect; the probability of having an *R* over one goes up 23.5 percentage points if an individual has personal experience.

In Estimations 2 and 3 the results are in line with those in the interval regression, but stronger. Even when controlling for background factors, political ideology is correlated with whether an individual has an *R* over one. More exactly, voters for the Left Party, the Green Party, the Social Democratic Party, and the Liberal Party are approximately 20 percentage points more likely to have an *R* over one than those who sympathize with Moderaterna (the default). The effect of voting for the Green Party is statistically significant at the 10% level and the others at 5%. It is somewhat expected that *R* is correlated with political ideology. If a person e.g. supports a party which policies in general imply sizeable redistribution, this person probably thinks that the marginal utility of income varies quite a lot among the population. This variation then is the person's reason to support redistribution. The belief in such a variation likely is correlated with the belief that ones own marginal utility varies in different situations.

In Estimation 4 we see that number of university credits has a weakly statistically significant effect; one extra semester is correlated with the probability of $R > 1$ being 3.6 percentage points higher when only including the life style variables. But this effect seems to be mostly due different backgrounds, political preferences and religiousness, since it disappears in estimation 5.

Table 6. Probit regressions, marginal effects

	1	2	3	4	5
Male	-0.023		-0.049		-0.050
	(0.064)		(0.069)		(0.076)
Age	0.006		0.003		0.000
	(0.006)		(0.006)		(0.006)
Siblings	0.045		0.039		0.053
	(0.124)		(0.127)		(0.124)
Middle income	0.134*		0.145*		0.148*
	(0.076)		(0.081)		(0.080)
High income	0.047		0.122		0.135
	(0.092)		(0.093)		(0.094)
Experienced	0.235***		0.240***		0.245***
	(0.074)		(0.075)		(0.071)
Left		0.216**	0.202**		0.169*
		(0.084)	(0.091)		(0.101)
Social Dem.		0.161**	0.194**		0.174**
		(0.081)	(0.084)		(0.086)
Green		0.175**	0.169*		0.138
		(0.086)	(0.091)		(0.096)
Liberal		0.175*	0.211**		0.203**
		(0.096)	(0.087)		(0.090)
Centre		-0.036	-0.036		-0.037
		(0.158)	(0.157)		(0.162)
Christian Dem.		0.178	0.181		0.227*
		(0.135)	(0.134)		(0.124)
Other party		0.033	0.044		0.018
		(0.127)	(0.128)		(0.134)
Religious		0.002	0.028		-0.011
		(0.106)	(0.110)		(0.118)
Law				0.023	-0.057
				(0.087)	(0.103)
Social				0.042	-0.051
				(0.115)	(0.143)
Teacher				0.058	-0.022
				(0.088)	(0.112)
Credits				0.002*	0.002
				(0.001)	(0.001)
Married				-0.050	-0.019
				(0.062)	(0.068)
Aanchor	-0.084	-0.120**	-0.090	-0.082	-0.101
	(0.060)	(0.060)	(0.065)	(0.064)	(0.070)
Constant	289	270	267	288	264

Notes: The marginal effects are evaluated at the mean of the independent variables. The discrete change in the probability for dummy variables is reported. Moderaterna is the default party. Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

5. Ordering and design effects, and a robustness discussion.

5.1. Ordering and design effects

The hypothetical grandchild had a male name (Erik) in 50% of the questionnaires and a female name (Anna) in the remaining 50%. This did not seem to affect the answers, and a Wilcoxon rank-sum test does not reject that the name used had no influence on the answers. The ordering of the answer alternatives was switched in 50 % of the questionnaires; hence, in 50% of the questionnaires the lottery that was changed started at 25,000 SEK if disabled instead of at 15,000 SEK. A Wilcoxon rank-sum test does not reject that the name used had no influence on the answers either. If these two changes do have an influence that we fail to capture, they do not influence in any systematic way since the four versions were distributed randomly among respondents.

Finally, we performed one more test of how the formulations in the questionnaire might influence the answers. In 50% of the questionnaires handed out to all groups except the engineering group, A and B were shifted; i.e., lottery B stayed the same and lottery A changed. The versions were distributed randomly. These three tests give in total eight versions of the questionnaire. If we neglect the name of the hypothetical grandchild, we have four versions (presented in Appendix 3). Tables 7 and 8 present the results of each of the four subsamples.

Shifting A and B was found to affect the answers. A Wilcoxon rank-sum test rejects that the name used had no influence on the answers. This means that we have an anchor effect. The respondents who received a questionnaire where lottery A stayed the same and lottery B changed more often stated that they had a very low *R*. This shift was made in 50% of the questionnaires handed out to all groups except the engineering group. In the engineering group, all questionnaires had lottery B changing. Therefore, the anchor effect has no systematic influence except in the engineering group. If the anchor effect was the same for this group as for the other three groups, we have overestimated the percentage of the engineering students with the lowest *R*. Our estimate of the mean *R* is then downward biased, implying that without this bias our result would have been even stronger. In the econometric analysis we included a dummy, "*aanchor*", for the respondents who received a questionnaire anchored toward lower *R* (i.e., lottery A staying the same and lottery B changing).

Several kinds of questionnaires were tested in the pilot study. No scale effect of the amount of money at stake was found. Making the answer alternatives asymmetric, with more alternatives corresponding to $R > 1$, did not change the results. Changing the steps in SEK between the alternatives did not have an influence either.

5.2. Robustness discussion

There is a risk that individuals do not actually know their utility function when paralyzed simply because they do not know what it is like to be paralyzed. However, the same risk is present in many other choice experiments; for example, do individuals know what it is like to be a millionaire? Furthermore, 70.2 % (40 of 57) of respondents with personal experience of mobility impairments had an *R* over one, meaning that the individuals who most likely had the best knowledge of their utility function when paralyzed answered in line with the rest of the respondents, in fact, the results were even stronger in this group.

Table 7. Choice experiment results for the respondents who received a questionnaire where lottery B changed

	B started at 15,000 SEK if paralyzed.				B started at 25,000 SEK if paralyzed.			
R	No.	Cum. no.	Freq.	Cum. freq.	No.	Cum. no.	Freq.	Cum. freq.
$R < 0.545$	12	12	0.245	0.245	17	17	0.279	0.279
$0.545 < R < 0.667$	1	13	0.020	0.265	0	17	0.000	0.279
$0.667 < R < 0.8$	2	15	0.041	0.306	2	19	0.033	0.311
$0.8 < R < 0.923$	2	17	0.041	0.347	0	19	0.000	0.311
$0.923 < R < 1$	2	19	0.041	0.388	2	21	0.033	0.344
$1 < R < 1.09$	2	21	0.041	0.429	8	29	0.131	0.475
$1.09 < R < 1.33$	2	23	0.041	0.469	3	32	0.049	0.525
$1.33 < R < 2$	4	27	0.082	0.551	3	35	0.049	0.574
$2 < R < 6$	15	42	0.306	0.857	19	54	0.311	0.885
$R > 6$	7	49	0.143	1.000	7	61	0.115	1.000

Note: The engineering group is excluded since not all versions of the questionnaire were distributed in this group.

Table 8. Choice experiment results for the respondents who received a questionnaire where lottery A changed.

	A started at 15,000 SEK if paralyzed.				A started at 25,000 SEK if paralyzed.			
R	No.	Cum. no.	Freq.	Cum. freq.	No.	Cum. no.	Freq.	Cum. freq.
$R < 0.545$	9	9	0.164	0.164	13	13	0.228	0.228
$0.545 < R < 0.667$	1	10	0.018	0.182	1	14	0.018	0.246
$0.667 < R < 0.8$	3	13	0.055	0.236	1	15	0.018	0.263
$0.8 < R < 0.923$	2	15	0.036	0.273	0	15	0.000	0.263
$0.923 < R < 1$	2	17	0.036	0.309	1	16	0.018	0.281
$1 < R < 1.09$	1	18	0.018	0.327	6	22	0.105	0.386
$1.09 < R < 1.33$	0	18	0.000	0.327	3	25	0.053	0.439
$1.33 < R < 2$	3	21	0.055	0.382	6	31	0.105	0.544
$2 < R < 6$	16	37	0.291	0.673	12	43	0.211	0.754
$R > 6$	18	55	0.327	1.000	14	57	0.246	1.000

Note: The engineering group is excluded since not all versions of the questionnaire were distributed in this group.

When we consider the effect of disability on utility, we should remember that people have a large capacity to adapt to adverse situations such as disability (Frederick and Loewenstein, 1999). The phenomenon that people in general overestimate the effect of changes is called a "focusing illusion." E.g., Kahneman and Thaler (2006:230) argue that "people often adapt surprisingly well to important changes in their lives, even such dramatic changes as becoming a paraplegic." When studying subjective well-being, psychologists often find that the disabled are happier than non-disabled people expect (see, e.g., Dijkers, 1999, and Schulz and Decker, 1985). Health economists have found similar results (see, e.g., De Wit et al., 2000). Stein (2002) presents an overview of these findings. Therefore one would guess that people also underestimate utility when paralyzed. What does this mean for people's estimates of their marginal utility? If people overestimate the fall in utility when paralyzed, they probably also overestimate the change in the marginal utility, but there is no reason to assume that they get the direction of the change wrong based on overestimating the fall in utility. This means that we probably can trust

the direction of our main result (disability generally increases the marginal utility of income) although we might have overestimated its size. In the extreme case where the fall in utility is entirely offset after, e.g., a year, then our results hold this first year. After that, both utility and marginal utility are the same as for people without a mobility impairment. In a recent study using longitudinal data, Oswald and Powdthavee (2008) find that adaptation takes place after the onset of disability, but is incomplete. The degree of adaptation is estimated to be around 30% to 50%.

There is however also the possibility of optimism bias (e.g., Kahneman and Tversky, 1979; Kahneman and Lovallo, 1993; and Lovallo and Kahneman, 2003), giving our results a bias in the opposite direction. Optimism bias would make the respondents overestimate the probability that the grandchild is born without a mobility impairment, even though we clearly stated a 50% probability. In this case respondents tend to prefer lotteries with high income if not disabled, which makes our estimate of the marginal utility when disabled biased downwards.

A potential misunderstanding could be that a respondent to some extent interprets the lottery as actually being about two different persons, one disabled and one not. Then she might answer based on a sense of fairness or some other ethical aspect. This could, e.g., be what Johansson-Stenman and Martinsson (2007) call a "random ethics model."

6. Conclusions

It is often implicitly assumed that disability generally lowers marginal utility of income. This article tests the relationship between being mobility impaired and marginal utility of income. Individuals' marginal utility (measured by a von Neumann-Morgenstern utility function) of income in two states is measured through experimental choices between imagined lotteries. The two states are: (1) paralyzed in both legs from birth and (2) not mobility impaired at all. An average income level (a monthly net income of 17,000 SEK, or approx. PPP US$ 1700) is used.

The main finding is that marginal utility of income is higher when paralyzed than when not mobility impaired at all for a large majority (62.9 %). The ratio of an individual's marginal utility of income when paralyzed to the individual's marginal utility of income when not mobility impaired at all is studied, and denoted *R*. The median *R* for average incomes is estimated at between 1.33 and 2. There were 292 valid (consistent) responses and the median *R* is statistically significantly (at the 0.005 % level) higher than one.

The econometric analysis shows that older individuals have a higher *R* and that individuals from an average-income family are more likely to have an *R* over one than those from a low-income family (the default). These two results are quite weak since they were only statistically significant in one regression, and only at the 10% level. Individuals with experience of paralysis have a higher *R*, and it is 23.5 percentage points more likely to be over one. Supporting the Left Party, the Green Party, the Social Democratic Party, or the Liberal Party does not correlate to the level of *R* in general when controlling for background factors. However, it does rise the likelihood of *R* being over one by approximately 20 percentage points.

Of the respondents with personal experience of mobility impairment, 70.2 % (40 of 57) had an *R* over one. This means that the individuals with probably the best knowledge of the utility function when paralyzed answered in line with the rest of the respondents, in fact, the result was even stronger in this group.

The results have potentially important implications for the optimal level of insurance. More specifically, it is suggested that more than full insurance of income losses connected to being disabled (paralyzed in both legs) is optimal, since optimal insurance coverage equals the marginal utility of income in each disability state, assuming no moral hazard and that there is actuarially

fair insurance available. Our result for optimal insurance is opposite to the implications of, e.g., Finkelstein et al. (2008) and Viscusi and Evans (1990).

Our results can also offer an alternative to the worries of, e.g., Sen (1997) and Roemer (1985, 1996, and 2001), that the utilitarian social welfare function (SWF) has unpleasant policy implications since it recommends resource transfers from disabled to non-disabled individuals. This worry is based on the assumption that disability makes the marginal utility lower. We found the opposite, and therefore the utilitarian SWF instead recommends resource transfers to disabled from non-disabled individuals, at least when it comes to paralysis in both legs.

E.g., Sen (1986) and Roemer (1996) argue that it is something conceptually different to summarize von Neumann-Morgenstern (VNM) utility than to summarize welfare, since VNM utility is not identical to welfare. If they are right, and one at the same time wants to use a utilitarian SWF, one has to decide which utility concept to summarize. For a discussion on this issue and disability, see Tengstam (2008).

Further research could include other categories of disability. One might also widen the perspective and study other states that could be assumed to lower utility, e.g., social isolation. One hypothesis is that circumstances that decrease utility generally increase marginal utility of income. This follows if income is a substitute for health and friends etc. However, absence of some states with low utility might be a complement to income, e.g., absence of a gambling problem or a shopping addiction. Empirical studies could help clarify which states are substitutes and which are complements.

Appendix 1

1.1. An illustration of the Viscusi and Evans (1990) method

A chemical worker survey was utilized by Viscusi and Evans (1990) to estimate state-dependent utility functions. The survey elicited each worker's perceived initial probability of suffering a workplace accident p_1. The workers were told that a new chemical would replace the chemical with which they currently worked. They were randomly assigned to either an asbestos, TNT, sodium bicarbonate, or chloroacetophenone group. Then the respondents assessed the posterior risk p_2. The survey ascertained the percentage wage increase δ ("the compensation rate") needed to compensate the surveyed worker for the increased risk. Each worker also reported his base earnings y.[10] Viscusi and Evans let $u(y)$ denote the utility of income in good health and $v(y)$ the utility of income after a job injury. Then a wage increase that equates the expected utility that the worker obtained from his initial job and the transformed job satisfies:

$$(8) \qquad (1-p_1)u(y)+p_1v(y)=(1-p_2)u(y(1+\delta))+p_2v(y(1+\delta)).$$

Viscusi and Evans constructed a first-order Taylor approximation of the utility functions in each health state. The base earnings y was used as point of expansion, and they used δ as the dependent variable in their regression. Substituting the Taylor approximations into equation (8) and solving for the endogenous value δ, they got:

[10] For simplicity we present their model with no taxes and with the replacement rate (the level of workers' compensation benefits after an injury) being 100 %.

(9) $$\delta = \frac{(p_2 - p_1)\beta_1}{\{(1-p_2)\beta_2 + p_2\beta_3\}y},$$

where $\beta_1 = u(y) - v(y)$, $\beta_2 = u'(y)$, and $\beta_3 = v'(y)$. It is only possible to estimate two of the three parameters and they set the coefficient $\beta_2 = 1$ with no loss of generality. The Gallant (1975) nonlinear least squares estimator is used to estimate β_1 and β_3. Viscusi and Evans test whether ill health lowers the marginal utility of income, or:

(10) $$\beta_3 = v'(y) < 1.$$

The Viscusi and Evans (1990) method is based on approximations, leading us to wonder how much this influences their results. Equation (9) implies that δy, the compensation rate in money value, is independent of y. δy is a function of p_1 and p_2, but is not influenced by income. This is contra-intuitive. Further, they assumed that β_1 and β_2, and thereby $\frac{u(y)-v(y)}{u'(y)}$, are the same for all individuals although individuals start at very different income levels. This could be seen to somehow contradict that $u'(y)$ and $v'(y)$ are allowed to differ. It seems that their approximations are not unproblematic.

In order to illustrate the Viscusi and Evans (1990) method, consider the following example. We have two individuals, the first's risk of an accident goes from 10% to 20%, and the other's goes from 10% to 40%. These are typical risk levels in the Viscusi and Evans (1990) dataset. They both start with a monthly net income of 20 (thousand SEK). We let them both have the following utility functions:

(11) $$\begin{cases} u(y) = 1 - \frac{5}{y} \\ v(y) = 0.8 - \frac{7}{y} \end{cases}.$$

These utility functions have a CRRA (constant relative risk aversion) equal to two. Given these utility functions, the first individual needs 12.5% compensation and the other 45%. These compensation rates are typical in their dataset. Putting the two individuals' data into equation (9) gives an equation system. Solving this equation system gives the estimates. β_3 is estimated at 0.286. This means that in their model, *R(y)* is supposed to be the same for all income levels, and it is estimated at 0.286. The correct value is 1.4. This proposes that the Viscusi and Evans (1990) estimator is at least sometimes rather imprecise.

1.2. Are our results driven by our approximations?

Two potentially important approximations are behind expression (7), which is used to calculate our estimate of *R*. Going from expression (4) to expression (5), we make first-order Taylor approximations, and in Table 1 we use the approximation $\frac{y_{p,A}+y_{p,B}}{2} \approx \frac{y_{np,A}+y_{np,B}}{2} = 17000SEK$.

To test whether our results are driven by these approximations, we make three examples. First we assume the following CRRA utility functions with CRRA = 0.5:

$$12) \quad \begin{cases} u(y) = \sqrt{y} \\ v(y) = 0.9\sqrt{y} \end{cases}.$$

In this case our estimate of R is 0.891, and the correct value is 0.9. Second, we assume the following CRRA utility functions with CRRA = 4:

$$(13) \quad \begin{cases} u(y) = 1 - \frac{500}{y^3} \\ v(y) = 0.8 - \frac{700}{y^3} \end{cases}.$$

In this case our estimate of *R* is 1.825, and the correct value is 1.4. Third, we assume the utility functions in expression (8). In this case our estimate of *R* is 1.57, and the correct value is 1.4. These three simulations capture quite extreme values of the concavity of the utility function, but all of them indicate that our approximations are ok. Although we might overestimate how far from unity *R* is, we do estimate *R* to be on the correct side of unity.

Another way to evaluate our estimator in expression (7) is to observe the following two things. First, if our estimate of *R* is higher than one, we know that the $y_{p,B}$ that makes the individual indifferent between lottery A and B satisfies:

$$(14) \quad \frac{(20-14)}{(y_{p,B}-14)} > 1.$$

This can be rearranged to:

$$(15) \quad y_{p,B} < 20.$$

Further we know from equation (4) that:

$$(16) \quad u(20) - u(14) = v(y_{p,B}) - v(14).$$

Now (14), (15), and that *v'(y) > 0* for all *y* imply:

(17) $u(20) - u(14) < v(20) - v(14)$.

We see that (17) $\Rightarrow$

(18) $$\frac{1}{6}\int_{14}^{20} v'(y)dy > \frac{1}{6}\int_{14}^{20} u'(y)dy .$$

Put in words, *v'(y)* in the interval 14 to 20 is on average higher than *u'(y)* in the interval 14 to 20. This holds irrespective of functional form of *u* and *v*.

Second, with similar reasoning the following can be shown. If our estimate is $\hat{R}$, then:

(19) $$\frac{1}{6/\hat{R}}\int_{14}^{14+\frac{6}{\hat{R}}} v'(y)dy = \hat{R}\left\{\frac{1}{6}\int_{14}^{20} u'(y)dy\right\}.$$

Put in words, *v'(y)* in the interval 14 to $14 + \frac{6}{\hat{R}}$ is on average $\hat{R}$ times larger than *u'(y)* in the interval 14 to 20. This holds irrespective of functional form of *u* and *v*.

Appendix 2. The questionnaire (the version where lottery B changed and started at 15,000 SEK if disabled):

What is one thousand SEK (USD 100), really?

A questionnaire survey

The purpose of this questionnaire is to investigate whether people believe that money has the same worth for different people regardless of their living situations. For example, 1,000 SEK can be worth more to a poor person than to a rich person. The study is part of a research project carried out at the Department of Economics and Statistics at the University of Gothenburg.

Responding to our questions is voluntary, but at the same time you can not be replaced by someone else. Your answers will of course be anonymous and we do not want your name. If you have questions, you are welcome to ask them while completing the questionnaire or to contact us afterwards.

Thanks in advance for your participation! Your answers are very valuable to us!

Sven Tengstam
Ph. D. student in Economics
University of Gothenburg
sven.tengstam@economics.gu.se
031-7861276

Handelshögskolan
VID GÖTEBORGS UNIVERSITET

General questions

Question 1. Are you…?

□ Female □ Male

Question 2. In what year were you born?

19 ……

Question 3. How many credits have you earned at the university level?

…… credits

Question 4. How many credits in economics have you earned?

…… credits

Question 5. What is you civil status?

□ Single
□ Married / cohabiting
□ Divorced
□ Other: ……

Questions about income

Now we want you to do a thought experiment and think about your future grandchild, or about another close person living two generations into the future. Let's call her Anna. We know that Anna will have a predisposition giving her a 50% probability of being born with both legs irreparably paralyzed. At the same time, the probability is 50% that she does not become mobility impaired. When you think about what Anna's life will be like, it feels like Anna will participate in a lottery. Whether or not she will have fully functional legs is determined lottery style.

Now imagine that it is in fact determined in a lottery, and that the lottery also determines Anna's disposable income (i.e., the money she will have at her disposal after tax). You will be asked to choose between varying lotteries. You shall choose the lottery that you think will be best for Anna.

No matter which lottery you choose, the probability that Anna becomes mobility impaired is 50%, and the probability that she does not become mobility impaired is 50%. However, her disposable income is influenced by which lottery you choose. You will make several choices between two lotteries (A and B). A will however be the same throughout and B will keep changing. The box shows A and an example of B.

Lottery A	
50 %	Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/month.
50 %	Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/month.
Lottery B	
50 %	Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/month.
50 %	Anna becomes mobility impaired. She gets a disposable income of 20,000 SEK/month.

Which of the lotteries do you feel would be best for Anna? Maybe you think that the lotteries are equally good since they deal with the same amounts of money. However, in lottery A Anna gets a higher disposable income if she is not mobility impaired, and in lottery B she gets a higher disposable income if she is mobility impaired. It is not self evident that these two lotteries are equally good for Anna.

Keep in mind: "Mobility impaired" implies that both of Anna's legs are irreparably paralyzed. No device exists that can give her the mobility back. Society pays all extra economic costs (e.g., for special trips and for adjusting her house) that arise due to being mobility impaired. The income differences thereby are actually differences in the amounts of goods and services she can buy and consume. She does not have access to any inheritance, any insurance money, or any other money besides her disposable income. Your choice of lottery does not influence Anna's job satisfaction or how hard she has to work. Thus, the lotteries only influence the salary and mobility – nothing else.

No matter what lottery you choose, society as to the rest is the same. Even if Anna is living far into the future, we assume that society generally looks like today. Anna will have the same percentage salary increase as in society in general no matter what lottery you choose.

Keep in mind that no matter what lottery you choose, the probability that Anna becomes mobility impaired is 50%. You can not influence her probability of becoming mobility impaired. The only thing you can influence is how her income is related to whether she becomes mobility impaired or not! Society in general is not influenced by your choice.

It is important that you think about what is best for <u>Anna</u>, and not about something else. There are no "right answers" to the questions and we ask you to make your choices as thoughtfully as possible. You are welcome to go back and change your answers if you realize that you have changed your mind.

Question 1.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 15,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

□ Lottery A □ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 2.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 17,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

□ Lottery A □ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 3.

Lottery A

50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B

50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 18 500 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 4.

Lottery A

50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B

50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 19 500 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 5.

Lottery A

50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B

50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 20,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 6.

Lottery A

50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B

50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 20 500 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 7.

Lottery A

50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B

50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 21 500 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 8.

Lottery A

50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B

50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 23,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 9.

Lottery A

50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B

50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 25,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Finishing questions

Question 1. Did you think it was difficult to answer the questions about the lotteries? Mark a number below, where 1 means very easy and 10 means very difficult.

1	2	3	4	5	6	7	8	9	10
Very easy									*Very difficult*

Question 2. How many siblings did you grow up with (include half-siblings you grew up with)?

- ☐ I grew up as an only child.
- ☐ One sibling
- ☐ Two siblings
- ☐ Three or more siblings

Question 3. What would you say that your family's income was when growing up?

- ☐ Much lower than in most families
- ☐ Lower than in most families
- ☐ Average
- ☐ Higher than in most families
- ☐ Much higher than in most families

Question 4. What alternative fits you best?

- ☐ I or a family member/close friend am paralyzed in both legs.
- ☐ I or a family member/close friend am paralyzed in one leg.
- ☐ I or a family member/close friend have a mild mobility impairment.
- ☐ Neither I nor a family member/close friend has a mobility impairment.

Question 5. Which party's policies do you think best match your opinions about how society should be governed?

- □ The Social Democratic Party
- □ Moderaterna
- □ The Center Party
- □ The Liberal Party
- □ The Christian Democrats
- □ The Left Party
- □ The Green Party
- □ Other: ……

Question 6. Generally, how often do you visit a church/mosque/synagogue (or equivalent)? Choose the most appropriate alternative.

- □ Every week
- □ Once a month
- □ Once a year
- □ More seldom than once a year

If you have any comments about this questionnaire, kindly write them here:

……..

……..

……..

……..

Thanks for taking the time to answer the questionnaire!

Appendix 3. The different versions of the questionnaire

3.1. The two first lottery questions in the version where lottery B changed, starting at 15,000 SEK if disable):

Question 1.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 15,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

□ Lottery A □ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 2.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 17,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

□ Lottery A □ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

3.2. The two first lottery questions in the version where lottery B changed, starting at 25,000 SEK if disabled:

Question 1.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 25,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

□ Lottery A □ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 2.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 23,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

□ Lottery A □ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

3.3. The two first lottery questions in the version where lottery A changed, starting at 15,000 SEK if disabled:

Question 1.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 15,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 2.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 17,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

3.4. The two first lottery questions in the version where lottery A changed, starting at 25,000 SEK if disabled:

Question 1.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 25,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

Question 2.

Lottery A
50% Anna does not become mobility impaired. She gets a disposable income of 14,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 23,000 SEK/mth

Lottery B
50% Anna does not become mobility impaired. She gets a disposable income of 20,000 SEK/mth
50% Anna becomes mobility impaired. She gets a disposable income of 14,000 SEK/mth

Which of the lotteries do you feel would be best for Anna?

☐ Lottery A ☐ Lottery B

Note that your choice only influences how the income is related to the mobility impairment. You can not influence her probability of becoming mobility impaired, or what society looks like.

References

Atkinson, A. B., 1970, On the measurement of inequality, Journal of Economic Theory, 2:244-263

De Wit, G., J. Busschbach and F. De Charro, 2000, Sensitivity and perspective in the valuation of health status: whose values count?, Health Economics, 9:109-26

Dijkers, M., 1999, Correlates of life satisfaction among persons with spinal cord injury, Archives of Physical Medicine and Rehabilitation, 80:867-76

Finkelstein, A., E. F. P. Luttmer and M. J. Notowidigdo, 2008, What good is wealth without health? The effect of health on the marginal utility of consumption, NBER working paper 14089

Frederick, S. and G. Loewenstein, 1999, Hedonic adaption, in D. Kahneman, E. Diener, and N. Schwartz [eds] Well-being: the foundations of hedonic physiology. New York. Russell Sage Foundation.

Gallant, A. R., 1975, Nonlinear regression, American Statistician, May, 29:73-81

Hartog, J., A. Ferrer-I-Carbonell and N. Jonker, 2002, Linking measured risk aversion to individual characteristics, Kyklos, 55, 3-26

Jianakoplos, N. A. and A. Bernaser, 1998, Are women more risk averse?, Economic Inquiry, 36, 620-30

Johannesson, M. and U. Gerdtham, 1995, A pilot test of using the veil of ignorance approach to estimate a social welfare function for income, Applied Economics Letters, 2:10:400-402

Johannesson, M. and U. Gerdtham, 1996, A note on the estimation of the equality-efficiency trade-off for QAYLs, Journal of Health Economics, 15:359-368

Johansson-Stenman, O., F. Carlsson and D. Daruvala, 2002, Measuring future grandparents' preferences for equality and relative standing, Economic Journal, 112, 362-83

Johansson-Stenman, O., 2005, Distributional weights in cost-benefit analysis – should we forget about them?, Land Economics, August 2005, 81 (3): 337-352

Johansson-Stenman, O. and P. Martinsson (2008) Are some lives more valuable? An ethical preferences approach, Journal of Health Economics, 27:3:739-752

Kahneman, D. and A. Tversky, 1979, Prospect theory: An analysis of decisions under risk., Econometrica, 47: 313-327

Kahneman, D. and D. Lovallo, 1993, Timid choices and bold forecasts: A cognitive perspective on risk taking. Management Science, 39: 17-31

Kahneman, D. and A. Tversky, 2000, (Eds.), Choices, values and frames New York : Cambridge University Press and the Russell Sage Foundation

Kahneman, D. and R. H. Thaler, 2006, Anomalies: Utility maximization and experienced utility, Journal of Economic Perspectives, 20:1:221-234

Lovallo, D. and D. Kahneman, 2003, Delusions of Success: How Optimism Undermines Executives' Decisions, Harvard Business Review, July, 56-63

Moreno-Ternero, J. D. and J. E. Roemer, 2005, Objectivity, priority, and the veil of ignorance, Core Discussion Paper, 2005/81

Oswald, A. J. and N. Powdthavee, 2008, Does happiness adapt? A longitudinal study of disability with implications for economists and judges, Journal of Public Economics, 92:1061-77

Rawls, J., 1971, A theory of justice, Cambridge MA: Harvard University Press

Roemer, J. E., 1985, Equality of talent, Economics and Philosophy, 1:151-181

Roemer, J. E., 1996, Theories of distributive justice, Cambridge, Mass., Harvard University Press

Roemer, J. E., 2001, Three egalitarian views and American law, Law and Philosophy, 20:4:433-460

Schulz, R. and S. Decker, 1985, Long-term adjustment to physical disability: the role of social support, perceived control, and self-blame, Journal of Personality and Social Psychology, 48:1162-72

Sen, A., 1986, Social choice theory, pp.1073-1181. In K Arrow and M. Intriligator, eds., Handbook of Mathematical Economics, vol. 3 Amsterdam: Noth-Holland

Sen, A., 1997, On economic inequality, Expanded edition, Oxford University Press, Oxford

Sloan, F. A., W. K. Viscusi, H. W. Chesson, C. J. Conover, and K. Whetten-Goldstein, 1998, Alternative approaches to valuing intangible health losses: the evidence for multiple sclerosis, Journal of Health Economics, 17, 475-497

Stein, M. S., 2002, Utilitarianism and the disabled: distribution of resources, Bioethics, 16:1:1-19

Tengstam, S., 2008, Let's aggregate the von Neumann-Morgenstern utility, mimeo

Viscusi, W. K. and W. N. Evans, 1990, Utility functions that depend on health status: estimates and economic implications, The American Economic Review, 80:3, 353-374

von Neumann, J. and O. Morgenstern, 1947, Theory of games and economic behavior, 2nd edition, Princeton, N. J., Princeton University Press

Previous doctoral theses in the Department of Economics, Göteborg.
Avhandlingar publicerade innan serien Ekonomiska Studier startades:

Östman, Hugo (1911), Norrlands ekonomiska utveckling
Moritz, Marcus (1911), Den svenska tobaksindustrien
Sundbom, I. (1933), Prisbildning och ändamålsenlighet
Gerhard, I. (1948), Problem rörande Sveriges utrikeshandel 1936/38
Hegeland, Hugo (1951), The Quantity Theory of Money
Mattsson, Bengt (1970), Cost-Benefit analys
Rosengren, Björn (1975), Valutareglering och nationell ekonomisk politik
Hjalmarsson, Lennart (1975), Studies in a Dynamic Theory of Production and its Applications
Örtendahl, Per-Anders (1975), Substitutionsaspekter på produktionsprocessen vid massaframställning
Anderson, Arne M. (1976), Produktion, kapacitet och kostnader vid ett helautomatiskt emballageglasbruk
Ohlsson, Olle (1976), Substitution och odelbarheter i produktionsprocessen vid massaframställning
Gunnarsson, Jan (1976), Produktionssystem och tätortshierarki – om sambandet mellan rumslig och ekonomisk struktur
Köstner, Evert (1976), Optimal allokering av tid mellan utbildning och arbete
Wigren, Rune (1976), Analys av regionala effektivitetsskillnader inom industribranscher
Wästlund, Jan (1976), Skattning och analys av regionala effektivitetsskillnader inom industribranscher
Flöjstad, Gunnar (1976), Studies in Distortions, Trade and Allocation Problems
Sandelin, Bo (1977), Prisutveckling och kapitalvinster på bostadsfastigheter
Dahlberg, Lars (1977), Empirical Studies in Public Planning
Lönnroth, Johan (1977), Marxism som matematisk ekonomi
Johansson, Börje (1978), Contributions to Sequential Analysis of Oligopolistic Competition

Ekonomiska Studier, utgivna av Nationalekonomiska institutionen vid Göteborgs Universitet. Nr 1 och 4 var inte doktorsavhandlingar. (The contributions to the department series 'Ekonomiska Studier' where no. 1 and 4 were no doctoral theses):

2. **Ambjörn, Erik** (1959), Svenskt importberoende 1926-1956: en ekonomisk-statistisk kartläggning med kommentarer
3. **Landgren, K-G.** (1960), Den "Nya ekonomien" i Sverige: J.M. Keynes, E. Wigfors och utecklingen 1927-39
5. **Bigsten, Arne** (1979), Regional Inequality and Development: A Case Study of Kenya
6. **Andersson, Lars** (1979), Statens styrning av de kommunala budgetarnas struktur (Central Government Influence on the Structure of the Municipal Budget)
7. **Gustafsson, Björn** (1979), Inkomst- och uppväxtförhållanden (Income and Family Background)
8. **Granholm, Arne** (1981), Interregional Planning Models for the Allocation of Private and Public Investments

9. **Lundborg, Per** (1982), Trade Policy and Development: Income Distributional Effects in the Less Developed Countries of the US and EEC Policies for Agricultural Commodities
10. **Juås, Birgitta** (1982), Värdering av risken för personskador. En jämförande studie av implicita och explicita värden. (Valuation of Personal Injuries. A comparison of Explicit and Implicit Values)
11. **Bergendahl, Per-Anders** (1982), Energi och ekonomi - tillämpningar av input-output analys (Energy and the Economy - Applications of Input-Output Analysis)
12. **Blomström, Magnus** (1983), Foreign Investment, Technical Efficiency and Structural Change - Evidence from the Mexican Manufacturing Industry
13. **Larsson, Lars-Göran** (1983), Comparative Statics on the Basis of Optimization Methods
14. **Persson, Håkan** (1983), Theory and Applications of Multisectoral Growth Models
15. **Sterner, Thomas** (1986), Energy Use in Mexican Industry.
16. **Flood, Lennart** (1986), On the Application of Time Use and Expenditure Allocation Models.
17. **Schuller, Bernd-Joachim** (1986), Ekonomi och kriminalitet - en empirisk undersökning av brottsligheten i Sverige (Economics of crime - an empirical analysis of crime in Sweden)
18. **Walfridson, Bo** (1987), Dynamic Models of Factor Demand. An Application to Swedish Industry.
19. **Stålhammar, Nils-Olov** (1987), Strukturomvandling, företagsbeteende och förväntningsbildning inom den svenska tillverkningsindustrin (Structural Change, Firm Behaviour and Expectation Formation in Swedish Manufactury)
20. **Anxo, Dominique** (1988), Sysselsättningseffekter av en allmän arbetstidsför-kortning (Employment effects of a general shortage of the working time)
21. **Mbelle, Ammon** (1988), Foreign Exchange and Industrial Development: A Study of Tanzania.
22. **Ongaro, Wilfred** (1988), Adoption of New Farming Technology: A Case Study of Maize Production in Western Kenya.
23. **Zejan, Mario** (1988), Studies in the Behavior of Swedish Multinationals.
24. **Görling, Anders** (1988), Ekonomisk tillväxt och miljö. Förorenings-struktur och ekonomiska effekter av olika miljövårdsprogram. (Economic Growth and Environment. Pollution Structure and Economic Effects of Some Environmental Programs).
25. **Aguilar, Renato** (1988), Efficiency in Production: Theory and an Application on Kenyan Smallholders.
26. **Kayizzi-Mugerwa, Steve** (1988), External Shocks and Adjustment in Zambia.

27. **Bornmalm-Jardelöw, Gunilla** (1988), Högre utbildning och arbetsmarknad (Higher Education and the Labour Market)
28. **Tansini, Ruben** (1989), Technology Transfer: Dairy Industries in Sweden and Uruguay.
29. **Andersson, Irene** (1989), Familjebeskattning, konsumtion och arbetsutbud - En ekonometrisk analys av löne- och inkomstelasticiteter samt policysimuleringar för svenska hushåll (Family Taxation, Consumption and Labour Supply - An Econometric Analysis of Wage and Income Elasticities and Policy Simulations for Swedish Households)
30. **Henrekson, Magnus** (1990), An Economic Analysis of Swedish Government Expenditure
31. **Sjöö, Boo** (1990), Monetary Policy in a Continuous Time Dynamic Model for Sweden
32. **Rosén, Åsa** (1991), Contributions to the Theory of Labour Contracts.
33. **Loureiro, Joao M. de Matos** (1992), Foreign Exchange Intervention, Sterilization and Credibility in the EMS: An Empirical Study
34. **Irandoust, Manuchehr** (1993), Essays on the Behavior and Performance of the Car Industry
35. **Tasiran, Ali Cevat** (1993), Wage and Income Effects on the Timing and Spacing of Births in Sweden and the United States
36. **Milopoulos, Christos** (1993), Investment Behaviour under Uncertainty: An Econometric Analysis of Swedish Panel Data
37. **Andersson, Per-Åke** (1993), Labour Market Structure in a Controlled Economy: The Case of Zambia
38. **Storrie, Donald W.** (1993), The Anatomy of a Large Swedish Plant Closure
39. **Semboja, Haji Hatibu Haji** (1993), Energy and Development in Kenya
40. **Makonnen, Negatu** (1993), Labor Supply and the Distribution of Economic Well-Being: A Case Study of Lesotho
41. **Julin, Eva** (1993), Structural Change in Rural Kenya
42. **Durevall, Dick** (1993), Essays on Chronic Inflation: The Brazilian Experience
43. **Veiderpass, Ann** (1993), Swedish Retail Electricity Distribution: A Non-Parametric Approach to Efficiency and Productivity Change
44. **Odeck, James** (1993), Measuring Productivity Growth and Efficiency with Data Envelopment Analysis: An Application on the Norwegian Road Sector
45. **Mwenda, Abraham** (1993), Credit Rationing and Investment Behaviour under Market Imperfections: Evidence from Commercial Agriculture in Zambia
46. **Mlambo, Kupukile** (1993), Total Factor Productivity Growth: An Empirical Analysis of Zimbabwe's Manufacturing Sector Based on Factor Demand Modelling
47. **Ndung'u, Njuguna** (1993), Dynamics of the Inflationary Process in Kenya
48. **Modén, Karl-Markus** (1993), Tax Incentives of Corporate Mergers and Foreign Direct Investments
49. **Franzén, Mikael** (1994), Gasoline Demand - A Comparison of Models
50. **Heshmati, Almas** (1994), Estimating Technical Efficiency, Productivity Growth And Selectivity Bias Using Rotating Panel Data: An Application to Swedish Agriculture

51. **Salas, Osvaldo** (1994), Efficiency and Productivity Change: A Micro Data Case Study of the Colombian Cement Industry
52. **Bjurek, Hans** (1994), Essays on Efficiency and Productivity Change with Applications to Public Service Production
53. **Cabezas Vega, Luis** (1994), Factor Substitution, Capacity Utilization and Total Factor Productivity Growth in the Peruvian Manufacturing Industry
54. **Katz, Katarina** (1994), Gender Differentiation and Discrimination. A Study of Soviet Wages
55. **Asal, Maher** (1995), Real Exchange Rate Determination and the Adjustment Process: An Empirical Study in the Cases of Sweden and Egypt
56. **Kjulin, Urban** (1995), Economic Perspectives on Child Care
57. **Andersson, Göran** (1995), Volatility Forecasting and Efficiency of the Swedish Call Options Market
58. **Forteza, Alvaro** (1996), Credibility, Inflation and Incentive Distortions in the Welfare State
59. **Locking, Håkan** (1996), Essays on Swedish Wage Formation
60. **Välilä, Timo** (1996), Essays on the Credibility of Central Bank Independence
61. **Yilma, Mulugeta** (1996), Measuring Smallholder Efficiency: Ugandan Coffee and Food-Crop Production
62. **Mabugu, Ramos E.** (1996), Tax Policy Analysis in Zimbabwe Applying General Equilibrium Models
63. **Johansson, Olof** (1996), Welfare, Externalities, and Taxation; Theory and Some Road Transport Applications.
64. **Chitiga, Margaret** (1996), Computable General Equilibrium Analysis of Income Distribution Policies in Zimbabwe
65. **Leander, Per** (1996), Foreign Exchange Market Behavior Expectations and Chaos
66. **Hansen, Jörgen** (1997), Essays on Earnings and Labor Supply
67. **Cotfas, Mihai** (1997), Essays on Productivity and Efficiency in the Romanian Cement Industry
68. **Horgby, Per-Johan** (1997), Essays on Sharing, Management and Evaluation of Health Risks
69. **Nafar, Nosratollah** (1997), Efficiency and Productivity in Iranian Manufacturing Industries
70. **Zheng, Jinghai** (1997), Essays on Industrial Structure, Technical Change, Employment Adjustment, and Technical Efficiency
71. **Isaksson, Anders** (1997), Essays on Financial Liberalisation in Developing Countries: Capital mobility, price stability, and savings
72. **Gerdin, Anders** (1997), On Productivity and Growth in Kenya, 1964-94
73. **Sharifi, Alimorad** (1998), The Electricity Supply Industry in Iran: Organization, performance and future development
74. **Zamanian, Max** (1997), Methods for Mutual Fund Portfolio Evaluation: An application to the Swedish market
75. **Manda, Damiano Kulundu** (1997), Labour Supply, Returns to Education, and the Effect of Firm Size on Wages: The case of Kenya
76. **Holmén, Martin** (1998), Essays on Corporate Acquisitions and Stock Market Introductions

77. **Pan, Kelvin** (1998), Essays on Enforcement in Money and Banking
78. **Rogat, Jorge** (1998), The Value of Improved Air Quality in Santiago de Chile
79. **Peterson, Stefan** (1998), Essays on Large Shareholders and Corporate Control
80. **Belhaj, Mohammed** (1998), Energy, Transportation and Urban Environment in Africa: The Case of Rabat-Salé, Morocco
81. **Mekonnen, Alemu** (1998), Rural Energy and Afforestation: Case Studies from Ethiopia
82. **Johansson, Anders** (1998), Empirical Essays on Financial and Real Investment Behavior
83. **Köhlin, Gunnar** (1998), The Value of Social Forestry in Orissa, India
84. **Levin, Jörgen** (1998), Structural Adjustment and Poverty: The Case of Kenya
85. **Ncube, Mkhululi** (1998), Analysis of Employment Behaviour in Zimbabwe
86. **Mwansa, Ladslous** (1998), Determinants of Inflation in Zambia
87. **Agnarsson, Sveinn** (1998), Of Men and Machines: Essays in Applied Labour and Production Economics
88. **Kadenge, Phineas** (1998), Essays on Macroeconomic Adjustment in Zimbabwe: Inflation, Money Demand, and the Real Exchange Rate
89. **Nyman, Håkan** (1998), An Economic Analysis of Lone Motherhood in Sweden
90. **Carlsson, Fredrik** (1999), Essays on Externalities and Transport
91. **Johansson, Mats** (1999), Empirical Studies of Income Distribution
92. **Alemu, Tekie** (1999), Land Tenure and Soil Conservation: Evidence from Ethiopia
93. **Lundvall, Karl** (1999), Essays on Manufacturing Production in a Developing Economy: Kenya 1992-94
94. **Zhang, Jianhua** (1999), Essays on Emerging Market Finance
95. **Mlima, Aziz Ponary** (1999), Four Essays on Efficiency and Productivity in Swedish Banking
96. **Davidsen, Björn-Ivar** (2000), Bidrag til den økonomisk-metodologiske tenkningen (Contributions to the Economic Methodological Thinking)
97. **Ericson, Peter** (2000), Essays on Labor Supply
98. **Söderbom, Måns** (2000), Investment in African Manufacturing: A Microeconomic Analysis
99. **Höglund, Lena** (2000), Essays on Environmental Regulation with Applications to Sweden
100. **Olsson, Ola** (2000), Perspectives on Knowledge and Growth
101. **Meuller, Lars** (2000), Essays on Money and Credit
102. **Österberg, Torun** (2000), Economic Perspectives on Immigrants and Intergenerational Transmissions
103. **Kalinda Mkenda, Beatrice** (2001), Essays on Purchasing Power Parity, RealExchange Rate, and Optimum Currency Areas
104. **Nerhagen, Lena** (2001), Travel Demand and Value of Time - Towards an Understanding of Individuals Choice Behavior

105. **Mkenda, Adolf** (2001), Fishery Resources and Welfare in Rural Zanzibar
106. **Eggert, Håkan** (2001), Essays on Fisheries Economics
107. **Andrén, Daniela** (2001), Work, Sickness, Earnings, and Early Exits from the Labor Market. An Empirical Analysis Using Swedish Longitudinal Data
108. **Nivorozhkin, Eugene** (2001), Essays on Capital Structure
109. **Hammar, Henrik** (2001), Essays on Policy Instruments: Applications to Smoking and the Environment
110. **Nannyonjo, Justine** (2002), Financial Sector Reforms in Uganda (1990-2000): Interest Rate Spreads, Market Structure, Bank Performance and Monetary Policy
111. **Wu, Hong** (2002), Essays on Insurance Economics
112. **Linde-Rahr, Martin** (2002), Household Economics of Agriculture and Forestry in Rural Vienam
113. **Maneschiöld, Per-Ola** (2002), Essays on Exchange Rates and Central Bank Credibility
114. **Andrén, Thomas** (2002), Essays on Training, Welfare and Labor Supply
115. **Granér, Mats** (2002), Essays on Trade and Productivity: Case Studies of Manufacturing in Chile and Kenya
116. **Jaldell, Henrik** (2002), Essays on the Performance of Fire and Rescue Services
117. **Alpizar, Francisco, R.** (2002), Essays on Environmental Policy-Making in Developing Countries: Applications to Costa Rica
118. **Wahlberg, Roger** (2002), Essays on Discrimination, Welfare and Labor Supply
119. **Piculescu, Violeta** (2002), Studies on the Post-Communist Transition
120. **Pylkkänen, Elina** (2003), Studies on Household Labor Supply and Home Production
121. **Löfgren, Åsa** (2003), Environmental Taxation – Empirical and Theoretical Applications
122. **Ivaschenko, Oleksiy** (2003), Essays on Poverty, Income Inequality and Health in Transition Economies
123. **Lundström, Susanna** (2003), On Institutions, Economic Growth and the Environment
124. **Wambugu, Anthony** (2003), Essays on Earnings and Human Capital in Kenya
125. **Adler, Johan** (2003), Aspects of Macroeconomic Saving
126. **Erlandsson, Mattias** (2003), On Monetary Integration and Macroeconomic Policy
127. **Brink, Anna** (2003), On the Political Economy of Municipality Break-Ups
128. **Ljungwall, Christer** (2003), Essays on China's Economic Performance During the Reform Period
129. **Chifamba, Ronald** (2003), Analysis of Mining Investments in Zimbabwe
130. **Muchapondwa, Edwin** (2003), The Economics of Community-Based Wildlife Conservation in Zimbabwe
131. **Hammes, Klaus** (2003), Essays on Capital Structure and Trade Financing
132. **Abou-Ali, Hala** (2003), Water and Health in Egypt: An Empirical Analysis
133. **Simatele, Munacinga** (2004), Financial Sector Reforms and Monetary Policy in Zambia
134. **Tezic, Kerem** (2004), Essays on Immigrants' Economic Integration
135. INSTÄLLD

136. **Gjirja, Matilda** (2004), Efficiency and Productivity in Swedish Banking
137. **Andersson, Jessica** (2004), Welfare Environment and Tourism in Developing Countries
138. **Chen, Yinghong** (2004), Essays on Voting Power, Corporate Governance and Capital Structure
139. **Yesuf, Mahmud** (2004), Risk, Time and Land Management under Market Imperfections: Applications to Ethiopia
140. **Kateregga, Eseza** (2005), Essays on the Infestation of Lake Victoria by the Water Hyacinth
141. **Edvardsen, Dag Fjeld** (2004), Four Essays on the Measurement of Productive Efficiency
142. **Lidén, Erik** (2005), Essays on Information and Conflicts of Interest in Stock Recommendations
143. **Dieden, Sten** (2005), Income Generation in the African and Coloured Population – Three Essays on the Origins of Household Incomes in South Africa
144. **Eliasson, Marcus** (2005), Individual and Family Consequences of Involuntary Job Loss
145. **Mahmud, Minhaj** (2005), Measuring Trust and the Value of Statistical Lives: Evidence from Bangladesh
146. **Lokina, Razack Bakari** (2005), Efficiency, Risk and Regulation Compliance: Applications to Lake Victoria Fisheries in Tanzania
147. **Jussila Hammes, Johanna** (2005), Essays on the Political Economy of Land Use Change
148. **Nyangena, Wilfred** (2006), Essays on Soil Conservation, Social Capital and Technology Adoption
149. **Nivorozhkin, Anton** (2006), Essays on Unemployment Duration and Programme Evaluation
150. **Sandén, Klas** (2006), Essays on the Skill Premium
151. **Deng, Daniel** (2006), Three Essays on Electricity Spot and Financial Derivative Prices at the Nordic Power Exchange
152. **Gebreeyesus, Mulu** (2006), Essays on Firm Turnover, Growth, and Investment Behavior in Ethiopian Manufacturing
153. **Islam, Nizamul Md.** (2006), Essays on Labor Supply and Poverty: A Microeconometric Application
154. **Kjaer, Mats** (2006), Pricing of Some Path-Dependent Options on Equities and Commodities
155. **Shimeles, Abebe** (2006), Essays on Poverty, Risk and Consumption Dynamics in Ethiopia
156. **Larsson, Jan** (2006), Four Essays on Technology, Productivity and Environment
157. **Congdon Fors, Heather** (2006), Essays in Institutional and Development Economics
158. **Akpalu, Wisdom** (2006), Essays on Economics of Natural Resource Management and Experiments
159. **Daruvala, Dinky** (2006), Experimental Studies on Risk, Inequality and Relative Standing
160. **García, Jorge** (2007), Essays on Asymmetric Information and Environmental Regulation through Disclosure

161. **Bezabih, Mintewab** (2007), Essays on Land Lease Markets, Productivity, Biodiversity, and Environmental Variability
162. **Visser, Martine** (2007), Fairness, Reciprocity and Inequality: Experimental Evidence from South Africa
163. **Holm, Louise** (2007), A Non-Stationary Perspective on the European and Swedish Business Cycle
164. **Herbertsson, Alexander** (2007), Pricing Portfolio Credit Derivatives
165. **Johansson, Anders C.** (2007), Essays in Empirical Finance: Volatility, Interdependencies, and Risk in Emerging Markets
166. **Ibáñez Díaz, Marcela** (2007), Social Dilemmas: The Role of Incentives, Norms and Institutions
167. **Ekbom, Anders** (2007), Economic Analysis of Soil Capital, Land Use and Agricultural Production in Kenya
168. **Sjöberg, Pål** (2007), Essays on Performance and Growth in Swedish Banking
169. **Palma Aguirre, Grisha Alexis** (2008), Explaining Earnings and Income Inequality in Chile
170. **Akay, Alpaslan** (2008), Essays on Microeconometrics and Immigrant Assimilation
171. **Carlsson, Evert** (2008), After Work – Investing for Retirement
172. **Munshi, Farzana** (2008), Essays on Globalization and Occupational Wages
173. **Tsakas, Elias** (2008), Essays on Epistemology and Evolutionary Game Theory
174. **Erlandzon, Karl** (2008), Retirement Planning: Portfolio Choice for Long-Term Investors
175. **Lampi, Elina** (2008), Individual Preferences, Choices, and Risk Perceptions – Survey Based Evidence
176. **Mitrut, Andreea** (2008), Four Essays on Interhousehold Transfers and Institutions in Post-Communist Romania
177. **Hansson, Gustav** (2008), Essays on Social Distance, Institutions, and Economic Growth
178. **Zikhali, Precious** (2008), Land Reform, Trust and Natural Resource Management in Africa
179. **Tengstam, Sven** (2008), Essays on Smallholder Diversification, Industry Location, Debt Relief, and Disability and Utility