



University Potsdam

Faculty of Economic and Social Science

Chair of International Politics

# **Migration and Development in Senegal**

## **A System Dynamics Analysis of the Feedback Relationships**

### **Diploma thesis**

**submitted by**  
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## List of Abbreviations

AMLD	Alliance for Migration, Leadership and Development
ANSD	Agence Nationale de la Statistique et de la Démographie
CERPOD	Centre d'Etudes et de Recherche sur la Population pour le Développement
CLD	Causal Loop Diagram
DRC	Development Research Centre
DSP	Direction de la Prévision et de la Statistique
EC	European Commission
EP	European Parliament
EVI	Environmental Vulnerability Index
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GNI	Gross National Income
GNP	Gross National Product
HDI	Human Development Index
HDR	Human Development Report
HWWA	Hamburgisches Welt-Wirtschafts-Archiv
IMF	International Monetary Fund
IOM	International Organisation for Migration
LABORSTA	Labour Organisation Statistics
LDC	Least Developed Countries
LIC	Low Income Countries
LMC	Lower Middle Income Countries
MDG	Millennium Development Goals
MEPN	Ministère de l'Environnement et de la Protection de la Nature
MI	Millennium Institute
MIDA	Migrations pour le Développement en Afrique
MIT	Massachusetts Institute of Technology
NELM	New Economics of Labour Migration
NEM	New Economics of Migration
NGO	Non-Governmental Organisation
ODA	Official Development Aid
OECD	Organisation for Economic Co-operation and Development
OIM	Organisation Internationale pour les Migrations
pc	Per capita
PRSP	Poverty Reduction Strategy Papers
SD	System Dynamics
TOKTEN	Transfer of Knowledge Through Expatriates Nationals
T21	Threshold 21
UMC	Upper Middle Income Countries
UN	United Nations
UNPF	United Nations Population Fund
UNDESA	Population Division of United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
UNOHRLLS	United Nations Office of the High Representative for Least Developed Countries, Landlocked Developing Countries and Small Island Developing States
UNSD	United Nations Statistics Division
WB	World Bank
WCED	World Commission on Environment and Development
WDR	World Development Report
WGI	World Governance Indicator
WRI	World Resources Institute
WWF	World Wide Fund for Nature

## Préface

### SUR MIGRATION ET DEVELOPPEMENT AU SENEGAL

La migration est devenue une variable centrale dans les cadres de politiques macro économiques de développement au 21ème siècle. Que l'on vive dans un pays développé ou dans un pays en développement, les problématiques migratoires se sont installées au cœur des agendas de développement par nécessité certes mais également parce qu'il est devenu évident pour tous les gestionnaires du développement que bien intégrée dans les politiques sectorielles, la migration peut générer des forces et/ou des ressources additionnelles pour le développement.

En ma qualité de Directeur Général Adjoint de l'Organisation Internationale pour les Migrations de 1999 à 2009, j'ai pu piloter, soutenue par une équipe d'experts dans le domaine de la Migration, l'initiative et l'évolution du concept Migration et Développement au sein de l'Organisation et dans les instances internationales, régionales et sous régionales qu'il nous était donné de fréquenter. Notre objectif était de faire inscrire la Migration dans leurs agendas et démontrer combien et comment l'intégration de la migration dans les politiques de développement qu'ils étaient en charge de formuler pouvait susciter et créer des valeurs ajoutées dans le processus de développement. Cependant, il fallait démontrer pour convaincre les décideurs de l'importance et de l'intérêt critique de l'intégration de la migration dans le processus de développement. C'est ce qui a donné naissance au concept de Migration pour le Développement en Afrique (MIDA).

Notre concept a fait son chemin aujourd'hui et dix ans après, il est indéniable que les résultats sont là, satisfaisants à souhait, parce que, non seulement le concept du MIDA est utilisé par la plupart des pays en développement (Afrique au Sud du Sahara et du Nord) dans leur partenariat avec leurs partenaires au développement (bi- et multilatéraux), mais la majeure partie de ces mêmes pays l'ont intégré dans leurs documents de stratégie de lutte contre la pauvreté ou de promotion du développement selon la nomenclature adoptée par le pays (Ghana, Sénégal, RDC, Mali, Cap Vert etc.).

Le reste est une question d'approche et de méthode de travail pour que les pays, qui choisissent de capitaliser les valeurs ajoutées que peut leur apporter une bonne gouvernance des phénomènes migratoires, puissent effectivement identifier et manipuler les indicateurs adéquats pour intégrer la migration dans leurs politiques sectorielles.

### L'INSTRUMENT MAJEUR EST LE T21.

Sans être économiste, mais en ma qualité d'agent de développement, ayant toujours travaillé dans le domaine de la recherche d'efficacité et de création de valeurs ajoutées dans

tous les programmes où il m'a été donné de travailler j' ai été convaincue de la pertinence de l'outil T21: le Threshold 21, crée par le MILLENIUM Institute. En effet , le T21 est un instrument d'analyse macro économique qui utilise des variables socio économiques et politiques, motrices ou non, pour établir des constats et dégager des perspectives dans le moyen ou long terme. Cette analyse systémique offre une ou des possibilités de jauger les influences et interférences des variables utilisées sur un programme donné.

Il nous a servi, dans le cas de la variable migration pour illustrer combien et comment l'intégration des Diaspora qualifiées ou moins, des fonds transférés par les migrants; des rémittences sociales autant dans le pays d'origine que dans celui de destination; des parcours migratoires et risques différents selon le genre, etc. apportent une lecture différente et des données appréciables dans l'analyse économique, sociale et politique et dans le temps pour un pays. Toutes ces données jouent un rôle et influencent négativement ou positivement l'évolution des sociétés dans les pays d'origine, de transit et /ou de destination. Il nous semblait essentiel d'alerter et de convaincre nos politiques pour que cette opportunité soit ajoutée à toutes celles qu'ils cherchaient pour améliorer nos performances économiques et sociales en ce début du 21ème siècle.

Le Sénégal, mon pays, a bénéficié de séries de formation sur l'outil T21 et a donné l'opportunité à nos cadres supérieurs travaillant dans tous les secteurs d'activités, générateurs de richesses dans notre pays pour aider les décideurs à gagner du temps et améliorer les performances des secteurs qu'on leur a confiés.

Le travail de notre jeune collègue Gunda Züllich est une illustration parfaite de l'ambition qu'un pays en développement a, pour armer ses ressources humaines.

Nous la félicitons et la remercions, ainsi que toute l'équipe qui l'a formée. En espérant que son travail nous apporte tout le changement de paradigmes de travail exigés maintenant pour notre développement.

Prof Ndioro Ndiaye

L'ancien Directeur Général Adjoint de l'Organisation Internationale pour les Migrations (OIM) et Présidente de l'Alliance pour la Migration, le Leadership et le Développement, DAKAR.



## Preface

### ON MIGRATION AND DEVELOPMENT IN SENEGAL

Migration has become one of the central variables within the framework of macroeconomic policies for development in the 21st century. Whether we live in a developed country or a developing country, migration issues have become embedded within the heart of development agendas through necessity but also because it has certainly become obvious to all development managers that migration can generate forces and / or additional resources for development when well integrated into sectoral policies.

In my capacity as Deputy Director General of the International Organization for Migration (IOM) from 1999 to 2009, I drove the initiative and the evolution of the concept Migration and Development in the Organization, supported by a team of experts in the field of migration, and I continued in international, regional and sub-regional instances that we attended. Our goal was to incorporate migration in their agendas and to show how much and in which way the integration of migration into the development policies they were in charge of could generate and create added value in the development process. It was important to demonstrate this to convince policy makers of the importance and the critical relevance of integrating migration into the development process. This is what spawned the concept of Migration for Development in Africa (MIDA).

Our concept has made its way and today, ten years later, it is undeniable that satisfactory results are there, because the concept of MIDA is not only being used by most countries under development (in Africa, South and North of the Sahara) in partnership with their development partners (bi- and multilateral), but most of these countries have also integrated it into their strategy documents regarding the fight against poverty or the promotion of development according to the nomenclature adopted by the country (Ghana, Senegal, Congo, Mali, Cape Verde etc.).

The rest is a matter of approach and the method of work, for those countries that choose to capitalize on the added values that can be obtained through the good governance of migration, is the effective identification and manipulation of the appropriate indicators to integrate migration into their sectoral policies.

### THE MAJOR INSTRUMENT IS T21.

Without being an economist, but in my capacity as an agent of development and having always worked in the research of efficiency and creation of value added in all programs that have been given to me, I have been convinced of the relevance of the tool T21: The Threshold<sup>21</sup>, created by the Millennium Institute. T21 is an instrument of macroeconomic analysis

that uses socio economic and political variables, drivers or not, to make findings and identify prospects in the medium to long term. This systemic analysis provides opportunities to gauge the influences and interferences of the variables used in a given program.

It served us, in the case of the variable migration, to illustrate how much and in which way the integration of qualified Diaspora or at least the funds transferred by migrants; the social remittances in both, the countries of origin and destination; the migration routes and different risks by gender provide a different interpretation of and significant data for the economic, social and political analysis and the analysis over time for a country. All this data plays a role and positively or negatively influences the evolution of societies in the countries of origin, of transit and / or of destination. It seemed essential we alert and convince our politicians for this opportunity to be added to all policies that sought to improve our economic and social performance in the early 21st century.

Senegal, my country, benefited from a series of training on the tool T21 and gave that opportunity to our political elite, which work in all sectors of activity generating wealth in our country, to help decision makers save time and improve the performance of sectors entrusted to them.

The work of our young colleague Gunda Züllich is a perfect illustration of the ambition that a developing country has to arm its human resources.

We congratulate and thank her and all the team that educated her. Hoping that her work gives us all the paradigm shift of work now required for our development.

Prof. Ndioro Ndiaye

Former Deputy Director General of the International Organization for Migration (IOM) and President of the Alliance for Migration, Leadership and Development, DAKAR.

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This work would not have been possible without the support of many special people, to whom I would like to give my thanks.

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## Abstract

This thesis investigates the reciprocal relationship between migration and development in Senegal. Therewith, it contributes to the debate as to whether migration in developing countries enhances or rather impedes the development process. Even though extensive and controversial discussions can be found in the scientific literature regarding the impact of migration on development, research has scarcely examined the feedback relationships between migration and development. Science however agrees with both the fact that migration affects development as well as that the level of development in a country determines migration behaviour. Thus, both variables are neither dependent nor independent, but endogenous variables influencing each other and producing behavioural pattern that cannot be investigated using a static and unidirectional approach. On account of this, the thesis studies the feedback mechanisms existing between migration and development and the behavioural pattern generated by the high interdependence in order to be able to draw conclusions concerning the impact of changes in migration behaviour on the development process.

To explore these research questions, the study applies the computer simulation method 'System Dynamics' and amplifies the simulation model for national development planning called 'Threshold 21' (T21), representing development processes endogenously and integrating economic, social and environmental aspects, using a structure that portrays the reasons and consequences of migration. The model has been customised to Senegal, being an appropriate representative of the theoretical interesting universe of cases. The comparison of the model generated scenarios - in which the intensity of emigration, the loss and gain of education, the remittances or the level of dependence changes - facilitates the analysis.

The present study produces two important results. The first outcome is the development of an integrative framework representing migration and development in an endogenous way and incorporating several aspects of different theories. This model can be used as a starting point for further discussions and improvements and it is a fairly relevant and useful result against the background that migration is not integrated into most of the development planning tools despite its significant impact. The second outcome is the gained insights concerning the feedback relations between migration and development and the impact of changes in migration on development. To give two examples: It could be found that migration impacts development positively, indicated by HDI, but that the dominant behaviour of migration and development is a counteracting behaviour. That means that an increase in emigration leads to an improvement in development, while this in turn causes a decline in emigration, counterbalancing the initial increase. Another insight concerns the discovery that migration causes a decline in education in the short term, but leads to an increase in the long term, after approximately 25 years - a typical worse-before-better behaviour.

From these and further observations, important policy implications can be derived for the sending and receiving countries. Hence, by overcoming the unidirectional perspective, this study contributes to an improved understanding of the highly complex relationship between migration and development and their feedback relations.

## Zusammenfassung

Die vorliegende Arbeit untersucht das wechselseitige Verhältnis zwischen Migration und Entwicklung im Senegal. Damit soll ein Beitrag zu der Debatte geleistet werden, ob Migration in Entwicklungsländern den Entwicklungsprozess eher fördert oder verhindert. Während die Frage nach der Auswirkung von Migration auf Entwicklung in der Literatur ausgiebig und kontrovers diskutiert wird, hat sich die Forschung bisher kaum den Rückwirkungsmechanismen zwischen Migration und Entwicklung gewidmet, obwohl sich die Wissenschaft sowohl darin einig ist, dass Migration den Entwicklungsprozess deutlich beeinflusst, als auch darin, dass der Entwicklungsstand eines Land das Migrationsverhalten bestimmt. Das bedeutet, dass beide Variablen weder abhängige, noch unabhängige, sondern endogene Variablen sind, die sich gegenseitig beeinflussen und damit Verhaltensweisen produzieren, deren Erforschung ein statischer, unidirektionaler Ansatz nicht gerecht wird. Deswegen fragt diese Arbeit nach den Rückkopplungsverhältnissen, die zwischen Migration und Entwicklung existieren, und nach den Verhaltensweisen, die durch die hohe Interdependenz entstehen, um daraus Rückschlüsse auf die Frage ziehen zu können, welchen Einfluss Änderungen im Migrationsverhalten auf den Entwicklungsprozess haben.

Um diese Forschungsfragen zu untersuchen, wurde ein Simulationsmodell zur nationalen Entwicklungsplanung, das 'Threshold 21' (T21), das Entwicklungsprozesse endogen darstellt und soziale, ökonomische sowie ökologische Aspekte miteinander verknüpft, um eine Struktur erweitert, welche die Gründe und Konsequenzen von Migration abbildet. Somit konnten nicht nur sämtliche Rückwirkungen zwischen, sondern auch innerhalb von Migration und Entwicklung in der Analyse berücksichtigt werden. Zur Veranschaulichung und um die Validität der Ergebnisse zu erhöhen, wurde das Modell an ein reales Land angepasst und die Forschungsfragen für dieses Land untersucht. Als angemessener Repräsentant der theoretisch interessanten Grundgesamtheit wurde der Senegal als Fallbeispiel ausgewählt.

Die Studie gliedert sich in fünf Kapitel. Während im ersten Kapitel, in der Einleitung, die Forschungsziele und -fragen sowie die Struktur der Arbeit dargestellt werden, begründet das zweite Kapitel die Methodenwahl. Anhand von den Erfordernissen für diese Studie wird die Simulationmethode System Dynamics als angemessenste Methode ermittelt, da sie sich besonders für die Darstellung und Analyse von komplexen Systemen eignet. Nachdem diese Methode aufgrund ihres geringen Verbreitungsgrads vorgestellt wird, bestimmt das Kapitel die Fallauswahl sowie die Datenerhebung und -nutzung. Das dritte Kapitel beschreibt die Modellstruktur. Zunächst werden generelle Eigenschaften geschildert und die wichtigsten Variablen definiert. Der Hauptteil des Kapitels widmet sich allerdings der Begründung und Beschreibung der neu entwickelten Struktur für die Gründe und Konsequenzen von Migration. Während jeweils ein kurzes Unterkapitel einen Überblick darüber gibt, welche grundsätz-

lichen theoretischen Ansätze aus der Migrationsliteratur in das Modell integriert wurden, stellen die darauffolgende Teile die konkret etablierten kausalen Relationen vor. Demnach wird Migration einerseits durch den Migrationswillen, der von dem Prokopfeinkommen, der Armutsrate, des Bildungs- und Gesundheitsniveaus, der Degeneration der Umwelt und des städtischen Bevölkerungswachstum abhängt, und andererseits durch die Migrationsfähigkeit, die von dem Netzwerk der Auswanderer, den Informations-, Kommunikations- und Transportkosten sowie den Migrationspolitiken beeinflusst wird, bestimmt. Als konkrete Konsequenzen sind die Auswirkungen auf die Demographie und die Migration selbst dargestellt sowie die Effekte, die durch Geldüberweisungen und Veränderungen des Bildungsniveaus (‚brain drain‘ und ‚brain gain‘) ausgelöst werden.

Das neu entwickelte Modell wird dann im fünften Kapitel genutzt, um die Forschungsfragen zu beantworten. Zunächst werden die relevanten Rückwirkungsmechanismen theoretisch erarbeitet und dargestellt. Anschließend wird das Langzeitverhalten (1980-2035) der relevanten Variablen für verschiedene Simulationen, die mit Hilfe des Modells erstellt wurden, präsentiert und analysiert. Diese Szenarien beabsichtigen nicht realistisch zu sein, sondern sind eher als unrealistische Experimente zu verstehen, die es ermöglichen zu beobachten, welches Verhalten auf drastische Veränderungen in exogenen Variablen folgt. Der Vergleich des ‚business-as-usual‘ Szenariums mit Simulationen, in denen die Intensität der Abwanderung, des Bildungsverlustes, des Bildungsgewinns, der Geldüberweisungen, oder der Abhängigkeit verändert wurden sowie der Vergleich der unterschiedlichen Simulationen untereinander ermöglichen die Untersuchung. Die extremen Annahmen machen das Verhalten besser sichtbar und vereinfachen somit die Analyse.

Die Studie bringt zwei wichtige Ergebnisse hervor. Erstens entwickelt sie ein umfangreiches Modell, das Migration und Entwicklung endogen erklärt und verschiedene theoretische Ansatzpunkte enthält. Dies kann sowohl als Grundlage für weitere Diskussion und Verbesserungen genutzt werden, ist aber vor allem vor dem Hintergrund, dass Migration in den meisten Modellen zur Entwicklungsplanung trotz des relevanten Einflusses nicht integriert ist, ein wichtiges und nützliches Resultat. Zweitens konnte die Analyse des Verhaltens des Modells wichtige Erkenntnisse bezüglich der Rückwirkungsmechanismen zwischen Migration und Entwicklung und der Wirkung von Veränderungen in Migration auf Entwicklung erzielen. So wurde z.B. herausgearbeitet, dass Migration sich positiv auf Entwicklung, gemessen am Human Development Index (HDI), auswirkt, dass es sich aber generell um ein sich ausgleichendes Verhalten handelt, da die positiven Einflüsse auf Entwicklung ihrerseits Migration verringern, wodurch die positiven Einflüsse wieder abnehmen. Des weiteren konnte festgestellt werden, dass Migration für das Bildungsniveau zunächst eine Verschlechterung und erst nach ca. 25 Jahren eine Verbesserung nach sich zieht. Darüber hinaus hat die Analyse

das sich selbst verstärkende Verhalten von Entwicklung verdeutlicht, das dazu führt, dass selbst eine kurzfristige Verbesserung des Entwicklungsniveaus durch Migrationsveränderungen sich fortsetzt und somit langfristig das Entwicklungsniveau positiv beeinflusst. Schließlich hat die Analyse verdeutlicht, dass der hohe Einfluss von Geldüberweisungen sich negativ auf Aspekte eines weiter gefassten Entwicklungsansatzes auswirkt, da dadurch sowohl die ökologische Nachhaltigkeit verringert, als auch das Abhängigkeitsverhältnis zu potentiellen Empfängerländern von Auswanderern verstärkt wird. Diese negativen Einflüsse reduzieren sich, sobald der Einfluss von Geldüberweisungen zugunsten von Bildungsveränderungen geschmälert wird. Andererseits konnte aufgezeigt werden, dass der positive Einfluss von Veränderungen im Bildungsniveau wegen der Trägheit dieser Variable und entgegengewirkender Effekte begrenzt ist.

Aus all diesen Beobachtungen können wichtige Politikempfehlungen für die Sende- und Empfängerländer von Migration abgeleitet werden. Durch das Überwinden der unidirektionalen Betrachtungsweise trägt diese Arbeit somit zu einem besseren Verständnis des hoch komplexen und von Rückwirkungsmechanismen geprägten Verhältnisses zwischen Migration und Entwicklung bei.



## 1 Introduction

International migration<sup>1</sup> has earned a lot of interest in recent years – medial, political, and scientific. Some say, it is one of the main challenges of our time. This is probably due to “the growing conviction that international migration cannot be seen in isolation from development” (Zoomers/van Naerssen 2006, 6).<sup>2</sup> Although it has been acknowledged that migration strongly impacts the national development<sup>3</sup> in both countries, the receiving and the sending one (World Bank 2003; de Haas 2008, 22; Zoomers/van Naerssen 2006, 6), the main consideration concerns the impact on developing countries<sup>4</sup>, as those suffer from poverty, low education and health levels. However, it is still very controversially discussed as to whether the impact of migration on development in these societies is positive or negative, hence, if migration hinders or enhances development. This study aims at adding to this discussion, but to do so, it focuses on the consideration of the feedback relationship between and within migration and development, as this has been often ignored by research on this topic. As exemplification, Senegal has been chosen as a case study to investigate a real country.

The reason for the diversity of assessment on the impact of migration on development is due to the fact that emigration in developing countries is followed by highly oppositional effects: on the one hand emigrants send money back home, increasing the family income. Those remittances exceed nowadays the total money transfer from North to South through official development aid (ODA) (Vogler 2000, 101; Zoomers/van Naerssen 2006, 6). In addition, it has been researched that emigrants can influence their home societies very positively through the so called ‘brain gain’ transferring the abroad gained knowledge by returning or by regular exchange since they maintain the connection to their home society as has been highlighted by the research on transnational identities (e.g. de Haas 2010, 246ff). On the other hand, emigration can decrease the level of education in the sending country as the ones leaving are often better educated than the average population. This phenomenon is known as ‘brain drain’ (e.g. de Haas 2010, 250). Furthermore, there are scientists pointing out that remittances can also lead to huge problems, such as a growing dependency (e.g. Zoomers/van Naerssen 2006, 21). Finally, so called ‘social remittances’ (de Haas 2008, 22) transferred through the maintenance of contact between Diaspora and the home country in-

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<sup>1</sup> In the following, the term migration will always refer to international migration when not indicated differently, as this study does not investigate interregional or intranational (urban-rural) migration.

<sup>2</sup> According to Zoomers/van Naerssen (2006, 6) other possible reasons why this topic is high on the agenda are increasing problems with the multicultural society in receiving areas, the perceived increase of Migrants from Africa, and the increasing ageing of the population in receiving countries.

<sup>3</sup> Being conscious that the term development is, although widely used, often vague defined, and refers to different concepts, it will be specified in detail in section 3.2.1. For now, it should be known, that development as it is used in this study refers to the Human Development Index (HDI), while a the term ‘broader development’ also considers poverty rate, ecological footprint and dependency levels.

<sup>4</sup> Development Countries are used in this thesis for the countries which are classified by the UNDP as countries with low human development, meaning that they exhibit a lower HDI than 0.5 (UNDP 2009a, 204).

cluding for example ideas, desires, behaviours, and business contacts, impact the home society, although it is controversially discussed whether this is in a positive or negative way (Appleyard 1989, 494f; de Haas 2008, 22; Ghosh 2006, 78; Kermer 2007, 154). Irrespective of positive or negative effects, it can be assumed that the intensity of the listed effects is higher for the South-North migration than for the South-South migration due to the larger differences that are not only followed by amplified remittances, but also by more brain gain and drain (Zoomers/van Naerssen 2006, 17). Therefore, most of the researches on the impacts of migration on development concern South-North migration, even though most of the world-wide migration is South-South migration. This study follows this trend for the same reason.

The perception and appraisal of those different effects for the sending country has changed over the last decades. It swung from optimism after WWII till the mid-70s, to a rather pessimistic one, pointing out problems such as the loss of human capital and dependency, back to a rather optimistic appreciation in the last decade, focussing amongst others on the positive effects of remittances as 'development aid from the bottom' and brain-gain through returning migrants (Bakewell 2008; de Haas 2008; Vogler 2000, 102). Although the increasing amount of remittances sent back to developing countries can partly explain and justify a rethinking of the consequences,<sup>5</sup> it has been criticised that the recent enthusiasm seems to forget the empirical and theoretical insights gained in the 'pessimistic decades' (de Haas 2008, 1). This debate about how to evaluate the impact of migration on development and what the net impact is, is politically very relevant as findings have important policy implications for receiving and sending countries as well as for national and international migration policies.

Although this question is everything but new, the reason to investigate this question again within this study is that literature up to now has often ignored the very important reciprocal relationship(s) (de Haas 2008, 1f). On the one hand, there is no doubt that migration impacts development, even though it is not clear in what direction. On the other hand, although there are very different approaches to explain migration and theories about its reasons,<sup>6</sup> most of them agree on the fact that people migrate to try to improve their own and their families' living situation and opportunities or escaping from indefensible living conditions. That means that migration is highly dependent on the development level, respectively the difference of development level in home and potential host country. Therefore, migration impacts development being at the same time influenced by development. In other words, "[m]igration si-

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<sup>5</sup> "Remittances sent back to developing countries rose from \$31.1 billion in 1990 to \$76.8 billion in 2000 to \$167.0 billion in 2005" (de Haas 2008, 1).

<sup>6</sup> For an overview of the different approaches, see for example Parnreiter (2000, 27ff), Massey et al. (1993), Haug (2000), or Lebhart (2002).

multaneously reshapes the socio-economic “development” context, which in their turn, are likely to influence subsequent migration patterns.” (de Haas 2008, 22; see also World Bank 2009, 158). Hence, this relationship is highly interdependent. Although this has been widely acknowledged, a “weakness of migration and development research has been the tendency to study *causes* and *impacts* of migration separately” (de Haas 2008, 1). Consequently, the reciprocation of development and migration is still very little investigated and understood (Gächter 2000, 171).

This is an important observation as research found that feedbacks are highly relevant for the understanding of social reality and the overall behaviour of social systems as only the consideration of those feedbacks allows the discovery of certain behaviour patterns, such as policy resistance<sup>7</sup>, which are essential for reliable policy analysis (Richardson 1991a, 2ff). From that it has followed that the interdependent-dependent view is inadequate for certain research questions analysis (Richardson 1991a, 4).<sup>8</sup> This study supposes that the question for the impact of migration on development is such a case, as “[m]igration is not an independent variable “causing” development (or the reverse), but is an *endogenous* variable” (de Haas 2010, 253). Hence, there is obviously a high interdependency, and ignoring the existence of the internal dynamics can be followed by misleading conclusions. Therefore, to investigate the highly debated question as to whether migration rather hinders or enhances development, first of all the reciprocal relationship between migration and development should be analysed. However, it has been highlighted that there are not only relevant feedback relations between development and migration, but also internal feedback structures for both, migration and development. While recent research on migration networks stressed the endogenous, non-linear processes within migration (de Haas 2008, 19f), it is widely acknowledged that the processes of development are highly interrelated (e.g. Pedercini 2009), and it has been claimed that their internal dynamics should be considered when analysing the impact of migration. Hence, to get a deeper understanding of the interactions and the generated behaviour of the system, the research needs to consider these internal dynamics as well (Appleyard 1989, 488; de Haas 2008, 1f/22f; Pedercini 2009, V-26).

In addition, as has been proposed by one of the few researches that accepted this challenge up to now and investigated the inherent dynamics of migration and development for

<sup>7</sup> Policy resistance can be defined as “the tendency for interventions to be delayed, diluted, or defeated by the response of the system to the intervention itself” (Sterman 2000, 5).

<sup>8</sup> Richardson (1991a) elucidates that the feedback concept is fundamental to Social Science and that “that great social scientists are feedback thinkers, and great social theories are feedback thoughts” (Richardson 1991a, 2) mentioning renowned researchers applying the feedback perspective from the past 200 years, such as David Hume, Adam Smith, Thomas Malthus, John Stuart Mill, David Ricardo, Georg Wilhelm Friedrich Hegel, Karl Marx, John Dewey, Alfred Radcliff-Brown, Bronisław Malinowski, Robert King Merton, John Maynard Keynes, Gunnar Myrdal, Karl Deutsch and David Easton (Richardson 1991a, 93/204).

two virtual countries (Pedercini 2009<sup>9</sup>), further research should refer to a real country. This not only facilitates the elaboration of country-specific insights (Pedercini 2009, V-26), but also allows a better validation of the model, as the knowledge of local experts and historical data can be used for this purpose, and certain relationships can be defined more accurately (de Haas 2010, 227). However, the main interest of the present study is to investigate the relationship between migration and development. The investigation of a real country mainly serves the improvement of validity of results and as exemplification. Senegal has been chosen for the case study, because it has been identified as an adequate representative for a small homogenous universe of cases, elaborated based on theoretical relevant characteristics. This country, while being a target country for African emigrants till the 80s, is confronted with increasing emigration to OECD countries since the 90s, causing intensified political discourse on migration policies (Gerdes 2007).

From all these considerations, it follows that the first objective of this study is the investigation of the reciprocal relationship between migration and development in Senegal, considering also the internal dynamics within migration and development. Doing that can reveal important insights for the second objective, the exploration of whether migration rather hinders or enhances development, taking into account those internal feedback relationships. Consequently, the research questions are the following:

- 1) Which are the relevant feedback loops between migration and development in Senegal?
- 2) What kind of behaviour patterns are generated by these feedback relationships?
- 3) What is the net effect of changes in migration on development, considering the relevant internal feedback relationships of and between migration and development?

To investigate these research questions, this study applies the computer simulation method System Dynamics. To facilitate the representation of the interactions between migration and development, the national development planning model called Threshold 21 (T21), that uses the SD method and has been customised to Senegal, is amplified by a migration structure. T21 endogenously represents the basic structure of national development and is used to analyse medium-long term development issues at the national level, integrating economic, social and environmental aspects of development planning (Pedercini/Barney 2010). However, the starting framework does not explain migration endogenously up to now, but assumes migration to be exogenous. Hence, based on literature, expert opinion and data research, this study elaborates a model structure representing the causes and consequences of migration in Senegal which is then integrated into the broader development

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<sup>9</sup> Pedercini (2009) developed "a resource-based migration and development model representing the socio economic systems of two virtual countries" (Pedercini 2009, V-26), analysing different scenarios, identifying in-

framework of T21, closing the feedback loops between development indicators and migration and thereby representing the endogenous dynamics of migration and development. Subsequently, the behaviour generated by this new developed structure is analysed. This exploration of different scenarios can then be used for answering the research questions.

Consequently, this study neither contributes to basic research<sup>10</sup>, nor to the strand of evaluation research<sup>11</sup>, but to the branch of applied research. That means that the short-term objective is to "explore the dynamics of a social system" (Miller/Salkind 2002, 3), and to understand the system and its behaviour including feedbacks, time delays, and the resulting policy resistance etc. In the long term, the gained insights should be useful to policymakers. Although this study does not aim at elaborating and analysing comprehensive policies, but rather focuses on the improvement of the understanding of the system and its behaviour, its answers on the research question lays the foundations for further policy research.

Hence, adding to the policy discussion in receiving and sending countries, its results are of high societal relevance. The insights gained could help on the understanding, how and what kind of migration could be desirable to foster development, and when migration is rather impeding these processes. In addition, the study addresses the problem that migration is not integrated into the development planning process, although it is widely acknowledged that migration impacts development and that this topic needs to be mainstreamed (Melde/Ndiaye-Coïc 2009, 113ff). Up to now, this subject is not even mentioned in the Poverty Reduction Strategy Papers (PRSP) (Zoomers/van Naerssen 2006, 27) one of the most important development planning instruments. This study proposes a development planning instrument that integrates migration. The scientific relevance of this study is given by its focus on the feedback perspective and the following insights concerning behaviour patterns and the debate about the net impact of migration on development, addressing one of the important shortcomings of the migration research, which is to ignore the inherent feedbacks and their effects on the system behaviour. Furthermore, an integrative framework about the relationships between migration and development is developed, synthesising different approaches to explain migration and proving if those hypothesis can explain the historical behaviour.

The presentation of the research is structured in the following way: After having outlined the objectives of this research, its research question, the general approach, and its scientific and societal relevance in this chapter, the following chapter illustrates the methodology used

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*herent dynamics of the system, and assessing possible policies.*

<sup>10</sup> Basic research establishes and proves hypothesis about causal relationship aiming at "the discovery of the nature of the relationships between variables" (Miller/Salkind 2002, 3).

<sup>11</sup> According to Miller/Salkind (2002, 3) evaluation research aims at assessing treatments applied to social problems.

for this study (chapter 2). First of all, by presenting the requirements of this study that need to be fulfilled, it is substantiated that simulation is applied as research method, and that System Dynamics has been chosen out of different simulation techniques (section 2.1.1). Afterwards, due to the relatively low level of familiarity with the chosen method, its main concepts, the principal steps of the modelling process and its potentials and deficiencies are presented (section 2.1.2). Subsequently, the decision for a single case study design (section 2.2.1) and the choice for Senegal (section 2.2.2) are elucidated. Finally, section 2.3 concerns the use and collection of data. The third chapter portrays the model structure that has been built for this study that can be seen as its analytical framework. Firstly, some of its general features, such as the unit of analysis, its connection to the broader development context, the time horizon, the model boundaries, and its validation, are sketched in section 3.1. Secondly, the subchapter 3.2 defines and specifies the two key variables, migration and development. The following two subchapters describe in detail the elements that have been included to integrate migration into the broader development model T21. The third subchapter (section 3.3) identifies the causes for migration. The first section gives an overview of the general approaches about causes of migration (section 3.3.1), highlighting which of them are incorporated. Thereafter, the following sections demonstrate the incorporated factors, establishing that migration is dependent on the will to migrate (section 3.3.2), composed by five elements, and the ability to migrate (section 3.3.3), consisting of three elements. The fourth subchapter, after giving a short outline of the general effects of migration on development (section 3.4.1), extracts five direct consequences (section 3.4.2). The fourth chapter analyses the model and its behaviour. While the subchapter 4.1 elaborates the relevant feedback relationships of the system in a theoretical way, the subchapter 4.2 contains the analysis of the system behaviour. After presenting the business-as-usual scenario, the base run (section 4.2.1), the behaviour of five different unrealistic scenarios are described, compared to the base run, and analysed, changing certain aspects of migration, such as the intensity of the migration rate (section 4.2.2), of brain drain (section 4.2.3), of brain gain (section 4.2.4), remittances (section 4.2.5), or dependency (section 4.2.6). Subsequently, section 4.2.7 compares the positive five scenarios, being those with a higher HDI as the base run. Finally, section 4.2.8 recapitulates the gained insights. The final chapter gives a summary of the objectives and the structure at the beginning (section 5.1). Secondly, it centralises the main results and portrays some considerations about their significance, the appropriateness of the application of SD, and the possibilities of generalisation (section 5.2). The study is concluded by developing some implications for the general policy trend (section 5.3), and offering some options for further research (section 5.4).

## 2 Methodology

To investigate the research questions discussed in chapter 1, this chapter describes the choice of an appropriate methodology containing the following three aspects. In section 2.1 the method selection defines the use and expression of models. Often, this part is not discussed in social science studies because most of them use verbal models instead of mathematical ones, although there is an expanding branch of studies applying mathematical approaches (Hanneman 1988, 24). In section 2.2 the choice between different numbers of observations and investigated cases, large  $n$  vs. small  $n$  approach, is discussed as is the final case selection. Section 2.3 reviews the type of data used, referring to qualitative (such as (expert) interviews) vs. quantitative (survey, statistics) data and its collection, including the inherent problems. The last section summarises the conclusions of this chapter.

### 2.1 Method Selection and Selected Method

This section aims at reasoning the choice of the method used in this study and presenting the chosen method, System Dynamics, in detail.

#### 2.1.1 Method Selection

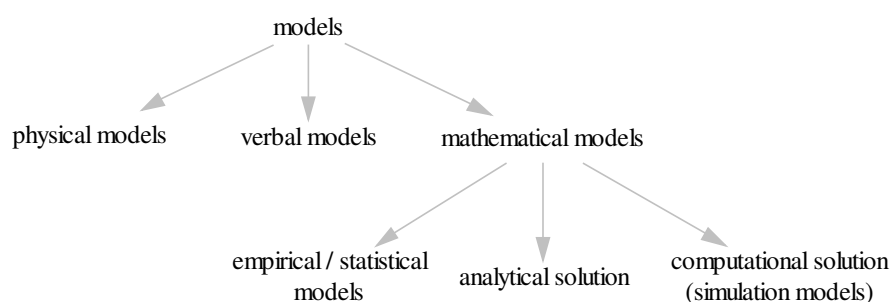
The choice of the most appropriate method for this study was done by establishing the method requirements for this study. Comparing the requirements with the features of different methods led to the decision to use simulation for this research. Guided by the requirements System Dynamics was chosen out of different simulation techniques. This process is described in the following sections. To start with, the following paragraph introduces a categorisation of the main methods used in science characterised by their modelling approaches.

The use of models is a fundamental part of scientific research. "A model is a simplification - smaller, less detailed, less complex, or all of these together - of some other structure or system." (Gilbert/Troitzsch 2005, 2). This means that they are an abstraction of reality, aiming for generalisation. As there are different ways to observe and especially explain reality, a model is a formalisation of these different views of reality. Building, describing, explaining, proving, discussing, and amending models is a basic task of science. There are several ways to model and present models. While physical models are mainly used by natural scientists, models in social science can be distinguished between verbal and mathematical models (Kopainsky 2005, 8; Morton 2009, 28; Hanneman 1988, 13).<sup>12</sup> Mathematical ones can be further divided into three different types. The first group of mathematical models contain empirical or statistical models which are often applied in social science, and are "used to evaluate a hypothesis or a set of hypotheses about the real world" (Morton 2009, 28). The

<sup>12</sup> The three types of models are characterised by their way of presenting the object or theory of concern. While physical models represent the object physically, verbal models do that using words, and mathematical models apply numbers, symbols, equations and formulas. Another category are 'formal model', but their definition differs between the cited authors.

ate a hypothesis or a set of hypotheses about the real world” (Morton 2009, 28). The second and third group differ in their objective: they “are solved to derive predictions” (Morton 2009, 28) and can be subdivided into those that can be solved with analytical solutions and computational models, so complex that analytical solutions are no longer possible (Gilbert/Troitzsch 2005, 10; Johnson 1999, 1514f; Martin 2009, 50; Morton 2009, 28). These computational are often also called simulation models. Confirming this categorization, Johnson (1999) divides methods of theory and model building in political science into rhetoric and informal logic, empirical research, and mathematical modelling and simulation.

*Figure 1: Categories of Models*



**Source:** own figure, based on Kopainsky 2005, 8; Morton 2009, 28

### *2.1.1.1 Method Requirements for this Research*

As outlined in the first chapter the “State of the Art” is the unidirectional investigation and explanation of migration and development, either concentrating on the developmental reasons for migration or the impact of migration on development. This study focuses on the reciprocal relationship and the endogenous mechanisms of migration and development, taking place in the broader context of socio-economic-environmental development. Hence, an appropriate methodology for the research questions presented needs to fulfil the following eight requirements:

Firstly, it needs to be able to represent feedback relations and endogenous mechanisms. Secondly, it has to offer a connection to the broader socio-economic-environmental context. To explore the feedbacks of the system, the internal processes between the three spheres of this context, economy, society and environment, need to be presented endogenously. Thirdly, it is necessary that non-linear relations can be modelled, generating non-linear behaviour. Non-linearity means that the effect is not proportional to cause (Sterman 2000, 22). This can have two reasons. Either the direct causal influence of one variable on the other is not linear or there are contradicting causal connections shifting their dominance. An example for the first case is the non-linear support of prospective migrants by migrants already living abroad, which either facilitate further migration through network effects, or become “being



hesitant or unwilling to assist" (de Haas 2008, 20) depending on the size of the Diaspora. An example for the shift in dominance<sup>13</sup> causes the non-linear relationship between development and migration, described by theories such as the 'mobility transition theory'<sup>14</sup> or the so called 'migration hump' (de Haas 2008, 14).<sup>15</sup> This non-linear relationship is not due to a direct non-linear causal influence, but rather to the shifting dominance of contradicting effects and active structure, such as the dominance of the lack of means to emigrate that is replaced by the dominance of the decreasing will to emigrate. Non-linear relationships and behaviour can only be represented by using differential, instead of difference equations (Kopainsky 2005, 13; Richardson 1991a, 34). The fourth requirement concerns the objective of the study to add to the branch of applied research, aiming to "explore the dynamics of a social system" (Miller/Salkind 2002, 3) and contributing to the understanding of the system and its behaviour. Consequently, the methodology needs to take dynamic behaviour into account, meaning that the behaviour changes over time depending on what has happened before. Another relevant aspect is the inclusion of accumulation processes leading to delays and inertia within the system. That means that for example the accumulation of migrants abroad will only lead to network effects increasing migration after some time, or further investment in education from remittances only become visible after some years. The sixth requirement is the representation of net effects. Assuming that migration impacts development in positive and negative ways, it should be possible to derive the final outcome of these oppositional effects. Furthermore, the method has to focus on the aggregated country level, as it is mainly this perspective which allows the observation and exploration of feedback relationships (Richardson 1991a, 346). Although this decision involves some disadvantages (discussed later in section 3.1.1), these have to be accepted, as the research of the individual level cannot address the research question concerning the feedback relationships between migration and development. As a final requirement, the methodology has to be appro-

<sup>13</sup> *The shift in dominance facilitates the replication that e.g. at one point in time reinforcing feedback mechanisms can lead to exponential growth or decline, whereas at another point in time balancing feedback mechanisms are dominant leading to equilibrium. Another example is the shift in dominance in a simple population model introducing carrying capacity and will be presented in section 2.1.2.1, when introducing the main concepts of System Dynamics.*

<sup>14</sup> *The theory of mobility transition identifies five different phases of socio-economic development that are characterised by certain population growth and migration behaviour (see e.g. Zelinsky 1971; Skeldon 1997; de Haas 2008, 12; Kermer 2007, 162–165). Phase 1: traditional, pre-industrial society with low population growth and low migration levels; Phase 2: early transformative society with high population growth and increasing emigration; Phase 3: late transformative society: with decreasing population growth and decreasing emigration (although urban-urban and circular migration becomes more important); Phase 4: modern society with population growth that stabilises population, and increase of urban-urban and circular migration as well as of immigration levels; Phase 5: future society with probably small decrease in population growth and high circular and immigration levels (see Kermer 2007, 163f).*

<sup>15</sup> *According to this approach (harkening back to Easterlin 1961) the correlation of (economic) development and migration is non-linear, as an increase of pc GDP in low income countries firstly leads to an increase of migration, but after reaching a certain level of pc GDP further economic improvement causes a decrease of migration levels (Gächter 2000, 164–169; de Haas 2008, 16; Naudé 2010, 342; Vogler 2000, 49). For criticism, see Kermer (2007, 165).*

priate for a descriptive and not prescriptive analysis. As the research question is not a normative one, the aim is not optimisation.

The summarised requirements are listed in Table 1. Most of them are characteristics of a complex system. According to Sterman (2000, 22) complex systems are characterised by many interconnected variables, feedback relations, high dynamic (change over time), delays and non-linearity (effect is not proportional to cause) producing counterintuitive behaviour as cause and effect are often distant in time and space. Consequently, these systems tend to be policy resistant, since the described complexity overwhelms our human ability to understand. In addition, the results of policies implemented in those systems change over time and are often either positive for the long-run or for the short-run.<sup>16</sup> Richardson (1991b, 164f) points out that this phenomenon of worse-before-better and better-before-worse behaviour can lead to addiction, meaning that the action that improves the situation in the short-run is repeated even though it worsens the situation in the long-run, ignoring the endogenous mechanisms. Furthermore, these systems tend to drift to low performance, are remarkably insensitive to many parameters, and possess leverage points or influential pressure points where the loop dominance changes (Richardson 1991b, 164f). To sum it up, the research question refers to a very complex system. The following paragraph, will explain why the computational or simulation model has been chosen out of the presented methods as appropriate for the research questions.

#### *2.1.1.2 Simulation as Appropriate Modelling Method*

To choose an appropriate method for my research question, the requirements outlined above (section 2.1.1.1) are compared with the described modelling approaches, presented in section 2.1.1. Table 1 shows that all requirements can only be fulfilled by a simulation model. The following discussion will justify this outcome by explaining the reasons for the other models failing the fulfilment.

Although it is probably possible to describe very complex systems in verbal models using everyday language, there are three fundamental problems. Firstly, language is not very specific and it is very common for conditions, delays, and whether relationships are linear or non-linear, one-way or feeding back to not be explicitly defined, leading to much room for interpretation. Hence, more explicit models, developed on the basis of the verbal, could differ a lot, possibly generating very different behaviour (Hanneman 1988, 21–26). Of course, it could be argued that insufficiently defined verbal models are a problem, but verbal models are not necessarily insufficiently defined. That is why Table 1 shows that it is possible to rep-

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<sup>16</sup> According to Sterman (2000, 22) complex systems are also historically respectively path-dependent, self-organizing and adaptive. As these characteristics are not as relevant for this study they are only added in the footnote.

resent those attributes with verbal models. However, it has been questioned whether it is possible to describe very complex systems accurately with normal language (Johnson 1999, 1510). The second even more relevant problem is that it is nearly impossible to illustrate the implications of those complex systems using logic and language. As Burch (1996, 69) puts it: "When the number of variables in a system becomes large, when the relationships are non-linear, when there are interactions and feedbacks, and when the system is dynamic - it becomes awkward if not impossible to express the theory in everyday language, and virtually impossible to 'eyeball' the implications of the system, or to infer outcomes from specified inputs." Finally, without quantifying the positive and negative effects of migration on development, it is not possible to infer the (net) outcome, especially including the interactive, non-linear relations. To sum it up, by describing the complex system in natural language, even if it is done very explicitly and accurately, it is very difficult to derive its dynamic behaviour and to improve the understanding of those complex systems.

*Table 1: Model Requirements and Their Fulfilment by Different Model Approaches*

		Verbal models	Mathematical model		
			Empirical/statistical model	Analytical solution	Computational solution (simulation model)
1	Feedback relations	√	X	X	√
2	Endogenous representation of a broader socio-economic-environmental context	√	√	X	√
3	Non-linear relations and behaviour	√	X	X	√
4	Dynamic behaviour	√	?	?	√
5	Accumulation	X	?	?	√
6	Net effect	X	?	?	√
7	Aggregated country level	√	√	√	√
8	Description	√	√	√	√

**Source:** own table, on the basis of Gilbert/Troitzsch 2005; Hanneman 1988; Johnson 1999; Kopainsky 2005, 1514f; Martin 2009, 50; Morton 2009; Richardson 1991a; Sterman 2000

Empirical or statistical models are not appropriate for the research question, mainly because of three reasons. Firstly, "statistical models typically aim to explain correlations between variables measured at one single point in time" (Gilbert/Troitzsch 2005, 18). That means they are useful for the discovery and proof of the nature of one-way relationships between single variables (Miller/Salkind 2002, 3). For applied research, aiming at the exploration of the dynamics of a social system (Miller/Salkind 2002, 3) and improving the understanding of the system and its behaviour, they are not adequate, as feedback relations, dynamic processes instead of static correlations and the embedding in a broader socio-economic-environmental context are ignored. In addition, statistical methods are almost all based on the assumption of linear relationship and therefore only adequate for limited complexity (Gilbert/Troitzsch 2005, 10; Hanneman 1988, 21–26). That means that statistical

models don't seem to be appropriate for the investigation of complex systems. The third problem for the analysis of the presented research question is that they often focus on the individual instead of the aggregated level (Gilbert/Troitzsch 2005, 10). While they are useful to develop "sophisticated individual-level models" (Johnson 1999, 1511), it is difficult to use them for the aggregation of implications of those individual-level models (Johnson 1999, 1511). Hence, it is difficult to derive further insights concerning the aggregated implications of the knowledge gained through basic research. However, it is exactly the use of this knowledge from basic research derived by using empirical or statistical models which is absolutely essential for the investigation of the research question, meaning that the results of this kind of research concerning one-way relationships of single variables is used in the simulation model to infer aggregated implications about the behaviour of the whole system and the overall net outcome.

Finally, the decision to use a simulation model instead of a mathematical model which can be solved in an analytical way is due to the fact that analytical solutions are only appropriate for restricted complexity. While it is hard and often unfeasible to address non-linear dynamic feedback relations, parallel actions, the complex socio-economic-environmental context and to involve large amounts of variables / players with analytical mathematical models, this is possible using simulation models (Gilbert/Troitzsch 2005, 16; Humphreys 2003, 170; Johnson 1999, 1511/1518; Martin 2009, 50; Vennix 1996, 43f).

In conclusion, a model can be specified as a logical statement or as mathematical equations, solved analytically or in a computer program "but to learn something from the specification, we need to examine how the behaviour of the model develops over time" (Gilbert/Troitzsch 2005, 15). If the model aims at exploring the dynamics of such a complex system as it is the case for this study that neither a logical or analytical solution is possible, then a simulation technique can facilitate its investigation.

#### *2.1.1.3 System Dynamics as Appropriate Simulation Method*

After having described why simulation is the appropriate method for this study, the following paragraphs will firstly give a very short introduction to the simulation method, and afterwards justify why the simulation method System Dynamics (SD) has been chosen to analyse the research question of this study.

A possible definition is provided by Bratley/Fox/Schrage (1987, IX): "Simulation means driving a model of a system with suitable inputs and observing the corresponding outputs." Simulation can be used for several different purposes. In science, it is employed for formalisation, proof, understanding, discovery, and prediction.<sup>17</sup> "Simulation is a young and rapidly

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<sup>17</sup> In addition to science, simulations can be utilised for training (e.g. flight simulator) and education (using the

growing field in the social sciences" (Axelrod 1997, 21) enlarging the analyses possibilities for social sciences in general (Axelrod 1997; Gilbert/Troitzsch 2005; Humphreys 2003, 170f) and for political sciences in specific (Johnson 1999). However, it is still rather a niche existence<sup>18</sup>, not mentioned in some methodology books and widely dispersed throughout the journals (Axelrod 1997, 22), although simulation enjoys several advantages (see section 2.1.2.3).

There are several simulation approaches and several characteristics, with the help of which those different approaches could be categorised. The choice of the approach used in this study should be guided by the discussed necessary requirements listed in Table 1 (page 11). Accordingly, feedback relationships not only need to be considered, but are somehow at the heart of the analysis. Richardson (1991a) elaborates two main actual strands<sup>19</sup> (or as he labels them 'threads') being concerned with the analysis of feedback relationships. He terms the two directions the "servomechanisms thread" and the "cybernetics thread". While the cybernetics thread focuses on the question of control and conditions for chaos, concentrating on feedback relationships as balancing or counteracting mechanisms, and assuming that complex systems are not understandable as dynamics only happen due to filtered randomness (Richardson 1991a, 128/333), the servomechanisms thread is convinced that reinforcing and counteracting feedback relationships are intrinsic to reality and the key to understanding complex systems as they generate dynamic behaviour (Richardson 1991a, 160/333).<sup>20</sup> Consequently, as this study does not aim to find possibilities to control the system, anticipating and compensating for disturbances, but rather to aims to improve the understanding of the system with its internally generated problems, it is the servomechanisms thread that is used for this study. This choice is confirmed for many reasons upon checking against other main differences elucidated by Richardson (1991a, 333), but the most obvious one being that the cybernetics thread uses verbal models and not simulation models as its modelling and representation method.

For the servomechanisms thread, which is the adequate one for this study, four different approaches are presented out of which three do not fulfil all the criteria of Table 1. Firstly,

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*aspect of understanding through making different simulations), as a substitute for human capabilities (programming an expert system), and entertainment (Axelrod 1997, 22; Gilbert/Troitzsch 2005, 4f).*

<sup>18</sup> According to Johnson (1999, 1512) possible reasons for its rare use in political sciences are a lack of training and investment due to the focus on empirical and statistical research, the former high expenses for an limited availability of individual computers, and the danger of analysis becoming unmanageable and disorganised, because of the high complexity simulations often want to represent.

<sup>19</sup> According to Richardson (1991a, 93), these two strands emerged from the following six different intellectual traditions: biology-mathematical models, econometrics, engineering, social sciences, biology-homeostasis, and logic.

<sup>20</sup> To get a deeper understanding of the two different approaches of feedback thought in social science the interested reader is recommended to consult Richardson (1991a). Criticism from servomechanisms on cybernetics thread is outlined on p. 321-328, and criticism cybernetics on servomechanisms thread is summarised on p. 328-332.

econometric models<sup>21</sup> are composed of finite difference equations (in opposition to differential equations) (Richardson 1991a, 34–44), “are purely data driven and have no claim of causality in their structure” (Pederchini 2003, 5) and thereby fail to generate non-linearity endogenously (Richardson 1991a, 314). Secondly, control theory<sup>22</sup> in economics pursues the goal of optimisation instead of description. Thirdly, causal-loop diagramming<sup>23</sup> does not quantify the effects and therefore it is unfeasible for the derivation of the net effect.<sup>24</sup> The only approach presented for the servomechanisms thread which fulfils all criteria is System Dynamics<sup>25</sup>. Hence, SD seems to be the appropriate method for the investigation of the presented research question.

This result is confirmed when checking three further criteria of the requirements listed in Table 1. Accordingly, the method should be able to represent the socio-economic-environmental context endogenously, it should be able to give an aggregated view instead of the individual perspective and it should aim at description instead of optimisation. The evaluation of four different selections of simulation techniques by (Pederchini 2005)<sup>26</sup>, Johnson (1999)<sup>27</sup>, by Gilbert and Troitzsch (2005)<sup>28</sup>, Davis and Bingham (2007)<sup>29</sup> disclosed that the only method that fulfils all those criteria is System Dynamics.

To sum it up, the analysis of the feedback structure is the heart of this study. Out of the two threads concerned with those feedback relationships presented by Richardson (1991a) the servomechanisms thread seem to be more adequate than the cybernetics thread. Out of the four presented approaches of this first thread as well as out of other selection of modelling techniques, only System Dynamics fulfils the required characteristics of the method for

<sup>21</sup> *Econometric modelling is defined as a method of "statistical modeling and estimation of socioeconomic systems for prediction and policy analysis" (Richardson 1991a, 315).*

<sup>22</sup> *Control theory in economics is defined as the "application of optimal and adaptive control techniques from engineering to econometric models" (Richardson 1991a, 315).*

<sup>23</sup> *Causal-loop diagramming is defined as "striving to derive behavioral implications intuitively from causal loop diagrams of circular causal feedback systems" (Richardson 1991a, 315).*

<sup>24</sup> *However, this approach can be used to visualise feedbacks from a quantitative model and will be used for that purpose in section 4.1.*

<sup>25</sup> *System Dynamics is defined as a "computer simulation of continuous, non-linear feedback systems, emphasizing an endogenous point of view" (Richardson 1991a, 315).*

<sup>26</sup> *The assessment of nine different computer-based models currently used to analyse development options yielded that only two models using System Dynamics included social, economic and environmental aspects (Population-Development-Environment model and the Threshold21), while five models concentrate mainly on the economic part of the system without representing the social and environmental aspects of the system appropriately, one is mainly focussed on natural resources, and one excludes the environmental part of the system (Pederchini 2005).*

<sup>27</sup> *All simulation techniques evaluated by Johnson (1999, 1513) focus on individual actors.*

<sup>28</sup> *Out of the seven simulation research methods presented by Gilbert and Troitzsch (2005) four focus on the individual level and two focus on prescription. Consequently, the only simulation method of this selection that is concerned with the aggregate level in a descriptive way is System Dynamics.*

<sup>29</sup> *Two out of five approaches used in organizations and strategy literature evaluated by Davis and Bingham (2007) aim at optimisation (NK fitness landscape and genetic algorithms), one models the individual level (cellular automata), and one (stochastic processes) is "particularly applicable when the research question, assumptions, or theoretical logic does not fit with a structured approach" (Davis/Bingham 2007, 489). Consequently, also from this selection only System Dynamics remains as adequate modelling method, being evaluated as "particularly applicable for understanding the behavior of systems with complex causality and timing"*

this study, including non-linear feedback relationships and thought in an endogenous way (Richardson 1991a), representing the socio-economic-environmental context of development endogenously (Pederchini 2005), and being concerned with the aggregate level in a descriptive instead of prescriptive way (Davis/Bingham 2007; Gilbert/Troitzsch 2005; Johnson 1999).

### 2.1.2 System Dynamics

After having justified that System Dynamics is the appropriate simulation technique for this study, the next section will give a short overview about this approach, the main concepts, the modelling process and some advantages as well as disadvantages.

SD was invented in mid 1950s by Jay Forrester of the Massachusetts Institute of Technology (MIT) to improve the ability to understand complex systems (defined at the end of section 2.1.1.1). At the beginning it was mainly used in business<sup>30</sup>, but became more known in the 1970s, when it was used for the Club of Rome's project on the predicament of mankind, culminating in the publication of the highly discussed book "The Limits to Growth" (Meadows et al. 1972). In the following years, other science disciplines than business management got interested and nowadays, SD is applied in the field of environmental and political science, economics, medicine, engineering (Forrester 1991, 5), and development<sup>31</sup> (Pederchini 2009, 17) amongst others. SD can be applied in different ways<sup>32</sup>, and the aim of the application of SD in this thesis is discovery, analysis and understanding. By framing the underlying structure of a complex system, System Dynamics is supposed to reproduce the observed behaviour. This means that, based on research, findings and hypotheses from scientific literature, a structure is built that represents the dynamic hypotheses of how variables are interrelated, reproducing the inherent feedbacks, non-linear relationships and delays of the system, which are often a problem for our understanding. Using this structure to compare and analyse behaviours of different simulations (including different assumptions), to experiment and to discover will provide insights into 'how the system works'.

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(Davis/Bingham 2007, 487).

<sup>30</sup> It was, for example, used to analyse and improve the structures of operations sequences and decision making (Schade 2005, 25).

<sup>31</sup> The strand of studies applying SD for development issues was mainly started by Khalid Saeed and continued by the development of broader national development planning models, such as T21, developed by Millennium Institute and the Population-Development-Environment model developed by the International Institute for Applied System Analysis (Pederchini 2009, 17).

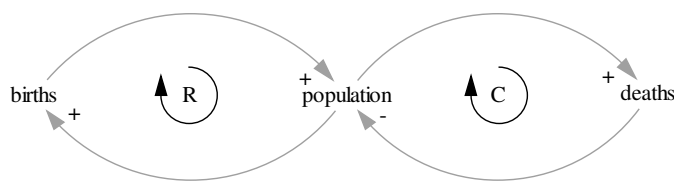
<sup>32</sup> Other possible applications for System Dynamics are firstly, teaching due to facilitating good visualisation and self-experiment (see e.g. Kopainsky et al. 2010), secondly, so called group model building aiming at making mental models of a group explicit, comparing it, agreeing on it (see e.g. Vennix 1996), and last but not least policy analysis, gaining insights into consequences of possible policies. Axelrod (1997, 3f) lists as possible purposes: prediction, performance, training, entertainment, education, proof and discovery.

### 2.1.2.1 Main Concepts of System Dynamics

The main concepts of SD are feedback thinking, which can be reinforcing or counteracting, the distinction between stocks and flows, being responsible for delays in the system, and the endogenous point of view, which is necessary for shifting loop dominance and the inclusion of non-linearities (Kopainsky 2005, 11). Those three concepts are described in this section.

First of all, as has been highlighted several times, the feedback concept is central to the SD approach, contributing “in significant ways to the evolution of the feedback concept in social science” (Richardson 1991a, 296). It means that there is a closed causal chain, a closed loop of mutual cause-and-effect, so that an effect perpetuates until it influences back to its initial cause<sup>33</sup>, after having passed one or any number of variables before. A feedback loop can be positive or negative, although these adjectives are not meant in a judging way. “Positive loops tend to reinforce or amplify whatever is happening in the system” (Sterman 2000, 12). That is why they are called reinforcing loops. “Negative loops counteract and oppose change” (Sterman 2000, 12), being termed as balancing or counteracting loops. As a simple example, the figure visualises the reinforcing (positive) and counteracting (negative) feedback of a simple population model (Kopainsky 2005, 12). While the reinforcing loop follows the logic that the higher the population the more births will happen, increasing the population etc, the counteracting loop reasons: more population will increase deaths, decreasing the population. It is important to note that the signs at the arrows head do not indicate increase or decrease, but only the polarity of the relationship (positive = same direction of change; negative = opposite direction of change): if births increase population increases, if births decrease population decreases.

Figure 2: Positive and Negative Feedback Loops in a Simple Population Model<sup>34</sup>



Arrows indicate the direction of causality. Signs ('+' or '-') at arrow heads indicate the polarity of relationships: a '+' denotes that an increase in the independent variable causes the dependent variable to increase, ceteris paribus (and a decrease causes a decrease). That is,  $X \rightarrow^+ Y \Leftrightarrow \delta Y / \delta X > 0$ . Similarly, '-' indicates that an increase in the independent variable causes the dependent variable to decrease; that is,  $X \rightarrow^- Y \Leftrightarrow \delta Y / \delta X < 0$ . The loop identifier (R) indicates a reinforcing feedback loop, (C) a counteracting feedback loop.

Source: Kopainsky 2005, 12

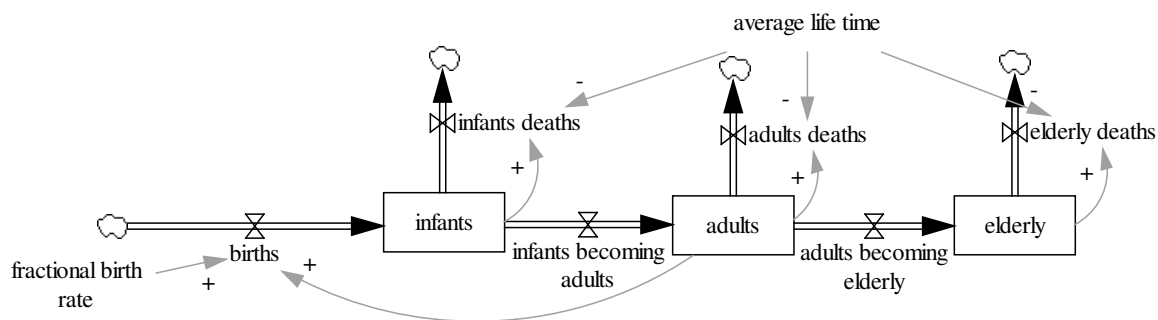
<sup>33</sup> Often, it can't be defined which variable started the feedback, being the initial cause, as this is exactly the question what was first, the egg or the chicken.

<sup>34</sup> Of course, this model is not complete as it ignores for example the very important effect of migration, being the focus of this study. For the moment, it is only used as a model for illustrating the main idea of reinforcing and balancing feedback loops.



The second crucial concept refers to the important status of stocks and flows. As soon as SD models are used for simulation and not only for illustration as above in Figure 2<sup>35</sup>, it needs to be identified whether a variable is a stock or a flow variable. “Stock variables are accumulations and indicate the status of the system through time” (Kopainsky 2005, 12), whereas flows represent the rate of change: they “increase or decrease a stock over some time interval” (Kopainsky 2005, 12), being either inflows or outflows. A stock can only be changed and thereby managed by a flow. This accumulation and decumulation is responsible for the delays in the system (Stermann 2000, 411). In the example of the population model (see Figure 2), population is a stock, whereas deaths and births are flows, changing the stock. Amending the structure, the stock of population could be subdivided into different age groups, such as infants, adults, and elderly, assuming that only adults are fertile and only the increase of that stock increases the flow ‘births’. By doing so, the delay inherent to the system is amplified, and an increase in births only feeds back with a delay of the time that is needed for the infants to become fertile respectively adults.

Figure 3: Stock and Flow Representation of a Simple Population Model with Delay



Source: own figure

Ignoring such delays is often the reason for mismanagement and instability, as policies are assumed to show effects as soon as they are implemented.<sup>36</sup> In addition, their existence impedes learning (Stermann 2000, 21ff).<sup>37</sup>

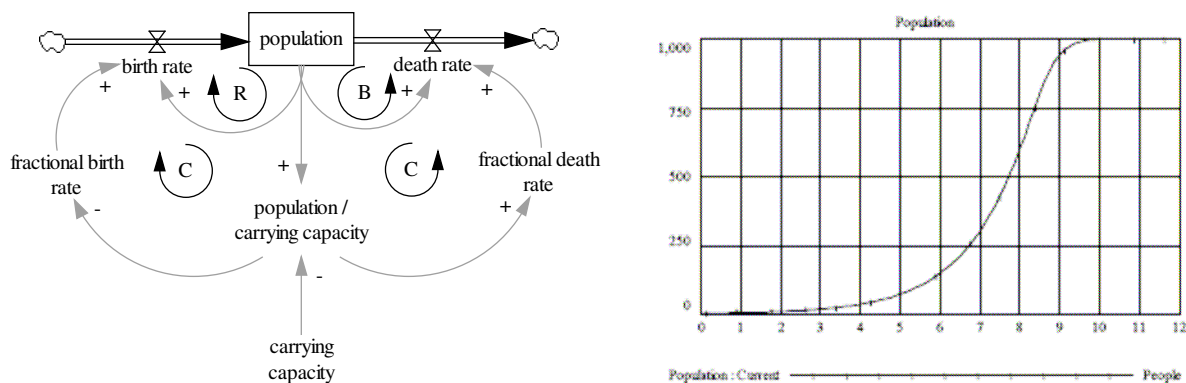
<sup>35</sup> In SD Figure 2 is called a causal loop diagram (CLD). This way of illustrating the structure of a system is used for capturing hypothesis about causes and dynamics, eliciting mental models of individuals or teams and communicating feedbacks and results of the analysis of a system. For further information see Sterman (2000, 137ff). To visualise the relevant feedbacks of this study, CLDs will be used in the Analysis part.

<sup>36</sup> Instability and mismanagement arise because the effect of the action taken is delayed, so that the action is continued until the effect is observable. That means that the effect of the action in the 'pipeline' is not considered, leading to an overshoot of the desired state. As an example, the fractional birth rate (in Figure 3) could be increased by policies aiming at a certain number of adults in the population. To augment the stock of adults the stock of infants is increased. When this policy is continued until the desired adult population is reached, the number of adults will overshoot the desired state as soon as the infants become adults, born in the years when there were already enough infants in the stock to become adult to reach the desired state, but the policy increasing the fractional birth rate was still in place (under the condition that it takes longer for adults to become elderly than for infants to become adult). For further information, please consult Sterman (2000, 21).

<sup>37</sup> Learning effects are assumed to be reduced, because more time is needed to 'cycle around the loops' and the past can not be compared to the current situation (Stermann 2000, 684ff).

The third essential concept is the endogenous point of view. Based on system theory<sup>38</sup>, SD focuses on the whole system, trying to understand and explain the dynamic behaviour by its endogenous relations and feedbacks rather than by exogenous input. Against this background, it is important that non-linear relationships can be represented endogenously, facilitating the shift of loop dominance and thereby altering the active or dominant structure (Kopainsky 2005, 13). Kopainsky (2005, 13) illustrates this shift of loop dominance introducing the carrying capacity<sup>39</sup> into the population model. The graph in Figure 4 shows that population first increases exponentially, then decreases its rate of growth, and finally reaches equilibrium as it approaches the limit to growth, namely the carrying capacity. This graph demonstrates the shift from the dominance of the reinforcing loop to the dominance of the counteracting loops, also termed as s-shaped growth.<sup>40</sup> With the help of SD, this shift can be generated from within the system (Kopainsky 2005, 12).<sup>41</sup>

Figure 4: Reinforcing and Counteracting Feedbacks in the Population Model with Carrying Capacity and Generated Behaviour



Source: Kopainsky 2005, 12

### 2.1.2.2 Modelling Process

Literature subdivides the modelling process in SD in several ways, ranging from three to seven different steps, but the fundamental activities remain nearly the same (Kopainsky 2005, 15). The following section gives a very short overview<sup>42</sup> of five different stages, namely problem definition, system conceptualisation, model formulation, model validation and policy

<sup>38</sup> In contrast to an analytical, mechanistic approach where the whole system is subdivided into its single components to analyse those in detail and elucidate simple, clear and reliable conclusions by reducing complexity, the system theory focuses on the whole system, the endogenous feedback relations of the single components and the resulting behaviour. Therewith, the insights concerning complexity are at the expense of simple, reliable conclusions referring single components (Schade 2005, 21)

<sup>39</sup> As a definition, "Odum (1989) and Rees (1992) suggested that carrying capacity is the number of individuals of a given species that a given habitat can support without being permanently damaged" (Hui 2006, 319).

<sup>40</sup> For further explanations of s-shaped growth, see Sterman (2000, 118ff).

<sup>41</sup> For a detailed definition and analysis of loop dominance, see Richardson (1995).

<sup>42</sup> For a detailed description, see Sterman (2000, 89ff).

analysis<sup>43</sup>, following Sterman's distinction (2000, 89ff), but using the terms proposed by Kopainsky (2004, 15).

As a first step, the purpose of the model needs to be defined, facilitating the decision about what should be included, and what can be ignored. This includes determining the problem or question, the time horizon<sup>44</sup>, the main variables, and identifying the historic behaviour of those main variables (Schade 2005, 27), the so called 'reference mode of behaviour' (Kopainsky 2005, 15; Sterman 2000, 90). The problem definition for this study is specified in the Introduction (see chapter 1).

Having defined the purpose of the model, the second step is the system conceptualisation. That means that a structure is conceptualised by identifying causal relationships between the variables of the system (Kopainsky 2005, 16), based on knowledge gained through literature review, expert interviews, etc. As SD aims at endogenous explanations, the causal chain for the main variables should be traced until explanations from within the model are found, closing and identifying the relevant feedback loops (Sterman 2000, 94ff). This automatically influences the definition of the model boundaries, being also an element of this second step, as model boundaries which are too narrow will leave important explaining variables exogenous, and therefore not necessarily improve our understanding of the system (Sterman 2000, 94ff). The final conceptualisation for this study is depicted in chapter 3<sup>45</sup>, adding the structure of migration to the broader national development model T21, explaining the causes of migration endogenously from within the system and closing the feedback loops by introducing the consequences.

As a third step, the conceptualisation of the system is translated into a simulation model. The model formulation includes the identification of mathematical equations for causal relationships, the quantification of the model's parameters, and the calibration of initial values and constants (Kopainsky 2005, 16). The elaborated simulation model that is used for this study is the outcome of this translation and is included in the CD that accompanies the printed version of the thesis (see Appendix F).

Once, a simulation model is formulated, the model validation starts, referring to model structure and behaviour (Barlas 1996), and defined as "the process of establishing confidence in the soundness and usefulness of a model" (Kopainsky 2005, 17).<sup>46</sup> A short overview about the validation process of the model for this study is given in section 3.1.4.

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<sup>43</sup> The final phase, called model use or implementation, is not mentioned, because this study focuses primarily on understanding the system.

<sup>44</sup> The time horizon is the time over which the behaviour of the system will be studied (Kopainsky 2005, 15).

<sup>45</sup> A simplified stock and flow representation of the migration-development structure is attached in Appendix A.

<sup>46</sup> It is not aimed at verifying or validating the model, as "valid implies supported by objective truth" (Sterman 2000, 846). However, as models are always a simplification of the real world, they never will be objectively

Although these steps are described one after the other, it is essential to bear in mind, that modelling is an iterative process, meaning that working on the model formulation can bring you back to change the system conceptualisation, and of course, testing behaviour and structure can lead to further specifications and changes within the preceding steps (Sterman 2000, 104).

A validated model is often used for policy analysis. That means that decision points are changed or new strategies are introduced and their effect on the system and variables of concern is analysed (Kopainsky 2005, 18; Sterman 2000, 103). However, the modelling exercise and the resultant simulations of the validated model can also be regarded as tools for discovering, and to further our understanding of how the system works (Miller/Salkind 2002, 46). This is the goal of the present study and to do so, chapter 4.2 analyses the system behaviour.

### 2.1.2.3 *Critical Evaluation of System Dynamics as a Simulation Method*

Having introduced the modelling technique SD, its main concepts and the principal steps of the modelling process, this section aims at briefly<sup>47</sup> discussing its main potential and deficiencies, since being conscious about them enables the user to judge if and under which circumstances the application is fruitful, and where its limits lie (Humphreys 2003, 166). Some of the following aspects concern simulation models in general, including SD, and some specifically refer only to the simulation technique SD.

As mentioned before, the first useful side-effect of simulation in general is that it can be seen as formalisation and explication of verbal theories, which is "much more precise than the textual form of the procedure and is therefore helpful in refining one's theory" (Gilbert/Troitzsch 2005, 3; see also Davis/Bingham 2007, 480/490ff; Humphreys 2003, 173). This is due to the fact that in opposition to verbal models a mathematical model cannot be run and consequently not be used without specifying constructs, relationships among constructs, assumptions, conditions, boundaries in an explicit way.

A second important contribution to science is that simulations, by putting together knowledge about discrete units and relations, often gained by basic research, make it possible to discover and explore the outcome and implications of theories in an 'artificial world' (Gilbert/Troitzsch 2005, 5; Hanneman 1988, 9; Johnson 1999, 1509; Davis/Bingham 2007, 480) being especially important as "it can be hard to anticipate the full consequences of even

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*true, but rather useful, illuminating, convincing etc. (Sterman 2000, 846). To do so, the validation is an important step in the modelling process.*

<sup>47</sup> As Axelrod (1997, 28) points out the discussion of strength and limitations needs a lot of space and reduces therewith the space that can be used for analysis. That is why only a short overview of advantages and disadvantages is presented. The interested reader is recommended to consult Davis/Bingham 2007; Gilbert/Troitzsch 2005; Hanneman 1988; Humphreys 2003; Johnson 1999.

simple forms of interaction." (Axelrod 1997, 24). Consequently, simulations are a very useful tool for applied research, asking for implications from basic research.

An additional value of simulations is that "[s]imulation allows the researcher to conduct experiments in a way that is normally impossible in social science" (Gilbert/Troitzsch 2005, 4) facilitating the discovery of counterintuitive behaviour and outcome generated by 'realistic' or counterfactual 'What if' scenarios. The outcome of these 'thought-experiments' (Axelrod 1997) is not to be taken as truth or prediction. Instead, their analysis can "clarify causal relationships and interdependencies" (Gilbert/Troitzsch 2005, 14) and improve the understanding of "the impact of alternative decisions" (Kopainsy 2005, 8), of the system and of its behaviour complementing the understanding gained by literature analysis (Sterman 2000, 35). Therefore, simulation can be seen as a third way between induction and deduction.<sup>48</sup>

A fourth important strength of simulations is their ability to investigate complex systems<sup>49</sup> and to reveal the counterintuitive behaviour generated by them which is hardly possible using other methods (Davis/Bingham 2007, 482; Gilbert/Troitzsch 2005, 10; Johnson 1999, 1525).<sup>50</sup> This is an important advantage, as it has been acknowledged that "[m]any of the political phenomena that seem important are prototypical complex systems" (Johnson 1999, 1525; see also Gilbert/Troitzsch 2005, 1; Hanneman 1988, 9; Richardson 1991a, 212).

Some features of SD compared to other simulation techniques have been clarified in section 2.1.1.3.<sup>51</sup> In addition, Pedercini (2003, 5) highlights that System Dynamics, being a causal-descriptive model, is distinguished due to its transparent and traceable representation of its endogenous explanations, in contrast to co-relational models, which are purely data driven, meaning that exogenous data input derives the results in a 'black box'. However, depending on the purpose of the research those features can be advantageous or disadvantageous and should not be generalised.

On the other hand, of course simulation in general and specially SD also contains disadvantages and risks as well. One important criticism of simulation in general, but also specifi-

<sup>48</sup> "Simulation is a third way of doing science. Like deduction, it starts with a set of explicit assumptions. But unlike deduction, it does not prove theorems. Instead, a simulation generates data that can be analyzed inductively." (Axelrod 1997, 24; see also Davis/Bingham 2007, 481; Gilbert/Troitzsch 2005, 26).

<sup>49</sup> As mentioned before (at the end of section 2.1.1.1), complex systems are characterised by dynamic feedback relations, non-linearities, delays, and multitude of variables, resulting in counterintuitive behaviour (e.g. Sterman 2000, 22).

<sup>50</sup> For example, most non-linear systems cannot be understood analytically and "[c]onventional statistical methods for analyzing social systems are almost all based on the assumption of a linear relationship between variables" (Gilbert/Troitzsch 2005, 10). In addition, for other methods it is difficult to take into account the diversity of activity (Johnson 1999, 1525) or to "reveal nonintuitive elaborations" (Davis/Bingham 2007, 482).

<sup>51</sup> For example compared to econometric models SD is able to generate non-linearity endogenously and, and represent causality instead of correlations. In contrast to other simulation methods, SD aims at description instead of optimisation, facilitates the derivation of the net effect, and the inclusion of endogenous processes between different sectors (such as economy, society and environment in the case of national development) and to give an aggregated view instead of an individual one.

cally of SD has been passed for the tendency or danger of developing highly complex, and very detailed models, which are hardly understandable even for the modeller him- or herself (Axelrod 1997, 6; Johnson 1999, 1512; Schade 2005, 39). On the other hand, as has been outline above, one of the essential potentials of SD in specific and simulation in general is to represent complex systems and to do so, of course, the complexity should not be reduced too much. In addition, this criticism for including too many details and complexity is not SD specific, but rather a problem for research in general (see Dür 2007, 290; Ganghoff 2005, 79). Aiming at simplification and generalisation of reality, it seems to be a general problem of all modelling techniques (including verbal models) to find the balance between being too realistic, including too much complexity and details or being too abstract, meaning that the model seems unrealistic and artificial (Johnson 1999, 1524). On the one hand, being too realistic can lead to so much complexity in the models that they are hard to be understood and proven completely accurate (Axelrod 1997, 23). On the other hand, being too abstract can result in an "overly simplistic and distant model that fails to capture critical aspects of reality" (Davis/Bingham 2007, 495f). That would reduce external validity. However, the danger of constructing too detailed models is probably higher for simulation than for analytical mathematical or statistical models, because with those it is simply not possible to include high complexity (as outlined above). On the other hand, compared with verbal models the complexity that can be represented in simulation models is smaller as all variables and relations need to be explicitly defined, conceptualised and operationalised (a claim for all models, which is easier to circumvent in verbal models than in simulation models). At least, SD has the guideline to rather concentrate on capturing and closing feedback loops in order to integrate the main endogenous explanations instead of focussing on a detailed specification of individual components (Sterman 2000, 96).

A second challenge of simulation in general concerns the claim of science to be replicable. Although it is principally possible to replicate all simulation models, the necessary description needs to be quite detailed, so that it often exceeds the scope of the paper or work and reduces the place for analysis. In addition, some simulation techniques suffer a lack of clear standards as they are quite young (Johnson 1999, 1524). However, this problem can be circumvented by adding the detailed description or the model itself as an appendix.

A third problem of simulation in general concerns the claim of contribution to knowledge accumulation, being the fundamental idea of research and science. This objective is more difficult for this young method due to a lack of training of maths and simulation in the social scientist society (Hanneman 1988, 25) being followed by a limited understanding of and familiarity with this research and therefore a higher need for explanations of the method, shortening the place for analysis. Therefore, the knowledge accumulation is complicated.

Yet, this should be no reason to refrain from the utilisation of a method as long as this method is seen as beneficial, but rather a reason for advocating more training.

Fourthly, it is argued that it may be difficult to 'write' with mathematics in addition to material phenomena (things) about cultural phenomena (the meaning of things) (Hanneman 1988, 21–26). It is true that it is often difficult to include cultural concepts and so called 'soft variables' such as for example 'trust', but there are studies doing that.<sup>52</sup>

A fifth SD specific difficulty is the misunderstanding of this modelling technique as a prediction technique. While there are simulation techniques aiming at prediction<sup>53</sup> SD models and their simulations are tools for discovery, for experimentation, for research and for learning, not primarily for prediction (Sterman 1991, 227). However, the misperception as a prediction technique has caused a lot of criticism for example in the book 'Limits to growth' for having 'predicted' things that did not happen (e.g. Lomborg 2001, 121),<sup>54</sup> being unjustified as the authors highlighted that the their report does not contain prediction, but "indications of the system's behavioral tendencies only" (Meadows et al. 1974, 100). Consequently, to avoid this kind of misperception it seems to be necessary to emphasise the purpose and the conditions and assumptions of the model and its scenarios as explicit as possible.

As a sixth deficiency, SD could be criticised for being a deterministic model, as deterministic relationships are rare in social science (Héritier 2008, 64). Nevertheless, in contrast to the probability distributions of probabilistic models, deterministic models permit simulations with unambiguous results, facilitating researches aiming at understanding basic interconnections and dependencies in a system (Kopainsky 2005, 8). Hence, these unambiguous results in the form of data rows are necessary for gaining understanding but of course, they should not be taken as predictions (see above).

Finally, Schade (2005, 39) highlights the problem that the modelling technique SD is easy to learn, leading to possible utilization without having acquired the basic knowledge of its underlying philosophy. However, insufficient knowledge is a problem for the use of all methods. In addition, the relatively easy application can be advantageous when the models are used by different actors in the planning process (Pedercini 2003, 21) and for learning about com-

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<sup>52</sup> One example of such an analysis about the determinant of trust is Luna-Reyes et al. (2008).

<sup>53</sup> Although it has been highlighted that even though some simulation techniques aim at prediction also the data rows of these techniques should not be perceived or taken as truth, loosing the consciousness that all models with their produced outcome are also only models, based on assumptions, which need to be proven and criticised (Martin 2009, 50).

<sup>54</sup> The book that increased the awareness level of SD and contributed very early to the 'sustainable development' concept (Schade 2005, 25) explored the consequences of (exponential) growth in a world with finite resources, arguing that there are limits to growth. According to one of the presented scenarios oil reserves would be emptied by 1992, assuming amongst others constant exponential growth and no further discoveries of new oil sources (Meadows et al. 1972).

plex systems, their features and the underlying philosophy through experimentation (see e.g. Kopainsky et al. 2010).

In summary, several problems of simulations in general can be listed, such as the balance between abstraction and the representation of the real world, the difficulties of replication and knowledge accumulation, and the problem of representing cultural phenomena using mathematics. For SD specific challenges have elucidated, such as the danger of perceiving simulations as truth, its deterministic approach, and finally, its user-friendliness. For most of these criticisms possible counterarguments have been presented. On the other hand, simulation in general is a method that helps to formalise verbal theories, making them explicit, facilitates the exploration of the aggregated implications of theories, allows the analysis of complex systems, and enables social scientists to conduct experiments and consequently, can be seen as a tool for discovery and improving understanding, going a third way between induction and deduction. SD in specific is characterised by its high potential to generate the non-linear behaviour of a complex system, endogenously replicating the causal structure in a transparent and traceable way. Especially for the research question of this study, exploring the feedback relation of migration and development in the very complex context of broader national development, the potential seems to outweigh the deficiencies.

## 2.2 Case Selection and Observations

After having chosen the use and expression of models, the second part of the methodology choice concerns the case selection. The following two sections will address the choice for the number of cases and observations that are investigated<sup>55</sup> and which case is chosen.

### 2.2.1 One Case and Many Observations

It has been stated that the choice of how many cases are investigated influences the external validity of the results (Gschwend/Schimmelfennig 2007, 24–28; Hönnige 2007, 225; Leuffen 2007, 207). External validity concerns the question as to whether generalisation is possible (Héritier 2008, 62). Now, there are two ways for generalisation. Firstly, it is possible to increase the number of cases, e.g. countries, to strengthen the confidence that the results are not only valid for the one special country under investigation, but can be generalised to other countries. Secondly, the number of observations of the same case, e.g. country, can be investigated at different instants in time (see Collier et al. 2004, 250ff) leading to higher confidence about the generalisation of the results over time for the investigated case, validating the results of the model (Hönnige 2007, 239).

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<sup>55</sup> Muno (2009, 113) distinguishes between qualitative (small *n* approach), quantitative (large *n* approach), single case study, whereas Plümper (2008, 66ff) differentiates between single case study, comparative case study, quantitative analysis, quasi experiments, and experiments.



Concerning the number of cases, this study applies a single case study, instead of a large scale or comparison approach, reasoning that the choice depends on the aim of the study (Plümper 2008, 25). If the aim were to test or validate the causal relationship of some variables, the number of cases should be high and a so-called large n approach should be applied, increasing the confidence in the generality and thereby the external validity of the investigated theory (Gschwend/Schimmelfennig 2007, 24–28; Hönnige 2007, 225). However, for in-depth investigation aiming at discovering causal processes and mechanisms, increasing their observations, and improving their understanding it has been recommended to choose the single case study approach (Gschwend/Schimmelfennig 2007, 24–28<sup>56</sup>; Hönnige 2007, 225; Leuffen 2007, 207). Consequently, this study is a single case study, as it aims at discovering causal feedback relationships, uncovering the generated causal mechanisms, and strengthening the understanding of those and the generated behaviour, using the causal relations that have been already validated by other studies. In other words, the present study uses the gained knowledge from other investigation with a large scale approach to add to the in-depth knowledge. A further reason for the single case study approach is the conclusion by some researchers that the impacts of migration on development tend to be quite country specific (Appleyard 1989, 493; de Haas 2010, 240). Analysing just one country, the study makes allowance for this.

Referring to the number of observations, they have been increased for this study to enhance the validity of the model and its behaviour. The decision was made to start the simulation in 1980. Hence, by modelling the structure of the system and comparing the generated data with the historical data of the past thirty years, the confidence in the results of the model and its validity is upgraded.

Nevertheless, this choice for in-depth analysis is at the expense of generalisation to other countries, which would be possible through large scale investigations. That is why Hönnige (2007, 225) concludes that the maximum of generalisation and acceptable depth of analysis at the same time can be reached with most-similar and most different system design, meaning by comparison approach.<sup>57</sup> Unfortunately, a comparison falls beyond the scope of this study, because of two reasons. Firstly, the model that is developed is highly complex and comprehensive, integrating a lot of interrelated variables as it aims at representing the complex socio-economic-environmental context of the investigated country. Secondly, due to the high number of observations, already the investigation of one country requires a huge amount of data for validation of the model behaviour. The research of these data and the

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<sup>56</sup> Gschwend and Schimmelfennig (2007, 24) call this approach process-tracing.

<sup>57</sup> The only exceptions where the results of a single case study approach can also be generalised according to Hönnige (2007, 225) is the approach of so called 'crucial case study' (Hague et al. 1998, 277) and 'tough cases' (Leuffen 2007), an expression for those cases where it is difficult to validate or falsify the hypothesis.

modelling of another country would be too time-consuming, and too high an expenditure in terms of cost and time is also recognised as a reason for a small case approach (Leuffen 2007, 207). Then again, it can be argued that it is doubtful whether the level of complexity is actually absolutely necessary and that it is maybe more worthwhile to increase the number of cases, having in mind that Leuffen (2007) warns of the diminishing marginal utility of in-depth analysis. That means that instead of increasing the depth of analysis, there is a point where increasing the width, the number of cases, would add more knowledge. In other words, according to Leuffen (2007, 213f) the case analysis should be as detailed as necessary and as broad referring to the number of cases, as possible. However, as outlined in the introduction, the aim of this study is to investigate exactly the complex interrelationships and endogenous processes of migration and development, as this is something that has not been done by research up to now, while single causalities have already been investigated a lot. Therewith, the decision seems to be justified in its concentration on in-depth analysis at the expense of the width of analysis.

Another aspect of the problem of validity and generalisation is that the choice of a single case study approach entails the heightened danger of selection bias, meaning an erroneous inference of one case to the universe of cases due to incorrect selection, for example the choice of an outlier that is assumed to be a representative case (Leuffen 2007, 204f). This danger can be diminished by identification of a homogenous universe (Hönnige 2007, 233). By subdividing the whole universe of cases into small homogenous universes of cases based on theoretically relevant characteristics and choosing one representative country for the group of concern, the attempt is made to reduce the danger of selection bias (see the following section 2.2.2). Consequently, it is assumed that the results of the chosen case could, to a certain extent and with a lot of caution, also be applied to the countries featured by the same theoretically relevant characteristics. At least the results could build a point of departure.

Anyway, for further investigations it could be interesting to carry out a comparison, based on the results of this present study, investigating whether the results can be generalised to other countries and if so, further enhancing confidence and external validity.

### 2.2.2 Senegal as a Single Case Study

As this study aims at discovering new insights for a topic that has not been investigated using the presented approach, the chosen case should be a representative, instead of an outlier. An outlier would rather be interesting for the search of explaining factors for cases that cannot be explained by existing theory (Evera 1997, 86). To select one country where the

research question is relevant and which can be considered to be a representative of a group of countries, the whole universe of cases is subdivided by theoretical relevant characteristics.

The first two relevant characteristics are quite obvious due to the fact that the research asks for the relationship between migration and development. Consequently, countries, for which the research could be relevant, should dispose of significant levels of emigration, and as I am focussing on the emigration to OECD countries, the emigration to OECD countries needs to be considerable. In addition, the countries of concern need to have low development levels because of two reasons. Firstly, the countries which are grouped as a more or less homogenous group concerning the relevant characteristics for the research should have a similar development level, as "it is readily acknowledged that specific measurable impacts of labor emigration on development should be made within the context of a country's stage of economic evolution" (Appleyard 1989, 487f, see also de Haas 2010, 256ff<sup>58</sup>). Secondly, the question of development is relatively more urgent for countries with low development levels than for other countries. Finally, one important condition for the model is a certain degree of political stability. This is due to the fact that on the one hand, political instability has very significant impacts on the development of a country (see e.g. Barro 1991; Fosu 1992; Nafziger/Auvinen 2002; Stewart et al. 1997). Hence, a certain level of political stability or at least the absence of war can be seen as a precondition for development. On the other hand, conflicts and wars are excluded variables<sup>59</sup> in T21, and it falls beyond the scope of this study to model their endogenous explanation. One reason for not being included in the model as an endogenous variable is probably that the causes for political instability are quite diverse and that conflicts, their starting point, and their development are rather unforeseeable. Consequently, as the absence of war is a precondition for the causal relations explaining development in the model, but can't be modelled endogenously, political stability should exceed a certain level in the past, and for the future, it needs to be assumed that it continues to exceed that level.

Starting with the characteristic of low development level, the lowest one is chosen, as different graduations of those levels exist. Now, there are several ways of grouping those countries plagued by lowest development levels and it is striking that the majority of those countries, independently of the way of grouping, are situated in sub-Saharan Africa<sup>60</sup>: 34 of the 54

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<sup>58</sup> De Haas (2010, 257f) underscores that the impacts of migration on development is quite dependent on the general development condition, criticising the agency approach, that ignores the fact that structure of the country matters, and that individuals have limited ability to overcome these. On the other hand, he also criticises the structuralist view for underestimating the impact of individuals.

<sup>59</sup> The model exhibits endogenous, exogenous and excluded variables, depending on the model boundaries. Further explications, see section 3.1.2.

<sup>60</sup> In this study sub-Saharan countries are those 48 countries as defined in the WDR (World Bank 2006, 347). According to UN, there are only 45 countries, defining for example Sudan as an Arab state (UNDP 2010, 226-

low income countries (LIC) (World Bank 2006, 347)<sup>61</sup>, 32 out of 53 least developed countries (LDC)<sup>62</sup>, and 34 of 42 countries with low Human Development Index (HDI) (UNDP 2010, 145f)<sup>63</sup>. For this study, as it applies a broader development approach, the group of countries with the lowest HDI are of special interest and to increase the homogeneity of the countries, acknowledging the fact that countries from the same continents are more homogenous than from different continents, only sub-Saharan countries are under investigation.

Out of those 34 sub-Saharan countries 15 countries dispose of a significant level of emigration, being defined as a higher emigration rate<sup>64</sup> as the average of those sub-Saharan African countries with a low HDI (UNDP 2009b, table A).<sup>65</sup> For eight countries the importance of emigration to other African countries seems to be more considerable than the emigration to OECD countries. This is shown by the fact that the majority of remittances received in those countries are from African and not from OECD countries (UNDP 2009b, table E; see also Appendix A). As the excluding criteria coincide in one country, there are eight countries left fulfilling the criteria so far. Looking at the political stability<sup>66</sup>, 17 of the 34 countries were assessed to be beyond the necessary level of political stability.<sup>67</sup> As 14 of these countries were already excluded due to the previous criteria, the homogenous universe of cases are five countries, namely Senegal, Gambia, Mauritania, Ghana, and Comoros. A table listing the 34 countries and the criteria is provided in Appendix A. These countries do not form a totally homogenous group, especially with Comoros being an island state in the very south of the continent. However, it has been underscored that not all characteristics need to be similar, but only the theoretically relevant ones to assume that inference is possible (Hönnige 2007, 247). Since it has been shown, that those five countries share the characteristics of interest for the research question, it is assumed that the results of a single case study for

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227).

<sup>61</sup> Only looking at income, *The World Bank* subdivides all countries in their *WDR* in LIC (low income countries), LMC (lower middle income countries), UMC (upper middle income countries), and countries with high income, depending on their per capita gross national income (GNI) (see e.g. World Bank 2006, 347).

<sup>62</sup> This is a category by UN representing "the poorest and weakest segment of the international community" (UNOHRLLS 2011a). They are identified by three criteria: low-income, low human capital status, and economic vulnerability (UNOHRLLS 2011b).

<sup>63</sup> The countries are subdivided in four groups with a very high, high, medium and low HDI. In 2010, UNDP changed their scoring system. That is why in *HDR* 2009, 24 countries were categorised as exhibiting a low HDI, out of which 22 were sub-Saharan countries (UNDP 2009a, 213).

<sup>64</sup> Emigration rate is defined as "The stock of emigrants from a country at a particular point in time expressed as a percentage of the sum of the resident population in the country of origin and the emigrant population" (UNDP 2009a, 209).

<sup>65</sup> As indicator the emigration rate from 2000-2002 is taken. For those years the average emigration rate in the sub-Saharan countries with low HDI was 3.6 (see Appendix A).

<sup>66</sup> The indicator used in this study is taken from *World Governance Indicators* (WGI). There, political stability and absence of violence captures "perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including domestic violence and terrorism" (Kaufmann et al. 2009a, 6).

<sup>67</sup> The countries are defined to be beyond the necessary level when the score of the indicator 'political stability and absence of violence' of the WGI (Kaufmann et al. 2009b, Table 'Political Stability No Violence') was assessed with a value below one in a scale from 0 to 5, 5 being high political stability, in one of the last 15 available years (see Appendix A).

one of those countries could also apply to the other four countries. However, to test this assumption, another country out of those five would need to be investigated using the same approach and the results should be compared. This would increase the validity of the results, although it still does not mean that the results are valid for all countries.<sup>68</sup>

Out of these five countries, Senegal has been selected, because it has already been chosen by other studies as a representative for south-north migration from sub-Saharan countries (Zoomers/van Naerssen 2006, 22). In addition, the state of data, although still difficult, is slightly better than in other countries, because Senegal was among the investigated cases in several empirical research projects.<sup>69</sup> Finally, donor circles provide resources for the provision of reliable information, as Senegal is a pilot country for improving migration statistics (Zoomers/van Naerssen 2006, 32).

Summing up the above, it has been shown that the choice for number of cases and observations influences the external validity, meaning the possibility for generalisation. For the present study the number of observation has been increased to 30 years to increase the confidence that the results can be generalised over time, even though only one case will be investigated, because the primary aim is discovery, and therefore in-depth investigation, instead of testing and a large n approach. The decision for a single case study generally impedes the inference to other countries, especially as the universe of cases is very heterogeneous and the impact is country specific. Nevertheless, to increase the possibility of generalisation, out of the whole universe of cases a group of countries is extracted that are characterised by the same theoretically relevant criteria, assuming that the results of this study could be similarly applicable to similar countries. As outlined before only five countries were defined as the homogenous group relevant for the study. This is a quite small universe of cases and it could be questioned as to whether the study becomes irrelevant as it represents less than one tenth of all African countries. On the other hand, reducing the criteria and thereby increasing the number of cases within the homogenous group would diminish the homogeneity and therefore the possibility for generalisation. Furthermore, the topic of migration and development is highly discussed and there is a call for closing the feedback loop and investigating the consequences. Hence, as it is not feasible to go in-depth and in-width at the same time; especially within the scope of this study, concentrating on a small universe of cases seems justified. After all, there are several ways of improving the validity of the re-

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<sup>68</sup> It has been highlighted that 'total' validity does not exist. The only final judgement about a theory can be made by falsifying (see e.g. Sterman 2000, 846ff).

<sup>69</sup> In 1982 a study on migration from Senegal River valley to France was carried out (see Condé et al. 1986; Findley et al. 1988). In 1993, beside Burkina Faso, Guinea, Ivory Coast, Mali, Mauritania, Niger, Nigeria, Senegal was part of the 'network of surveys on migration and urbanisation in West Africa' (Bocquier/Traoré 1998; CERPOD 1995). Recently, the International Migration Survey selected Senegal and Ghana as cases for migrant-sending countries in West Africa, and collected there primary data on migration (see Eurostat 2000).

sults. Firstly, it is desirable to test the results by comparing the present case with another case of this homogenous group, increasing the validity of the results. Secondly, the analysis and comparison of cases with other criteria, such as medium HDI, lower emigration rates, or mainly emigration to Africa would be interesting and could increase the gained insights. Due to the fact that these further steps go beyond the scope of this study, I will act on the advice of Leuffen (2007, 211) that as a first step it is more desirable to concentrate on one group of the universe of cases, instead of analysing as many different types of the existing universe of cases, although this should be the final objective.

### 2.3 Data Collection

This section outlines which kind of data is used, what the inherent problems are and how this study will deal with them.

Simulation models, being mathematical models, require quantitative data with metric units. As described above, this data is not to 'feed' the model, but to be able to compare the generated behaviour of the model, which is generated by the structure built on the base of the state of the art theory, with the historical data thereby validating the model. Regardless of the way of using quantitative data, its use is accompanied by several problems, but also by some advantages compared with qualitative data. For example, it is difficult to operationalise qualitative concepts of social sciences such as 'development' (see section 3.2.2), 'democracy', 'good governance' or social phenomena such as ideologies, interests or decisions in a quantitative way, obtaining metric units (see e.g. Bürklin/Welzel 1994, 333). Furthermore, if doing so, it often leads to a very high data requirement, higher than in natural sciences, as the behaviour of humans differs more than that of molecules (Humphreys 2003, 171). Finally, qualitative data is less standardised and thereby more flexible for the exploration of the research question and contextual details (see e.g. Bürklin/Welzel 1994, 333). Hence, Weiss concludes that "[q]ualitative data are apt to be superior to quantitative data in density of information, vividness, and clarity of meaning" (Weiss 1968: 344f). On the other hand, the high level of standardisation is accompanied by a higher level of precision, reproducibility, and generalisation. In addition, metric data allows the calculation of the overall net outcome, for example of a stock with an in and an outflow (see section 2.1.2.1). Finally, the collection of quantitative data is sometimes appraised as being less time consuming, to name just a few of the advantages and disadvantages of quantitative and qualitative data research. Nevertheless, it has been widely acknowledged that especially for the migration topic, the available data is exceedingly problematic. In addition to the general rather difficult state of data in developing countries, "[d]ata on international migration is hampered by the fact that borders in sub-Saharan Africa are porous, and that official statistics fail to capture informal/illegal migration" (Naudé 2010, 333). Furthermore, the definitions differ (e.g. regarding labour migration vs. refugee movement), there is a lack of long-time series, and it

tion vs. refugee movement), there is a lack of long-time series, and it is international data, meaning that the crossing of borders requires an exchange or some kind of coordination. However, not all countries collect data and the quality differs a lot. Hence, Gächter (2000, 172) concludes that the main problem of migration research is due to data problems.<sup>70</sup> Certainly, migration is obviously a topic where data collection is very difficult and where it is doubtful that available data is very reliable. There are scientists advocating that research with very uncertain data is problematic and should be avoided. However, other scientists argue that “the larger danger lies in pointlessly ‘looking under the light’ when the object sought lies in darkness but could with effort be found. Large parts of social science have already diverted their focus from the important to the easily observed, thereby drifting into trivia” (Evera 1997, 47). The research aim should be primarily guided by theoretical or empirical questions, not by technical rules, such as only investigating observable concepts, since this could really lead to irrelevant research as most of the concepts in political science are difficult to observe (Miller 2007, 131). Nevertheless, there is an evident problem concerning the reliability of the quantitative data that are necessary for the present study. To increase this, it has been advised firstly, to work with secondary sources, as they facilitate good documentation, allowing the reader to recheck them (Miller 2007, 135). Secondly, it is advisable to ensure the data by different sources (Miller 2007, 135). Finally, most textbooks recommend the combination of quantitative and qualitative approaches, e.g. statistical data and expert opinion, the so called triangulation<sup>71</sup> (Jick 1979, 602). Consequently, this study tries to mitigate doubtful reliability of data by using aggregated statistical data from well-known, esteemed secondary sources, such as the data bases of the World Bank, IMF, UN-agencies, IOM, and the national statistical office, but also data and assumptions derived from literature review. In addition, this data is verified by a Senegalese expert commission that also reviewed and discussed the model structure. Finally, one expert interview was undertaken with Mrs. Ndioro Ndiaye<sup>72</sup>, amongst others Deputy Director General of the International Organisation for Migration (IOM) from 1999 to 2009, who founded “an agency for promoting the analysis, dialogue, study and training in migration and leadership as well as the impact of these on Africa’s development” (AMLD 2011, Preamble in their statute) called ‘Alliance for Migration, Leadership and Development’ (AMLD)<sup>73</sup>. Although it is obvious that more expert interviews would have been desirable, this was not possible due to limited time resources in the coun-

<sup>70</sup> That is why he proposes to change from migration studies to the exploration of sedentariness (Gächter 2000, 172)

<sup>71</sup> For further information about the meaning and the ways of performing it, see Jick (1979).

<sup>72</sup> Before being President of AMLD, Mrs Ndioro Ndiaye filled numerous high-level positions, amongst others working as Deputy Director General of IOM and as Minister for Social Development and as Minister for Women's, Children's and Family Affairs of Senegal. For further information about her activities see Appendix B.

<sup>73</sup> For further information about the non-governmental organisation (NGO), please see AMLD (2011).

try, as the comprehensive discussions with the expert commission required nearly all the time that was spent in the country.<sup>74</sup>

To conclude, it has been shown that the use of quantitative data is accompanied by problems of reliability, especially for the topic of migration. As the chosen method approach requires the use of those data, some measures have been presented to improve the reliability, among them the use of reliable secondary sources in form of data bases and literature, as well as review by national experts in the form of group discussions as well as an expert interview. This does not ensure that the data is absolute reliable, but at least it enhances the reliability.

## 2.4 Interim Conclusion

Summing up the whole first chapter, three aspects of the methodology have been addressed. Firstly, based on the developed requirements for this research, it has been shown that applying a simulation model is the most promising approach. Out of the existing simulation approaches, System Dynamics has been chosen as the most appropriate one and therefore its main concepts, the modelling process and the inherent advantages and disadvantages of this method are presented. Secondly, it has been justified that the present research applies a large scale approach in a temporal dimension, meaning a high number of observations, but is a single case study, concerning the number of countries. A restricted possibility for generalisation is facilitated by extracting a homogenous group of five countries out of the whole universe of cases fulfilling the theoretically relevant criteria, and choosing Senegal as one case out of this group, assuming that some inference to the other four countries could be possible. Finally, the problems with the used quantitative data have been discussed and measures taken to counteract these problems have been presented.

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<sup>74</sup> Further information about the expert input can be found in Appendix B. The original interview with Mrs. Ndioro Ndiaye is included in the CD that accompanies the printed version of the thesis.



### 3 Analytical Framework: Theory Based Model Structure

This chapter presents the analytical framework of this study. This is manifested in the model that has been built for analysis in the fourth chapter. To portray this model, this chapter is subdivided into five different parts. The first part outlines some general features. The second part depicts the definition and specifications of the key variables. The following two parts establish and justify the newly developed causal structure for migration. While the third part discusses the causes for migration addressing in detail which theoretical approaches are in- and excluded, the fourth part sketches the consequences of migration distinguishing between the discussion of the general impact on development, and the single direct effects of emigration that are represented in the model. Finally, a short interim conclusion summarises the whole chapter.

#### 3.1 General Features of the Model

The model developed for this study aims at representing the causes and consequences of emigration from Senegal to OECD countries, embedding them in the broader development context with the purpose of exploring the inherent feedback relationship of migration and development on a macro-level, as well as the behaviour of the system by means of simulations. To do so, the national development planning model T21-Senegal is amplified by the integration of causes and consequences of this emigration in an endogenous way. Therefore, relevant causes and consequences were extracted from literature, on the basis of which a structure was built. The following subchapters present the above-mentioned general features of the model, being the unit of analysis, the connection to the broader development context, the time horizon, the model boundaries and its validation.

##### 3.1.1 Unit of Analysis

The unit of analysis for this study is the country Senegal on an aggregated level. This was one of the requirements for the method selection due to the fact that this perspective facilitates the observation of feedback relationships (Richardson 1991a, 346), not being possible to apply an individual perspective. However, it implies several disadvantages. For example, it is not possible to infer results from the macro-level to the micro-level without knowing the distribution (Vogler 2000, 72). This is especially relevant when it comes to income distribution, because it indicates the level of inequality, an important variable for development (see section 3.2.1), and the effect of raising income on migration is also dependent on distribution.<sup>75</sup> On the other hand, Vogler (2000, 74) mentions that this problem is more severe for cross-sectional studies of several countries than for longitudinal studies of one country. An-

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<sup>75</sup> An increase in the average pc income can either signify that more people stay when higher income groups profit from that increase and they have no reason to migrate anymore, or that more people migrate when the increase benefits poorer income groups, enabling them to migrate (Vogler 2000, 74).

other disadvantage of the country-wide aggregation is that the different experiences of individuals or communities are not taken into account although they can strongly differ from the overall aggregated country perspective or may even be oppositional.<sup>76</sup> Nevertheless, there are also several reasons in favour for the aggregated perspective. Firstly, this analysis focuses on feedback relationships and they are only observable on an aggregated level (Richardson 1991a, 346). Secondly, several macro-reasons for migration can be included, such as population growth rate, network effects etc. (Vogler 2000, 184).<sup>77</sup> Thirdly, the analysis at a micro level would require much more data (Gilbert/Troitzsch 2005, 58f), and fourthly the personal decision to migrate is never completely rational and some factors may be at the same time reasons for and against migration for different population groups<sup>78</sup> (Lee 1966, 50f). “We must expect, therefore, to find many exceptions to our generalizations” (Lee 1966, 51) and the most convenient way to do so, is to assume average values for the relationships on an aggregated level. Finally, the focus on the aggregated level concentrating on the average values allows an overall picture of the relationships to be obtained, their feedbacks and the resulting behaviour patterns, instead of losing oneself in individual experiences and destinies, which is probably one reason why Johnson (1999, 1513) advocates using aggregated approaches for modelling of social processes.

### 3.1.2 T21-Senegal: Connection to Broader Development Context

To facilitate the analysis of the endogenous processes between migration and development, this study uses the development planning model T21 for the representation of the broader development context, because it is one of the few models that represents the internal dynamics of the socio-economic and ecological system of a nation endogenously. Using the System Dynamics modelling technique that seems to be advisable for the replication of endogenous processes and able to integrate the different relevant development spheres (see section 2.1.1.3), T21 is a tool for medium-long term development analysis and planning at the national level (Pedercini/Barney 2009). The assessment of nine different computer-based models currently used to analyse development options on the basis of twelve criteria draws the conclusion that “Threshold 21 appears to be the most useful methodological tool considered in this analysis in terms of its potential contribution to creating a comprehensive approach to development planning” (Pedercini 2003, 40). It has been developed and customised to more than twenty countries by a non-profit organisation, called the Millennium Institute (MI)<sup>79</sup>, which promotes long-term integrated global thinking. However, the starting

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<sup>76</sup> For example, the experience of families or communities where many people did not survive the odyssey of an unregistered emigration is oppositional to the experience that remittances allow a better life style.

<sup>77</sup> Applying a micro level approach would make it necessary to introduce them as exogenous variables or to aggregate micro level data falling beyond the scope of this study.

<sup>78</sup> Lee (1966, 50) gives as example that a bad education system may be a reason for parents to migrate while for house owners with taxable real estate the low tax rate may be a reason to stay.

stitute (MI)<sup>79</sup>, which promotes long-term integrated global thinking. However, the starting framework, which can be amplified, modified and refined when applied to a specific country<sup>80</sup>, assumes migration exogenously. Hence, while customising the starting framework for Senegal<sup>81</sup>, a model structure explaining migration endogenously was added to T21-Senegal, closing the loops between development indicators and migration. The reasoning for this added structure is described in this chapter, while the framework for T21 is not the focus of this study.<sup>82</sup> However, when analysing the feedback loops and the model behaviour (see Chapter 4), some relevant parts of the T21-Senegal structure concerning the research question of this study, will be discussed and referred to.

### 3.1.3 Time Horizon and Model Boundary

The time horizon of the model is 1980 to 2035. The long historical period of 30 years and the resulting high number of observations (see section 2.2.1) facilitates a useful validation test of the model behaviour. The simulation of 25 years into the future is a compromise between the principle that a simulation (especially of a real country) should not be too long on the one hand, as the adequacy of the results can be doubted. On the other hand, the simulation should not be too short, to facilitate the analysis of long-term behaviour. This is important as several effects, e.g. the returning of emigrants who gained knowledge abroad, need some time to come out and only a long time horizon allows the analysis of those delayed reactions and changes in the behaviour mode.

Concerning the model boundaries, endogenous, exogenous and excluded variables can be distinguished between. While endogenous variables are explained and generated from within the model structure, exogenous variables are part of the model, influencing other variables, but instead of being generated by the structure, they are given exogenously. Excluded variables do not appear in the model structure at all, not necessarily because they are assumed to have no influence, but rather as their inclusion is hardly possible and would add unnecessary complexity, such as earthquakes or political struggle in the case of T21. The decision about in- and exclusion depends on the focus of the study (see section 2.1.2.2). Whereas endogenous modelling is fundamental for those variables that are at the centre of the study, variables which are necessary, but not the focus of analysis can be assumed exo-

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<sup>79</sup> See MI (2011).

<sup>80</sup> The starting framework was customised for the first time in 1994. Up to now, the model has been applied to more than twenty different countries such as Malawi, Bangladesh, China, Italy, and the United States (MI 2007, 1ff; Pedercini/Barney 2010).

<sup>81</sup> The author of this study had the chance to collaborate with MI for the application of the framework for Senegal in 2009/2010.

<sup>82</sup> For an overview of the model and its possible application for analysis of interventions to achieve the millennium development goals (MDG), see Pedercini and Barney (2010). For the history and roots of T21, see Barney (2002). For a detailed description of the model see MI (2011a, 2011b). The application to Senegal, the T21-Senegal, amplified by the migration structure elaborated in this thesis, is included in the CD that accompanies the printed version of the thesis (see Appendix F).

generously. On the other hand, some exogenous variables are not incorporated endogenously as it was not possible within the scope of this study.<sup>83</sup> Those variables should not be the centre of analysis, as they will not be impacted by the system behaviour. Those that are assumed as a precondition to reduce complexity, such as a certain level of political stability, should be excluded. Table 2 depicts the model boundaries of T21 in general and the added migration part in specific.

*Table 2: Model Boundaries for T21 in General and the Migration Part in Specific*

	<b>Endogenous</b>	<b>Exogenous</b>	<b>Excluded</b>
<b>General T21</b>	GDP	World GDP	War
	Population	Foreign investment	Political struggle
	Life expectancy	Grants	Ethnic issues
	Education	Exchange rate	Earthquakes
	Poverty rate	Gini coefficient	Global warming
	Water demand	Inflation	
	Energy demand	Rain cycles	
	Public debt	Good Governance <sup>84</sup>	
<b>Migration part</b>	Emigration to OECD countries	Multiplier for education level of emigrants	Emigration of refugees
	Loss of human capital	GDP, education level, life expectancy of OECD countries	Emigration of displaced people
	Gain of human capital	Length of stay of emigrants	Human trafficking
	Remittances	Inner-African migration	
	Diaspora	Age and sex distribution of emigrants	
	Rural-urban migration	Proportion of registered emigrants	

Source: for T21 in general: MI 2007, 6 / for migration part: own table

### 3.1.4 Validation

As mentioned in section 2.1.2.2, the model validation is an important step in the modelling process. Although not aiming at ‘full validation’ in the sense of ‘objective truth’ as models are always a simplification and therewith never objectively true (Sterman 2000, 846), the validation process should test whether the model is useful, illuminating, convincing etc. (Sterman 2000, 846). This testing can be divided into the validation of the structure and the validation of the behaviour (Barlas 1996). Possible tests of the soundness of the structure are the dimensional consistency check, and the consultation of experts, whether they assess the structure as an appropriate representation of the system. Increasing the confidence into the generation of reasonable behaviour can be done by tests, such as a sensitivity test, extreme condition test, or replication of historical behaviour, although it is essential to know that the aim of System Dynamics is not the identical replication, but rather the reproduction of the general trend of behaviour. This is seen as a proof that the model structure comprises the

<sup>83</sup> For example, although Good Governance and the Gini coefficient were good indicators for aspects of ‘development’ as defined in this study (see section 3.2.1) they could not be integrated endogenously.

<sup>84</sup> An indication about the definition of good governance can be derived by looking at the six dimensions that are integrated in the WGI, which are voice and accountability (civil and political rights), political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption (Kaufmann et al. 2009a, 2).

relevant feedbacks of the system and therefore generates its essential behaviour patterns (for the whole paragraph, see Kopainsky 2005, 17).<sup>85</sup>

Tests proposed by Barlas (1996) and Sterman (2000, 859ff), including the ones mentioned above, were conducted, achieving satisfying results. While, as mentioned above, this does not warrant the correctness either of the structure or of the calibrated intensity of single factors, especially the discussion with local experts increased the confidence in the model structure (see Appendix B), while the satisfactory representation of the historical behaviour of several hundred variables for the last 30 years, strengthened the trust in the model behaviour and its usefulness. Graphs visualising the simulated behaviour of some main variables compared to their data are presented in Appendix C.<sup>86</sup>

### 3.2 Key Variables: Definition and Concept Specification

The aim of this study is to investigate the feedback between two key variables, namely migration and development. Although the concept of 'migration' is probably not as discussed as it is the case for 'development', both terms need some definition and concept specification concerning their use in this study.

#### 3.2.1 Development

The definition of this concept and therewith its measurement is highly controversial. This subchapter aims at shortly presenting three main different approaches<sup>87</sup>, and justifying the approach used in this study.

While the first two approaches agree on the definition that 'development' is a term describing progress of prosperity or improvement of quality of life, the third approach, mainly elaborated by the 'critical development studies', criticises this perspective for several reasons. According to them, 'development' is first of all a hegemonic concept, equating prosperity with "the forms of life created by industrial civilization" (Escobar 1988, 429) devaluating other ways of life and leading to cultural monoculture (Sachs 2007, 3f). Secondly, it is a relative concept, so that those countries 'lacking behind' will never reach the developed societies, as they will further 'advance' (Sachs 2007, 4ff). Thirdly, the western way of life (up to now) is not sustainable<sup>88</sup>, and therefore this 'development' cannot be taken as role model for the rest of the world (Sachs 2007, 2).<sup>89</sup> Although these criticisms are not deniable, they should not

<sup>85</sup> In this paragraph, only few examples for validation tests are given. For further tests and explication, see Barlas (1996) and Sterman (2000, 858ff).

<sup>86</sup> The Appendix C only portrays a selection of variables, while all other variables can be looked at using the model that is included in the CD that accompanies the printed version of the thesis. This CD also contains the elaborated data base as Excel file.

<sup>87</sup> Of course, the abbreviated discussion of these approaches is not able to consider all aspects comprehensively. For further information, please refer to the cited references.

<sup>88</sup> A common definition of sustainable development is "development that satisfies the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, 43).

<sup>89</sup> If all countries of this world were 'developed' as the Western hemisphere, five to six earths would be necessary

lead to refrain from the research as to how to improve the quality of life or prosperity. Instead, this perspective highlights the importance of defining development thoughtfully, including for example aspects of environmental degradation and scrutinising universality<sup>90</sup> and its limits.

To a certain extent this is the difference between the other two approaches. While the first approach, which was the prevalent one for a long time, evaluates prosperity on the base of economic growth and considers pc GDP or its growth rates as a reliable indicator of overall progress (Cypher/Dietz 2009, 30), the second approach criticises this reduction of 'development' to economic production emphasising that 'development is primarily and fundamentally about people' (UNDP 2010, 1). Hence the second approach is convinced that 'development' encompasses additional aspects, and that those aspects also need to be represented in the measurement (e.g. Gächter 2000, 168). One of the pioneers in questioning the focus on economic development and elaborating a new indicator was UNDP, presenting the HDI in 1990. While the reactions to its first publication clarify its progressiveness at that time (UNDP 2010, 16), several new indicators<sup>91</sup> have been developed since then (Constanza et al. 2009) and there is an ongoing discussion which variables<sup>92</sup> should be integrated into the concept 'development'. In the meantime, the discussion and the search for a more comprehensive concept and its measurement also entered the sphere of policy makers<sup>93</sup>, and international initiatives<sup>94</sup> have been launched to collect, evaluate and share information about measuring societal progress.

Of course, the problem of this second approach is the diversity of indicators, hindering the comparison of states on the basis of one indicator that is accepted by the majority, and for which also historical data is available to facilitate research. In addition, this approach strug-

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(Sachs 2007, 2).

<sup>90</sup> *It should be underlined that this is a huge debate especially concerning other concepts such as democracy, gender equality and human rights in general without an unambiguous result even for scientists that have been researching this topic for a long time. For example Donnelly (1984, 419) concludes at the end of his book "Basic human rights are, to use an appropriately paradoxical phrase, relatively universal".*

<sup>91</sup> *Among these new approaches are the Index of Sustainable Economic Welfare, Genuine Progress Indicator, Green GDP, Genuine Savings, Ecological Footprint, Living Planet Index, Happy Planet Index, Subjective Well-Being, Gross National Happiness (Constanza et al. 2009).*

<sup>92</sup> *It is debated if concepts like social capital, human security, human rights, empowerment, justice, equity, sustainability, environmental depletion or degradation, safe and fair distributed environment like clean water, food and air, but also the protection from climate change, good governance, happiness and subjective well-being need to be considered and if so, how (UNDP 2010, 17ff).*

<sup>93</sup> *Among those policy makers is the UN Statistical Commission aiming at mainstream environmental-economic accounting (UNSD 2011), the French Government, compromising 25 prominent social scientists to identify the limits of GDP as indicator, and propose new measurements (Stieglitz et al. 2009), and the German Bundestag, which established a committee of enquiry with similar objectives (Deutscher Bundestag 2011).*

<sup>94</sup> *Two examples for those international initiatives is 'Beyond GDP', a high-level conference hosted by the EC, EP, Club of Rome, OECD and WWF with objectives "to clarify which indices are most appropriate to measure progress, and how these can best be integrated into the decision-making process and taken up by public debate" (<http://www.beyond-gdp.eu/>), and 'Wikiprogress', a global internet platform "for sharing and exchanging information in order to evaluate societal progress" (For further information, please see [http://www.wikiprogress.org/index.php/Main\\_Page](http://www.wikiprogress.org/index.php/Main_Page)).*

gles with the difficulty of operationalising qualitative social concepts in a quantitative way (see e.g. Bürklin/Welzel 1994, 333).

That is why, there are still scientists justifying the use of only economic indicators (pc GDP / pc GDP growth rate) as appropriate by emphasising that their measurement is easier, arguing that they also indicate the level of broader development due to a high correlation and causality, and underlining that economists using them are aware that development encompasses much more than production (Cypher/Dietz 2009, 31ff).

Although measurement and availability of historical data militate in favour of the use of economic indicators, four reasons led to the decision to apply the second approach in this study. Firstly, the correlation of economic variables and other elements that are part of a broader development concept could not be found for all countries.<sup>95</sup> Secondly, the causality can be doubted, as economic growth does not necessarily lead to development in a broader sense, especially when development encompasses elements such as sustainability or equity.<sup>96</sup> Thirdly, the use of only economic indicators remains a reduction that implies that development can be equated with economic growth, even though it is highlighted that this is not the case. This is especially important with respect to the criticism passed by the critical development studies. Finally, notwithstanding the problems caused by diversity, these problems seem to be intrinsic to the concept 'development', being one of those concepts in social science which "are not observer-neutral, but involve self-reference" (Kratochwil 2008, 88).

The choice of an indicator provided by this second approach is guided by two criteria. Firstly historical data need to be available for the validation of the behaviour generated by the model. Secondly, it should be already internationally acknowledged to ensure its acceptance and validity. That is why, 'development' as it is used in this study refers to the concept elaborated by UNDP (2010), indicated by the Human Development Index<sup>97</sup>, encompassing the aspects of income, education and health. Accordingly, "Human development is the expansion of people's freedoms to live long, healthy and creative lives" (UNDP 2010, 22). However, UNDP itself mentions that a broader concept of development should also encompass at least three more elements (UNDP 2010, 65). The search for reasonable indicators for them shed light on the fact that the first element 'empowerment'<sup>98</sup> cannot be analysed in

<sup>95</sup> Research has shown that the level of income, while showing a high correlation when considering a large sample of countries, is rather an unreliable indicator for human development (in the sense of HDI) for lower-middle and upper-middle income countries (Cypher/Dietz 2009, 56).

<sup>96</sup> For example, inequality can rise when economic growth is based on rapid industrial growth in urban areas paired with slow growth of agriculture (UNDP 2010, 72).

<sup>97</sup> The HDI is a "composite index measuring average achievement in three basic dimensions of human development - a long and healthy life, access to knowledge and a decent standard of living" (UNDP 2009a, 210). For its calculation the following indicators are used: life expectancy at birth, adult literacy rate, gross enrolment ratio, and GDP per capita (PPP US\$) (UNDP 2009a, 208).

<sup>98</sup> Empowerment is "an increase in people's ability to bring about change" (UNDP 2010, 66). Factors increasing empowerment are education and information, democracy as well as civil and political rights (UNDP 2010, 65).

this study, as important components are exogenous variables in T21 and therefore do not reveal the behavioural changes of the system.<sup>99</sup> The second element 'income equity'<sup>100</sup> is also difficult to consider, as its most popular measurement (UNDP 2010, 72), the Gini coefficient<sup>101</sup>, is also an exogenous variable in T21<sup>102</sup>. That is why, poverty rate<sup>103</sup>, an important and unbearable consequence of income inequality is taken as an indicator. Finally, the third element 'sustainability'<sup>88</sup> is taken into account by analysing two potential vulnerabilities<sup>104</sup>, since their behaviours indicate whether present behaviour compromises "the ability of future generations to meet their own needs" (WCED 1987, 43). Firstly, the environmental vulnerability is represented by the ecological footprint<sup>105</sup>. Secondly, to track the danger of vulnerability caused by migration, the level of dependency on the economic development and migration policies of potential receiving countries is considered, represented by 'remittances as a share of GDP'.

In conclusion, this study uses the HDI as an indicator for 'development', while 'broader development' is represented by the HDI, the poverty rate, the ecological footprint and 'remittances as a share of GDP'. In this way, the measurement of 'development' is internationally acknowledged, has available historical data at its disposal, and does not reduce development to economic indicators only. The indicators for 'broader development' based on the insights provided by the UNDP (2010) enlarge the concept by those factors that are practicable for the scope of this study.

<sup>99</sup> Although education is included endogenously in the model, Good Governance (see footnote 84) and therewith the other aspects of empowerment are only considered in an exogenous way.

<sup>100</sup> UNDP (2010, 72ff) considers 'equity' as the second element, encompassing the aspects of gender disparities, and inequality in income, education and health. While the aspect of gender equality is not considered in this study (see section 3.3.1), inequality in access to health and education is considered by the HDI. Consequently, an additional indicator is only necessary for the missing aspect of income inequality.

<sup>101</sup> The Gini coefficient is a measure of the inequality of a distribution, a value of 0 expressing total equality and a value of 1 maximal inequality (UNDP 2010, 224).

<sup>102</sup> That means that data is used for the historical behaviour DSP (1997 and 2004) and for the future, it is assumed that the Gini coefficient stays constant at the value of 2010 so that an increase of income will benefit all income groups proportionately.

<sup>103</sup> Poverty rate refers to the proportion of people living below the national poverty line, which is based on the cost of basic needs (ANSD 2004, 8). Since 2010, the UNDP publishes a poverty-adjusted HDI as a further improvement of their initial indicator. To be able to use historical data, it has been decided to use the 'old' HDI and look separately at poverty development.

<sup>104</sup> "Countries and people are vulnerable when their human development is threatened by various risks" (UNDP 2010, 78)

<sup>105</sup> "The Ecological Footprint has emerged as the world's premier measure of humanity's demand on nature. It measures how much land and water area a human population requires to produce the resource it consumes and to absorb its carbon dioxide emissions, using prevailing technology" (Global Footprint Network 2011). If demand exceeds supply it makes a country vulnerable since it does not respect the limitation of resources. Of course, it is problematic to insist on environmental sustainability in countries where for example energy consumption is needed for further economic development, while the 'development' and actual way of life of the so called 'developed world' is based on the overexploitation of natural resources. However, exactly this is the idea of a more comprehensive indicator, considered environmental degradation (also for the evaluation of industrialised countries) to be aware of the limitations. Moreover, this does not prescribe which conclusion should be drawn, but it enables consideration of adequate policies.



### 3.2.2 Migration

"Migration is defined broadly as a permanent or semipermanent change of residence" (Lee 1966, 49) or as "the relocation of people within space that involves their permanent or temporary change of residence" (Mafukidze, 2006, 103). However, this broad definition encompasses very different types of migration. The following paragraphs specify migration as it is researched in this study and defines important characteristics of migrants, mentioning also the specifications that could not be included.

Firstly, this study focuses on emigration to high income countries, although internal and south-south migration outnumbers south-north migration for Africa (Zoomers/van Naerssen 2006, 8). However, the share of so called south-north migration is increasing. While 57% of international migration in the 1960s happened between developed countries, in 2005, the share was reduced to 37% (Kermer 2007, 143). Beside the amount of migration, three reasons led to the focus on south-north emigration.<sup>106</sup> Firstly, this study tries to explore the endogenous relationship of migration and development. On the contrary, inner-sub Sahara African migration has been attributed to artificial borders<sup>107</sup> (Naudé 2010, 334), conflicts, and environmental disaster (Zoomers/van Naerssen 2006, 11), all reasons that are not represented endogenously in the model (see section 3.1.3). Hence, intercontinental migration can be ascribed to those migrants that are better educated and better-off, whereas intra-continental migration is seen more as a survival strategy, led by push factors. That leads to the second reason for the focus. The effects of south-north migration are assumed to be higher reasoning that the differences between home and host countries are higher so that more remittances can be sent because of better job opportunities and better salaries, more knowledge can be gained, business contacts could lead to greater effects, and more human capital can be lost, as higher technology and opportunities attract higher educated people (Zoomers/van Naerssen 2006, 17). Additionally, developing countries receive and send people in south-south migration, so that net remittances can end at plus/minus zero. The third reason for the focus on south-north migration is its high political relevance, especially looking at immigration policies, the call for increasing selection mechanisms to recruit qualified personnel, and the debates about the protection of the 'fortress Europe'. For simplicity, OECD countries are taken as reference group for high-income countries, as more than 90% of those emigrants living in other countries than in Africa are resident in Europe and Northern America (UNDP 2009b, table B).<sup>108</sup> Immigration from OECD countries is not considered due

<sup>106</sup> The analysis and the presented new model structure concern emigration to high income countries, while inner-sub Saharan African migration is only included as exogenous variable and will not be analysed.

<sup>107</sup> Zoomers and van Naerssen (2006, 18) point out that part of South-South migration is the continuation of indigenous patterns of mobility (i.e. traditional, seasonal movements within one and the same eco-region) which is only defined as migration due to artificial man-made borders.

<sup>108</sup> According to the study by UNDP (2009b, table B) 55.7% of the total emigrant stock resident in Africa, 3% in

to its marginal existence (Migration DRC 2007).<sup>109</sup> Nevertheless, the 're-immigration' of returning emigrants from OECD countries is incorporated, as they play an important role in adding to the total population, as well as to the education level of the country, since it is assumed that they gain additional knowledge abroad (see section 3.4.2.5).

As a second specification, the study investigates voluntary instead of forced migration.<sup>110</sup> However, the definition of forced migration is debated. While some authors stand up for subsuming so called 'economic refugees' under this category, as they are often risking their lives on the journey and therewith heightening the moral obligation to protect and support them (see e.g. Naudé 2010, 332), others plead against this to ensure that those refugees as defined by UNHCR<sup>111</sup> are protected against prosecution (see e.g. Sunjic 2000, 152). However, as done by statistics, this study refers to 'voluntary migration', including 'economic refugees' in opposition to refugees as defined by UNHCR. The exclusion of forced migration as well as trafficking of human beings is due to the fact that the causes for migration for those people, such as persecution or trafficking are not included in the model (see section 3.1.3). In addition, the number of refugees should be small in the countries with a certain level of the political stability, which was one of the criteria for the case selection (see section 2.2.2).

Thirdly, the study assumes that transnational migrants<sup>112</sup> make up an important share of emigrants to OECD countries. As they are involved in the social, cultural, economic and political affairs of both countries, upholding personal connections in and committed to home and host country (de Haas 2010, 246f; Parnreiter 2000, 38ff), the transnational bonds increase, intensify and prolong the interaction of emigrants to their home country, and therewith the transfer of money, ideas, knowledge and (business) contacts. This implies that first of all, remittances become more sustainable, and secondly transnational emigrants add to the knowledge of their home country, not only by returning, but also through holiday visits,

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*Asia, 38.1% in Europe, 0.2% in Latin America and the Caribbean, and 2.9% in Northern America. Although this data concerns only the years 2000-2002, it indicates that people emigrate mainly to OECD countries if not to other African countries.*

<sup>109</sup> According to calculations based on the fourth version of Global Migrant Origin Database (Migration DRC 2007) 9% of the stock of immigrants in Senegal are from OECD countries. Although this number cannot be used as an exact proportion due to assumptions and interpolation of the database, it is usable as approximation.

<sup>110</sup> Forced migration is often used for refugees, asylum seekers, displaced, and internally displaced people, that are forced to move because of war, natural disasters, or persecution (Kermer 2007, 135; Zoomers/van Naerssen 2006, 8). Naudé (2010, 332) offers a broader definition, stating that "forced migration is seen as the international movement of people due to desperation".

<sup>111</sup> "A refugee, according to the Convention, is someone who is unable or unwilling to return to their country of origin owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion" (UNHCR 2010, 3).

<sup>112</sup> Transnational migrants are defined as "immigrants whose daily lives depend on multiple and constant interconnections across international borders and whose public identities are configured in relationship to more than one nation-state." (Glick-Schiller et al. 1997, 121). An important reason for their development is the technological revolution regarding communication and transportation means (de Haas 2010, 246; Parnreiter 2000, 38-41).

intensified electronic communication etc. (de Haas 2010, 246f), increasing the importance of the stock of emigrants living abroad, the so-called Diaspora. A further explanation of this concept and an outline of its inclusion into the model is given in section 3.4.2.5. Although the Diaspora can include several generations of the initial emigrant, as long as their descendants are somehow connected to the initial home country (Zoomers/van Naerssen 2006, 11f), experience showed that the connection declines in further generations (Zoomers/van Naerssen 2006, 37). Due to this finding and to reduce complexity, this study only considers the first generation.

Fourthly, the model does not distinguish between different lengths of migration<sup>113</sup>, but assumes an average time of stay abroad, including the short-term as well as permanent migrants. Similarly, the model does not distinguish between migration for studies, for work, or due to family reunification. That means that the stock of emigrants is not disaggregated, although it can be assumed that the majority of migrants referred to in this study are labour migrants (IOM 2009, 130).<sup>114</sup> However, the stock of emigrants include the other groups as well thereby, for example when calculating the remittances sent per migrants an average is taken, balancing that some migrants send a lot because they are earning money while other can't send anything, for example due to their studies.

Focussing on emigration to OECD countries, further specification of the direction<sup>115</sup> and the distance<sup>116</sup> of migration are not considered. In addition, although Senegal is an important transit country, those transitory migrants<sup>117</sup> are not considered as an own group, as those staying in Senegal belong to the inner-African migration, and those that finally continue to OECD countries are part of the emigration group. By using an average for the gain of remittances and knowledge, it is considered that those are not remitting or returning to Senegal,

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<sup>113</sup> According to Kermer (2007, 135ff), permanent migration refers to the enduring change of residence, long-term migration is used for change of residence longer than one year, short-term migration is used for change of residence between three and twelve months, temporal migration means migration, where the employee changes residence for a certain time arranged in his/her employment contract (on a regular or irregular basis), and circular migration includes private or professional changes of residence up to 30 days. A discussion about the reasons for different migration length can be found at Vogler (2000, 24ff).

<sup>114</sup> According to the national statistical office 68% of the emigrants that left between 1997 and 2001 declared as the main reason for migration professional reasons, *manqué de travail* and found employment, while 13% left because of marriage and other family reasons, and 10% left for studies (IOM 2009, 130).

<sup>115</sup> For the analysis of internal migration, for example, the distinction between urban-urban vs. rural-urban plays an important role (Kermer 2007, 136). However, the model includes a structure for rural-urban migration in Senegal, but this is not the focus of this study.

<sup>116</sup> A whole strand of literature focuses on the analysis of destination choice. For an outline of possible explanations, please consult Vogler (2000, 22ff).

<sup>117</sup> Transitory migrants are those that, aiming at a final destination, for example Europe, sometimes stay several years or even forever in transit countries, when neither the continuation of the movement is possible, nor returning to the home country due to the 'failed migration', as no money has been earned, but the family members 'invested' in the migration of that person (Zoomers/van Naerssen 2006, 20f).

but to their home countries. Finally, the endogenous differentiation between registered and unregistered emigration could not be integrated due to the scope of this study.<sup>118</sup>

Summing it up, migration as it is analysed and endogenously modelled in this study concerns voluntary emigration to and re-emigration from OECD countries mainly by transnational labour migrants that stay an average time of 20 years abroad (Senegalese Expert Commission, 18.6.2010). Emigrants are higher educated than the average in Senegal (Docquier/Marfouk 2005, 24; Docquier et al. 2008; Ndiaye, 26.6.2010; Senegalese Expert Commission, 18.6.2010), mainly between 15 and 34 years old and male (IOM 2009, 129f).<sup>119</sup>

### 3.3 Causes for Migration

There are many theories explaining migration. This chapter aims at presenting the explanation used in this study and implemented into the model. To do so, the first section gives a short overview of the general theoretical approach pointing out in- and excluded elements of different theories. Afterwards, the model structure of the causes of migration is portrayed in detail, consisting of the will to migrate and the ability to migrate.

#### 3.3.1 Overview of Included and Excluded Theories

There is a vast amount of literature dealing with the reasons for migration. They can be subdivided into several theories and approaches.<sup>120</sup> While up to the early 1980s mutually excluding theories were dominant, recent developments focus on synergies between different migration theories, arguing that combination and integration of different approaches is possible to a certain extent, although it has been doubted that an all-explaining meta-theory can be elaborated (de Haas 2008, 3). The approach of this model is not to replicate one single theory, but to extract single factors influencing migration, allowing the integration of several aspects of different approaches, although not all findings can be incorporated. This section presents the approaches that influenced the structure of the model of this study, discussing elements that are in- and excluded.

Searching for single factors that cause migration, push/pull theory<sup>121</sup> builds a good point of departure, as it includes some of the relevant factors, amplifying the main insight of neoclas-

<sup>118</sup> The model uses an exogenous constant proportion to distinguish between registered and unregistered emigration, but mainly to be able to calibrate the education level of emigrants as the data by Docquier et al. (2008) refer to registered emigrants, while it is assumed that unregistered emigrants have the same education level as the stay-home population.

<sup>119</sup> According to the national statistical agency, 84.2% of emigrants that left between 1997 and 2001 were male and they were mainly between 15-34 (67.8%), and 35-54 (26.3%). Only 3.9% were under 15, 1.6% between 55-74 and 0.1% over 75 (IOM 2009, 129f). These proportions are used for the simulation for the whole time horizon.

<sup>120</sup> For an overview of different migration theories, see Parnreiter (2000, 27ff), Massey et al. (1993), Haug (2000), or Lebhart (2002).

<sup>121</sup> The push-pull approach dominated the migration explanation till the 1980s (Parnreiter 2000, 26) and is still very popular in migration literature (de Haas 2008, 9). Its foundations were laid by Lee (1966), although he did not employ the term himself (de Haas 2008, 9). It is assumed that the decision to migrate can be explained by so called pull factors concerning the attractiveness of the area of destination due to higher wages,

sical theory<sup>122</sup> that economic differences between sending and receiving country lead to migration, by additional factors such as poverty, access to social services, environmental, and demographic reasons. In addition, it allows a macro-level perspective and the integration of other theoretical insights (de Haas 2008, 9). However, the push/pull approach as well as the neoclassical approach, although being used in several studies have often been criticised for several reasons (see e.g. de Haas 2008, 8ff). One important criticism concerns the reduction of migration reasons to a rational choice decision and the consequent exclusion of other significant reasons for migration. However, the logical conclusion of this relevant criticism that the difference of economic situations cannot be seen as exclusive reason for migration, is not to deny the relationship but to include those that were excluded by the neoclassical approach.

Therefore, the first amendment of the pure push/pull approach is the integration of migration costs as one of the important selection mechanism of migration. It has been found that especially poor people tend to be unable to migrate leading to the phenomena that especially the poorest people, regions and countries do not exhibit high emigration rates (Ghosh 2006, 72). For those people and regions economic growth even leads to higher emigration rates, due to the fact that it can help to obtain the necessary means and information for migration (de Haas 2010, 239; Parnreiter 2000, 45; Vogler 2000, 17). Consequently, the neoclassical assumption of a linear relationship between development and migration in sending countries has to be denied (de Haas 2010, 239). That is why, the model adds to the push and pull factors a structure representing that potential resources for migration (income) in relation to migration cost affect the emigration rate (for further explanation and details, please see section 3.3.2.4). Other selection mechanisms, such as age, gender (Lee 1966, 56; see section 3.2.2), and the education level (Docquier/Marfouk 2005, 24; see section 3.4.2.4) are incorporated as well.

A further improvement pertains to the affiliation of the network effect (for details and explanations, see section 3.3.3.1), since the push/pull approach fails to explain durable and self-sustaining emigration (for example Massey et al. 1993; Vogler 2000, 17). In addition, network theory and the inclusion of selection mechanisms could give some insights into the

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*political stability etc., and push factors referring to factors of the area of origin, such as population growth, unemployment, poverty, political instability, wars, environmental degradation or in general low living standard (Kermer 2007, 165; Vogler 2000, 36ff). Criticism of this approach can be found for example in de Haas (2008, 8-11).*

<sup>122</sup> *Neoclassic theory assumes that the main reason for migration is the difference of economies regarding their abundance of labour versus capital and therefore of their wages. On a micro level, migration is seen as the voluntary and rational decision by the individual for the own utility maximisation. From a macroeconomic perspective, migration serves the optimal allocation of the production factor labour followed by the convergence of wages and employment (Jones/ Mielants 2010, 1; Kermer 2007, 165; Parnreiter 2000, 27f; Vogler 2000, 17). An overview of criticism of this approach and enhancements partly responding to the critique, such as the human capital approach, the Harris-Todaro model, and NEM can be found in Vogler (2000, 18ff).*

phenomena that some people of the same country or region migrate while others stay, as well as into the destination decision, which cannot be explained by neoclassical or push/pull approaches (de Haas 2008, 8). However, as this study looks at the aggregated macro level it does not aim to represent or investigate these differences.

The livelihood approach<sup>123</sup> has been considered and confirmed the decision to integrate social services as relevant reasons for emigration (see section 3.3.2.3). However, the main message of this approach, which is that emigrants are not victims but develop their own strategies to improve their livelihood, not individually but on a household basis (de Haas 2010, 244ff), could not be incorporated, as neither individuals nor households are modelled, but only the aggregated values representing the average.

The findings provided by the New Economics of Migration (NEM)<sup>124</sup> could partly be integrated. Similar to the livelihood approach, NEM points out that the migration decision is taken by the nuclear or extended family rather than by the individual sharing costs and benefits (Ghosh 2006, 34; Jones, Mielants 2010, 1–2; Parnreiter 2000, 31/2). The difference between families and individuals is not replicated as this research focuses on the aggregated macro-level modelling average values. The second important aspect of NEM, the concept of relative deprivation<sup>125</sup>, could only partly be taken into account as a migration reason since the convenient indicator, the Gini coefficient representing income inequality, is exogenous in T21. However, as for the concept ‘broader development’, the poverty rate is used as compensation (see section 3.3.2.2). Thirdly, NEM establishes non-functioning credit and insurance markets as a reason to migrate (Ghosh 2006, 34), as their absence makes it necessary for households to share risks. This aspect is integrated by using the level of social services and poverty as indicator for functioning insurance markets (see section 3.3.2.2 and 3.3.2.3).

The fact that international migration is often the prolongation of internal migration (Kermer 2007, 156; Parnreiter 2000, 44) is considered by using urban population growth as a reason for emigration (see section 3.3.2.5), which is modelled endogenously.

<sup>123</sup> “A livelihood strategy can then be defined as a strategic or deliberate choice of a combination of activities by households and their individual members to maintain, secure, and improve their livelihoods” (de Haas 2010, 244), while “livelihood comprises the capabilities, assets (including both material and social resources), and activities required for a means of living” (de Haas 2010, 244).

<sup>124</sup> According to this approach, named by some authors New Economics of Labour Migration (NELM) (for example de Haas 2010) “[i]nternal and international migration can (...) be perceived as a household response to income risk” (de Haas 2010, 243). It has been stressed that the lack of insurance possibilities (in a private market or by public institutions) is an important reason for the need to diversify risks, since otherwise unforeseeable events such as unemployment, illness, crop failure, or price risk can easily lead to a life in poverty (Kermer 2007, 146; Parnreiter 2000, 31; Vogler 2000, 28).

<sup>125</sup> The term ‘relative deprivation’ is used for ‘the feeling of poverty’ due to comparison of the own wealth and possessions with richer surrounding people, combined with the wish to obtain a similar living standard, and the feeling that this is possible (Gächter 2000, 162ff; Parnreiter 2000, 31f). This term stresses that it is not necessarily the absolute poverty which is pivotal, but rather the relative one.

The insights gained by so called ‘transitional models’<sup>126</sup>, such as the theory of ‘migration hump’ or ‘inverted U’<sup>15</sup> and the mobility transition theory<sup>14</sup>, are not explicitly integrated into the model as those approaches are not primarily theories about the causations of migration, but rather theories about the long-term behaviour of migration and its description (Kermer 2007, 165). While the migration hump approach assumes a fixed long-term behaviour of migration (an inverted U)<sup>127</sup>, mobility transition theory establishes the correlation between population growth and migration levels, linking the insights from demographic transition theory<sup>128</sup> to those from the ‘inverted U’.<sup>129</sup> However, instead of assuming correlations or a fixed long-term behaviour of migration and searching for explanations for that, this study aims at modelling the explanatory structure to be able to look at the behaviour generated by this structure. That is why these approaches are not considered, but rather possible explanations, as far as this is possible.

The insights elaborated by historical-structuralists, rooted in Marxist political economy and dependency theory, such as world system theory and dual labour market approach, could only partly be incorporated. While they agree on the fact that the differences between countries can be seen as (one of the) reasons for migration, their focus lies on the analysis of the reasons for this existing inequalities and the question as to whether those are inherent in the capitalistic system, blaming the push/pull theory for being ahistoric and static as push and pull factors are perceived as given, not made (Parnreiter 2000, 45). Although being fundamental, this discussion would exceed the scope of this study and the time horizon of the model. Nevertheless, this structuralist perspective underlines the importance of integrating structural constraints into the causes of migration, such as the selection mechanisms discussed above. In addition, the evaluations of the consequences of migration, questioning the optimism of neoclassical approach are further discussed in section 3.4.1.

Generally, it has been criticised that migration studies focus on migration, although migration level are quite moderate compared to the high differences between countries. From that, it has been followed that a high preference for the home country and the hope for further im-

<sup>126</sup> *Transitional models refer to the phenomenon that a certain transition in society, just as demographic transition, modernization, increasing mobility etc. (de Haas 2008, 16).*

<sup>127</sup> *Gächter (2000, 164-169) showed that this behaviour can be explained by different approaches, such as the transformation from an agricultural to an industrial society, NEM, migration costs, and networks.*

<sup>128</sup> *According to demographic transition theory, societies experience a transition from low population due to high birth and death rates to an increase of population caused by decreasing death rates paired with still high birth rates, to finally end at a higher equilibrium of population, as birth rates decrease as well, reaching the death rates level. The basics of this theory were developed by Warren Thompson (1929), but by convention the article by Frank Notestein (1945) is regarded as its first definition. However, more than 50 years of science refined the theory also asking for explanations for this transition. For a comprehensive overview, see Kirk (1996).*

<sup>129</sup> *Accordingly, the socio-economic development level causes on the one hand different population growth rates (demographic transition) and on the other hand, changing migration rates (mobility transition). Consequently, demographic variables can be taken as indicators for the socio-economic structure and its development (Vogler 2000, 186), which can be related to migration behaviour (see e.g. Kermer 2007, 162–165).*

provement exists (Vogler 2000, 184). However, this is incorporated in the calibration of influence of migration causes on actual migration levels.

Finally, to give a comprehensive outline of included theories, it should be mentioned that the findings by the approach of transnational migrants (see section 3.2.2) are also incorporated, although being mainly relevant for the consequences of migration. It is assumed that with decreasing communication and transport costs, people uphold tighter links to their home community sending more remittances (see section 3.4.2.3), transferring more knowledge back home (see section 3.4.2.5), and increasing the network effect (see section 3.3.3.1).

Although political instability, (armed) conflicts or even war are acknowledged to be highly relevant as push factors for emigration (Adepoju 2000, 384; Kermer 2007, Naudé 2010, 139/337/350; Vogler 2000, 36ff/185f) these aspects are not integrated in the model, as one criteria for the case selection was that a certain level of political stability can be presumed (see section 2.2.2).

Due to the limited scope of this study, it is not possible to integrate the gender aspect. In addition, as this aspect has only recently started to be researched, verified information, theories, and data are restricted (Ndiaye, 26.6.2010; Parnreiter 2000, 41ff). However, especially for gender indices and therefore for a more comprehensive evaluation of development, the incorporation of this aspect would be desirable.

### 3.3.2 Will to Migrate

The following sections describe five factors, two pull and three push factors, constituting the will to migrate in the model. The strength of pull factors is determined by the difference between the value in Senegal and potential receiving countries for e.g. pc income (see e.g. Kermer 2007, 146), assuming that migrants are 'pulled' by the variance. The importance of this comparison has also been stressed by Ndiaye (26.6.2010). In contrast, the driving force of push factors such as poverty, lack of rural resources, and urban population growth, is dependent on the absolute value of those variables in Senegal. However, the will to emigrate caused either by the absolute value or the difference is summed up and delayed, assuming that perception, change of migration will and behaviour needs some time (de Haas 2008, 11; Lee 1966, 50). The subsequent five sections follow the same structure, giving an outline of the structure of the model referring to the specific reason for emigration in the first paragraph that is followed by a short discussion with reference to literature, presenting approaches and empirical findings that led to their integration, as well as doubts on their relevance.

#### 3.3.2.1 *Pc Income, Wages and Unemployment*

One of the most important reasons for migration in the model is the difference in pc GDP between Senegal and the potential host countries (average OECD country). Real pc GDP is



taken as indicator of the difference in the economic situation and employment opportunities instead of the use of unemployment, or wage differential, due to insecure employment data<sup>130</sup>. This solution has been practiced by several other scientists (e.g. Naudé 2010, 342 ; Vogler 2000, 86).

This causality, economic reasons as a cause for emigration, has a long tradition. Ravenstein, stated in this 'Laws of Migration' at the end of 19. century, which can be seen as "the starting point for work in migration" (Lee 1966, 47), that "the origin of migration was economical" (Ravenstein 1889, 305).<sup>131</sup> Later scientists affirmed this causality as one of the 'root causes', stressing that the main driver is not the absolute economic situation, but the difference between the home country and potential host countries (e.g. Adepoju 2000, 392; de Haas 2008, 9; Parnreiter 2000, 28). Neoclassic theory<sup>122</sup> and push and pull models<sup>121</sup> are based on this finding (Parnreiter 2000, 44).

The important criticism that those theories tend to reduce the reasons for migration to economic factors has been discussed above (see section 3.3.1). However, despite the fact that the causes for emigration cannot be reduced to economical reasons and that the additional factors discussed above need to be included, empirical research and representative sample surveys (micro census) from all over the world regularly affirm that the search for work and higher wages, in other words the economic situation, is the main motive for migrants to migrate (Naudé 2010, 350; Parnreiter 2000, 25). In addition, it has been shown that the strength of this causal effect is especially high for emigration from Africa, higher for example than for emigration from Asia (Vogler 2000, 185).<sup>132</sup> Finally, this causation is proved by an extensive survey and study about determinants for migration in Senegal finding that more than 85% of men migrate because of economic reasons<sup>133</sup> and a higher pre-migration level of unemployment among migrants (Eurostat 2000, 70/74) and has been affirmed by the local experts (Ndiaye 26.6.2010; Senegalese Expert Commission 18.6.2010).

### 3.3.2.2 Poverty

To represent not only the average economic situation as an important reason for the migration decision (as described above), but in addition, integrating that the will also depends on the income distribution, the absolute value for poverty rate<sup>134</sup> is taken as another

<sup>130</sup> Employment data from different sources vary notably (cp. LABORSTA 2011; UNSD 2010; ANSD 2006, 1/41). One reason for the uncertainty of employment data is the existence of a huge informal sector. In Senegal, over 50% of GDP is produced in the informal sector (ANSD 2005, tableau 10) and it can be assumed that even a higher proportion of working people are active in this sector, as wages are normally lower.

<sup>131</sup> Grigg (1977, 43) restated Ravenstein's Laws, and formulated as 11th law: "The major causes of migration are economic".

<sup>132</sup> Vogler (2000) concluded this in his econometric investigation of determinants of Migration to Germany between 1981-1995 with the most extensive data set by then.

<sup>133</sup> Reasons for migration differ significantly between men and women. Only nearly 25% of women stated economic reasons as the reason for their migration. On the contrary, family reasons were declared by under 10% of men and 57% of women, and other reasons, such as studies, fear of war or persecution etc. by 4 % of men and 25% of women (Eurostat 2000, 74).

on the income distribution, the absolute value for poverty rate<sup>134</sup> is taken as another explaining variable of migration.

“Poverty is definitely a factor” (Ndiaye 26.6.2010) for emigration. It is mentioned as one of the push factors by push and pull models (see e.g. Adepoju 2000, 383; Naudé 2010, 336 Zoomers/van Naerssen 2006, 19). In addition, following the logic of NEM<sup>124</sup>, the integration of poverty as a reason for migration is necessary due to two reasons. Firstly, the existence of poverty can be seen as an indicator of scarce social protection systems and high income risk. As diversification of risks is seen as one of the main motivations for migration by NEM, it seems justified to use poverty as an indicator of this motivation. Secondly, relative deprivation<sup>125</sup> is seen as another significant reason for migration. As relative deprivation is positively related to inequality of income and wealth (Gächter 2000, 166), it can be followed that high inequality levels increase migration (Vogler 2000, 28). However, as mentioned before, the integration of inequality is not possible as the Gini coefficient is an exogenous variable in T21. Therefore, the best remaining indicator for unequal income levels that is generated endogenously and is integrated is the poverty rate.

Some scientist doubt the causality of poverty and migration, as poverty can also be seen as a selection mechanism impeding emigration due to the lack of means for migration (see section 3.3.2.1). However, this aspect is integrated by the structure that compares migration cost with income (see section 3.3.2.4) and its existence does not contradict that poverty is a cause for migration at the same time.

That “the United Nations has singled out poverty as a major factor in international migration” (Ghosh 2006, 72), and local experts (Senegalese Expert Commission 18.6.2010) as well as empirical studies confirmed this causality (see e.g. Eurostat 2000, 69)<sup>135</sup>, militates in favour of the integration of poverty as a migration cause.

### 3.3.2.3 Social Services

In addition to the indicators for the financial situation, the model integrates two indicators for the situation of the social services. By using the differences in health and education levels between Senegal and the potential receiving countries as a reason for migration, not only the monetary facet of development is considered, but also those aspects that are incorporated into the HDI to avoid the reduction of human well-being to economic aspects (see sec-

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<sup>134</sup> The poverty rate refers to the proportion of people living below the national poverty line, which is based on the cost of basic needs. Data for this proportion is taken from the national statistic agency ANSD (2004, 8/12)

<sup>135</sup> A survey of 556 non-migrants and 199 migrants in Senegal found that ca. 60% of migrants evaluated their financial situation as barely sufficient, whereas only approx. 40% of non-migrants evaluated their situation five years ago as barely sufficient. In addition, more non-migrants evaluated their situation as sufficient (ca. 30%) than the pre-migrants (ca. 20%) (Eurostat 2000, 69).

tion 3.2.1). As an indicator for the health level, life expectancy at birth is chosen, while the education level is represented by the average literacy rate.

There are three approaches justifying the integration of these indicators for social services. Firstly, although not mentioned in all push and pull approaches, several scientists agree upon the fact that social services, and especially the education level, are reasons for migration. By some, better access to social services and education opportunities are seen as general pull factors (see e.g. Naudé 2010, 336). Others argue that “[a]nother important ‘push’ that propels internal migration—mundane, but no less critical—is the lack of adequate public services” (World Bank 2009, 167) such as schools, health care centres, hospitals, public and private amenities (World Bank 2009, 167). Since international emigration is the prolongation of internal migration, it can be justified that a lack of social services leads to migration. However, by using the difference in education and health levels as a reason for migration, the focus is on the pull-approach. Secondly, the livelihood approach<sup>123</sup> is in line with this consideration. Arguing that migration is a strategy to “maintain, secure, and improve their livelihoods” (de Haas 2010, 244), a difference in necessary capabilities and services can lead to the decision to leave for a place where those requested things exist. Similarly, de Haas assumes that migrants move, “because they expect to be able to make a more satisfying living elsewhere” (de Haas 2008, 10), to places that “offer better social and economic opportunities in terms of individual freedom, safety, education, health care, paid labour, entrepreneurial activities and amusement.” (de Haas 2008, 10). In other words, the “main cause for migration is seeking for a better life” (Ndiaye 26.6.2010), including aspects of health and education. Thirdly, as described above, one of the main reasons for migration according to NEM is a non-existent or malfunctioning insurance market and social protection system. In addition to the use of poverty as an indicator of their lack, the difference in health level is seen as a meaningful operationalisation, since health can be assumed to be more superior the better the insurance system and the better the social protection system.

#### 3.3.2.4 *Environmental Degradation*

As an indicator of environmental degradation the model incorporates the ratio between the actual fish stock and the carrying capacity<sup>39</sup>, assuming that a decrease in the fish stock increases emigration.

“The natural environment is perhaps the oldest determinant of migration and displacement of people” (Naudé 2010, 338), and environmental degradation has often been seen as one of the ‘root causes’ of migration (Adepoju 2000, 384; de Haas 2008, 9; Zoomers/van Naerssen 2006, 19). Decreasing crop yields (Kermer 2007, 139) and the destruction of natural resources (Vogler 2000, 36ff) are seen as a push factor, from a push and pull perspective. Generally, water scarcity, land degradation, conflicts over natural resources, and envi-

ronmental disasters have been listed as environmental reasons for migration (Naudé 2010, 336-339). Water scarcity is difficult to explain endogenously, especially as it is tightly connected with climate change, which is excluded from the model, much as conflicts and environmental disasters are (see section 3.1.3). Consequently, the reason for inclusion concerns the environmental degradation. The decision to use an indicator representing the degradation of fishing resources instead of for example land degradation is due to three reasons. First of all, the fish sector is highly relevant in Senegal. It has been estimated that one out of six Senegalese works in the fish sector (FAO 2008, 18) and that between 25 and 30% of total export is linked to fishing (FAO 2008, 15). That is why a worsening in the fishing results leads to high unemployment within the families for which fishing was the traditional working field (Chauzy 2006), and consequently leads to the search for other income possibilities, if necessary abroad (Senegalese Expert Commission 18.6.2010). Secondly, fishermen are tightly connected to the 'business' of crossing to Europe, since they possess boats. Thirdly, although it has been mentioned that land degradation is a significant problem in Senegal (MEPN 2004), the available data for arable land does not represent this (ResourceSTAT 2010). Hence, land degradation is difficult to use as an indicator.

However, using environmental degradation as a reason for migration has been criticised. Firstly, de Haas (2008, 10) stresses that "many migrants tend to move from areas with relatively low population densities and relatively little environmental degradation to environmentally degraded areas with high population densities" to find "better social and economic opportunities" in more crowded areas. Secondly, some empirical research concluded that "determinants related to environmental degradation and resource scarcity, such as irrigation, and water stress index/EVI [Environmental Vulnerability Index] are not found to be significant" (Naudé 2010, 350).

Nevertheless, the use of fish resources is seen as representing a relevant factor for migration especially as it indicates both resource degradation, and economical income opportunities (Senegalese Expert Commission 18.6.2010).

### 3.3.2.5 *Urban Population Growth Rate*

The last incorporated reason for migration increasing the will to migrate is urban population growth rate, assuming that an increase in urban population growth augments emigration.

Population growth is one of the earliest explanations of migration, being one of the main factors in the gravity model of migration<sup>136</sup>, which was the basic approach for explaining migration (Vogler 2000, 30) for 100 years. Still, population pressure is seen as one of the 'root

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<sup>136</sup> The gravity approach that can be traced back to Carey (1858) assumes that migration results from attraction and repulsion, and builds thereby the basics for push/pull approaches (Vogler 2000, 30).

causes' of migration (de Haas 2008, 9). From a push/pull perspective, population pressure has been postulated as an important push factor (Kermer 2007, 139). However, the indicator for population pressure changed. While originally, absolute population was seen as a repulsive force (Vogler 2000, 30), it was later replaced by population growth (Vogler 2000, 86), and recent empirical research found only a significant correlation between urban population growth and international migration (Vogler 2000, 186). That leads to the question as to whether this correlation is equal to causation and what are the substantiations. While one approach of reasoning is that growth in population size and density leads to pressure on natural resources, and subsequently to competition and conflict over them (Naudé 2010, 336f), another approach focuses on the possible negative effect of population growth on real wages and pc income, indirectly influencing migration (Naudé 2010, 343; Vogler 2000, 86). The third reasoning, mainly known as the theory of mobility transition<sup>14</sup>, refers to the simultaneity of socio-economic 'development' and demographic transition<sup>128</sup>. As discussed in section 3.3.1 according to this approach population growth is not causation for migration, but rather a correlation. Higher migration and higher population growth both happen in a period of transformation, but not necessarily because of each other. The fourth reason why urban population growth should be incorporated as a causal factor for international migration is that it is an indicator of rural-urban migration, being modelled endogenously in the presented model, since internal migration is postulated to be a predecessor of international migration (Kermer 2007, 156; Ndiaye 26.6.2010; Senegalese Expert Commission 18.6.2010).

To sum it up, on the one hand, the use of population growth as a variable that affects migration indirectly (through pc income or wages), as well as the use as a proxy for the development process, can be criticised, as SD tries to model direct effects, at least when the variables in question exist in the model, such as pc income and variables representing the level of development, such as education and health levels. On the other hand, rural population growth can be seen as a proxy for pressure on natural resources and as prolongation of rural-urban migration.

### 3.3.3 Ability to Migrate

Besides the initial will to migrate, an important determinant for the actual emigration rate is the ability to migrate. This ability is influenced by policies, the immigration policies in the potential receiving countries as well as policies in the sending country and the cost of migration in relation to the existing means for migration. The cost of migration is affected by networks and the changes in information, communication and transportation costs, whereas the means for migration depend on pc disposable income<sup>137</sup>. To represent these causalities, the

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<sup>137</sup> Pc disposable income in the model includes GDP minus taxes that are paid, plus domestic interest payments, subsidies and transfers as well as private current transfers, which are assumed to equal remittances.

model firstly derives the relative migration cost integrating the network effect and the effect from changes in technology. Secondly, relative disposable income is related to those relative migration costs to represent that migration ability only increases if the means for migration increase. This is the case, when migration cost relative to disposable income decreases, or disposable income relative to migration cost increases, while the ability stays the same, when for example both migration cost and disposable income decrease proportionately. Finally, policies, such as immigration restrictions enhance or limit the ability to migrate. The effect of the ability to migrate is a multiplicative effect on the indicated emigration rate derived from the will to migrate, as this effect can only reinforce migration, when there is an emigration will. If there is no desire for emigration, the ability to migrate would not initiate people to emigrate. On the other hand, if there is no ability to emigrate, for example because of a complete emigration prohibition<sup>138</sup>, the will to migrate, even if being extreme, will not lead to emigration (assuming that the prohibition can be implemented).

In the following, the single components affecting migration ability are presented in detail, namely the network effect, information, communication and transportation costs as well as migration policies.

### 3.3.3.1 Network Effect

The model integrates the so called network effect by multiplying the stock of emigrants abroad with their help for potential new emigrants, considering only the first generation<sup>139</sup> (see section 3.2.2). This help decreases in a non-linear way when the stock increases, incorporating the finding that emigrants reduce their help and even can become 'gatekeepers' (de Haas 2008, 20) once they get the feeling that they are already surrounded by other emigrants. Consequently, an increasing stock of migrants increases the network effect, but in a non-linear way, as the help per emigrant decreases. The increasing network effect decreases migration costs and therewith augments the ability to migrate.<sup>140</sup>

Although the network effect is only recently highly debated, Lee (1966, 54) already wrote that migration increases migration, as experience has been gained, increasing the ability to judge the positive and negative factors in the destination country. This approach has been refined and developed further to an acknowledged factor for emigration, not elucidating why emigration emerges, but especially explaining why migration, once started is self-perpetuating and even reinforcing (Adepoju 2000, 390; Hödl et al. 2000, 14; Kermer 2007,

<sup>138</sup> Of course, a complete emigration prohibition is a hypothetical assumption, as there are people emigrating in an informal way. In addition, a country where exit is completely prohibited refers mainly to states such as Cuba or North Korea. Nevertheless, it helps to conceptualise the model structure and to understand the model behaviour by simulations, see section 4.2.

<sup>139</sup> Of course, this support can also be rendered by second or third generation emigrants, but as described before, the model considers only the first generation of emigrants (see section 3.2.2).

<sup>140</sup> As the model focuses on the aggregated level (see section 3.1.1), the selecting effect of this network effect is

138/144; Parnreiter 2000, 36ff), even if the situation in the sending country has improved (Vogler 2000, 41), or emigration becomes more difficult, because of restrictive immigration policies for example (Parnreiter 2000, 38). The explanation points out that networks reduce the cost and risk of migration, because emigrants abroad can pass on information about the receiving country and crossing possibilities, organise jobs and housing beforehand, give financial assistance through remittances, help with psychosocial problems, facilitate the integration in the new surrounding or even grant access through marriage (Eurostat 2000, 86-93; Parnreiter 2000, 36ff).

The network effect has been confirmed by empirical research evaluating data from a potential receiving country (Vogler 2000, 186), but also for Senegal specifically. An empiric study found out that in Senegal, nearly 75% of emigrating men had a network (parent or partner) and more than 90% of women, around 90% of emigrants expected and 80% received help from their network and for 70% most information came from their family at the destination<sup>141</sup> (Eurostat 2000, 92ff). Hence, it has been concluded, that "the presence of the network (parent or partner) is often the actual reason for their migration" (Eurostat 2000, 93).

In addition, the integrated reinforcing network effect also represents two other findings. Firstly, it has been shown that family reunion is an important factor for emigration (Eurostat 2000, 74<sup>142</sup>; Kermer 2007, 145<sup>143</sup>). Secondly, following the logic of the NEM approach, a higher stock of emigrants abroad also increases relative deprivation in the country and the feeling that emigration could improve their own situation, because of the increasing knowledge about the living standard abroad as well as the increased living standard of those families receiving remittances from emigrants abroad (e.g. Vogler 2000, 41; Ndiaye 26.6.2010).

### 3.3.3.2 *Information, Communication and Transport Costs*

The significant improvements in the information, communication and transportation sector are followed by two consequences in the model. Firstly, like the network effect, they decrease the migration cost.<sup>144</sup> Secondly, the model also integrates their effect on transnational ties leading to higher knowledge transfer and more remittances sent by emigrants.

The increasing impact of the advancement in the transportation sector on migration is already identified by Ravenstein (Grigg 1977, 43). Also, Lee (1966, 53) postulated that "[t]he

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*not considered, as only people with well-known abroad receive this help (Parnreiter 2000, 36ff).*

<sup>141</sup> 45% postulated that most information came from family at origin, 14% have been there before, while television and radio were each for under 6% the main information source. Newspaper, school, agencies, tourists etc. were negligible (Eurostat 2000, 92).

<sup>142</sup> The survey found out that family reunion was the reason for migration for 57% of women in Senegal, although it was only postulated by less than 10% of men (Eurostat 2000, 74).

<sup>143</sup> In 2001, the official reason for 70% of legal emigrants in USA, and between 50-60% in Europe was family reunions, although the trend indicates that income gets more important (Kermer 2007, 145).

<sup>144</sup> Although being a simplification of reality, it is assumed that those developments lead to a linear decrease of migration costs.

volume of migration is related to the difficulty of surmounting the intervening obstacles". However, migration costs as a hindering factor for migration, respectively the reduction of those costs as an enhancing factor for migration, was ignored for a long time especially by the neoclassical approaches and the push/pull theory<sup>145</sup>, until they were integrated by the human capital approach (Vogler 2000, 18). The reasoning for their integration is quite obvious concerning shrinking costs for transportation, as movement becomes cheaper and thereby the ability to migrate increases (as long as income does not decrease as well, see section 3.3.3; Ndiaye 26.6.2010). Concerning information costs, migration risks, costs and uncertainty, hindering reasons for migration (Vogler 2000, 24) are reduced through improved opportunities to get information about the potential host country, the labour market situation or ways to get there (Ndiaye 26.6.2010). Communication costs follow the same logic and build a synergistic effect with the existence of a network as friends and family can pass information more easily. As the effect of transportation, information and communication costs on migration costs is multiplied with the network effect on migration costs, this synergy is represented in the model. In addition to the influence of the transportation and telecommunication revolutions on migration costs, they are also, as mentioned before, assumed to increase relative deprivation since the knowledge of higher living standards diffuses more easily. However, this link is not modelled additionally, as one link affecting migration positively is expected to be sufficient.

Finally, the improvements in all of these sectors "have dramatically expanded the opportunities for migrants and their families to maintain transnational ties, to maintain transnational livelihoods and to construct transnational identities" (de Haas 2008, 14). Consequently, the model replicates their influence on the knowledge transfer of emigrants (see section 3.4.2.5), as well as remittance sent per emigrant (see section 3.4.2.3).

### 3.3.3.3 *Migration Policies: Emigration Restrictions and Permissions*

Migration policies affecting the ability to migrate concern either immigration policies from potential receiving countries as well as emigration permissions by the sending country.<sup>146</sup> For simplicity, the model represents both in one variable called 'emigration permission'. It is assumed that those policies can strongly in- and decrease the ability to migrate and therefore migration, for example through measures like sending back emigrants that arrive in OECD countries despite the prohibition of emigration.

<sup>145</sup> That is why these approaches were criticised for not being able to explain why international emigration is smaller than intra-national or interregional although the differences in income etc (the main factor for those approaches) are higher for the international migration (see e.g. Kermer 2007, 155; Vogler 2000, 20).

<sup>146</sup> Although for Senegal, it is probably immigration policy restricting emigration, countries existed and still exist where emigration is restricted by the sending country (see Cuba, North Korea or in former times the Soviet Union). In addition, sending countries can support the implementation of immigration restrictions based on agreements with potential receiving countries, see for example Libya.



This does not represent reality comprehensively, since it has been shown that more restrictions rather increase unregistered emigration, migration cost and risks (because of longer and perilous itineraries, payments for facilitators, no access to the social protection system in the receiving country) than really stop emigration (Hödl et al. 2000, 16f; Ndiaye 26.6.2010; Vogler 2000, 44; Zoomers/van Naerssen 2006, 15). Consequently, increasing immigration restriction probably further increases the unbearable situation that more and more unregistered emigrants die on their crossing.<sup>147</sup> However, there are two reasons why this model does not integrate the side effects of emigration restrictions in a more realistic way. Firstly, as mentioned before (see section 3.2.2), to reduce complexity, unregistered emigration is an exogenous variable only used to give an approximation for the education level of emigrants. Although the issue of illegalisation of emigrants is a very important one, unfortunately it goes beyond the scope of this study to integrate all reasons and effects into the model.<sup>148</sup> Secondly, for this model that tries to understand the system and its behaviour, it is helpful to integrate a parameter that allows for in- and decreasing migration to analyse the impact and the emergent behaviour. Nevertheless, once the model should be used for policy analysis, it is important to adjust the link.<sup>149</sup> The selectivity of immigration policy concerning education is further discussed in section 3.4.2.4.

### 3.4 Consequences of Migration

Looking at the consequences of emigration, direct effects of emigration and the assessment of the general effect on development can be distinguished between. While a consensus concerning direct consequences can be observed, the general effect on development is controversially discussed. Although this discussion is not decisive for modelling, as only direct effects with their consequences are integrated, its outline clarifies the interest in research question if the net effect of changes in migration on development is positive or negative. That is why this chapter firstly gives a short overview of the debate on the general effect. Subsequently, the five direct effects integrated in the model and their consequences are presented, being the effect on migration itself (network effect), the effect on population, the effect of remittances, of brain drain and brain gain. While the effect on population and brain drain happens in the moment of emigration, the other three effects are driven by the stock of emigrants affecting the home society for a long period, since the bonds of Diaspora

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<sup>147</sup> The organization Fortress Europe (2010) estimates that "at least 14.921 people have died since 1988 along the European borders".

<sup>148</sup> For the interested reader, please see Jahn/Straubhaar (1998) to gain insight into the discussion about the role of illegal immigrants in the labour market. For the discussion in political science whether democratic states should and could control undesired immigration, consult for example Freeman (1995/1996), Brubaker (1995), and Perlmutter (1996).

<sup>149</sup> For example, emigration permissions could decrease migration cost and thereby only indirectly the ability to migrate instead of assuming that those policies really affect the ability to migrate directly. If desired, the side effect of affecting the proportion of unregistered emigrants could be introduced. However, this is reasonable if this proportion is of interest for the analysis.

to home country uphold for a long time. This can be explained by the reasons for emigration. When people emigrate as a risk sharing strategy (see NEM<sup>124</sup>), or to improve livelihood (see livelihood approach<sup>123</sup>), leaving for and being financed by the whole household, it becomes clear that the connection is sustained over a long period. This conclusion is supported by the insights into transnational migrants (see 3.2.2).

### 3.4.1 General Effect on Development

The general effect of emigration on development is highly controversially debated. Historically, the assessment changed from the original optimism by developmentalists in the 1950s and 1960s, which was replaced by neo-Marxists pessimism in 1970s and 1980s and is now shifting back to a rather more positive view (de Haas 2010, 227). According to de Haas this can be attributed to “more general paradigm shifts in social and development theory” (de Haas 2010, 227). While optimism is mainly based on neoclassical theory and its developmentalist approach, pessimism refers to historical-structuralists and neo-Marxist views, such as dependency theory (see e.g. Frank 1966; Baran 1973), world systems theory (see e.g. Wallerstein 1974, 1980) dual labour market theory (see e.g. Piore 1979), and cumulative causation theory (Myrdal 1957). From a neoclassical perspective, migration is an adjustment mechanism, allocating the resource labour in the most efficient way, which increases economic growth in sending and receiving areas and countries (Appleyard 1989, 487; Gächter 2000, 17; Ghosh 2006, 30; Naudé 2010, 332)<sup>150</sup>, driven by resource-maximising agents (Massey et al. 1993, 435f). On the contrary, according to historical-structuralist approaches migration is caused by expansion of the capitalist system with its inherent logic of asymmetric growth in core and periphery zone, and thereby increases spatial economic disparities and dependency structures (de Haas 2010, 232-238; Jones/Mielants 2010, 2f; Massey et al. 1993, 444ff; Parnreiter 2000, 32-36). Consequently, migration can be seen as a path to modernisation (cp. neoclassical view<sup>122</sup>, and mobility transition approach<sup>14</sup>), assuming a net North-South transfer, and underlining the poverty reduction effects of remittances and brain gain (de Haas 2010, 229). On the contrary, structuralism emanates from a net South-North transfer focussing on effects such as brain drain, increasing inequality, dependency etc (de Haas 2010, 229). While these focus on the strength of individual emigrants and their agency underestimating structural constraints, those tend to overestimate the role of structure sometimes ruling out the “limited but real capacity of individuals to overcome constraints and po-

<sup>150</sup> *In the same logic, it is a substitute for trade and capital movement also being mechanisms for optimal resource allocation (Vogler 2000, 33). However, studies showed that emigration can increase trade, leading to the conclusion that they are no substitutes (Drinkwater et al. 2003, 13-16). However, trade seems to be more favourable for industry countries, while migration improves primarily the situation in development countries (Drinkwater et al. 2003, 14). In addition, the global gain from migration is much higher than from trade. According to an estimation by the World Bank, “emigration from developing countries equal to 3 per cent of the labour force of high income countries (...) could lead to (...) twice the global gain from full merchandise trade liberalization” (Ghosh 2006, S. 30).*

tentially reshape structure" (de Haas 2010, 241). In general, it can be noticed that the picture of theoretical models and empirical studies does not allow a definite conclusion (de Haas 2009; Drinkwater et al. 2003, 39).

However, this study does not aim to present this debate in all its detail<sup>151</sup>, as its approach is not the evaluation and discussion of whole theories, but rather to model the single direct effects, to integrate those in the broader development context, and by doing so, to derive some insights using simulations. The integration of five direct effects with their subsequent consequences (see section 3.4.2.1 till 3.4.2.5), will represent the influence of migration on development as defined in section 3.2.1, as for example pc income is affected through remittances and population, and education through brain gain and drain. Some of the indirect effects are already outlined in the following section, while others become clear and are presented in detail in the Analysis chapter (see section 4.2), when describing the feedbacks. However, while the attempt has been made to integrate as many possible effects, some could not be integrated due to the limited scope of this study. For example only some aspects of social change that can be induced by migration are considered, such as brain drain, brain gain, including the transfer of other ways of thinking and acting (see section 3.4.2.4), and the improved financial situation due to remittances (Appleyard 1989, 496), aging of population, and the possible increase of fertility rates if brain drain exceeds brain gain (Ghosh 2006, 80). However, it is neither considered that emigration can impact gender roles and emancipation<sup>152</sup>, nor that it can negatively influence the psychology of the whole society<sup>153</sup>. The integration of these aspects could be a task of further research.

### 3.4.2 Direct Effects of Migration and Their Consequences

The direct effects of migration that are integrated into the model are the effect on migration itself (network effect), the effects on population, remittances, brain drain and brain gain.

#### 3.4.2.1 Effect on Migration

The first obvious consequence of migration is that more people live abroad. As long as more people emigrate than return and die (the two outflows of the emigration stock), the

<sup>151</sup> A comprehensive overview of the opposing assessment can be found in de Haas (2010). For an outline of negative and positive effects, please see Ghosh (2006, 95–98). Drinkwater et al. (2003, 39) represent different theoretical models and studies about the impact of migration, especially on growth rates, concluding that its assessment is ambiguous for sending countries, while in receiving countries an increase of growth could be diagnosed.

<sup>152</sup> Some authors argue that migration can enhance emancipation, when women as left-behinds get more responsibility, take over men's roles, participate in the labour market, and manage financial affairs (Appleyard 1989, 496; Ghosh 2006, 78f; Kermer 2007, 154). Others warn that women's seclusion can also be increased if they are for example left in the care of male relatives (Ghosh 2006, 78f).

<sup>153</sup> It has been noted that emigration can lead to 'absence and emptiness' (Ghosh 2006, 80), that families are torn apart, children 'lose' their parents, and young men should emigrate, as it becomes something like a rite of fledging (Kermer 2007, 154). In addition, unregistered migration and human trafficking have high psychological influences, and produce new vulnerabilities (illness, risky journey, exploitation of skills) (Zoomers/van Naerssen 2006, 36).

stock of emigrants living abroad will increase. As outlined in section 3.3.3.1, called 'Network Effect', there are three reasons why an increasing stock of emigrants leads to further migration, reinforcing itself. Firstly, network effects reduce migration costs and facilitate migration. Secondly, the possibility of family reunion, an important way to gain access to admission, increases. Finally, communication with an increased number of emigrants living abroad and things that could be obtained with the sent remittances increase relative deprivation and consequently migration.

### 3.4.2.2 *Effect on Demography*

The second consequence incorporated in the model is quite obvious as well. Emigration as well as returning emigrants affects population. The model adds net migration (immigration minus emigration) to the stock of population. This stock is disaggregated into male and female as well as into 81 age groups, and thereby enables the analysis of the effects of emigration not only on the total population, but also on the population pyramid<sup>154</sup>, since mainly young male people emigrate while the returnees are accordingly older. That means that the working age population is reduced possibly causing the problem of insufficient labour force. The term 'brawn drain' describes this situation that the emigration of young, able-bodied men (from rural areas) potentially leads to labour shortage, especially in the agricultural sector, and thereby to decreasing productivity (de Haas 2010, 235; Ndiaye 26.6.2010). However, the loss of workforce only reduces productivity when the demand exceeds the supply, meaning when there is no unemployment (Vogler 2000, 99f). With the actual high levels of unemployment and employment in the informal sector<sup>130</sup> this is not probable in the short run. Instead, emigration by the working age population decreases unemployment (if existent) and thereby increases pc income. In other words, pc income increases as population decreases while production does not decrease due to high unemployment rates.

### 3.4.2.3 *Remittances*

A highly relevant consequence of emigration are financial remittances that are sent back home. To integrate those remittances into the model, firstly their development should be explained endogenously, and secondly their consequences, especially on development relevant variables, need to be defined and incorporated.

To perform the first task, the endogenous computation of the amount of remittances, the model multiplies the stock of emigrants with remittances sent per emigrants<sup>155</sup> (Spatafora 2005, 81). Instead of disaggregating emigrants by their numerous characteristics that lead to

<sup>154</sup> The population pyramid shows in a graph the distribution of various age groups, divided by sex, and can be used for analysing population dynamics as well as an indicator for the extent of development based on the demographic transition theory (see footnote 14).

<sup>155</sup> The model does not disaggregate between informal and formal remittances. For information about effects and reasons of informal remittances and policies to direct them in formal channels, see Ghosh (2006).

different levels of remittances<sup>156</sup>, an average amount of remittances is used. However, this average amount is not static but depends on the average labour cost for emigrants in OECD countries (Spatafora 2005, 81), which is based on the average pc GDP in OECD countries, the education level of emigrants, assuming that higher educated emigrants earn more money (see e.g. Ghosh 2006, 22), and finally, the proportion of salary that is sent home. This proportion is negatively influenced<sup>157</sup> by relative information, transportation and communication cost, due to three reasons. Firstly, the reduction of those costs decrease transaction costs, something that can even be intensified by policies, leading to higher remittances (see e.g. Ghosh 2006, 35). A second reason is that decreasing communication and transportation costs increase transnationalism (see section 3.2.2) and thereby the bonds that lead to more remittances. Finally, as a third reason, less money has to be spent on communication with stay-at-home family and friends, and visits to Senegal. Hence, more money can be sent. To facilitate the exploration of the system in section 4.2 it is assumed that this proportion in addition to the incentives by communication and transportation costs, can also be influenced exogenously (for example through policies to reduce transaction costs<sup>158</sup>). However, these incentives increase the proportion of salary that is sent in a non-linear way, limited on the one hand by the proportion that is needed by emigrants for their own living cost and on the other hand, by a minimum that is sent anyway to support the stay-at-homes. Since a certain level of political stability is secured by the case selection (see section 2.2.2), the political situation in the sending country is not included as a influencing factor, as proposed for example by Spatafora (2005, 81-84) or Ghosh (2006, 47ff).<sup>159</sup>

The second task is the definition and modelling of the two consequences of those remittances, one positive and one negative. The positive represented consequence in the model is increasing disposable income, as remittances are added as private current transfers to household revenue (e.g. Ghosh 2006, 51; de Haas 2010, 249; Kermer 2007, 153; Senegalese Expert Commission 18.6.2010; Vogler 2000, 101). Empirical research even found that the share of remittances on household income in Senegal was up to 90% (ILO 2004, 24).

This increased disposable income is assumed to be followed by two consequences. Firstly, it decreases poverty. This aspect is doubted by authors that stress that especially pioneer

<sup>156</sup> It has been pointed out, that the level of remittances is dependent on characteristics of migrants, such as un-registered and registered, as well as on the motives for emigration, for example it differs between those with a specific economic target and those that decided to stay permanently abroad. For further information, see Ghosh (2006, 22ff and 47ff).

<sup>157</sup> That means that a decrease in information, transportation and communication costs causes an increase in the proportion of salary that is sent.

<sup>158</sup> For example, it has been criticised that a lack of competition because of restrictive regulatory frameworks, market imperfection and inefficiency led to high transaction costs (Ghosh 2006, 36), which could be tackled by policies.

<sup>159</sup> Spatafora (2005, 82) stresses that low levels of law and order, risks of expropriation, and political instability may decrease the amount of remittances sent per emigrant.

migrants often come from wealthy households, while the poor stay, so that the remittances even increase inequality in the country (e.g. Appleyard 1989, 493; de Haas 2010, 249; Zoomers/van Naerssen 2006, 21).<sup>160</sup> However, due to decreasing migration costs and increasing migration means (see section 3.3.3) in later stages of migration also poorer people migrate decreasing inequality (de Haas 2010, 249; Ghosh 2006, 72-75). In addition, remittances are often used for basic consumption (Ghosh 2006, 72-75), permitting to hypothesise that they contribute to poverty alleviation. Empirical research in Senegal even showed that an important share, between 30 and 80%, of family needs are covered by remittances (Adepoju 2000, 385) and evidence was found that inequality has been reduced on the basis of pc expenditure on consumption (Appleyard 1989, 494). Furthermore, remittances can be invested in community assets benefiting the poor (Ghosh 2006, 72ff).<sup>161</sup> Hence, Ndiaye (26.6.2010) concludes that remittances “contribute to improve the way of life at the family level” and the assumption seems to be justified that a significant proportion of migrants are poor people (even if not the prevailing one) decreasing poverty through remittances (Ghosh 2006, 72ff; Kermer 2007, 153; Senegalese Expert Commission 18.6.2010).

A second effect of increased disposable income is the augmentation of private investment and private consumption (e.g. Kermer 2007, 153). It has been widely discussed as to whether only investment or also consumption leads to positive effects on the economy. Some authors argue that the use of remittances mainly for consumption affects the economy negatively as primarily luxury goods and ‘unproductive’ are consumed, leading to an increase in price levels, overvalued exchange rate (Drinkwater et al. 2003, 22), and an encouragement of imports (Appleyard 1989, 492; Ghosh 2006, 59). Others elaborate that consumption of food, health, education, information technologies etc. also increases productivity, especially in the long run (Appleyard 1989, 492; Gächter 2000, 161f; Ghosh 2006, 51) and that consumption has a positive effect on the economy since consumption can generate additional employment, income (de Haas 2010, 249f; Ghosh 2006, 67), as well as the accumulation of rural assets (Drinkwater et al. 2003, 22). In the model, as it applies a resource based approach (Pederchini 2009, 14f), only increasing investment leads to an increase in production following the logic that an increase in consumption is not possible if there is no increase in production. Nevertheless, the positive effect of remittances on production is taken into account in the following way. Firstly, an increase in pc disposable income also enlarges investment, even assuming that the main share of remittances is consumed (Adepoju 2000, 385; Vogler 2000, 101). Secondly, the model follows the logic that increasing pc

<sup>160</sup> It has been noted that this emigration by wealthy persons possibly leads to “islands of wealth” (Zoomers/van Naerssen 2006, 36) deepening the social stratification between migrant and non-migrant household, which is even intensified when social obligations and social cohesiveness is weakened (Ghosh 2006, 77f).

<sup>161</sup> Those community friendly initiatives are often initiated by migrant associations, sending collective remittances and collecting additional funds for the implementation of development programmes (Ghosh 2006, 77f).

disposable income leads to increasing propensity to save, dividing disposable income into private consumption and investment. Consequently, also the share of the increased pc disposable income that is invested is raised (de Haas 2010, 249f; Ghosh 2006, 66). The boost of private investment is followed in the long-run by multiplier effects (Kermer 2007, 153), such as positive effects on production, investment itself, public revenue and services.

The negative consequence of remittances integrated in the model is the emergence of dependency, measured as 'share of remittances on GDP'. Although on the one hand, it has been argued that they support the development process more effectively than development aid (de Haas 2010, 228), breaking up the inherent dependence structure and destructive mechanisms of aid<sup>162</sup>, on the other hand, it has been warned of growing dependency on the economy and immigration policies of receiving countries (Ghosh 2006, 60; Vogler 2000, 101; Zoomers/van Naerssen 2006, 21). That is why the analysis of simulations will consider the ratio of remittances as a share of GDP as one indicator of vulnerability (see section 3.2.1).

Some possible consequences are not considered within the model. Firstly, inflationary effects due to increased demand and fixed supply (Vogler 2000, 101) are not incorporated, since it can be assumed that they may reverse in the longer term (Appleyard 1989, 494). Secondly, it has been mentioned that agriculture production may be declined because it is replaced by remittances (Appleyard 1989, 494). However, this seems to be a short-time effect as in the long term remittances can contribute to farm modernisation (Ghosh 2006, 52f). Thirdly, the appreciation of external value of its currency (Dutch disease) has been ignored as its effects turned out to be marginal (Ghosh 2006, 59). Fourthly, unlike official aid or natural resource revenues, encouraging corruption and wasteful spending, remittances do not decrease countries competitiveness since they are widely distributed (Ghosh 2006, 54ff). Finally, effects on the balance of payment, remittances as a source of foreign exchange for financing imports are not incorporated (e.g. Appleyard 1989, 492; Ghosh 2006, 54ff; Vogler 2000, 101).

#### 3.4.2.4 *Brain Drain*

The fourth important consequence of emigration is the so called brain drain. Brain drain can be defined as "the migration of skilled workers" (Docquier/Marfouk 2005, 3) and therefore as the loss of human capital due to emigration. Although, the brain drain perspective has been questioned from a transnational perspective as further contact and exchange can preserve their knowledge for the sending country (de Haas 2010, 248), it can't be denied that emigrants do their everyday life abroad, meaning that they won't be available as work

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<sup>162</sup> *It has been argued that government-to-government development aid is easy money that increases corruption and deform economies establishing a culture of economic laziness and dependency, hindering the development of accountability and responsibility (Moyo 2009).*

force, and they are not 'at home' to help children with their homework etc. Hence, there is a loss. Nevertheless, their skills and knowledge probably not only 'return' when they return physically, but earlier through communication etc. This transfer of knowledge, part of the brain gain effect, is integrated by the model (see section 3.4.2.5), but its existence is no reason for ignoring brain drain effects.

The reasons for the emigration of higher qualified people are multifarious. Firstly, the receiving countries "play an active role in 'cherry picking'" (Zoomers/van Naerssen 2006, 19), with their selective immigration policy (de Haas 2010, 244; Kermer 2007, 146f).<sup>163</sup> Another reason is the socio-economic situation in the country of origin paired with the knowledge that the situation for qualified people in other countries could be much better (Adepoju 2000, 286f; de Haas 2010, 244; Ndiaye 26.6.2010). This is especially the case when the variance of income due to education is high in the receiving country (Vogler 2000, 38ff). In addition, it is easier for educated people to get information and to obtain the means for migration (Vogler 2000, 38ff), and finally, the rate of return in human capital is higher in economies with a higher education level (Drinkwater et al. 2003, 19; de Haas 2010, 244). However, the model does not compute the reasons for brain drain, but assumes that the education level of emigrants is by a constant factor higher than the education level within Senegal, based on the research of Docquier and Marfouk (2005, 24; Docquier et al. 2008). This is in line with the assessment of the local experts (Ndiaye 26.6.2010; Senegalese Expert Commission 18.6.2010) and the findings of the World Bank (2009, 157) that although skilled migration increased in absolute terms, skilled migration in relative terms is fairly constant. Nevertheless, for the exploration of the system in section 4.2, it is assumed that this proportion can be changed exogenously (for example through more less selective immigration policies).

The first important consequence of brain drain is that the stock of people with primary (literate people), secondary and tertiary education is reduced. If the education level of emigrants is on average higher than the average education level in the country of origin, the stock of educated people is proportionally more reduced than the stock of total population and therefore the education level in the sending country decreases. On the other hand, if emigrants are on average less educated than the inland population the education level would even increase compared to the case that emigrants have the same education level as the inland population. However, of course, compared to the case that only uneducated people emigrate, also the emigration of less (but still to a certain extent) educated people signifies a loss of human capital. As an indicator of the average level of education, the model computes

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<sup>163</sup> While admission regulations of OECD countries have in general become increasingly restrictive since the 90s (Eurostat 2000, 99; Hödl et al. 2000, 16f; Parnreiter 2000, 36; Vogler 2000, 115), highly qualified emigrants are exempted (Hödl et al. 2000, 16f), and an increasing debate has emerged as to how to facilitate and even stimulate their emigration to reduce the scarcity of qualified labour force that will potentially increase due to



the average adult literacy rate as well as the average years of schooling. The reduced education level affects several variables, such as fertility rate, school enrolment, water demand, and labour demand, the most relevant for this study being the decrease in productivity (see e.g. Kermer 2007, 153) as not only the best educated but also those with a more productive attitude leave, being more ambitious, harder working, cleverer etc. (Appleyard 1989, 489). An imperfect replacement of those qualified emigrants and the loss in human capital leads to a decline in productivity (Appleyard 1989, 489; Kermer 2007, 152; Vogler 2000, 99f). Indeed, this is not necessarily the case when those emigrants did not work before leaving as the supply exceeded demand (Appleyard 1989, 488; Kermer 2007, 152), but as education is a rare resource in so called 'developing countries' with a low HDI (Vogler 2000, 99f), this aspect is not considered in this study. The second relevant consequence of brain drain is the loss of public funds, if the education of emigrants is financed by the sending country (public school), but used in the receiving country, neither increasing the productivity nor paying taxes in the sending country (Appleyard 1989, 490; Kermer 2007, 153). However, a certain level of return on investment will be reached as remittances are positively influenced by the education level of emigrants (see section 3.4.2.3). Depending on the initiated multiplier effects by remittances, migration of educated people could also end as fiscal gain, especially if remittances replace necessary public social transfers (Kermer 2007, 153). To reduce complexity, and as public protection systems are rather marginal in so called developing countries, the potential replacement of social transfers by remittances is not included into the model. Similarly, possible side effects concerning the in- respectively decrease of incentive for education are not considered in the model as they seem to balance each other.<sup>164</sup>

### 3.4.2.5 Brain Gain

The final included consequence of emigration is brain gain. This term describes the situation that emigrants, by acquainting new knowledge abroad and transferring it to their home society, increase the education level in the sending country. Although the size of brain gain is highly debated as well as the question as to whether its impact balances or even outbalance brain drain, and therefore whether it leads to positive development effects,<sup>165</sup> its existence is not even denied by its critics (e.g. Schiff 2005).

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*ageing of the population in OECD countries.*

<sup>164</sup> On the one hand, it has been postulated that brain drain could lead to an increase of education offers and incentives for human capital investment (Appleyard 1989, 490; Drinkwater et al. 2003, 1) because of the prospect of higher wages and less unemployment through emigration, being successful with higher probability when emigrants are educated (Drinkwater et al. 2003, 18). On the other hand, brain drain and the inherent loss of investment in human capital (of governments or private companies) could produce a negative incentive to further invest in human capital (Vogler 2000, 99f).

<sup>165</sup> For example, it has been pointed out that the knowledge gain is limited due to emigrants that do simple work in factories or agriculture, the bounded willingness to return, when the conditions in the home country are worse, and the confined possibility to use the new know-how for example due to the lack of adequate machines (Vogler 2000, 101f). On the other hand, the fact that "[s]everal political, academic, and business lead-

To model brain gain, the model assumes that a part of not educated emigrants either study abroad or gain knowledge by living there, increasing the stock of educated emigrants (Ndiaye 26.6.2010; Senegalese Expert Commission 18.6.2010). These exogenous proportions can be changed by policies (e.g. through intensive education programs in the receiving country). Subsequently, the additional knowledge can be transferred in two ways. Firstly, upon returning the educated emigrants are added to the stock of educated people in Senegal (e.g. Kermer 2007, 153). The model takes into account that a certain proportion does not return and this proportion is assumed to be changeable through policies for the explorative scenarios in section 4.2. Secondly, based on the findings of transnational migration studies (see section 3.2.2), it is assumed that educated emigrants transfer knowledge even before returning physically through intensified communication (for example via e-mail and skype), home visits and holidays, physical or virtual short-term assignments. Some authors pointed out that the positive<sup>166</sup> impact is even intensified by not only transferring knowledge, but also information, ideas, behaviours, identities, new ways of thinking and acting, as well as (business) contacts (Appleyard 1989, 494f; de Haas 2008, 22; Kermer 2007, 154; Ndiaye 26.6.2010). Although it has been noticed that these 'social transfers' (Zoomers/van Naerssen 2006, 6) or 'social remittances' (de Haas 2008, 22) can also be followed by negative<sup>167</sup> consequences, it is doubtless that knowledge is transferred. Even though this type of exchange in reality does not necessarily increase the education level in terms of average years of schooling, it adds to the knowledge in the country and finally increases productivity. Therefore, the model represents this transfer as a gain in education. However, as their knowledge and skills are not usable the whole year long (as their day-to-day-work takes place abroad), it is assumed that their knowledge is only added for an average proportion of the year. This proportion can be changed by policies<sup>168</sup> and by the intensity of transnational identities, as more regular and reliable contact enhances the knowledge transfer. As described before, this intensity is dependent on transportation, information and communication costs. However, it is assumed that the transfer of so called social remittances refers mainly to emigrants with tertiary education, since those can transfer new ideas, skills and business

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*ers in developing countries began as emigrants" (World Bank 2009, 168) underline that there is a gain in knowledge.*

<sup>166</sup> Positive impact could be created by the 'transfer' of entrepreneurship (de Haas 2008, 22), new ideas, openness, democratic values possibly leading to weakening traditional and rigid societies and increasing social mobility (Ghosh 2006, 78).

<sup>167</sup> Negative consequences could be feelings of relative deprivation (de Haas 2008, 22), and the enhancement of prestige value for foreign goods paired with psychological downgrading of domestic goods (Ghosh 2006, 78).

<sup>168</sup> Possible policies could be the support and involvement of migrants networks and Diaspora organization in receiving countries, dual citizenship (Kermer 2007, 157ff; Zoomers/van Naerssen 2006, 29) or national programs that encourage and facilitate short term assignments of expatriates based on the needs of the country, such as TOKTEN (Transfer of Knowledge through expatriates nationals) (Zoomers/van Naerssen 2006, 29) or MIDA (Migrations pour le développement en Afrique) (Melde/Ndiaye-Coïc 2009, 31).

contacts that really influence productivity. That is why only the knowledge of tertiary emigrants is added to the indicator representing the education level of the country.

### 3.5 Interim Conclusion

This chapter outlined the structure of the model of this study. The first subchapter gave an overview of the general features, defining the unit of analysis, describing how the migration model structure is connected to the T21-Senegal that reproduces the broader development context, determining the time horizon and the model boundaries as well as depicting the validation process for this model. In the second subchapter, the main variables of this study, development and migration, are defined and discussed. The third and fourth subchapter picture the structure of the migration part of the model that has been newly developed for this study. The first part of both subchapters explicitly shows which theoretical approaches are in- and excluded. The following parts discuss those causes and consequences of migration that have been incorporated into the model based on the literature and describe how they are integrated. Summarizing the developed migration structure, there are seven variables that are assumed to generate a certain will to migrate, some due to their absolute values (poverty, environmental degradation, and urban population growth rate), others due to their relative value compared with the value of potential receiving countries (real pc GDP, literacy rate, and life expectancy). The will is summed up, and delayed, assuming that perception and change of will to migrate and migration behaviour needs some time. The final emigration rate depends on this will and the ability to migrate. The ability depends on migration cost in relation to the pc disposable income, and the national emigration as well as the immigration policy of potential host countries. For simplification, as for the discovering exercise of the feedback relationships and the behaviour of the systems, it is not relevant which country restricts emigration and therefore the model does not differ between the policies of host and home country and thereby only represents the relative emigration permission. Migration cost is influenced by the changes in communication, information and transportation costs and the network effect. As consequences, the model replicates the effect on migration itself (network effect), the effect on demography, the generated remittances that increase household revenue, the loss of human capital due to the emigration of educated people (brain drain), and finally the brain drain due to knowledge gain abroad and its transfer either by returning or by ongoing communication with families and friends that stayed at home, exchanging their new skills while being abroad. The elaborated structure is visualised as a simplified stock and flow diagram in Appendix A.

The next chapter analyses the behaviour of this model structure which tries to replicate the main interrelations between migration and development to find some answers to the research question.

## 4 Analysis: Simulation of Migration in Senegal

After having established the unidirectional links, causing and following migration that have been integrated into the model, this chapter aims at closing the loops and deriving some insights from the feedback perspective. To do so, section 4.1 gives an overview of the relevant feedback loops that are inherent in the modelled system from a theoretical perspective. That means that by analysing the established structure of the model, those existing feedback relationships are elaborated that are relevant for the explanation and analysis of the behaviour of the simulations. Only the relevant ones are portrayed as it would be impossible to represent all feedback loops connected to migration and development. Consequently, from the initially identified feedback relationships only those are sketched that emerged to be the important ones during the process of analysis of the simulations. Due to the scope of the study, the process of identification of the relevant feedbacks is not further described. Although the discovery of the relevant feedback relationships already improves the understanding of the processes within the system, it does not automatically give an indication of the strength of the different loops and the overall behaviour of the system. That is why in section 4.2 the dominance of the existing relationships is explored by simulating hypothetical scenarios, analysing the generated behaviour of the system and comparing them. Having done that, it is possible to derive some insights into the behaviour patterns of the system and the net effect of changes in migration on development considering the feedback relationship of migration and development. Finally, the gained insights will be summarised in section 0.

### 4.1 Closing the Loops: Relevant Theoretical Feedback Relationships

This section gives an overview of the relevant existing feedback relationships between development indicators and emigration that are incorporated in the model. As the model is based on literature and insights of the real system, it is believed that those feedbacks also exist in reality.<sup>169</sup> However, of course not all existing feedback relationships of the real system are represented in the model as a model is always a simplification of reality (Gilbert/Troitzsch 2005, 2). Instead, those causes and consequences of migration discussed in the previous chapter are included and their causal chain is traced until explanations from within the model are found to provide endogenous explanations, as it is the aim of SD (Sterman 2000, 94ff, see also section 2.1.2.1). Yet, not all feedback relationships incorporated in the model are outlined in this section, as this would exceed the scope of the study. That is why this section only discusses those feedback relationships that are the most relevant ones for the analysis of the generated model behaviour of the scenarios of section 4.2.

<sup>169</sup> *The reasoning for the integrated causes and consequences of migration are discussed in section 3.3 and 3.4. Further causalities that are presented in this section are part of the T21, its reasoning (see e.g. MI 2011b; Pedercini/Barney 2010) and the country specific adjustment. Several causalities that are not discussed in the section 3.3 and 3.4 are substantiated in the following footnotes.*

Of course, other feedback relationships also influence the behaviour of the system, but their influence was found to be less decisive. All the presented feedback relationships are visualised using causal loop diagrams (CLDs). In comparison to stock and flow diagrams, they allow the feedback loops to be illustrated without showing all variables that are necessary for the calculation in the simulation model, so that the figure becomes easier to follow and the feedback is visible at first sight.<sup>170</sup> To further improve clarity, the CLD of the whole system is subdivided into five sub-CLDs by means of which the feedbacks are explained in the following section. However, it is important to keep in mind that a variable from one of the sub-diagrams is the same variable that appears in other sub-diagrams. The way to interpret those CLDs, is mentioned in Figure 2 (p. 16): the signs ('+' or '-') at the end of the causal arrows indicate the polarity of the relationship, and thereby whether the change, *ceteris paribus*, causes either a change in the same ('+') or in the opposite ('-') direction and should not be interpreted as either an increase or decrease. The loops labelled as 'C' loops are counteracting loops, meaning that an initial impulse is counteracted once the impulse 'returns' to the initial variable. 'R' loops are reinforcing loops describing that the impulse is intensified every time it circles around the loop. This concept is often known as a vicious or virtuous circle. Finally, the figures show the six exogenous variables which are used to generate the scenarios that are discussed in the following section, section 4.2, to clarify at which point the changes intervene in the model. It is important to emphasise that a comprehensive policy structure that replicates side effects etc. has not been constructed as the scenarios generated by these exogenous changes do not aim to replicate reality. Instead, these exogenous variables are used as an instrument to conduct experiments with the model to investigate its behaviour and the dominance of the feedback loops.

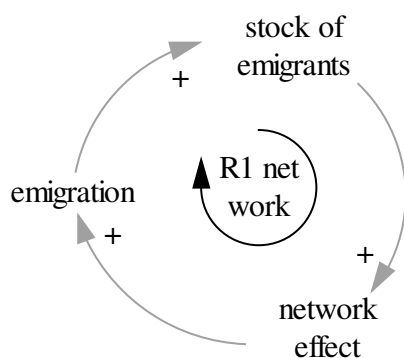
The first sub-CLD (see Figure 5) shows the reinforcing feedback loop of migration due to the network effect, called the 'R1 network'. This relationship is probably one of the few feedback relationships to have already been widely discussed in the migration literature (see section 3.3.3.1). Accordingly, emigration increases the stock of emigrants living abroad. Those people support willing emigrants to migrate by helping with information, jobs and housing etc., reducing migration costs and thereby increasing emigration, which further increases the stock of emigrants. Although the relationship between emigration stock and the network effect is non-linear (see section 3.3.3.1), the feedback remains a reinforcing loop as long as an increasing stock of emigrants does not lead to a decreasing network effect. This would only be the case if emigrants abroad not only stopped supporting their family and friends from

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<sup>170</sup> A disadvantage of those CLDs is that they do not show if the variables are stock, flows or auxiliary variables. In addition, as not all variables are included, it is not obvious with the help of which variable the simulation model calculates the behaviour. For the reader interested in the technical details, please consult the elaborated model that is included in the CD that accompanies the printed version of the thesis (see Appendix F) or for the general starting framework of T21 the documentation by MI (2007).

home, but if they started to scare people away. It is doubtful that this would happen. Consequently, it is questionable whether emigrants living abroad really can be seen as ‘gate-keepers’ (de Haas 2008, 20). Probably it is more precise to say that the increasing effect due to the network effect can be reduced, once the stock reaches a certain limit. However, it will still be higher than if there were no network effect at all.

Figure 5: CLD of Migration Feedback



Source: own figure; For explanation for interpretation see Figure 2 (p. 16)

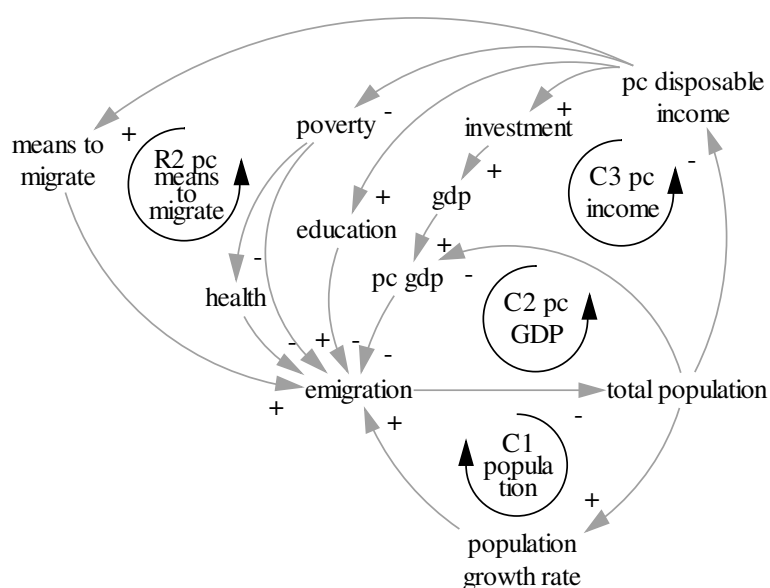
The second sub-CLD (see Figure 6) depicts the feedback relationships between population and emigration. The diminution of population due to emigration is followed by several effects feeding back to emigration. Four main feedback loops can be identified. The first counteracting feedback loop, called ‘C1 population’, portrays that the reduction of population signifies a reduction of population growth rate in urban and rural areas, diminishing one of the causes for emigration and thereby counteracting the initial rise in emigration. ‘C2 pc GDP’ shows that a drop in population due to emigration enlarges pc GDP as it is split between fewer people, counteracting the initial increase of emigration.<sup>171</sup> Similarly, a decline in population also amplifies pc disposable income. This relationship is part of the third counteracting feedback loop ‘C3 pc income’. It portrays that the rise in pc disposable income due to emigration reduces emigration through several channels. Firstly, higher pc disposable income leads to higher investment, and therefore higher GDP and pc GDP, causing a reduction in emigration. Secondly, the resulting dwindling poverty not only reduces emigration as it is one reason for emigration, but also improves health levels, since people can afford the medical fees<sup>172</sup>, inducing a drop in emigration will, since health levels are an indicator of the state of

<sup>171</sup> Of course, GDP is also influenced by the labour force in the country. Knowing that migrants in Senegal are mainly male (84.2%) and between 15 and 54 years old (94.1%) (IOM 2009, 129f, see also section 3.2.2), and consequently that emigration primarily reduces the labour age population, it could be assumed that another relevant causality is the reduction of GDP. However, this feedback relationship (a reduction of the labour population that decreases GDP and consequently amplifies the initial increase in emigration) is not portrayed as the decrease in population only leads to labour shortages if there is no (respectively only the natural) employment rate. Since the unemployment level in Senegal is high (see footnote 130), it is quite probable that this reinforcing loop is very weak.

<sup>172</sup> This causality is integrated in the model as it has been pointed out that medical fees are decisive for access

social services. Finally, a rise in pc disposable income increases the education level, enhancing the enrolment rate as parents are more willing to invest in the education of their children.<sup>173</sup> Besides this negative influence of pc disposable income on emigration (in the sense of ‘opposite direction’), pc disposable income also influences emigration positively (in the sense of ‘same direction’). The emerging reinforcing feedback relationship is the third one represented in Figure 6, called ‘R2 pc means to migrate’. It illustrates that an initial increase in emigration, that led to an increase in pc disposable income, augments the available means to migrate and thereby the ability to migrate, further intensifying real emigration.

Figure 6: CLD of Population Feedbacks



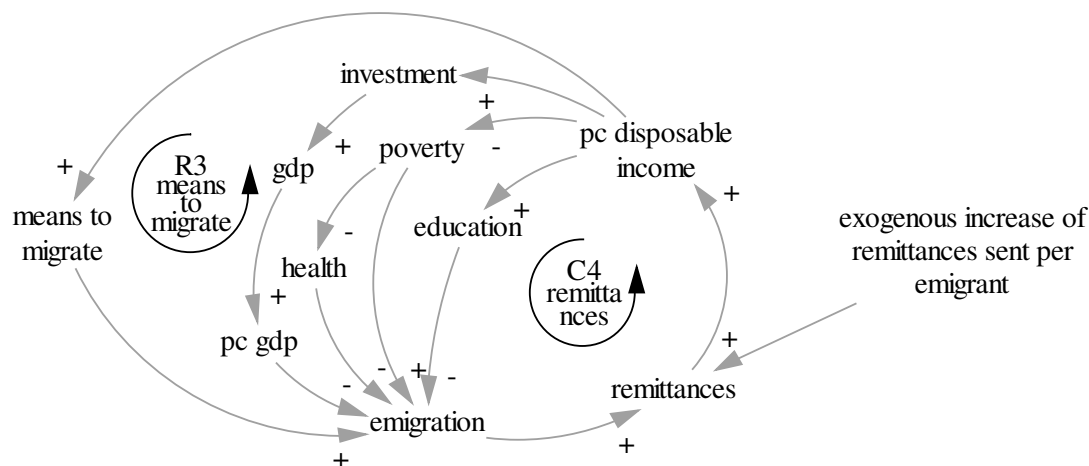
Source: own figure

Figure 7 shows the feedbacks related to the remittances and emigration interaction in the third sub-CLD. The figure resembles Figure 6 except that pc disposable income is not changed by population, but by remittances, and that remittances do not influence pc GDP directly. Accordingly, a downturn in remittances due to a drop in emigration leads to a decrease in pc disposable income followed by the same consequences as described above. On the one hand, ‘C4 remittances’ describes a counteracting feedback as the decrease in income is followed by worse levels of pc GDP, poverty, health and education leading to a rise in emigration, counteracting the initial drop. On the other hand, the reinforcing loop ‘R3 means to migrate’ can be identified since a decline in income also diminishes means to migrate and thereby amplifies the initial drop in emigration. The final aspect in Figure 7 is the variable ‘exogenous increase of remittances sent per emigrant’ used for the simulation of

to basic health care in Senegal (Senegalese Expert Commission, 18.6.2010).

<sup>173</sup> This causality is integrated in the model as it has been shown by research (Burney/Irfan 1995) and affirmed by the Senegalese Expert Commission (18.6.2010).

Figure 7: CLD of Remittances Feedbacks



The fourth sub-CLD presents five feedback relationships related to education and emigration (see Figure 8). The analysis of these feedbacks is a bit more complicated than for the other feedback relationships discussed above as there are more possibilities to close the loop than only one, explaining why the 'resource' loop can be counteracting as well as reinforcing, depending on the strength of brain drain and brain gain. The figure shows that education influences emigration and emigration affects education both in a positive (in the sense of 'same direction') and in a negative (in the sense of 'opposite direction') way. However, for the influence of education on emigration, it can be assumed that the negative affection is dominant, as it is the more important connection. That is why 'C5 brain gain' and 'R4 brain drain' could be identified unambiguously. Both loops follow the reasoning that a decline in education creates a rise in the will to emigrate, one of the reasons being that it is one of the indicators of the state of social services (see section 3.3.2.3), subsequently increasing emigration and educated emigration. 'C5 brain gain' describes that this higher educated emigration is followed by an increase of the education levels of the emigrants living abroad increasing the education level in the country through three channels. Firstly, high education levels abroad produce more educated returning emigrants adding to the education level in the country as emigrants are assumed to be higher educated than the average level in Senegal (see section 3.4.2.4) and to have gained additional knowledge abroad (see section 3.4.2.5). Secondly, this positive influence of the education level of emigrants abroad on education is strengthened by the knowledge transfer of emigrants while staying abroad, the importance

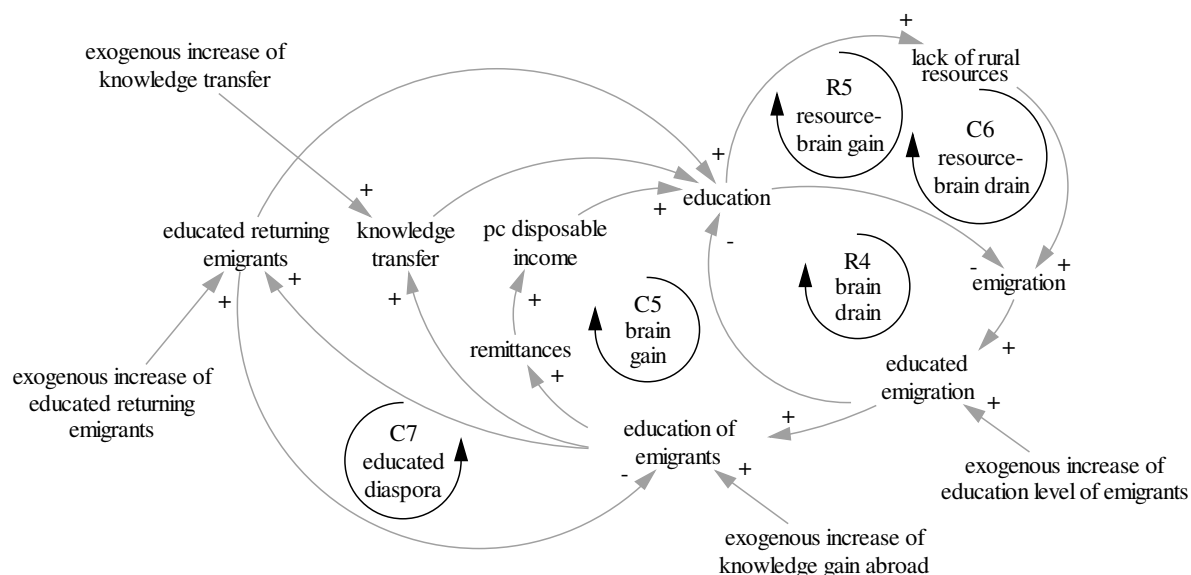


of which has been underlined by the concept of transnational emigrants (see section 3.2.2). Thirdly, the higher education level of emigrants abroad increases their earnings and thereby the money they remit back home. Consequently, higher remittances enlarge per disposable income. All three aspects, educated returning emigrants, knowledge transfer, and per disposable income feed back to the education level in the country, counteracting the initial decline. On the contrary, 'R4 brain drain' portrays the reinforcing relationship, as emigration not only increases the education level as described above but also decreases it in the moment that emigrants are on average higher educated than the average in the sending country (see section 3.4.2.4). As this is the case in Senegal and therefore incorporated in the model, the loss of human capital decreases the education level in the country, further extending the will to migrate due to bad social services, and thereby emigration itself. Exactly the fact that emigration both increases and decreases the education level, leads to the situation that the loop concerning the lack of rural resources can be reinforcing and counteracting, depending on the dominance of the connection between emigration and education. The connection between education and emigration is the same for both. Education increases the level of technology and thereby the ability to exploit natural resources more efficiently. This often causes overexploitation being accompanied by depletion of necessary natural resources and resulting in their lack, increasing especially the will to emigrate for people from rural areas, as it concerns their basis of life. In the model, this connection is reproduced using fish resources as an indicator of rural resources (see section 3.3.2.4). Now, whether this loop is reinforcing or counteracting education depends on the dominance of the connection between emigration and education. If the loss of human capital is higher than its gain this loop is counteracting, otherwise it is reinforcing migration. Hence, if human capital loss exceeds its gain in this loop, a rise in emigration heightens the educated emigration, declining the education level in the country and counteracting the initial increasing impulse. Otherwise, the increased brain gain amplifies education, reinforcing the initial rise. The fifth feedback relationship in this sub-CLD, the 'C7 educated Diaspora', is neither directly connected to the development element education nor to emigration, but it is presented here as it has been found to play an important role in the scenarios of section 4.2. It shows that the changes in the education level of emigrants abroad are always counteracted as for example its increase leads to a rise in educated returning emigrants. In the moment of their re-immigration they not only increase the education level in the country but also diminish the education level of emigrants abroad and thereby counteract the initial increase of this level.

Finally, Figure 8 shows four exogenous variables that are used for the simulations of section 4.2. For the brain drain scenarios 'exogenous increase of education level of emigrants' alters the education level of the people leaving the country, which could be done for example

by changes in the selectivity of the immigration policy of potential receiving countries. The other three variables are used for the brain gain scenarios. 'Exogenous increase of knowledge transfer' influences the proportion of the year for which the knowledge of educated emigrants is available for the home country expecting that policies can intensify the exchange between the Diaspora and the home country. 'Exogenous increase of educated returning emigrants' changes the proportion of educated emigrants that do not return, assuming that policies can strengthen and weaken incentives for returning. 'Exogenous increase of knowledge gain abroad' affects the proportion of non-educated emigrants that gain knowledge abroad for example due to education programs in the receiving country.

Figure 8: CLD of Education Feedbacks



Source: own figure

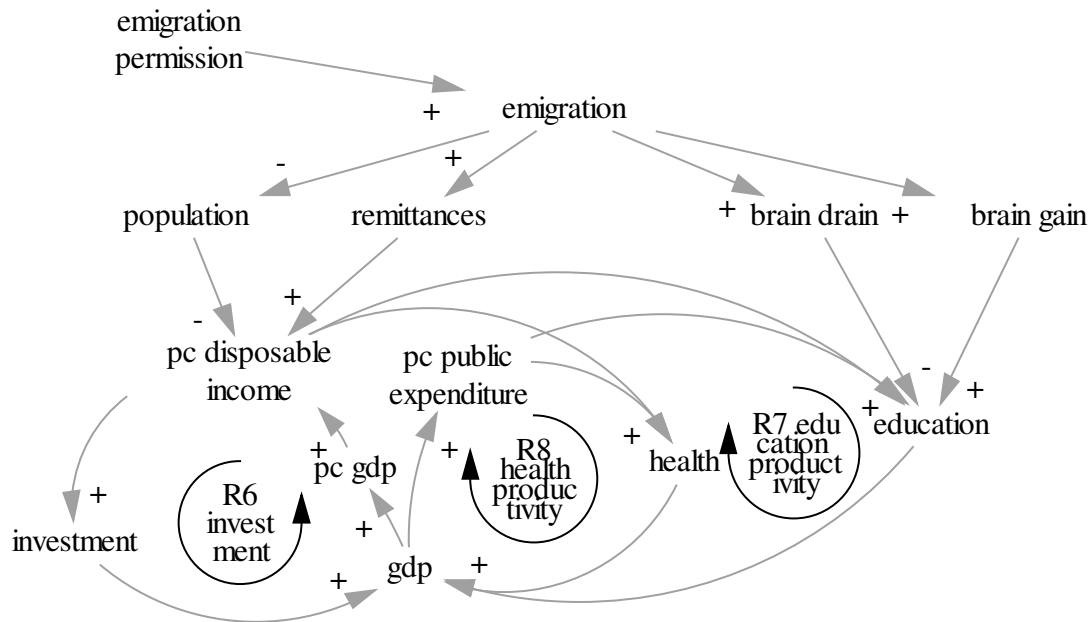
The final sub-CLD presents three reinforcing loops although they are not directly connected with emigration. However, they emerged to be very relevant for the migration-development interrelation as they can be activated by the consequences of emigration and thereby feed back into emigration. Those feedbacks are not pictured anymore, as they were illustrated in the previous figures. Nevertheless, it is important to keep their existence in mind. As shown in Figure 9 (and the sub-CLDs above) emigration influences population, produces remittances, brain gain and brain drain. While the changes in population and remittances affect pc disposable income, brain gain and drain affect the education level in the country. Now, the change in pc disposable income activates all of the three reinforcing loops presented. 'R6 investment' portrays that decreasing disposable income (for example due to a drop in remittances), reduces investment, thereby GDP, pc GDP and finally, again, pc disposable income. Of course, the reinforcement is also possible in an increasing way. Depending on the direction of the initial impulse (in- or decrease), this loop could be labelled as a

vicious or virtuous circle. The reinforcing loop 'R7 education productivity' shows that education increases productivity, and subsequently GDP and disposable income, causing a further rise in education level, as higher income positively affects school enrolment, for example as it can enable parents to send their children to school.<sup>174</sup> This reinforcing loop is further intensified by the mechanism that the enlargement of GDP leads to more tax revenue and thereby more public expenditure, also for education (assuming that the share of expenditure per resort is not changed), causing a further rise in the education level. The third reinforcing loop in this CLD is the 'R9 health productivity' working quite similarly to the 'R7 education productivity' loop. An improvement in health levels raises productivity, production (GDP), and thereby pc public expenditure and pc disposable income, both feeding back positively to health levels. That means that the self-reinforcement of GDP is based on the feedback through several channels, such as investment ('R6 investment'), education ('R7 education productivity') and health ('R9 health productivity'). Although this mechanism also can be observed for other factors of productivity, such as infrastructure, these three channels – pc income, education, and health - are presented because of four reasons. They are probably the most important ones, they are influenced by emigration, they feed back to emigration and they include the determinants of the chosen development indicator, HDI. The important insight that can be gained by this CLD is that once one of these variables is changed, one or more reinforcing loops are activated, spreading to the other loops, further reinforcing the initial and the other loops. That is why once a country is on a declining or a growing path, this trend will be further intensified. In the following, these reinforcing loops will be referred to as 'development loops'. Although the exogenous variable that induces a change in the overall level of emigration could be represented in all of the previous CLDs, it is shown in Figure 9 because this figure gives a good overview of the different effects of emigration. The exogenous variable 'emigration permission' changes the overall emigration with all its effects by altering the ability to migrate, assuming that the permissions/restrictions for emigration are in- or decreased.

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<sup>174</sup> It has been shown that school enrolment, the decision for investment in human capital formation is highly dependent on household income and parental education (Burney, Nadeem A. / Irfan 1995, 34).

Figure 9: CLD of Development Feedbacks Induced by Emigration



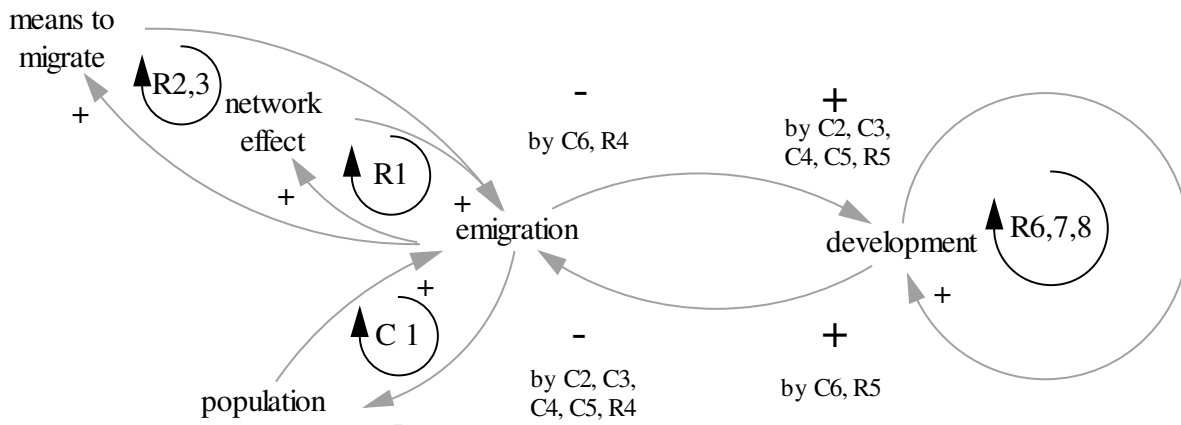
Source: own figure

As mentioned at the beginning of this section, these five sub-CLDs do not present all of the existing feedback relationships of the system influencing the outcome of the simulations. For example, mortality and fertility, being influenced by health, education, and pc disposable income affect population, thereby pc disposable income, feeding back to health and education, as well as population growth rate, feeding back to emigration. However, the feedbacks portrayed give an overview of those feedback mechanisms concerning the migration – development relationship that have been identified to be the most relevant ones for the explanation of the model behaviour in the following scenarios.

Summarising the insights gained through investigating the theoretical feedback relationships of the model (see Figure 10), it can be shown that there is a strong self-reinforcing feedback for emigration due to the means to migrate and the network effect (R1-3), while only one loop, the population loop, opposes this tendency by self-counteracting emigration (C1). For the relationship between migration and development, taking HDI as the main indicator as discussed in section 3.2.1, the analysis disclosed that although several relationships indicate a counteracting loop between those two main variables, some reinforcing loops can also be identified. In total, there are five counteracting loops between emigration and development (C2-C6), while only two loops are reinforcing the behaviour (R4 and R5). However, as the dominance of those different loops can vary, the number of loops does not necessarily indicate which loop is prevalent. Finally, it has been revealed that development, using HDI as indicator, amplifies itself through, at least, three reinforcing loops (R6-8). The only feedback loop presented in the previous CLDs that is not restated is the ‘C7 educated Diaspora’

as it influences neither emigration nor education directly. However, it has been described above due to its significant role in counteracting the increase of the education level of emigrants living abroad.

Figure 10: CLD of Feedback Relationship between Development (indicated by HDI) and Emigration



Source: own figure

Having elicited theoretically the existing main feedback relationships clarify why it is hardly possible to derive their dominance and thereby the behaviour of the system without using a simulation. By experimenting with the model and simulating different scenarios the modeller can learn how the established system behaves and why. The following section describes the simulations generated for this study, and analyses them from a feedback perspective.

## 4.2 Exploring the Model Behaviour: Analysis of Counterfactual Scenarios

This subchapter aims at exploring the behaviour of the model structure described above (see chapter 3) by simulating and analysing different scenarios. Scenarios refer to assumed changes in exogenous variables. Those exogenous variables that are altered for the following scenarios have already been mentioned in the CLDs of the previous sections. The generated scenarios are a mixture between counterfactual and unrealistic future scenarios. Counterfactual scenarios assume changes of exogenous variables for the past, so that those scenarios generate a difference to the actual present being therefore per se unrealistic. Future scenarios assume changes for the future and thereby generate normally possible future developments. As mentioned before, this study does not aim at generating realistic scenarios for policy analysis, but rather at elucidating the relevant feedback loops of the migration-development system in Senegal, their strengths, the generated behaviour patterns and the overall outcome. To serve this purpose, firstly, the scenarios do not claim to simulate possible reality. Instead, they are experiments using extreme assumptions to clarify the impact facilitating the analysis. For the purpose of policy analysis a more detailed policy structure would be necessary to include side effects etc. Secondly, it is necessary to investigate the

long term behaviour of the system as several effects exhibit significant delays. Due to the fact that these delays are often very long (e.g. up to 20 years for the returning of higher educated emigrants) important behaviours, such as worse-before-better-behaviour can only be observed with a time horizon of approximately 50 years, as can be seen later in the analysis (e.g. in Figure 14). Consequently, the scenarios need to meet two requirements. Firstly, they should be identifiable as unrealistic scenarios to circumvent the danger that they are considered as realistic future predictions or real policy scenarios, and secondly, they need to simulate the changes for approximately 50 years. The first requirement is in favour of applying a counterfactual scenario. However, starting the simulation in 1960 to meet the second requirement is not convenient due to two reasons. Firstly, being the year of independence in Senegal, it can be doubted that the structure of today is adequate for the first decade of independence, and secondly, the data requirements for fifty years cannot be fulfilled within the scope of this study. On the other hand, to simulate a pure future scenario does not seem convenient either as the adequacy of simulation results of a real system for fifty years in the future can be doubted, in addition to the danger that those simulations could be misperceived as aiming at representing realistic scenarios. Therefore, it has been decided to mix both approaches, using the whole time horizon of the simulation from 1980 till 2035 for the observation of the consequences of changes in exogenous variables, so that these changes are introduced in 1980, and continued into the future. This means that both have been facilitated: observation of the changes for more than 50 years and pointing out that the generated scenarios do not aim at representing realistic scenarios but rather experimenting to improve understanding of the system and its behaviour. Hence, applying this mixture of counterfactual and future scenarios, the dominances of the theoretical feedback relations (see section 4.1) are investigated and the behaviour of the system is explored by presenting and analysing the impact of the exogenous changes and their subsequent feedbacks. To do so, first of all, the 'base run' of the model is presented and discussed to picture the behaviour of the system without exogenous changes (section 4.2.1). Afterwards, different scenarios are compared to the 'base run'. While the first scenario explores the behaviour of the system when migration with all its effects is in- respectively decreased, assuming exogenous changes in migration permission (see section 4.2.2), the following three scenarios alter one by one the intensity of the primarily debated effects of migration, maintaining the residual effects compared to the 'base run'. Thereby making it possible to analyse the impact and the feedback of the single effects. Hence, brain drain is investigated by changing the selectivity of emigration altering the education level of emigrants (section 4.2.3), brain gain is explored by altering the knowledge gain abroad and its transfer (section 4.2.4), and the effect of remittances is analysed by modifying the proportion of earned money sent per emigrant (section 4.2.5). The effects on migration and on demography are not scrutinised in that way due the fact that

they are based on the number of emigrants and once this number is changed (as in the first scenario) remittances, brain drain and gain also change. These first four scenarios, assuming a change that is maintained for the whole period, disclose that the scenario with high emigration permission, leading to high emigration rates, generates the highest values for HDI mainly due to the high levels of remittances. As this directly increases the dependency level (indicated by remittances as share of GDP) the question arises if this 'strategy' of increasing development by remittances, but at the same time heightening the dependency level holds danger for future development supposing that one day economic development, immigration and/or money transfer policies of the potential receiving countries change. That is why the last scenario investigates what would happen if money transfer becomes more difficult, changing the exogenous variable, the proportion of earned money sent per emigrant in the middle of the simulation (section 4.2.6).

All sections primarily scrutinise the main variables of this study, development indicated by HDI and emigration rate. Additionally, particularities are described and illustrated. The end of every section gives a short summary of the insights gained through the analysis of the particular scenario. However, as described when defining development it has been noticed that it is desirable to include further aspects into the evaluation of the development level. Therefore, the last section (section 4.2.7) compares the positive simulations that improve development (HDI) in the country relative to the 'base run' scenario additionally by means of the indicators for 'broader development', being HDI, poverty rate, remittances as a share of GDP and ecological footprint (see section 3.2.1).

It is important to emphasise again that these simulations do not aim at 'forecasting' the future or deriving realistic policy scenarios. This implies that, aiming at giving an idea of the general behavioural trends and permitting their analysis, the general behavioural outcome and its trend is of greater significance than the absolute values of the variables of concern.

The following sections follow the same internal structuring. First a short introduction explains the counterfactual scenario. Afterwards, the results of the experiment are presented and interpreted from the feedback perspective.

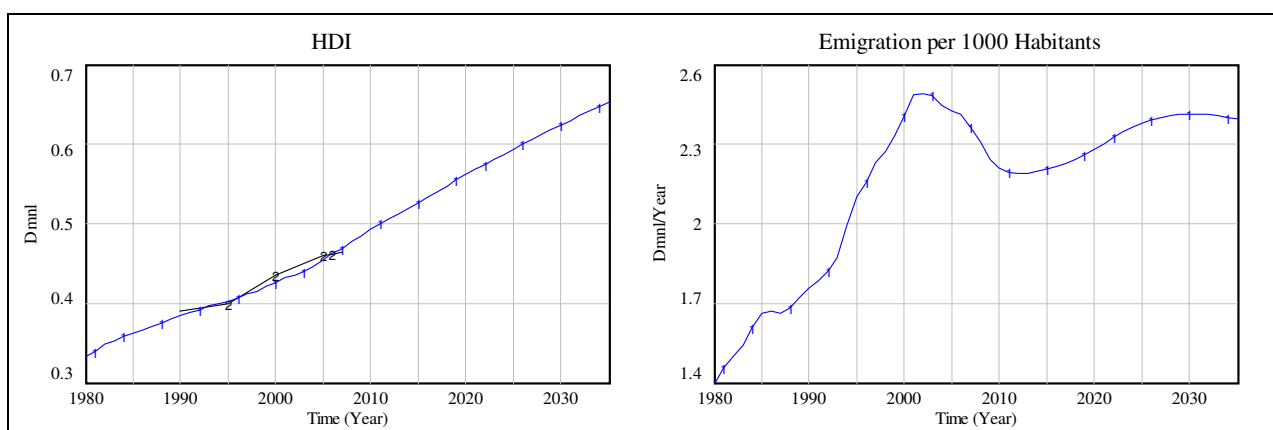
#### 4.2.1 Base Run

The 'base run' scenario is the business-as-usual scenario leaving the exogenous variables unchanged. It is the basis for the subsequent analysis of the counterfactual scenarios as they are compared to its behaviour.

Figure 11 shows the development of the main two variables of this study. The graph on the left hand side pictures the HDI, the indicator for development, while the emigration rate, which is emigration per 1000 habitants, is displayed on the right hand side. The y-axis is the

scale for the variables, labelled with their units, while the x-axis indicates the time horizon of this model. The legend presents the name of the simulation run ('base run'), and the way the variable is represented in the graph (blue line 1). For HDI, data is available for the period from 1990 till 2007<sup>175</sup> represented in a second line in the left hand graph, called Data (black line 2). Unfortunately, reliable data for the emigration rate to other countries than Africa, which are mainly OECD countries<sup>108</sup>, is not available and therefore not visible in the graph. Nevertheless, the behaviour shown in this graph is validated to a certain extent since this emigration rate (this flow) generates the behaviour of the stock of emigrants living in OECD countries, for which data is available (see Appendix C, Figure d).

Figure 11: HDI and Emigration Rate for Base Run



'Base run': blue line 1 / 'Data': black line 2

Figure 11 shows that the HDI increases the whole simulation period from approximately 0.35 in 1980 to around 0.65 in 2035.<sup>176</sup> However, it is visible that the slope becomes steeper around 2005. While in the first 25 years, the HDI is enlarged by approximately 0.1, it is augmented by nearly 0.2 during the following 25 years. This already indicates the force of the reinforcing 'development loops' (R6-8), presented above.

The emigration rate shows a quite different behaviour. Before analysing its behaviour, it is important to notice that the graph shows a rate instead of absolute emigration numbers. As the population in Senegal increases steadily<sup>177</sup>, it is possible that the absolute number of emigrants increases even when the rate decreases. The simulated behaviour of the rate pictures a rise from approximately 1.5 in 1980 to 2.5 in 2000. Afterwards, a decline to circa 2 in 2010 can be observed that is followed by another increase to nearly 2.5 again. However, it

<sup>175</sup> Data is taken from UNDP (2009b, table G).

<sup>176</sup> The HDI measures the relative achievement in the three basic dimensions of human development (long and healthy life, knowledge and a decent standard of living) by choosing minimum and maximum values for the underlying indicators (UNDP 2007, 355ff). Consequently, assuming a minimum value of 0 (as it is done for education), a value of 0.65 signifies that 65% of the maximum value is reached.

<sup>177</sup> From 5.635 million in 1980 to 11.28 million in 2005 (UNDESA 2009), and according to the base run simulation of T21 further to 19.74 million in 2035 or see Appendix C (Figure a).



can be seen that at around 2030 the rate starts to shrink again. The behaviour of the emigration rate is explained by analysing its components, which are represented in Figure 12, portraying the emigration rate by reason (left hand side), and the network effect (right hand side), comparing the will to emigrate to the final emigration rate.

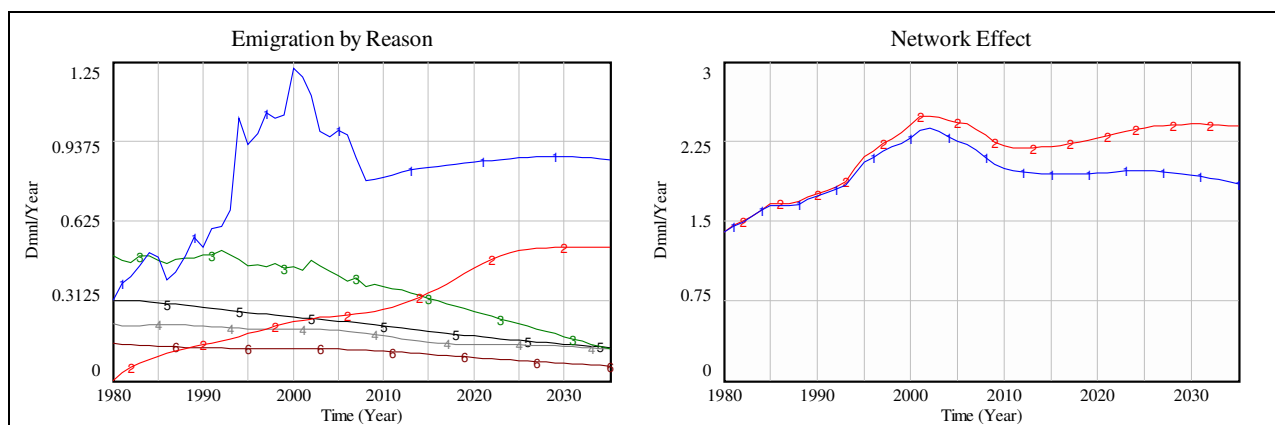
As described in section 3.3.2, there are six variables generating a certain will to migrate. These reasons for emigration and their changing intensity over time are shown in the left hand side of the Figure 12.<sup>178</sup> Having them in one graph, allows comparison of their intensities. The main factor for emigration is thereby the pc income difference (blue line 1), indicated by real pc GDP difference (see section 3.3.2.1). The sharp increase until 2000 is due to the increasing real pc GDP in OECD countries, while it stays rather constant in Senegal. The subsequent decrease is attributed to a decline in real pc GDP in OECD countries, while income in Senegal starts to increase. After 2008, real pc GDPs enlarge in both regions, but obviously for the following 15 years the rate of increase is higher in OECD countries, causing a small rise in the will to emigrate due to income difference. Around 2025, the growth rate of both countries seems to equalise, stabilizing the will to emigrate. However, of course pc real GDP in OECD countries still significantly exceeds the income in Senegal, resulting in the high will to emigrate. Moreover, the difference in absolute terms further rises (from approx. 5 million in 1980 to approx. 29 million CFA99/year/person in 2035), but the relationship between both income levels starts at least to stabilise at the end, so that income in Senegal is approximately 2.4% of that in OECD countries. The second factor for emigration will is environmental degradation (red line 2). Although its influence is minimal at the beginning<sup>179</sup>, the ongoing increase in environmental degradation, indicated by the fish stock, generates a rising will to emigrate due to environmental reasons, so that in 2035, it is the second important cause for emigration. However, the degradation of fish stock in the model is not infinite. Around 2025, the fish stock reaches a new equilibrium which is approximately two thirds lower than its initial value in 1980. The reason that the fish stock is not completely depleted is that the reduced stock leads to a decline in capture, increasing the stock again. This counteracting feedback loop accounts for the stabilisation of the will to emigrate due to environmental degradation produced by line 2. On the contrary, emigration caused by the absolute

<sup>178</sup> The values are based on the ability to migrate that existed at the beginning of the simulation, in 1980. In this manner, it is possible to use the relative ability to migrate (income to migration cost ratio divided by its initial value) as the effect of ability to migrate which is per definition one in 1980. That means that the will to emigrate equals the final rate in 1980. As soon as the ability to migrate changes in relation to its initial value the relative value and therewith the effect also alters, influencing the final emigration rate. In other words, the existing ability to migrate of 1980 is integrated in the will to emigrate. However, the simulation shows clearly that the impact of the ability to migrate increases over time.

<sup>179</sup> In 1980, environmental degradation does not produce additional emigration, because carrying capacity equals fish stock in 1980, so that no degradation is indicated. Although this might not represent reality, local experts agreed on this assumption as the estimation of carrying capacity is barely possible. Consequently, the level of will to emigrate due to environmental degradation that existed in 1980 is integrated in the other causes, similarly as it is done for ability to emigrate (see footnote 178). That way, the relative degradation and its inducing strength is represented in the model and its simulations.

poverty level (green line 3) was the most important cause in 1980, but since poverty is steadily decreasing, the will to emigrate due to poverty does the same reaching the level of the induction of the literacy rate and the urban population growth rate in 2035. Fourthly, emigration created by the difference in literacy rate levels (grey line 4) decreases for the whole simulation as literacy rates in Senegal improve, while they stay stable in OECD countries. Fifthly, emigration procured by population growth rate (black line 5) decreases, also decreasing emigration will, but at a slower rate, so that these two lines equalise at the end of the simulation. Finally, life expectancy heightens relatively more compared to OECD countries, leading to a reduction in emigration caused by health levels (brown line 6). The reason for the general trend that education and health levels increase, while poverty and population growth rate decline has already been mentioned describing the HDI graph. Once the reinforcing 'development loops' (R6-8) are activated they tend to improve the situation in the country.

Figure 12: Emigration Rate by Reason for Base Run



Left hand side: 'Emigration by income difference': blue line 1 / 'Emigration by lack of rural resource': red line 2 / 'Emigration by poverty': green line 3 / 'Emigration by urban population growth': grey line 4 / 'Emigration by literacy rate difference': black line 5 / 'Emigration by life expectancy difference': brown line 6  
 Right hand side: 'Will to emigrate per 1000 Habitants': blue line 1 / 'Emigration per 1000 Habitants': red line 2

The graph on the right hand side shows the sum of all single reasons as the will to emigrate (blue line 1) in comparison to the final emigration rate that includes the ability to migrate (red line 2). This ability is dependent on migration cost, mainly affected by the network effect and the decreasing cost of transportation, communication and information, and migration means, primarily subject to pc disposable income. The network effect is mainly related to the stock of emigrants abroad. Looking at this graph, it can be observed that the ability to migrate significantly increases the emigration caused by development reasons, but in a non-linear way. In the beginning, the will to emigrate equals the final emigration rate, as the level of ability to migrate in 1980 is the basis for the will to emigrate<sup>178</sup>. Over time, the difference in both rates increases, signifying an increasing ability to migrate. In 2010, the effect of the in-

*ducing strength is represented in the model and its simulations.*

creasing ability becomes so strong that it causes a renewed increase of the emigration rate, although the will to emigrate caused by development indicators stays more or less stable and even decreases after 2030. The increasing strength can be explained by the reinforcing loops 'R1 network', 'R2 pc means to migrate', and 'R3 means to migrate'. However, as mentioned before, the relationship between the network effect and number of emigrants is non-linear, as the more emigrants are abroad every single emigrant probably reduces his/her supporting activity, and facilitators can become gatekeepers (see section 3.3.3.1). As the network effect is an important factor for the ability to migrate (as it decreases migration cost), the rate of slope of the ability to migrate decreases. Hence, also the emigration rate stabilises and even starts to decrease after 2030, but at a slower rate than the will to emigrate. Comparing the increasing strength of the R1-3 loop with the continuously decreasing population growth rate and its impact on the emigration rate, outlined above, it can be assumed that over time, the reinforcing loops R1-3 become stronger than the counteracting loop C1.

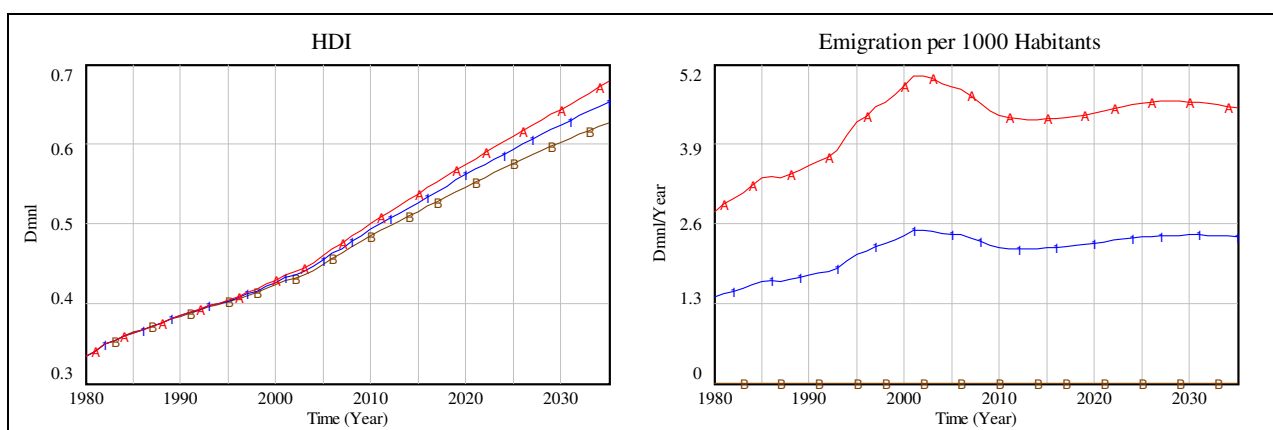
In conclusion, it has been shown that HDI increases in the 'base run' scenario mainly due to a strong reinforcement of the 'development loops' (R6-8). In addition, the will to emigrate declines for all variables except for two variables: the 'lack of rural resources' due to the positive impact (in the sense of 'same direction') of education on exploitation of natural resources, and pc GDP due to the fact that the comparison between the value in Senegal and OECD countries is decisive and growth for OECD is higher. Thirdly, the non-linear influence of the reinforcement due to network and means for migration on emigration was illustrated. Finally, it could be determined that over time the reinforcement of migration due to network and means to migrate (R1-3) becomes stronger than the counteracting impact of population growth rate (C1). Having given this short outline of the behaviour and its explanation of the main variables for the 'base run' scenario, the following sections compare the results of the counterfactual scenarios to the 'base run' scenario.

#### 4.2.2 Migration: Changing Emigration with all Its Aspects

The first counterfactual simulation changes emigration permission exogenously. In the 'no emigration' scenario, emigration is not allowed at all and in the 'more emigration' scenario emigration permission is doubled. As described before (see section 3.3.3.3), the model does not include that an increase in immigration restriction is probably accompanied by an augmentation of informal migration. Other side effects, such as possible social and political conflicts as people feel observed, are not considered either. Moreover, it is assumed that it is possible to impede emigration. Hence, it is obvious that this is not a realistic scenario, but it facilitates the exploration of the drastic experiment as to what would happen if emigration was zero or very high respectively.

Figure 13 shows the result of this simulation for the two main variables. The first observation is that, although all scenarios produce a rise in HDI, the 'more emigration' scenario (red line A) generates the best values for the development indicator HDI, while the 'no emigration' scenario (brown line B) exhibits the lowest improvement of HDI. Moreover, the difference of the scenarios increases continuously, starting with the same value in 1980 and differing approximately 4% from the 'base run' in 2035. This is due to the fact that the slope of increment for the 'more emigration' scenario is steeper, while the slope of the 'no emigration' scenario dwindles at an increasing rate. That indicates that the reinforcing 'development loops' (R6-8) induced by emigration and causing the increase in HDI are significantly stronger in the 'more emigration' than in the 'no emigration' scenario.

Figure 13: HDI and Emigration Rate for More and No Emigration



'Base run': blue line 1 / 'More emigration': red line A / 'No emigration': brown line B

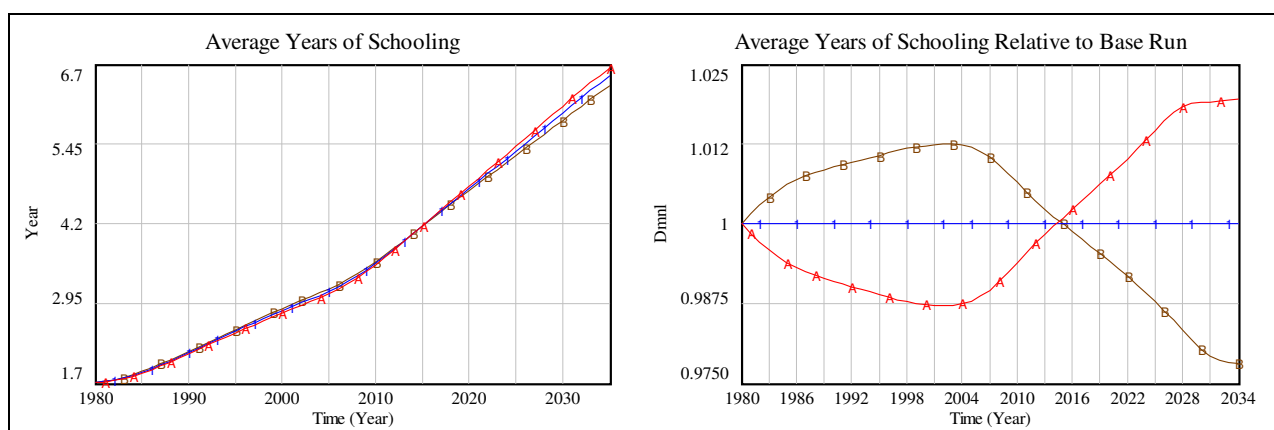
This is a relevant finding, as it shows that the overall influence of emigration to development is positive, in the sense of causing a change in the same direction. As discussed before, it has been highly discussed as to whether migration enhances or impedes development. The results of this simulation indicate that with the assumptions of this model the overall impact of emigration enhances development in spite of brain drain effects.

Nevertheless, knowing that emigration apart from its positive impact induces also negative effects especially for the education level in the country, the development of the education level is presented in Figure 14. As an indicator, 'average years of schooling' is shown, as this variable influences the productivity in the country including not only literate people as done by the indicator average literacy rate, but also skilled people from secondary and tertiary education.<sup>180</sup> However, the development for average literacy rate is quite similar. The graph on the left hand side portrays the behaviour in years, giving an impression of the overall development of the education level in the country. Similar to the HDI behaviour, the graph shows that the indicator increases for the whole period for all three scenarios, but it also re-

<sup>180</sup> This indicator is defined as follows: "Average years of schooling of adults (aged 15+) is the years of formal

veals that at least at the end the 'more emigration' scenario exhibits the best while the 'low emigration' scenario generates the lowest value. Unfortunately, the graph does not appropriately disclose the interesting differences between the different scenarios. That is why the graph on the right hand side pictures the development of the indicator for the 'more emigration' and the 'no emigration' scenario relative to the 'base run' scenario. This graph uncovers that high emigration at the beginning of the simulation leads to lower education levels than those reached by the 'base run', while no emigration produces a stronger increase of average years of schooling than that generated by the 'base run'. However, after approximately 20 years, the trend reverses and the education indicator relative to its results in the 'base run' starts to decrease for 'no emigration' and increase for 'more emigration' scenario.

Figure 14: Average Years of Schooling Relative to Base Run for More and No Emigration



'Base run': blue line 1 / 'More emigration': red line A / 'No emigration': brown line B

This behaviour can be explained by the different timing of the effects and the delays of the system. Emigration causes human capital loss in the moment that people leave the country. Therefore, at the beginning of the simulation, the loss of human capital compared with its occurrence in the 'base run' is higher in the scenario with high emigration, and lower when nobody emigrates, demonstrating the strength of 'R4 brain drain'. On the contrary, brain gain due to returning emigrants only happens with an important delay of the time of their stay, which is assumed to be on average 20 years (see section 3.2.2). However, this brain gain is then, once the emigrants are returning, significantly higher as more people return with the additionally acquired knowledge from abroad, which is missing in the 'no emigration' scenario. In addition, the brain gain through knowledge transfer from abroad also develops its strength with a delay, since the stock of emigrants, starting with the same value at the beginning only enlarges over time. Yet, the more emigrants live abroad, the more knowledge can be transferred and therefore the brain gain rises when the stock of emigrants living abroad increases. Hence, the 'C5 brain gain' develops its strength only over time. The third

effect acquiring its strength with delay is caused by changes in remittances and population increasing per disposable income in the 'more emigration' scenario, since more emigrants send remittances and income is divided by fewer people and diminishing it in the 'no migration' scenario. The difference activates the reinforcing 'development loops' (R6-8), incrementing the level of education. The delay of this impact is due to the slowly enlarging stock of emigrants sending remittances, and the delay between income, investment, GDP, public revenue, public expenditure and finally the education level. Especially the results of investment in education can only be observed with a significant time lag, as education takes time<sup>181</sup>.

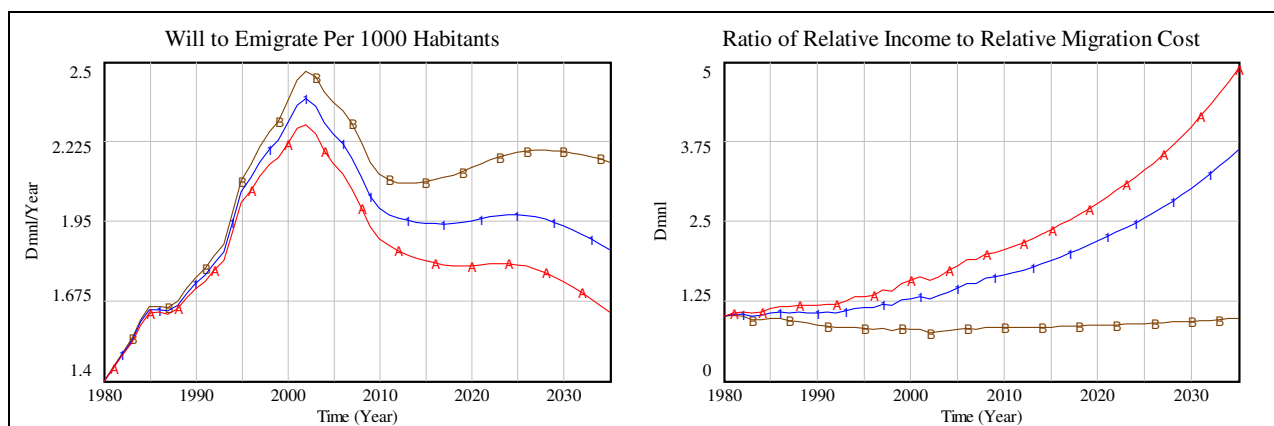
This insight demonstrates in a convincing way that it is necessary to explore the behaviour over a period of time that allows the investigation of medium and long term behaviour. While during the first 30 year emigration produces a negative impact on education in the 'more emigration' scenario, the system generates better results in the long term which could even be amplified in the further future, as the reinforcing loops, once activated, tend to intensify the positive development. This behaviour pattern, although well-known as worse-before-better or on the contrary better-before-worse situations (e.g. Sterman 2000, 22), is often disregarded when it comes to policy implementation as primarily the short term effects are focused on, leading to undesirable policy outcomes in the long term.

Up to now, this subchapter mainly analysed the one-way influence of emigration on development, instead of discussing the feedback relationships between migration and development. This is due to the fact that the two simulations of this section consider those feedbacks only in a minimal way, as emigration rate is highly influenced exogenously by emigration permissions. For example, in the 'no emigration' scenario, migration does not increase although the factors causing emigration worsen. Figure 15 shows that the will to emigrate (left hand side) is the highest for the 'no emigration' and lowest for the 'more emigration' scenario increasing their difference over time, as the development indicators causing the will to emigrate improve the most for 'more emigration'. However, the ratio of migration means and costs (right hand side) is much more favourable for 'more emigration', since firstly, the increasing stock of emigrants diminishes migration costs due to help from the network. Secondly, the increase in income due to the raise in remittances and decline in population, enlarges the means for migration. Both effects reinforce themselves and thereby the ability to emigrate (see R1-3). These impacts are nearly invisible in the final emigration rate (Figure 13), as the effect of emigration permission doubles the effect of the ratio of migration means and costs for the 'more emigration' scenario while it makes it impossible to emigrate in the

<sup>181</sup> The model replicates the Senegalese education system, where primary education takes 6 years, lower secondary education takes 4 years, upper secondary education takes 3 years, and tertiary education takes on

‘no migration’ scenario. That explains why the final emigration rate for the ‘more emigration’ scenario increases so steeply for example from 1980 till 2000, although its will to emigrate is the lowest. However, the question remains which influence exceeds the other when there is not such a strong exogenous impact like the assumed changes in emigration permission, the will to migrate or rather the ability to migrate.

Figure 15: Will to Emigrate and Ratio of Emigration Means and Costs for More and No Emigration



‘Base run’: blue line 1 / ‘More emigration’: red line A / ‘No emigration’: brown line B

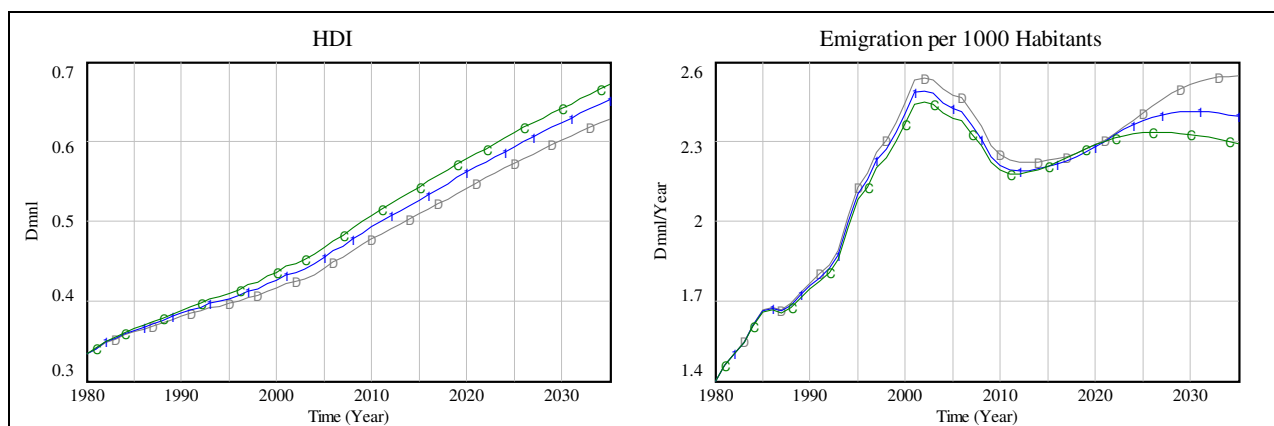
Summing up the insights of this section: Firstly, it has been shown that the overall impact of emigration seems to increase the overall development level. Secondly, the education level shows a worse-before-better behaviour for the ‘more emigration’ scenario due to change in the dominance of the ‘R4 brain drain’ which is replaced later by ‘C5 brain gain’ and ‘R7 education-productivity’ due to delays in the system. Thirdly, high emigration leads on the one hand to a decline in the will to emigrate due to better development levels (C2-C5), while it activates the reinforcing loops R1-3 opposing this counteracting behaviour. Up to now, it is not clear whether the reinforcing or the counteracting effect is stronger without exogenous influence, as in these scenarios the ability to migrate was strongly affected exogenously by assuming changes in emigration permission.

#### 4.2.3 Brain Drain: Changing Emigration of Educated Emigrants

The second counterfactual scenario assumes an exogenous change in the education level of emigrants. Although the model does not consider the reasons for this change, a very realistic possible cause is the selectivity of immigration policy by potential receiving countries. Highly debated in those countries because of their skills shortage, this policy has an important impact on the sending countries demonstrated by the following two scenarios. However, starting the change in the past and simulating drastic assumption these scenarios are not aiming at forecasting the future, but only at exploring the consequences of the counterfactual experiment. The ‘no brain drain’ scenario assumes that only uneducated people emigrate

resulting in no human loss at all. The 'more brain drain' scenario makes the assumption that the multiplier for the education level of emigrants of the 'base run' is doubled, so that for example the literacy rate for emigrants is not only 20% higher than it is in the 'base run' scenario based on the research of Docquier and Marfouk (2005, 24; Docquier et al. 2008), but 40% higher.

Figure 16: HDI and Emigration Rate for More and No Brain Drain



'Base run': blue line 1 / 'No brain drain': green line C / 'More brain drain': grey line D

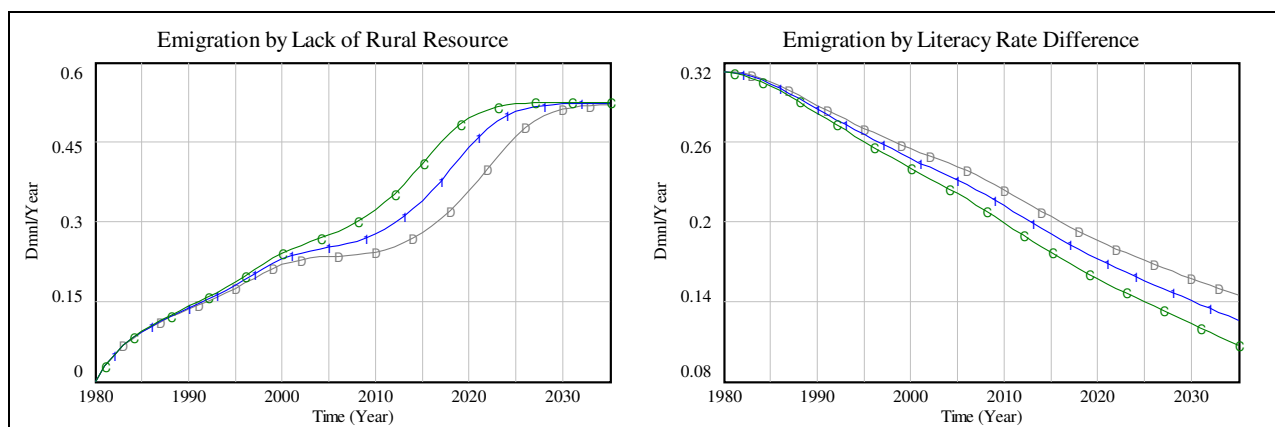
Figure 16 presents a clear picture for the behaviour of the development indicator HDI (left hand side). The improvement by the 'no brain drain' scenario (green line C) clearly exceeds the 'base run' (blue line 1), while the 'more brain drain' (grey line D) scenario shows the worse results, although also in this scenario the indicator increases for the whole period. This is due to the fact that the exogenous change in the education level of emigrants directly influences the education level in the country, activating the reinforcing 'development loops' (R6-8). As an outcome, real pc GDP, education levels and life expectancy (the indicators of HDI) improve in the 'no brain drain' scenario, while they rise at a lower rate in the 'more brain drain' scenario. It is important to notice that this is the overall outcome, despite the fact that the other relevant factors increasing development levels followed by emigration do not support this outcome. While population levels do not differ a lot, remittances are significantly higher for the 'base run' and 'more brain drain' scenario. The difference in remittances is caused by two factors. Firstly, the stock of emigrants is slightly higher in the 'base run' and even larger in the 'more brain drain' scenario due to higher emigration rates. Secondly, remittance sent per emigrant is significantly lower for the 'no brain drain' scenario, as the education level of emigrants abroad decreases sharply when only uneducated people emigrate and less educated people gain less money abroad. Nevertheless, in spite of higher remittances in the 'more brain drain' scenario, the impact of lower education levels dominates, clearly illustrating the brain drain effect.



Interestingly, the emigration rate (right hand side) shows a different behaviour than one would intuitively expect. Although the 'more brain drain' scenario (grey line D) produces the highest emigration rate for the whole period, the emigration rates converge between 2015 and 2020, and only at the end, from approximately 2030 onwards, the emigration rate exceeds the other two scenarios as would be reasonable according to the development level. This cannot be attributed to differences in the ability to emigrate, as this ability is very similar between the 'base run' and the 'no brain drain' scenario and only slightly lower for the 'more brain drain' scenario. This slight difference is caused by the fact that the means for migration are lower in the 'more brain drain' scenario (as GDP is lower), surpassing the slightly higher network effect due to a larger stock of emigrants, and resulting in a lower migration cost for that scenario. Instead, the unintuitive behaviour is due to the will to emigrate and in specific to the loop 'C6 resource-brain drain'. While the will to emigrate for the other factors in the 'more brain drain' scenario clearly exceeds the will of the 'no brain drain' scenario, the will to emigrate caused by the lack of rural resources clearly counteracts this behaviour, generating the highest values for 'no brain drain' and the lowest for the 'more brain gain' scenario. That explains why the emigration rate in the 'no brain drain' scenario does not decrease as much as it could be assumed when looking at the development indicator HDI. However, the graph also shows that the influence of this loop changes over time. Due to education and the knowledge of how to exploit the stock more efficiently, the fish stock in- respectively decrease only with a delay, since the loop needs some time to really develop its strength. Once amplified, high education levels in the 'no brain drain' scenario lead to a fast decline in the fish stock, while the relatively lower education levels in the 'more brain drain' scenario produce a slower reduction. Nevertheless, once reaching the point that capture dwindles due to the diminished stock, and thereby stabilising the stock, this counteracting loop (lower stock diminished capture, increasing the stock) becomes dominant generating a new equilibrium and thereby equalising emigration caused by this factor for both scenarios.

Figure 17 illustrates this behaviour. On the one hand, emigration due to lack of rural resources, in this model indicated by the decline of the fish stock (left hand side) has an important influence for the period between 2000 and 2030 causing more emigration for the 'no brain drain' scenario. On the other hand, emigration caused by literacy rate difference (right hand side) decreases with a significantly steeper slope in the 'no brain drain' scenario. Emigration due to difference of real pc GDP and life expectancy difference behave in a similar way, intensifying the higher emigration rate for the 'more brain drain' scenario, which can be observed in the final emigration rate (Figure 16, right hand side) once the impact of lack of rural resources diminishes around 2030.

Figure 17: Emigration by Lack of Resources and Literacy Rate Difference for More and No Brain Drain



'Base run': blue line 1 / 'No brain drain': green line C / 'More brain drain': grey line D

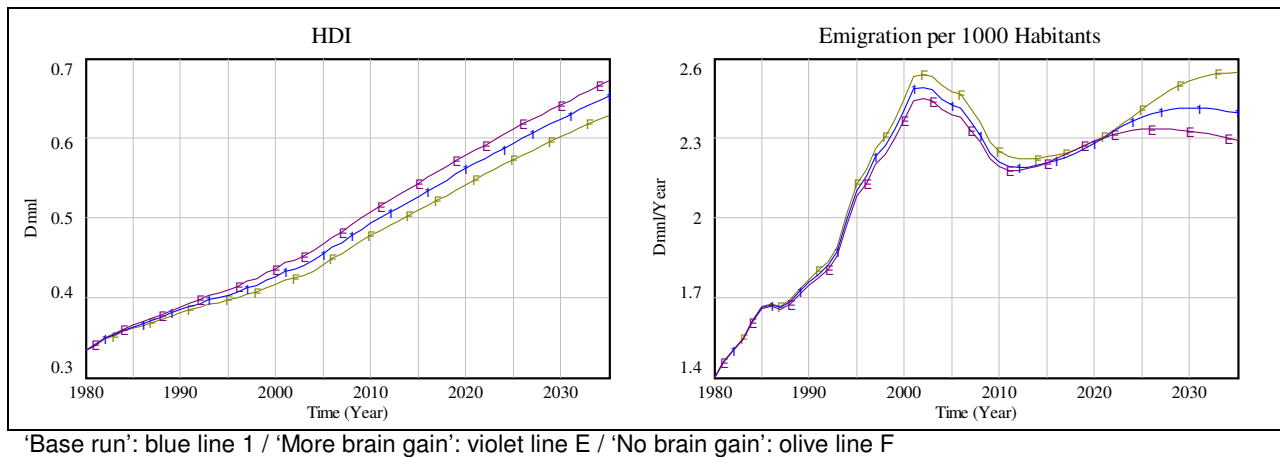
Summarising the gained insights, it has been found out that the change in education levels of emigrants strongly influence the education level in the country, subsequently significantly affecting the intensity of the development loops (R6-8), meaning that a drop of this education level of emigrants leads to a significant increase in HDI. This is in fact the case although remittances shrink. Finally, the impact of lack of rural resources on the will to emigrate driven by brain drain (C6) contradicts the general trend that more development leads to less emigration, but only for a certain period.

#### 4.2.4 Brain Gain: Changing Knowledge Gain Abroad and Its Transfer

The third counterfactual scenario alters the knowledge gain abroad and its transfer. That means that three different variables can be changed to simulate two extreme scenarios for high and no brain gain. Firstly, people gaining additional knowledge abroad is set to zero for the 'no brain gain' scenario, while for 'more brain gain' it is assumed that all uneducated emigrants obtain education abroad (of course with the convenient delay that is needed for education). Secondly, the transfer by transnational emigrants while being abroad is nonexistent in the 'no brain gain' scenario, while the 'more brain gain' simulates the assumption that the knowledge of educated emigrants with tertiary education (see section 3.4.2.5) is available for Senegal during the whole year. Thirdly, the 'more brain gain' does not change the proportion of educated emigrants staying abroad for their whole lives, which is estimated at 10%. On the contrary, in the 'no brain gain' scenario it is assumed that all educated emigrants are staying abroad, setting the brain gain through returning to zero. As underlined before, these scenarios are intentionally unrealistic to facilitate the exploration and discovery of the impact of the changes.

Figure 18 represents the results for the above described simulations. As expected, the graph on the left hand side portrays that the HDI increases in all scenarios, but with the steepest slope for the 'more brain gain' scenario (violet line E), and at the lowest rate for the 'no brain gain' scenario (olive line F).

Figure 18: HDI and Emigration Rate for More and No Brain Gain



While the strong increase in education levels for the 'more brain gain' scenario strengthens the R7 loop, the lowering of education levels in the 'no brain gain' scenario weakens the force of this loop. Normally, one could expect that this is followed by the activation of the other two development loops, R6 and R8. Yet, while the changes in productivity are visible from the beginning on, the differences in investment and health, the indication for the changing strength of the R6 and R8 loop, can be observed only after 1995 for the 'more brain gain' and after 2005 for the 'no brain gain' scenario. This is due to the fact that in the first decades there is no significantly different or even an opposing inducement of the R6 loop by differences in remittances. This can be ascribed to two reasons.

Firstly, the lower education levels in the 'no brain gain' scenario increase emigration and thereby the stock of emigrants sending remittances, while both are decreased in the 'more brain gain' scenario compared to the 'base run'. Hence, the C5 loop counteracts the initial positive influence of emigration on education by reducing the stock of emigrants and thereby remittances. Around 1995, the impact of higher education levels of the stock of emigrants in the 'more brain gain' scenario compared to the 'base run' leads to higher remittances despite the fact that the stock of emigrants is smaller. From that point on, the R6 loop is differently activated in the 'more brain gain' and the 'base run' scenario. From this it can be followed that the activation of the R6 loop by the R7 loop is weak, otherwise investment would already show higher differences between the 'more brain gain' and 'base run' scenario before 1995.

The second reason for the differences in remittances can be seen comparing the 'no brain gain' and the 'base run', uncovering another counteracting structure. The education level of the stock of emigrants is higher for the 'no brain drain' scenario than for the 'base run' leading to higher earnings of the emigrants and thereby higher remittances sent per emigrant. This is true, although the stock is not increased by knowledge gain abroad. Instead, it is higher as its increase through educated emigration is not counteracted by the loop C7 since there is no re-emigration. The two factors lead to the fact that remittances for 'no brain gain'

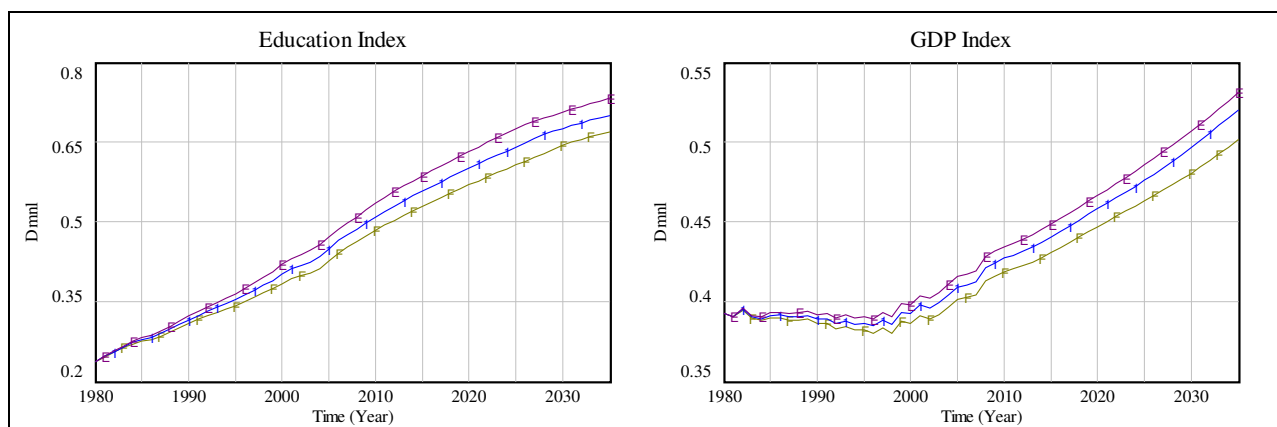
are even slightly higher than for the 'base run', and subsequently its activation of the R6 loop, opposing the weaker activation of the R7 loop. Only after 2005, the strength of the R7 loop and its influence on the other development loops leads to a difference in investment between the two scenarios. This signifies that the C7 loop in the 'base run' leads to a decline in the education level of emigrants abroad and thereby remittances and the inducement of the R6 loop. This is always the case when educated emigrants return.

The emigration rate, presented on the right hand side of Figure 18 pictures a similar behaviour as it has been shown for the 'brain drain' scenarios in section 4.2.3. The emigration rate for the 'no brain gain' scenario in general exceeds the 'base run', while the 'more brain gain' scenario undermines it. However, between 2015 and 2020 all three scenarios generate nearly the same results. The difference in the scenarios is due to the difference in the development indicators, real pc GDP, poverty, life expectancy, and literacy rate, while the convergence can be attributed to the influence of the lack of rural resources described above (see section 4.2.3). The only difference to the brain drain scenarios is that in this case the 'R5 resource-brain gain' loop is dominant, since education levels are changed by brain gain and not by brain drain.

Beside these intuitive results concerning the overall outcome of brain gain to development indicators and emigration, it is interesting to discover the different impact on the separate components of the development indicator HDI. Figure 19 shows that the difference between the 'more brain gain' and the 'base run' scenario for the education index of the HDI is smaller than for the GDP index,<sup>182</sup> although the reason for the overall difference of the HDI is the change in education levels. This is due to two different education indicators. While the education index of the HDI is derived by considering primary and secondary enrolment rate and average adult literacy rate, the productivity and resulting changes in GDP are dependent on the variable 'average years of schooling' including also tertiary education. While the difference between both scenarios is rather small for primary and secondary education since the increase of knowledge gain and transfer mainly refers to higher education (see section 3.4.2.5), the impact is high for tertiary education. Hence, 'average years of schooling' differs significantly and thereby productivity and GDP. On the contrary, in the 'no brain gain' scenario, as no educated people return, neither those with primary, secondary nor those with tertiary, the HDI education index already demonstrates an important difference to the 'base run'. This is not significantly enlarged as the knowledge transfer by transnational migrants in the 'base run' is not so high, so that its loss is small compared to the gain in the 'more brain gain' scenario.

<sup>182</sup> Before calculating the HDI, its three dimensional indices are calculated, deriving the relative achievement for each of the dimensions. Accordingly, the indicator value is the achievement of the country relative to the

Figure 19: HDI Components, Education and GDP Index, for More and No Brain Gain



'Base run': blue line 1 / 'More brain gain': violet line E / 'No brain gain': olive line F

Although it would be interesting to investigate the effects of the three changes concerning brain gain one by one, comparing their impact, this is not possible within the scope of this study. However, for the exercise of this study, it is more important to explore the induced behaviour by changes in brain gain, rather than to scrutinise which form of brain gain is the most relevant one. Nevertheless, for further research this aspect could be interesting.

To recapitulate the gained insights, it has been observed, that brain gain impacts education and the 'R7 education productivity' loop immediately, while the inducement of the other two development loops (R6,8) is delayed due to counteracting changes in remittances caused by the changes of the education level of emigrants living abroad (C5 and C7). For example for the 'no brain gain' scenario the initial negative effect of no brain gain is opposed by heightened remittances caused by the increase of the stock of emigrants due to low development indicators and the raise of education levels of emigrants abroad due to no returning. Secondly, it could be shown that the inducement of R6 by R7 is weaker than the activation through remittances. Thirdly, it could be affirmed that the impact of the resource loop driven by brain gain (R5) contradicts the general trend that more development leads to less emigration for a certain period. Fourthly, it has been found that the impact of brain gain on tertiary education is higher than on primary and secondary education. That is why the education index of HDI is not that strongly increased by the 'more brain gain' scenario as it only considers primary and secondary education, while the impact on productivity due to higher education levels also considers tertiary education which is strongly increased by brain gain. Finally, it has been declared that there is more possibility to increase brain gain (referring to tertiary education) than to decrease it, as its level is not very high in the simulation.

#### 4.2.5 Remittances: Changing Remittances Sent Per Emigrant

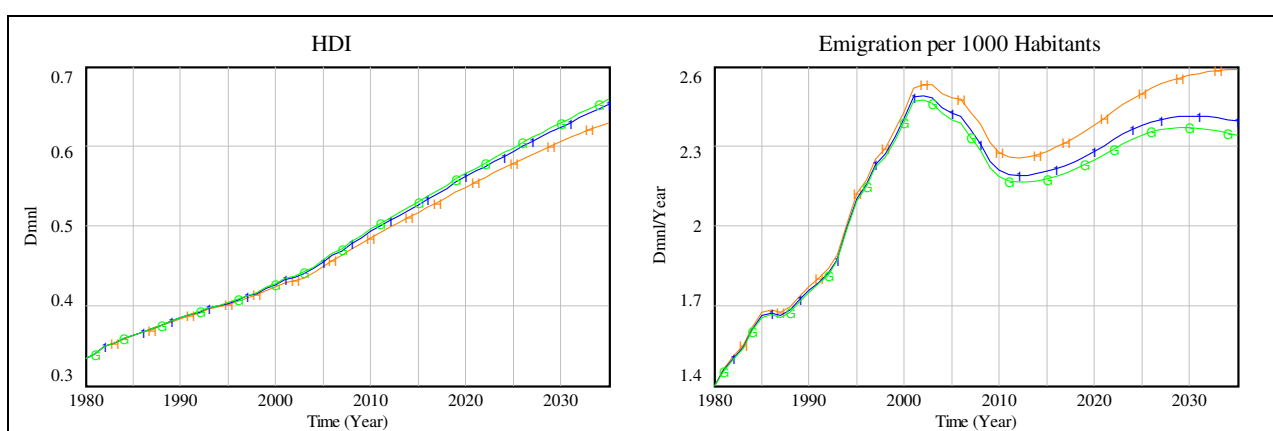
The fourth counterfactual scenario alters the amount of remittances that is sent per emigrant. In the 'more remittances' scenario a higher proportion of the money that is earned by emigrants abroad is sent home to Senegal, assuming that policies can increase the incentive to send more money, for example through reducing the transaction cost. However, as in the other scenarios, a policy structure with these side effects has not been built, as this study first of all aims at exploring the behaviour that would be generated if the assumed changes happened. Assuming that emigrants need at least 25% of their earnings for their own subsistence, they send 75% of their earnings in the 'more remittances' scenario. On the contrary, the 'no remittances' scenario assumes that no remittances are sent at all. Once again, these are exaggerated assumptions to facilitate the exploration of the induced behaviour changes more easily.

Figure 20 presents the simulation results for the described scenarios. On the left hand side, the graph for HDI shows that this development indicator improves most in the 'more remittances' scenario (light green line G) and least in the 'no remittances' scenario (orange line H). Although this is all but surprising, the simulation reveals one factor that can be easily overlooked when thinking of increasing remittances. The graph shows that the improvement in the 'more remittances' scenario is only slightly higher than in the 'base run', the reason being that even though the proportion that is sent in the 'more remittances' scenario is increased by half, the other factor specifying the amount of remittances does not differ a lot from the 'base run'. While the stock of emigrants sending remittances is quite similar for all scenarios, the changes in the proportion that is sent is the main cause for the difference in the amount of remittances. In 2035, for example, the stock of emigrants for the 'more remittances' scenario is less than 2% lower than for the 'base run', while remittances sent per emigrant is nearly 15% higher. However, since this proportion is limited and assuming that a significant proportion is already sent, the changes in remittances are low and therewith their impact on the system. On the contrary, assuming that no remittances are sent at all produces a significant difference. However, originally the model assumes that there is a minimum proportion that is sent, as research has shown that the family bonds are stable and strong. If the proportion is set to this minimum the difference to the 'base run' scenario is small, similar as for the 'more remittances' scenario, but of course in the other direction.

Nevertheless, the difference is attributed to the changes in remittances. While the small difference in remittances between the 'more remittances' and 'base run' leads to small variances in the HDI, the lack of remittances in the 'no remittances' scenario generates a significant variance, demonstrating the huge impact that remittances have on the system. While in all scenarios described up to now, emigration was followed by remittances and the subse-

quent effects (see Figure 7), these are missing in the ‘no remittances’ scenario. This leads to the deletion of the direct effect on income, but also of the following reinforcing effects on production, health and education by the ‘development loops’ (R6-8). Due to the reinforcement that happens in the ‘base run’ and the ‘more remittances’ scenario, the gap becomes larger over time, as not only the reinforcement gets stronger over time, but also the education and health productivity loops (R7,8) are activated with a delay. While the GDP index of HDI already shows difference in 1990, the variance for the education index of HDI starts to vary from 2000 on.

Figure 20: HDI and Emigration Rate for More and No Remittances



‘Base run’: blue line 1 / ‘More remittances’: light green line G / ‘No remittances’: orange line H

The graph on the right hand side in Figure 20 shows the emigration rate for the three scenarios. While it is the highest in the ‘no remittances’ scenario, it is the lowest in the ‘more remittances’ scenario. Consequently, the stock of emigrants is the largest for the ‘no remittances’ scenario. Normally, this would lead to a strong reinforcement due to the reinforcing loops R1, R2, and R3. This is not the case for the ‘no remittances’ scenario. Although the network effect is the highest for this scenario, increasing the ability to migrate, the overall ability to migrate is the lowest for the ‘no remittances’ scenario. From that it can be followed, that the impact of missing remittances on the ability to migrate (R3) exceeds both, the network reinforcement R1, and the reinforcement due to ‘R2 pc means to migrate’ caused by population decrease.

Furthermore, the investigation of these variables brings out another interesting insight. It has been mentioned that the overall ability to migrate for the ‘no remittances’ scenario is the lowest, while the will to emigrate is the highest for this scenario due to the low development levels. The fact that the final emigration rate is the highest for this scenario reveals that the impact of the will to migrate, mainly driven by development indicators, is stronger than the ability to migrate, even though it is driven by three reinforcing loops (R1-3). For the ‘more remittance’ scenario that means that the ability to migrate is the highest, while the will to mi-

grate is the lowest, resulting in the lowest final emigration rate. This behaviour could be also observed in the brain gain and brain drain scenario. This is an important finding as it makes it possible to clarify the dominance between will and ability to migrate. While it has been shown in section 4.2.2 that higher emigration leads to higher development levels and subsequently to a lower will to emigrate, it could not be figured out whether this is also the case for the final emigration rate due to the high exogenous influence on the ability to migrate in that scenario. On the contrary, this scenario shows that even though the ability to migrate opposes the behaviour of the will to emigrate, the will to emigrate is dominant in defining the overall behaviour of the final emigration rate. In other words, low development levels lead to high emigration even when the ability to migrate opposes this outcome. This is an important insight as it proves that the overall influence of development to emigration is negative (in the sense of influencing 'in the opposite direction') even if they are opposed by the reinforcement of emigration through R1-3. Together with the discovery that the overall influence of emigration on development is positive, in the sense of causing a change in the same direction (see section 4.2.2), this suggests that the dominant relationship between development and migration is a counteracting loop (see Figure 9). This is a relevant finding as counteracting loops exhibit the danger of being policy resistant, as exogenously introduced changes, for example through policies, are counteracted by those loops. Assuming for example that emigration was forced to increase development levels, those increased development levels would decrease emigration levels counteracting the policies. That is why, implementing policies in such policy resistant systems can be very costly, as the inherent forces of the system are not used but combated or in other words, the inherent forces of the system resist the policies by counteracting them (Sterman 2000, 5ff).

Summarising the insights gained in this section, three insights have been elaborated. Firstly, the increase of development levels through a rise in the proportion of money that is sent as remittances by emigrants abroad is restricted, and, assuming that already a significant proportion is sent, quite low. Secondly, the reinforcing impact of the R3 loop, changing the means to migrate through remittances, exceeds the strength of the network reinforcement (R1) and the reinforcement due to means to migrate caused by population changes (R2). Finally, the overall impact of development on emigration is negative (in the sense of opposite direction), even when the ability to migrate (mainly R3) opposes this net outcome. Having elucidated in section 4.2.2 that the dominant effect of emigration on development is positive (in the sense of 'influencing in the same direction'), it can be followed that the dominant feedback between migration and development is a counteracting loop, exhibiting the danger of policy resistance.



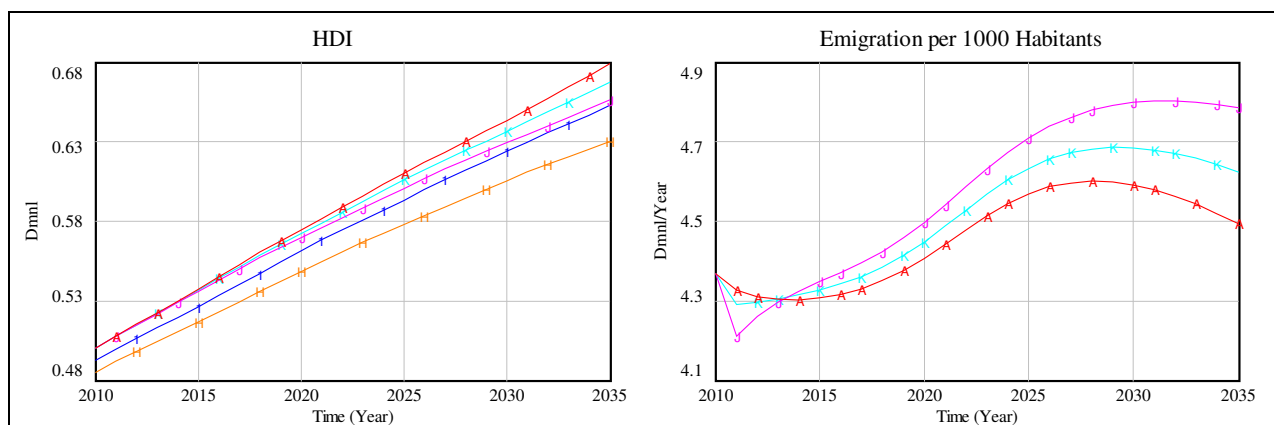
#### 4.2.6 Dependency: Stop of Increased Remittances in 2011

Comparing the outcomes of the simulations up to now shows that the 'more emigration' scenario generates the best HDI development. It has been shown that a very important factor for this positive improvement is the impact of remittances. On the other hand, it has been noticed that high levels of remittances are often accompanied by high levels of dependency. That is why the fifth counterfactual scenario aims at exploring the danger of becoming dependent on economic development, immigration and money transfer policies of potential receiving countries. To do so, this section analyses two scenarios that replicate the situation that remittances play an important role for the development for the first 30 years, establishing a certain degree of dependency by adopting the assumption of the 'more emigration' scenario for the whole period of time. That means that the permissions for emigration are doubled, increasing the ability to emigrate and thereby emigration significantly. To elucidate whether this strategy holds danger and if development progress can be reversed once remittances dwindle, it is assumed that in 2010, the transfer of remittances becomes more difficult. The 'no remittances after 2010' scenario assumes that no remittances can be sent at all, while in the 'fewer remittances after 2010' scenario the proportion of money earned abroad that is sent home is set to its minimum of 25% (see section 4.2.5). In this way, the two scenarios of this section quit the systematic of the preceding scenarios by not simulating one change for the whole period, but changing the exogenous variance only for a period of time.

Figure 21 portrays the results of the two new scenarios of this section 'no remittances after 2010' (pink line J), and 'fewer remittances after 2010' (turquoise line K). In the graph on the left hand side, showing the development of HDI, they are compared with the 'base run' (blue line 1), the 'more emigration' (red line A), and the 'no remittances' scenario (orange line H) which are described in detail in the previous sections. The graph represents the behaviour only for the period 2010 until 2035, as the simulation in the years before is for the two new scenarios exactly the same as for the 'more emigration' scenario, since the exogenous difference only starts in 2010. The graph shows that the slope of increase declines for both new scenarios as a consequence of this change with a delay of approximately 5 years after the remittances have been reduced. This decline increases over time and is stronger for the 'no remittances after 2010' scenario, which nearly reaches the value of the 'base run' scenario in 2035. This is due to the fact that the reduction in remittances compared to the 'base run' scenario diminishes income directly and thereby the GDP index of HDI as well as the health index due to higher poverty levels. In addition, the decline in pc disposable income is followed by a reduction in the inducement of the 'development loops' (R6-8). Hence, also the education level is reduced, but with the typical delay that has already been observed several

times for education and therefore in 2035, the reduction of education index is lower than for the GDP index. However, it should be mentioned that the GDP of the 'no remittances after 2010' while starting to exceed the GDP simulation of the 'base run' after 2000, equalises at around 2025, and finally undermines it. On the contrary, it exceeds pc GDP and thereby the GDP index of HDI of the 'base run' for the whole simulation period highlighting the important impact of the 'C2 pc GDP' and the 'C3 pc income' counteracting high emigration rates as they lead to substantial reduction in population being followed by an increase of GDP which decreases the initial high emigration. However, keeping in mind that this loop played a minor role in the previous scenarios concerning brain drain, brain gain and remittances, it can be followed that this loop is primarily important when emigration and thereby the changes in population are extremely high. Finally, the last scenario in this graph, the 'no remittances' scenario shows that the lack of remittances for the whole period leads to a significant lower HDI for the presented period and that the difference increases over time.

Figure 21: HDI and Emigration Rate for No and Fewer Remittances after 2010



'Base run': blue line 1 / 'More emigration': red line A / 'No remittances': orange line H / 'No remittances after 2010': pink line J / 'Fewer remittances after 2010': turquoise line K

The graph on the right hand side in Figure 21 presents the development of emigration rate for the two new scenarios and the 'more emigration' for the period between 2010 and 2035. To improve the visibility of differences, the 'base run' and the 'no remittances' scenario are not presented, as they exhibit significant lower emigration rates due to the strong exogenous influence of emigration permission for the other three scenarios (see section 4.2.2). While the ability to emigrate is the highest for the 'more emigration' scenario due to high means for migration and high emigration permission, the will to emigrate is the lowest for this scenario. Interestingly, the 'no remittances after 2010' scenario shows a sharp decline for the emigration rate in 2011. This behaviour is attributed to the sharp drop in income due to missing remittances in 2010 leading to a decrease in ability to migrate. From 2011 on, the emigration rate continuously increases due to the worsening of the development indicators, especially those that are directly connected with disposable income, such as real pc GDP, poverty, and

life expectancy. Only after 2030, the increase seems to stabilise and even slowly to decrease due to the equalisation of income growth rates between sending and receiving country (see section 4.2.1). The 'fewer remittances after 2010' scenario shows a similar behaviour for the emigration rate, except that the sharp decline is not as deep and its increase is not as high, because the loss of remittances is not as large as for the 'no remittances after 2010' scenario. However, the graphs affirm the findings of the previous section that the impact of the high development level exceeds the influence of the ability to migrate.

These two scenarios and their comparison to the 'base run', the 'more remittances', and the 'no remittances' scenarios demonstrate that a stop in remittances will always lead to a reduction in the improvements by development indicators and thereby to an increase in the emigration rate. However, it has also been brought out that the time when remittances arrive in the sending country produces a higher development level, which is not deleted when one day the transfer of remittances is no longer possible. For example, comparing the 'no remittances' with the 'no remittances after 2010' scenario shows that the 30 years of receiving a lot of remittances in the 'no remittances after 2010' scenario resulted in a development push that is still visible in 2035 and the reason for the important difference between the two scenarios in 2035. The fact that 'no remittances after 2010' nearly reaches the development level of 'base run' and even undermines GDP of the 'base run', indicating that the 'no remittances after 2010' scenario may also undermine the development indicator HDI of the 'base run' one day, can result in misleading analysis if this fact is taken as a proof for the assumption that a sending country should not allow the establishment of dependency structure, as the gained improvement will reverse one day. On the contrary, such an analysis ignores that the 'base run' scenario receives remittances all the time, also after 2010, when the 'no remittances after 2010' scenario maintains the higher development level even without any remittances from abroad. Summing up the remittances that are received during the whole period from 1980 until 2035, in the 'base run' scenario approximately 4% more remittances are sent, while it exhibits the lower HDI, a value that is about 2% lower than in the 'no remittances after 2011' scenario. Even though these differences are small, it shows that a push in investment, for example through remittances, including investment in education and health, results in a push in development indicators, which remains even if the level of investment cannot be upheld. This is due to the fact that the reinforcing 'development loops' (R6-8) are activated, and the earlier and the stronger this happens, the higher the impact on the whole system over time. That is why policies concerning migration can have a positive impact on the system behaviour, although the previous section found that the emigration-development relationship is a counteracting one and thereby exhibits policy resistance. In other words, even though the initial change of emigration to influence development levels will be counter-

acted by the system, the activation of the 'development loops' (R6-8) further intensifies the improvement of HDI, even if the initial emigration change is reset.

Nevertheless, this model does not include the negative side effects of the loss of dependency such as weak or unfavourable bargaining positions for example in trade negotiations. On the other hand, even if a sending country does not accede an unfavourable trade agreement which may lead to worse transaction conditions for remittances, this country is in better condition (also in the long-term) than a sending country that never received many remittances. Consequently, the fear of a stop of high remittances reception should not lead to policies that diminish the incentives to send remittances. After all, the question to what extent dependency is a danger comprises more aspects than only the behaviour of the development indicator HDI and is thereby dependent on the priorities of each country. However, to facilitate the inclusion of the dependency aspect in the assessment of development outcomes, the last section will compare the dependency levels of the different favourable simulations to give an overview as to which scenario is accompanied by which dependency level.

To sum up the result of this section, four findings could be yielded. Firstly, the stop of remittances worsens development levels, at the beginning the GDP index of HDI, and with a delay and not that strongly, the education index. Secondly, the impact of population on pc GDP has been pointed out by elucidating that the result for overall GDP can be worse while those for pc GDP are better highlighting the importance of the C2 and C3 loop, especially when high emigration rates cause strong population changes. Thirdly, the insight of the previous section that the overall impact of development on emigration is negative (in the sense of opposite direction) could be affirmed. Fourthly, it has been uncovered that a push in development (e.g. through remittances) will augment the development level, activating the reinforcing loops R6-8, effecting the future development even when the remittance flow is stopped. Hence, changes in migration will affect the system even if the initial change is counteracted by the system as was discussed in the previous section.

#### 4.2.7 Comparison of Development Behaviour of Positive Scenarios

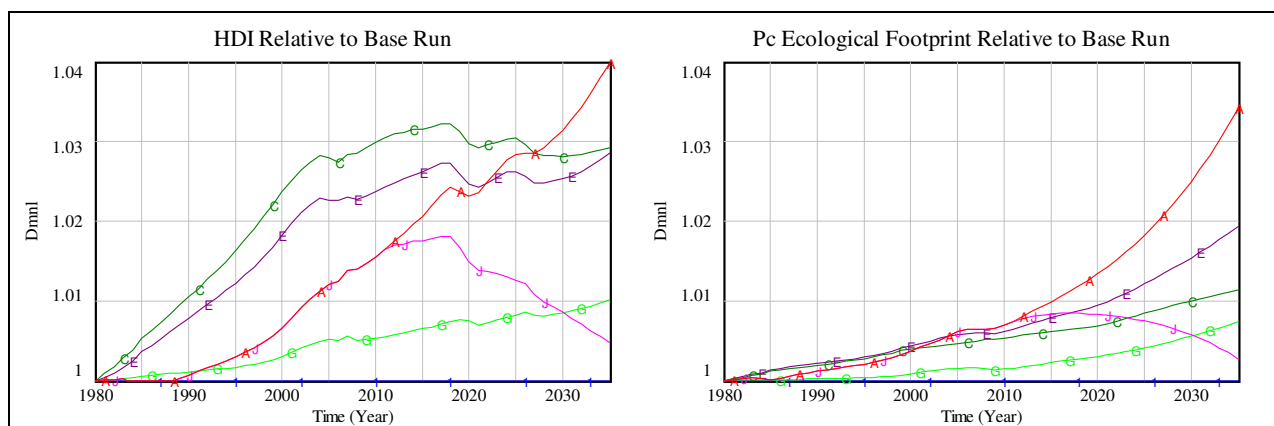
As mentioned before, the HDI as an indicator of development ignores some aspects that should be considered when assessing the 'broader development' level of a country, and therefore when evaluating different scenarios concerning development. Consequently, to give a more comprehensive picture of the level of development that is created in each scenario, this section compares the development outcome of the five positive scenarios that have been described above by presenting not only the overall HDI, but also two of its components, as well as the three development aspects poverty, remittances as a share of GDP as an indicator of the dependency level and the ecological footprint. Positive scenarios are those that generate a better behaviour for the development indicator HDI than it is done by

the 'base run'. In other words, these scenarios improve the situation in the country relative to the business-as-usual scenario. The analysis of the new aspects will lead to further insights concerning their relation and possible side effects, while the comparison of the different positive scenarios foster their evaluation pointing out their relation to each other

Figure 22 portrays on the left hand side the overall HDI for the five positive scenarios relative to the 'base run' (blue line 1), enhancing the visibility and clarity of the differences. The scale presents the difference in proportion, meaning that for example in 2035, the 'more emigration' scenario (red line A) exhibits a HDI that is nearly 4% higher than the 'base run'. The graph shows that the 'more emigration' scenario, although undermining the 'no brain drain' (green line C) and the 'more brain gain' scenario (violet line E) until 2020, reaches the best HDI in 2035. In addition, the trend of this scenario indicates that the difference to the 'base run' further enlarges at an increasing rate, revealing that the reinforcing loops R6-8 are very active in this scenario. Until 2010, the 'no remittances after 2010' (pink line J) simulate the same results as the 'more emigration' scenario (light green line G), as their assumptions are the same. In 2010, the prohibition of sending remittances after 2010 in the 'no remittances after 2010' scenario results in a sharp drop in the differences in development relative to the 'base run', undermining even the lowest positive scenario 'more remittances' at around 2030. However, until 2035, its HDI is still better than that of the 'base run', although the trend indicates that this probably changes in the further future when the assumptions (policies) do not alter. For a long time, more than 45 years, the HDI of the 'no brain drain' scenario is the best. Its difference to the 'base run' increases sharply at the beginning, but around 2005 the rate of increase diminishes, stabilising at a level that is around 3% higher than the 'base run'. However, as the 'base run' also improves for the whole period that does not mean that HDI stays stable, but only that the difference relative to the 'base run' scenario stays relatively constant. This is mainly due to the fact that the change is primarily based on the changes in education, the increase of which is limited distinct from the increase of GDP (further described below). Additionally, remittances are significantly smaller than in all other scenarios presented in this graph (see also Figure 24), and thereby the reinforcing development loops R6-8 are primarily activated by education, reaching certain limits around 2005. A similar behaviour can be observed for the 'more brain gain' scenario. The difference for this scenario is lower than for the 'no brain drain' scenario, but also shows a steep increase until 2005. Afterwards, distinct from the 'no brain drain' scenario the differences still rise, but at a significantly lower rate than before, so that in 2035, the differences of the 'no brain drain' and the 'more brain gain' scenario converge. As it will be illustrated by Figure 23, the fact that the difference in the 'no brain drain' is higher than in the 'more brain gain' scenario is due to the significantly higher education index in the 'no brain drain' scenario, while the further increase

of the 'more brain gain' scenario is attributed to the continuous increase in the GDP index, also after 2005. The final difference represented in the graph is that from the 'more remittances' scenario, which enlarges continually, but at the lowest rate of all the pictured scenarios. The reason that its difference is so small is that the stock of emigrants stays relatively small in this scenario (see section 4.2.5).

Figure 22: HDI and Pc Ecological Footprint for Positive Scenarios Relative to Base Run



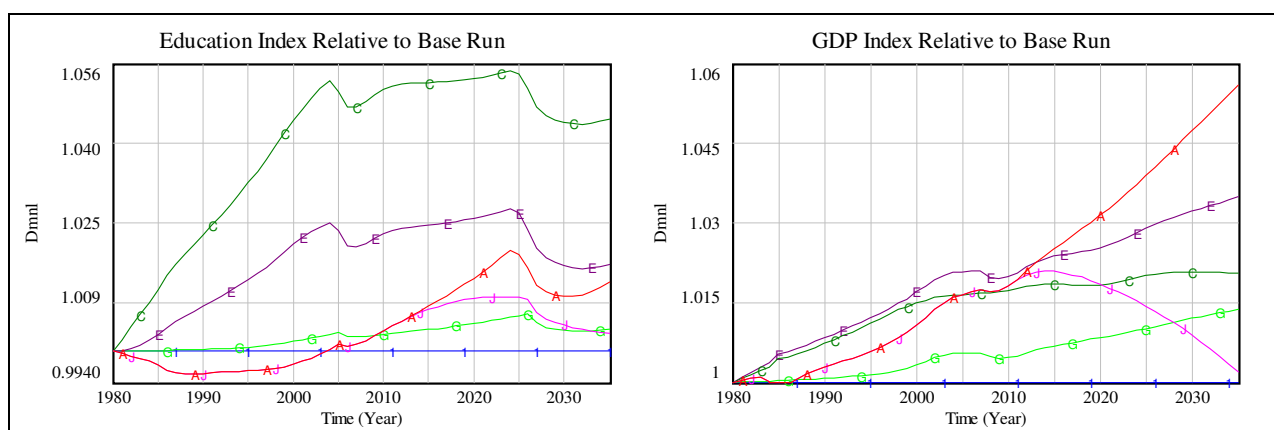
'Base run': blue line 1 / 'More emigration': red line A / 'No brain drain': green line C / 'More brain gain': violet line E / 'More remittances': light green line G / 'No remittances after 2010': pink line J

The graph on the right hand side of Figure 22 shows the pc ecological footprint<sup>105</sup>. As discussed in section 3.2.1 this variable is looked at to consider the aspect of sustainability when evaluating the development outcomes of the scenarios. The graph shows certain similarities in the development of the differences as those that can be observed in the HDI graph on the left hand side, especially for the 'more emigration', 'no remittances after 2010', and the 'more remittances' scenario, only that the simulation results for the HDI have more oscillations. Certainly more important is that the assessment is oppositional. While for the HDI higher values signify an increase in development, high values for the ecological footprint stand for a worsening of this development aspect. The highest difference relative to the 'base run' exhibits 'more emigration', while the difference from 2010 on diminishes for the 'no remittances after 2010' scenario. The difference for the 'more remittances' scenario increases at the lowest rate. However, the important difference of the behaviour in this figure compared to the development of the HDI is that the two scenarios that are mainly driven by the changes in the education sector, exhibit lower differences than they do for the HDI. While the scenario with the highest HDI for a long time, the 'no brain drain' scenario, generates a significantly lower difference for the pc ecological footprint than the 'more migration until 2010' scenario, the 'more brain gain' scenario only slightly undermines it, although its HDI is lower than that for the 'no brain drain' scenario, revealing that the higher the impact of education, the lower the difference for the pc ecological footprint. This is due to the fact that the ecological footprint is mainly driven by energy consumption, which is tightly connected with capital intensity, reasoning that the higher capital intensity the higher the

reasoning that the higher capital intensity the higher the industrialisation and thereby energy consumption. This leads to the situation that the ecological footprint is worst in those scenarios in which remittances and the resulting increasing investment and the R6 are the main reason for the improvement in development, indicated by HDI, while the melioration of HDI in those two scenarios with education as the main driver, also worsen the pc ecological footprint relative to the 'base run', but less than in the capital driven scenarios.

Figure 23 illustrates the determinants of the difference in HDI for the five scenarios, representing the behaviour of two of its components, the GDP index (right hand side) and the education index (left hand side), again relative to the simulation results of the 'base run'. The third component of HDI, the health index is not portrayed as its behaviour is very similar to that of the GDP index. This is ascribed to the fact that as indicator for the health level, average life expectancy is used, which is dependent on the access to basic health care, but also on real pc GNP, and therewith on GDP<sup>183</sup>. In addition, access to basic health care is also highly influenced by the level of poverty (acknowledging that poverty determines if people can pay medical fees), which is affected by disposable income. Consequently, these graphs disclose whether the difference in HDI (Figure 22) is mainly due to the difference in GDP and health or due to the variance of education.

Figure 23: HDI Components, Education and GDP Index, for Positive Scenarios Relative to Base Run



'Base run': blue line 1 / 'More emigration': red line A / 'No brain drain': green line C / 'More brain gain': violet line E / 'More remittances': light green line G / 'No remittances after 2010': pink line J

However, before comparing the two graphs, the graph for the education index (left hand side) should be analysed in more detail, as it reveals some particularities of the behaviour of education levels. First of all, it can be observed that education levels exhibit certain limits. For example, the abrupt decline in difference around 2005 is due to such a limit. In this period all scenarios achieve the maximal enrolment rate for primary school. Hence, the 'no

<sup>183</sup> It has been found that life expectancy is highly dependent on income, although this influence decreases with increasing income (WRI et al. 1998). That is why the model assumes that beyond \$20,000 per person per year, wealth is no longer a factor limiting life expectancy.

brain drain' and 'more brain gain' scenarios cannot increase their education levels at a higher rate than the 'base run' on the base of higher primary enrolment rates. However, the scenarios reach this limit at slightly different time intervals. While, in the years before 2005, the 'no brain drain' and the 'more brain gain' scenario exhibit better enrolment rates than the 'base run' due to their better education level (reasoning that educated parents are more willing to invest in education of their children), around 2005 this difference in enrolment rates vanishes as the maximum rate is reached. Consequently, the difference does not further increase. The drop of the difference around 2004 for all scenarios is ascribed to the fact that in the years when 'no brain drain' and 'more brain gain' have already reached the maximum, the 'base run' can increase on a higher rate until it also achieves the maximal enrolment rate. As the graph shows the behaviour relative to the 'base run' the fact that the increase in the 'base run' scenario is higher than in the other scenarios is visible as a drop. The same explanation can be applied to the drop around 2025, when the scenarios achieve the maximal enrolment for the lower secondary. The discovery of those limits of the system is highly important as it explains why certain scenarios continue the improvement at a higher rate, as could be observed in Figure 22. Although the increase in GDP also exhibits limits (for example environmental and resource limits) and the HDI is calculated assuming a limit for GDP<sup>176</sup>, all scenarios are far from reaching those limits in the simulated time horizon. That is why those limits are not visible in the GDP index, but in the education index.

A second particularity concerns the method of changing the education level in the country. Although the first association of how to change education levels is to invest in education, the graph shows that education level is not only dependent on those investments and consequently the enrolment rates, which have already reached their limits, as described above, but also on the stock of educated people relative to that of uneducated people. These stocks are changed by adult education, by death or by migration. As investment in education is not primarily invested in adult education<sup>184</sup>, and it takes time for people to die, an important influencing factor is migrants and their level of education. For example, the immense difference for 'no brain drain' to the 'base run' scenario is mainly due to the fact that all educated adult people stay in the country instead of emigrating while all emigrants are uneducated, both reducing the proportion of the uneducated stock. Hence, the decrease of education level of the emigrants abroad creates an increase of the education level in the country. On the other hand, the same decrease also reduces the brain gain effects (C5), as emigrants abroad earn less, the knowledge transfer decreases and the educated re-immigration. The result that even though the overall impact of 'no brain gain' undoubtedly increases the education level

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<sup>184</sup> In Senegal, under 0.5% of the public education expenditure is invested in adult alphabetisation (ANSD 2006, 151f).



in the country shows that the negative causation (in the sense of influencing in the 'opposite direction') of brain drain is stronger than the positive causation (in the sense of influencing in the 'same direction') due to brain gain. On the contrary, in the 'more brain gain' scenario the stock of uneducated and educated adults in the country does not increase through changing the migration behaviour, but through the various channels of brain gain. The lower positive impact compared to the 'no brain drain' scenario shows that the strength of this strategy is lower than changing the stocks directly through migration of uneducated and keeping educated people. This can be explained as the 'more brain gain' strategy only increases the stock of educated people, while the 'no brain drain' strategy changes both stocks, it decreases the stock of uneducated people and increases the stock of educated people.<sup>185</sup>

The third special feature of the education index has already been discussed in section 4.2.3 and can be affirmed by scrutinising the two scenarios that assume more emigration permission, the 'no remittances after 2010' and the 'more emigration' scenario. They show that higher emigration leads to a decline in education levels relative to the 'base run' at the beginning as emigrants are assumed to be higher educated than the population in Senegal (see section 3.4.2.4). Hence, the stock of educated people is more reduced relative to the stock of uneducated people uncovering the strength of the 'R4 brain drain' loop. However, the strong increase in the GDP and thereby public expenditure for education and the delayed but growing strength of the 'C5 brain gain' loop, among others, creates a higher and increasing improvement of education levels relative to the 'base run' from 2005 on disclosing that the dominance of the 'R4 brain drain' loop is replaced by the 'R7 education productivity' and the 'C5 brain gain' loop. This change of dominance of those different loops causes the worse-before-better scenario discussed in section 4.2.3.

After having analysed the particularities of the education index, the comparison between the education and GDP index reveals their impact on the changes in HDI. For the 'more emigration' scenario this difference in HDI is mainly ascribed to the difference in the GDP. Moreover, although until 2005 the education index is even worse than the 'base run', the steep and steady increase of the difference in the GDP, already exceeding the difference of all other scenarios around 2010, leads to an overall increase for HDI. This increase is mainly based on the increase of income due to significantly more remittances and less population. The 'no remittances after 2010' scenario allows the supposition that the impact of population decrease is marginal compared to the remittances increase since after 2010, the difference in this scenario declines only due to the lack of remittances. This assumption is affirmed

<sup>185</sup> *The high influence of the inert stocks is also the reason why an increase in GDP can delay changes in education as a raise in GDP decreases mortality prolonging the existence of a large stock of uneducated people as they live longer and thereby delays the improvement of the relation between the stock of educated and uneducated people. However, as this is a detail that has not been found to be one of the main influencing be-*

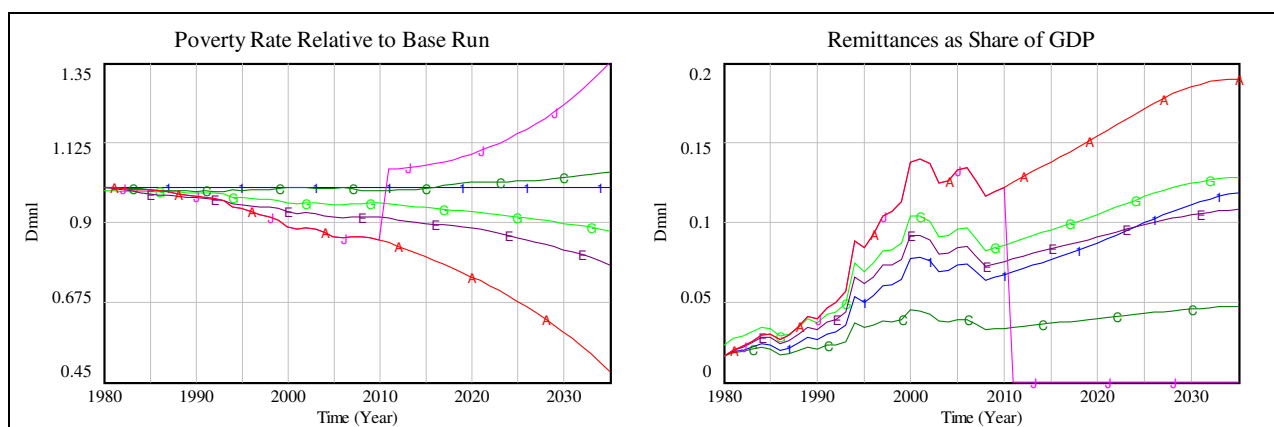
when comparing the 'no remittances' (section 4.2.5) and the 'no emigration' scenario (section 4.2.2) to the 'base run': While the huge difference between those two scenarios and the 'base run' is due to remittances only the minor difference between the two scenarios is due to population. Distinct from the first two scenarios, for the 'no brain drain' scenario the difference in overall HDI is mainly attributed to the changes in the education index. However, there is also a difference in the GDP index relative to the 'base run', which is even higher than the difference between 'more emigration' and 'base run' for the first 25 years. This is due to the increased productivity, activating the R7 and subsequently the R6 and R8 loops. Because of these loops there is still a small increase in difference after 2005, although in the 'base run' these loops are newly activated by more remittances every year in comparison to in the 'no brain drain' scenario. Similarly, the difference for the 'more brain gain' scenario is mainly due to changes in education. Additionally, in this scenario the education level of emigrants abroad increases, and thereby their earnings and remittances, explaining why the difference for that scenario further augments even after the difference in education stays relatively stable. Finally, the increase of difference in the 'more remittances' scenario is ascribed to the increase in the GDP, subsequently activating also the R7 loop, but as can be observed the resultant improvement in the education level is lower than that for the GDP.

The last two graphs of this section concern poverty and dependency and are presented in Figure 24. The graph on the left hand side portrays the development of the poverty rate for the five positive scenarios relative to the 'base run'. That means that for example in 2035, the poverty rate for the 'more emigration' scenario is more than 50% lower than in the 'base run', while it is approximately 35% higher in the 'no remittances after 2010' scenario.

The difference of poverty rates of the 'more emigration' scenario decrease for the whole period due to the continuous decrease in population and increase in remittances, both augmenting disposable income and thereby lowering poverty rates. The difference in the 'no remittances after 2010' scenario illustrates in an impressive way that remittances have an important impact on poverty rates by adding to household revenue and thereby augmenting disposable income. Although poverty rates are significantly lower until 2010, the lack of remittances lead to an increase in poverty, reaching levels that are even 35% higher than in the 'base run' in 2035. This high causality is also visible looking at the 'no brain drain' scenario. Although its GDP index exceeds that of the 'base run', its poverty rate behaves similarly to the 'base run' for the first 35 years of the simulation, and even slightly overshoots the 'base run' after 2015. This result can be explained as the lack of educated emigrants reduces the education level for the stock of emigrants and thereby their remittances. Consequently, higher levels of GDP due to higher productivity are neutralised by missing remit-

tances, leading to similar household revenues as those in the 'base run'. Similar to this reasoning, the difference in poverty rates for the 'more brain gain' scenario increases due to the fact that higher GDP levels increase income, and remittances do not counteract this gain in income, but even add slightly more, since remittances slightly outnumber those from the 'base run'. While the stock of remittances slightly undermines that of the 'base run' due to better development levels, remittances sent per emigrant exceed those of the 'base run' caused by intensified education of the stock of emigrants abroad and thereby their education levels. The 'more remittances' exhibits lower poverty rates than the 'base run' increasing its difference over time. However, the difference is smaller than in the 'more brain gain' scenario although remittances overshoot those in the 'more brain gain' scenario at the end, because the increase of income due to higher productivity is missing. From these observations it can be followed that remittances play an important role in increasing income levels and thereby diminishing poverty directly, and enlarging investment means and thereby capital levels and production (R6). Although income levels can also be increased by an enhancement of productivity for example through education, this way does not impact poverty directly. That is why policies that are mainly focussed on education can even worsen poverty levels relative to the business-as-usual scenario, if they reduce remittances as a side effect. On the other hand, remittances signify higher dependency levels on economic development and immigration policies by OECD countries.

Figure 24: Poverty Rate Relative to Base Run and Remittances as Share of GDP for Positive Scenarios



'Base run': blue line 1 / 'More emigration': red line A / 'No brain drain': green line C / 'More brain gain': violet line E / 'More remittances': light green line G / 'No remittances after 2010': pink line J

This high correlation between low poverty levels and high dependency levels can be observed by analysing the graph on the right hand side in Figure 24, representing remittances as a share of nominal GDP at market prices. This graph does not picture the behaviour relative to the 'base run' and therefore the graph shows for example that the share for the 'more emigration' scenario accounts for nearly 20% of the whole GDP in 2035, while it drops to 0%

in the 'no remittances after 2010' scenario. Comparing the two graphs discloses that in most scenarios the behaviour is oppositional. While in the 'more emigration' scenario the share steadily increases, demonstrating the growing dependency and signifying that remittances grow at a higher rate than GDP, the difference in poverty rates diminishes steadily. However, the slope of the 'more emigration' scenario decreases significantly at the end of the simulation indicating that the growth of GDP approaches the growth of remittances. In the 'no remittances after 2010' the dependency is zero from 2010 on since no remittances are received anymore. However, as was shown earlier, this is accompanied by relatively high poverty levels. The focus of the 'no brain drain' scenario on education is accompanied by low remittances levels, not passing 5% of GDP, and therefore low dependency. However, it has been pointed out that this is not favourable for the poverty rates. An interesting case is the 'more brain gain' scenario as it is an exception to the trend that higher dependency levels are correlated to lower poverty rates. Although its share of remittances relative to GDP exceeds the 'base run' until 2025, it produces lower dependency levels in the following years, and the trend indicates that the difference of both scenarios further decreases, while at the same time the poverty levels further decline compared to the 'base run'. This is due to the fact that the difference in income and thereby poverty is mainly due to higher productivity based on education that activated the development reinforcement through R6-8 increasing income, instead of high levels of new remittances as it is in the 'more emigration' scenario. However, distinct from the 'no brain drain' scenario, the level of remittances is not lower but slightly higher than that of the 'base run'. Yet, the difference in GDP is significantly higher and therefore the proportion of these two variables is lower than in the 'base run'. The 'more remittances' scenario shows an increasing dependency, although the rate of increase also diminished at the end of the simulation.

Summarising the outcome of the five compared scenarios, Table 3 presents the ranking order for the five scenarios for each of the analysed development aspects in 2035, with 1 signifying the best outcome. That means that for poverty rate, ecological footprint and dependency the lowest outcome reaches the best value 1. The first column shows the line labels of the scenarios in the graphs. The final column adds all points together revealing the overall outcome, with the lowest number standing for the best result. However, the table should not be taken as a comprehensive evaluation of development outcomes, as for example education and GDP are entered twice, since the overall HDI in addition to two of its components are counted. Moreover, this table does not replicate the extension of differences. It rather aims at supporting the attempt of giving an overview of the impacts of the different exogenous changes on the development aspects presented.

Table 3: Ranking Order for Positive Scenarios for Different Development Aspects in 2035

N o	Development indicator Scenario	HDI	Education index	GDP index	Ecological footprint	Poverty Rate	Depen dency	Sum
A	'More emigration'	1	3	1	6	1	6	18
C	'No brain drain'	2	1	4	3	5	2	17
E	'More brain gain'	3	2	2	5	3	3	18
G	'More remittances'	5	5	5	2	4	5	26
J	'No remittances after 2010'	6	5	6	1	6	1	25

The best outcome is valued with 1. While for HDI, education index, and GDP index the highest outcome is the best, it is the lowest for ecological footprint, poverty rate and dependency,

However, as the aim of this section is not to provide an evaluation of the simulation results at one point of time, mainly the insights gained by comparison between the positive scenarios should be summed up. First of all, the oppositional effect of the exogenous changes on HDI and ecological footprint has been demonstrated, meaning that a high HDI (positive for the development assessment) is often correlated to high ecological footprint (negative for the development assessment). Yet, it has also been pointed out that the negative relationship is mainly due to the capital intensity. That is why the scenario in which the improvement is mainly based on amelioration of education levels, the 'no brain drain' scenario, exhibits relatively high HDI levels and relatively low ecological footprint values. Secondly, the comparison has disclosed that the improvement of education levels is limited by the achievement of maximal enrolment rates and that these limitations are earlier relevant than the limits for the increase in the GDP. Consequently, the rate of improvement of scenarios based on education rather than on remittances decreases over time, while it tends to further increase in those scenarios mainly based on remittances. Thirdly, it has been found out that education levels are highly inert due to the existing stocks of educated and uneducated adults, and that these stocks can be changed more effectively by retaining all educated emigrants and forcing the emigration of all uneducated (no brain drain strategy) than by more brain gain. Fourthly, the worse-before-better behaviour for the education index that was discussed in the section 4.2.2 happening due to change of loop dominance from 'R4 brain drain' to 'C5 brain gain' and 'R7 education productivity' could be affirmed. Fifthly, it has been shown that the impact of the decrease of population is relatively small compared to the impact of decreased remittances. Finally, it has been highlighted that on the one hand, remittances play an important role for poverty reduction, due to its twofold impact on household revenue. Hence, missing remittances can even counteract increase in household revenue due to higher productivity. On the other hand, high remittances cause high dependency levels. That is why the dependency level is highly related to poverty levels. However, it also has been shown that this relation dwindles when the improvement of income levels and thereby of poverty levels is not mainly based on remittances, but rather on the reinforcement of the development loops R6-8, intensifying each other, and/or on education without reducing remittances, such as in the 'more brain gain' scenario. Generally, Table 3 shows that there is no scenario that achieves

the best values for all development aspects, especially due to the oppositional effects between remittance induced GDP increase and ecological footprint as well as between remittance induced poverty reduction and dependency. However, the comparison elucidates that the improvement of education can reduce dependency levels as well as the worsening of ecological footprint. On the other hand, it has been uncovered that remittances are fundamental for poverty reduction and the activation of the reinforcing loop R6-8. Moreover, the direct affection of pc disposable income exhibit fewer limits than the change of education levels. In conclusion, it is a question of priorities in the decision of which strategy is more convincing for a country.

#### 4.2.8 Summary of the Results Gained in the Simulations

The previous sections analysed ten different scenarios, compared them to the base run and to each other, gaining several insights about the feedback relationships and their dominance (first research question), generated behaviour patterns (second research question), and the overall net effect of changes in migration on development (third research question). Although at the end of every section, a final paragraph summarised the findings and a table containing the collected insights can be found in Appendix A, it may be difficult to get an overall impression of them. That is why this section summarises the gained insights categorised by areas for which they are relevant. These areas are on the one hand the main drivers of the impact of emigration on development, education, remittances and population, and on the other hand, the net outcome of the system. At the end of this section, Table 4 collects the presented insights, indicating after each finding, in which scenario it was discovered.

For the area of education five behaviour patterns could be identified. Firstly, it has been found that the changes caused by education are limited due to the achievement of maximal enrolment rates, hampering the activation of the reinforcing development loops (R6-8) and thereby the continuous intensification of improvement. Secondly, the increase of education levels in the country is accompanied by a decrease in the development levels of emigrants living abroad due to C5 and C7 lowering remittances. This decline in remittances is followed by relevant consequences on the development levels, as the activation of the 'R6 investment' loop is stronger when this is done by remittances than through the 'R7 education productivity' loop. Consequently, the self-reinforcement of development driven by investment (R6) is delayed when it is mainly activated by education increase (R7) lacking the inducement of remittances. Thirdly, it could be demonstrated that the education level is highly inert due to existing stocks of educated and uneducated adults. These stocks and their relation to each other - which is the same as the education level in the country - can be changed more effectively when the stock of uneducated people is decreased (e.g. by emigration) and the stock of educated people is increased (e.g. by keeping of educated people in the country)

rather than by only enlarging the stock of educated people (e.g. by brain gain). Fourthly, it has been highlighted that brain gain mainly affects tertiary education, being important to acknowledge as this influences productivity, but is not visible in the education index of HDI since this index only considers primary and secondary education. Fifthly, it could be revealed that the level of brain gain is not very high in the simulation, so that there is more possibility to increase it than to decrease it.

The second important driver of the impacts on development due to emigration is remittances. For this area three insights have been found. Firstly, the simulations showed that remittances are a very decisive factor for the GDP index of HDI, so that their lack significantly decreases the development level. Changes in remittances immediately affect the GDP and health index and with a delay the education index. Secondly, it could be revealed that remittances strongly increase the ability to migrate (and subsequently emigration, again enlarging remittances) and that the strength of this reinforcement of emigration (R3) exceeds that due to network and population (R1 and R2). Thirdly, it has been discovered that the impact of the mainly discussed policy regarding remittances which is to provide incentives to increase the money that is sent by emigrant is limited as the earnings and the proportion of money that can be sent cannot be heightened infinitely. Instead, remittances are increased at a higher scale by the increase of emigrants living abroad.

For the area population, the third driver changing development levels due to emigration, two findings can be presented. Presuming high emigration levels and therefore a strong reduction of population, the decreasing impact on pc GDP as it is divided by less people (C2 and C3) can lead to the situation that the pc GDP level is equal to the 'base run' even though the overall GDP is worse. However, this impact is only outstanding when emigration rate is changed and not only its aspects, as population is not significantly changed by remittances or education.<sup>186</sup> In addition, it could be elucidated that the impact of remittances exceeds the impact of population regarding their influence on development levels in the country.

Referring to the net outcome of the system, eight insights could be extracted. They do not only concern the development level indicated by HDI, but also the 'broader development' level considering poverty, dependency indicated by remittances as a share of GDP, and the ecological footprint.

First of all, it could be shown that the behaviour of the feedback between migration and development affirms the supposition derived by the identification of the feedback relations in a theoretical way that the overall influence of emigration on development is positive (in the sense of influencing in the same direction), and the dominant influence of development not

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<sup>186</sup> Of course, there is an impact of education and remittances on population through the altering of mortality and

only on the will to emigrate but also on the final emigration rate is negative (in the sense of influencing in the opposite direction). This negative relation even exceeds the strength of the opposing loops reinforcing migration due to the ability to migrate (R1-3), although those loops increase their strength over time in a non-linear way, exceeding the strength of another loop counteracting migration due to population (C1). In addition, the negative relationship between development and emigration is also opposed by the lack of rural resources, especially when education is high in the country, but only for a certain period. However, the dominant behaviour stays negative. From this, it can be followed that the dominant feedback between migration and development is a counteracting loop and thereby exhibits the danger of policy resistance, as the exogenous influence (e.g. a policy) is always counteracted by the system. For example, assuming that it had been acknowledged that an increase in migration heightens the development levels and therefore this increase was forced by policies and development levels rose, these would feed back to emigration, decreasing it so that it would need more effort by policies to uphold the high level of emigration. Another finding concerning the overall behaviour of the system and its net outcome is that the simulations uncovered a worse-before-better behaviour in the case of increasing emigration due to delays of the system. While emigration causes immediately a decline of education due to brain drain, the positive effects of brain gain and the activation of the 'R7 education productivity' by 'R6 investment' due to changes in population and remittances develop their strength only over time. As a further insight, it has been disclosed that the development loops R6-8, reinforcing pc GDP, education, and health, are very decisive for the behaviour of the system. They are not only responsible for the increasing trend of HDI also in the 'base run' scenario but also the cause for continuous intensification of improvement of HDI even after favourable changes concerning migration have been reset. That means that even if high emigration rates, that have risen development levels, are counteracted by the system (due to the counteracting behaviour between migration and development) or favourable migration policies, that have increased development levels, are stopped (such as in the 'no remittances after 2010' scenario), the improved development levels automatically activate the reinforcing development loops (R6-8) which continue to intensify themselves even if the initial reason for the increase is not existent anymore. Furthermore, light has been shed on the fact that improvements in HDI induced by remittances are followed on the one hand by decreasing poverty, which is positive for the assessment of broader development, but on the other hand by higher values for dependency and ecological footprint, which is negative for the evaluation of broader development. On the contrary, improvements in HDI induced by education exhibit the above mentioned limits to growth, opposing effects, lower impact on poverty and a



weaker activation of the important loop reinforcing development levels through investment (R6), but on the other hand dependency levels and ecological footprint are not increased as much as through the improvement induced by remittances. It has been concluded that it depends on the priorities of a country as to which strategy is more convincing.

Table 4 summarises the insights presented. The first row considers behavioural insights referring to education behaviour, the second concerns those related to remittances, the third presents the behavioural findings pertaining to population, and the final row concludes the findings concerning the net outcome.

*Table 4: Gained Insights about Behaviour Patterns and Net Outcome*

Area of behaviour	Insights
<b>Education</b>	<ol style="list-style-type: none"> <li>1. Increase in education is limited due to achievement of maximal enrolment rates, hampering further development reinforcement (R6-8) [comparison 2]</li> <li>2. Increase in education levels in the country is accompanied by a decrease in the development levels of emigrants living abroad due to C5 and C7 lowering remittances and consequently delaying the reinforcement through development loops (R6-8) as the activation of R6-8 is weaker by changes of education than of remittances [brain gain 1,2]</li> <li>3. Education inert due to existing stocks of educated and uneducated adults. These stocks can be changed more effectively by changing both stocks (emigration of uneducated and keeping educated people, no brain drain) than by only increasing educated stock (more brain gain) [comparison 3]</li> <li>4. The impact of brain gain on tertiary education is higher than on primary and secondary education (impact visible for productivity but not that much for HDI) [brain gain 4]</li> <li>5. As brain gain is not very high in the simulation, there is more possibility to increase it than to decrease it [brain gain 5]</li> </ol>
<b>Remittances</b>	<ol style="list-style-type: none"> <li>1. Remittances play an important role for development levels (immediately for GDP and health, and with a delay and not as strong for education) [dependency 1]</li> <li>2. Remittance impact on ability to migrate (R3) exceeds impact by network (R1) and population (R2) [remittances 2]</li> <li>3. Improvement of HDI through the increase of proportion of remittances sent per emigrant by increasing incentives is restricted [remittances 1]</li> </ol>
<b>Population</b>	<ol style="list-style-type: none"> <li>1. C2 and C3 play an important role presuming high emigration rates (population effect can enhance pc GDP levels even if overall GDP is worse) [dependency 2]</li> <li>2. Impact of population on pc disposable income and subsequently emigration (C2-3) is smaller than that of remittances (C4) [comparison 5]</li> </ol>
<b>Net outcome</b>	<ol style="list-style-type: none"> <li>1. Counteraction of emigration due to population growth rate (C1) diminishes over time, while reinforcement due to ability to migrate (R1-3) increases [base run 4]</li> <li>2. Dominant influence of emigration on development is positive ('influencing in the same direction') [migration 1]</li> <li>3. Dominant influence of development on emigration is negative ('influencing in the opposite direction') even if this direction is opposed by a) the ability to migrate (R3) [remittances 3, dependency 3], and the 'lack of resource' loop, but only for a certain period [base run 2, brain drain 3, brain gain 3]</li> <li>4. Dominant feedback relation between migration and development is a counteracting loop exhibiting policy resistance [remittances 4]</li> <li>5. Worse-before-better behaviour for education in the case of high emigration due to the change of dominance from 'R4 brain drain' to 'C5 brain gain' and 'R7 education productivity' caused by delays of the system [migration 2, comparison 4]</li> <li>6. Dominant behaviour of reinforcement of development through R6-8 so that the reinforcement continues even if the initial activating cause is reset (by the system)</li> </ol>

Area of behaviour	Insights
	<p>due to policy resistance, or by changing policies) [base run 1, brain drain 1, dependency 4,5]</p> <p>7. Increase of HDI level induced by remittances strongly decreases poverty, but increases ecological footprint and dependency [comparison 1,6,7]</p> <p>8. Increase of HDI level induced by education exhibits limits to growth, opposing effects, and lower impacts on poverty, but also on the ecological footprint and dependency [comparison 1,8,9]</p>

### 4.3 Interim Conclusion

This chapter analysed the model structure and its behaviour from a feedback perspective. The first subchapter elaborated the main theoretical feedback loops based on the structure of the model. In four sub-CLDs the influence of emigration to itself, to population, to remittances and education were presented, shedding light on the subsequent feedbacks on emigration. In addition, one diagram elucidated that changes in emigration activate the reinforcement of the three aspects of development that are incorporated in the HDI. Hence, this section identified two loops reinforcing emigration (R1-3) that are opposed by one counteracting loop (C1). For the connection between emigration and development, indicated by HDI, five counteracting loops (C2-C6), and only two reinforcing loops (R4 and R5) were brought out, while a clear reinforcing structure could be disclosed for development in itself (R6-R8). Subsequently, to explore the actual behaviour generated by this structure, the second subchapter portrayed the base run and in five sections ten counterfactual scenarios. The first four sections analysed the behaviour of the system based on exogenous changes, scrutinising for every change the effects of an in- and a decrease of the exogenous variable. Thereby, the impact and feedback caused by changes in the intensity of migration, brain drain, brain gain and remittances have been explored. The fifth section investigated the danger of becoming dependent by analysing the system behaviour that is generated when after a period of high emigration the sending of remittances is reduced. In the sixth section, the 'broader development' level of those five scenarios that generated higher development levels, indicated by HDI, than the 'base run', were compared to each other also examining in addition to HDI two of its components, the GDP and the education index, as well as poverty rates, remittances as share of GDP and the ecological footprint. At the end of each section a small paragraph summarised the gained insights. A table containing the collected insights can be found in Appendix A. To facilitate an overall impression of these results, the final section presents the same conclusion but categorised by areas. To ameliorate clarity they are summarised in Table 4 (see p. 113).

## 5 Conclusion

This final chapter aims at concluding this study. To do so, the first section summarises the objectives of this thesis and its structure. A second section outlines and discusses the main results, the appropriateness of the application of SD to derive those results, and the possibilities of generalisation. A third section derives some implications for the general policy trend, and the last section offers some options for further research.

### 5.1 Summary of Objectives and Structure

This section gives a short summary of the objectives of the study, its research question, its relevance, and its structure.

The main objective of this study was to investigate the reciprocal relationship between migration and development in Senegal. This first objective should facilitate the second objective being to add to the discussion as to whether migration is rather an opportunity or a danger for development. Consequently, the research questions were: Which are the relevant feedback loops between migration and development in Senegal, what kind of behaviour patterns are generated by these feedback relations, and what is the net effect of changes of migration on development considering the internal feedback between migration and development. While research on this discussion can probably fill libraries, the relevance of this study is given by its focus on the reciprocal relationship since migration research has often focused on the unidirectional perspective, although it has been found that migration not only highly impacts development, but that development aspects also strongly affect migration. Hence, the variables are neither independent nor dependent variables, but endogenous variables, influencing each other and thereby producing behaviours that cannot be adequately researched with a static independent-dependent view. Consequently, the research of important, highly discussed questions such as the impact of changes in migration on development needs to consider this circular causality and its influence on the behaviour.

To investigate the mentioned research questions, first of all an adequate research methodology had to be found. Chapter 2 outlines the approach used in this study. The first subchapter concerns the choice of the method. It elaborates the requirements for the method, and reveals that the most promising method is simulation as it fulfils those requirements, most of them concerning the ability to represent complex systems. For the same reason, out of the different simulation approaches System Dynamics is identified as the most appropriate simulation technique, and as this method is not yet highly distributed in Political Science and the knowledge of its basics cannot be presumed, the main concepts, and the principal steps of the modelling process are portrayed. Finally, potentials and deficiencies of its application are presented and discussed. The second subchapter presents the case selection. Firstly, it

is justified that this study aiming at discovery instead of testing investigates only one case, but increases its validity by enlarging the number of observations to 30 years. Secondly, Senegal is selected for the single case study as it is identified as a convenient representative for the homogenous universe of cases consisting of five countries, elaborated based on four theoretical relevant characteristics. The third subchapter describes that mainly quantitative data is used, acknowledging the doubt on their reliability, and presenting how this study tries to improve it.

Having defined the methodology, the third chapter presents the model structure that has been built for this study. Aiming at representing the internal feedback relations between migration and development endogenously, the model structure of the development planning model T21-Senegal is amplified by a migration structure. To do so, the causes and consequences of migration have been elicited from literature, verified and amplified by Senegalese experts. Subsequently, a model structure has been conceptualised and translated into a simulation model, which has been integrated into the T21-Senegal. To portray the developed model, the third chapter firstly outlines some general features, such the unit of analysis, the connection to the broader development context, the time horizon, the model boundaries, and the validation of the model. The second subchapter defines and specifies the key variables migration and development. The third subchapter demonstrates the newly developed causal structure for the causes for migration. While the first section outlines the included and excluded theories, the second and the third section establish that migration is dependent on the will to migrate on the one hand, composed by six different elements, and on the other hand by the ability to migrate, integrating three components. The fourth subchapter presents the newly developed causal structure for the consequences. Again, the first section gives an overview of the main strands of literature discussing the general impact of migration on development, while the second section depicts the five direct consequences of migration that are integrated in the model.

The established model is then used for the analysis to find some answers to the research questions. The analysis is elaborated in chapter 4. The first subchapter presents in a theoretical way the relevant feedback relations of the model that emerged by integrating the different unidirectional links into the same model and closing the loops. The second subchapter portrays the simulations generated with the model and analyse the strength of the connections, the loops, and the overall generated behaviour. These scenarios do not aim at replicating reality as they are not generated by changes of comprehensive policy structures. Instead, they are rather unrealistic experiments that allow scrutinising what kind of behaviour is produced when drastic exogenous changes are introduced as this facilitates the visibility of the reaction and thereby the exploration.

## 5.2 Results and Considerations

After having outlined the objective and the structure of this study, this section aims at summarising and discussing its results, being firstly the development of the model, and secondly, the insights that could be gained by the analysis, investigating the three research questions by using the model. After having done so, one paragraph reviews the appropriateness of the application of SD for this study, as it is still an uncommon method for political sciences. Finally, an outline of the possibilities for generalisation is given.

The first outcome of this study is the development of an integrative framework representing the internal structure of development, the internal structure of migration and the interaction between the two in an endogenous way incorporating several aspects of different theories. While the structure about the development processes is the model structure of T21-Senegal, developed by MI, the structure of the migration part and its connections to the T21 structure have been elaborated for this study. An overview of the structure of the migration part of the model can be found in Appendix A, while the reasoning for this structure is described and discussed in section 3.3 and 3.4. The whole working model is included in the CD that accompanies the printed version of the thesis (see Appendix F).<sup>187</sup> Three criticisms on the model structure should be discussed. Firstly, as highlighted when describing the model structure (see chapter 3), there are several aspects that are not considered, although they are discussed in the literature, either because it has been decided that they are not relevant, due to difficulties in integrating them or because of the scope of this study. However, every theory and consequently its model, irrespective if it is expressed verbally or mathematically, is a simplification of reality excluding certain aspects. The main important step is to discuss why certain aspects have been integrated and others not and to make those excluded aspects and the assumptions explicit. This is often easier for mathematical models than for verbal. Having elaborated such an explicit model allows discussion of the structure as well as amplification of the presented structure by the aspects that are considered to be missing. This is the task of further research. Possible starting points are outlined in section 5.4. A second possible aspect for criticism is the high complexity of the model, as it integrates not only various variables, but also their interrelation, arguing that the high complexity is accompanied by the danger, that even for the modeller its behaviour becomes difficult to understand. Although this objection is legitimate, this plea can be overruled. Firstly, while finding an appropriate degree of simplification and complexity is a general problem, the present study needed to incorporate several details to reproduce the complexity of the system, as

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<sup>187</sup> For further information about T21, please refer Pedercini and Barney (2010) for an overview of the model and its possible application for analysis of interventions to achieve the millennium development goals (MDG). For the history and roots of T21, see Barney (2002) and for a detailed description of the model see MI (2007, 2011a, 2011b).

the investigation of this complexity with its feedbacks, dynamic behaviour and delays was the purpose of this study. Secondly, the difficulty of this task of investigating the feedbacks in a highly complex system should not cause one to recoil from meeting this challenge. A third aspect for which criticism can be passed on is the validation of the model. On the one hand, the validity of the model has been increased by modelling the structure of a real country instead of developing a generic model, since this allowed that firstly local experts could verify the model structure, and secondly, that the behaviour generated by the model could be compared to the real historical behaviour. Both strengthened the trust in the model structure and its behaviour. On the other hand, it could be argued that the complexity of the model (see above) hampers its validation, as there were not solely a compact number of dependent-independent connections included as is often the case in political science research. Furthermore, the unfavourable state of data, especially of variables concerning migration, raises doubt on the validation through data comparison. Although this is a potent argument, again it can be countered with the reasoning that the difficulties should not account for not asking certain research questions and the measures that were possible within the scope of this study to increase the trust in the validity of the structure have been taken. To sum it up, the first outcome is a complex and integrative framework of the interrelation between development and migration, excluding certain aspects as is done by every model, and validated to the extent that was possible within the scope of this study. Firstly, it can serve as a basis for discussion and enhancement. Secondly, especially against the background that migration is not integrated into most of development planning tools despite its relevant impact on development and the call for its mainstreaming (Melde/Ndiaye-Coïc 2009, 113ff), it can be used for development planning exercises, when it is further amplified with comprehensive policy structures. Hence, this model can be seen as a valuable outcome.

The second outcome of this study is the insights that could be gained by using the model to find answers on the three research questions. Concerning the first research question, asking for the relevant feedback loops between migration and development in Senegal, section 4.1 elaborated the existence of several contradicting feedbacks. Summing them together, five counteracting and only two reinforcing feedback relations could be identified. Accordingly, emigration influences development positively (in the sense of 'same direction'), while development feeds back in a negative way (in the sense of 'influencing in the opposite direction'). Nevertheless, the strength of the connection can vary and therewith the number does not indicate the dominance. In addition, it could be revealed that both, emigration and development exhibit strong relationships that reinforce their behaviour irrespective of the other variable, although for emigration one feedback with counteracting behaviour could be identified opposing the reinforcing trend. Altogether, 15 relevant feedback relations have been

found, although these are already those that, in the process of analysis, have been found to be the relevant ones.<sup>188</sup>

However, the gain of insight through of these results alone is limited as they do not reveal anything about the strength of the feedbacks and therefore about the resulting behaviour. That is why, several scenarios have been simulated and analysed to facilitate the reply to the second research question, asking for the behaviour patterns generated by these feedback relationships (see section 4.2). The diverse findings are summarised in section 4.2.8.<sup>189</sup> This section does not aim at iterating all these findings (for a detailed summary, see section 4.2.8) as most of them are included when presenting the findings about the net outcome of the system as only their discovery facilitated these insights. Therefore, only the results concerning the third research question, asking for the net effect of changes in migration on development, considering the internal feedback between migration and development, are presented.

It could be found that the dominant effect of migration on development is positive ('influencing in the same direction'), hence, that high migration levels are positive for development, indicated by HDI. However, focussing on the internal feedback, it has been elucidated that development feeds back to migration in a negative way ('influencing in the opposite direction'). Consequently, one of the main findings of this study is that the dominant behaviour of migration and development is a counteracting behaviour. That means that an increase of emigration leads to an improvement of development, indicated by HDI, while this on its part declines emigration, counterbalancing the initial increase. This is the case, even though the general trend is opposed by the increase of resource depletion due to higher education levels and the strong self-reinforcement of emigration due to the effects of network and means to migrate, both being raised by migration and heightening migration rates. This counteracting structure exhibits policy resistance, since policies implemented to increase migration rates or its positive aspects for development, such as remittances or brain gain, will be counteracted by the system, so that the maintenance of those policies requires huge efforts. Following the same logic, policies to decrease emigration, such as restrictions of migration, decline development levels (relatively), resulting in a further increase of emigration, if not legally, than unregistered.

A further important insight that could be gained is that this positive net effect of emigration on development varies between the different aspects of development. Looking at the net ef-

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<sup>188</sup> Some of the feedbacks that are not considered in this study, as their influence has been found to be less decisive, such as the impact of and on mortality and fertility.

<sup>189</sup> While a table containing the insights categorised by the scenarios in which they were gained can be found in Appendix A, the summary (including table) of those insights structured by area for which the behaviour patterns are relevant can be found in section 4.2.8.

fect of high migration levels on education, a worse-before-better behaviour could be identified. That means that high emigration causes a (relative) decline in education levels in the short run, while the levels increase (relatively) in the long term. This is due to the change of dominance from brain drain to brain gain and the activation of self-reinforcement of development caused by delays of the system.

Concerning the net effect on pc GDP and health (the other two aspects of HDI) a continuously increasing improvement has been found. This is due to the strength of the self-reinforcement of development due to the reinforcing loop between GDP and investment, education and health. These loops are decisive for the improvement of development and the net effect of migration on development as they amplify positive changes in development (e.g. caused by migration changes). Hence, it has been disclosed that because of this reinforcement an improvement in the development levels due to changes in migration can lead to further amelioration even after resetting these changes (due to a stop of policies or counteraction by the system, see above) as the upgraded levels of education, GDP, and health strengthen the force of their own reinforcement, heightening their levels on a larger scale.

Referring to the net effect on indicators of a broader development level, an important difference could be revealed depending on the dominant driver of the impact of emigration on development, which is on the one hand education, and on the other hand remittances and population. When the dominant drivers are mainly remittances and population, the positive impact on the overall development level indicated by HDI is accompanied by unfavourable effects for the ecological footprint, since it is mainly driven by energy consumption, which is tightly connected to capital intensity, and the dependency levels, indicated by remittances as share of GDP. Therefore, sustainability is decreased, as these two factors are important components of this concept. In addition, the improvement through increasing remittances is restricted as the money sent per emigrant cannot be raised infinitely. On the other hand, these two drivers have a higher impact on poverty reduction and the above mentioned development self-reinforcement through investment, education and health. On the contrary, when the main driver of the influence of migration on development is education through increasing brain gain or decreasing brain drain, the negative side effects on sustainability are reduced, but this strategy tends to have a lower impact on poverty, a lower activation of development loops, and exhibits limits of increase due to the achievement of maximal enrolment rates, opposing effects, such as the decline of remittances due to the decrease of education levels abroad caused by the increase of education levels in the country, and inertia of stocks of uneducated people. Especially, due to this inertia of the stock of uneducated people, it could be reasoned that the strategy of decreasing brain drain more effectively increases the education level in the country than the intensification of brain gain, as both



stocks, of educated and uneducated people, are changed instead of affecting only one stock.

While these results could be criticised due to doubts of the huge impact of remittances on development, the decisive role of the self-reinforcement of development that could be uncovered by analysing the generated behaviour of the model, or the lack of integration of certain aspects as outlined above, this behaviour is only the result of the model with its assumptions and exclusions. Moreover, the focus on the feedback perspective derived some insights that are seldom discussed in that explicit form. For example, although de Haas stated that there is a feedback, he does not address the direction of this feedback and its implications (de Haas 2008, 2010), and although a huge strand of literature assumes the positive connection between development (e.g. transition theories), especially the growing discussion about network effects gave rise to the doubt as to whether self-maintaining migration is stronger. The investigation of the strength of feedbacks which can change over time, added the dynamic perspective so that the change of feedback dominance could be disclosed. For example, concerning the impact on education, this study enriched the discussion about brain drain vs. brain gain revealing that brain drain is an important problem, but has the chance to be counteracted in the long run. Similarly, considering the delays of the system, it could be shown that the increase of brain gain is restricted as it does not change the stock of uneducated people in the country, being one factor why the change of education levels is highly inert. In conclusion, the second outcome of this study, the insights gained by replying on the research questions, contribute to the scientific and societal debate as they investigate the controversial debate about the relation between migration and development from a feedback perspective, deriving significant and partly unintuitive findings about the net impact of changes in migration on development.

Before outlining the implication of those results for policy and further research, a relevant question concerns the appropriateness of the applied method. Although the method met the requirements of this study, especially by being able to represent the dynamics of the system, time delays, feedback relations and other non-linear interacting processes in an endogenous way, it is questionable if these insights could not have been gained also by concentrated and focussed thinking applying a verbal model. On the one hand, this would have reduced the costs and efforts as the data research alone took a lot of time. On the other hand, the use of this method offered two advantages. Firstly, the development of the model forced exact concept specification, operationalisation, and a coherent definition of relations and assumptions. Of course, this is required by all models, but, especially when models become very complex, it is easy to miss out on this task. Secondly, the development of a simulation model allowed the exploration of the outcome of the established structure by carrying out unrealistic 'what if'

experiments. This facilitated the appraisal of the net effect, and the discovery of several un-intuitive behaviours, such as the worse-before-better behaviour, the limitations to growth of education, or the restricted possibility to increase remittances without raising emigration. Although it might be true that this is also possible by concentrated logical thinking, that approach holds the danger of disregarding assumptions and their consequences, while the simulation does not forget anything that has been implemented in the model. After all, it depends on the assessment of people's ability to capture the implications of highly complex systems by rigorous thinking alone and to specify their concepts and assumptions in a disciplined way, if the costs and effort that are needed to build such a model are judged to be justified by the simplification of discovery and the support of explicit model formulation. Agreeing with several scientists (see e.g. Davis/Bingham 2007, 482), this study concludes that simulation is a profitable tool for both aspects.

Finally, it should be discussed to what extent the results of this study can be generalised. The outcomes summarised above have been elaborated applying a single case study approach to allow the in-depth analysis replicating the complex interactions of the system. This decision is accompanied by the reduction of the width of the analysis to one single country, the country Senegal. Therefore, it is only possible to generalise the results to a limited extent. However, the degree of possible generalisation varies for the first and the second outcome of this study. Concerning the model structure, it is supposed that it is valid for an enlarged universe of cases since it replicates the general structure of causalities of the migration-development system. However, the presented structure is primarily appropriate for the application to least developing countries, as for the migration from industrialised countries and emerging nations, certain aspects need to be adjusted, as for example, the comparison to higher developed countries (the average of OECD countries may not be appropriate), the role played by remittances, the impact of the lack of rural resources, or the importance of labour conditions, just to name a few of them. In addition, of course, the specific intensity of the single causalities has to be adapted to the country of concern, but the general structure is assumed to be transferable to other least developing countries. Regarding the model structure of T21, it already has been applied to several different countries, increasing therefore the trust in its generalisation. For the newly developed migration structure this application to other least developing countries is a task for further research. Regarding the results of the analysis of feedbacks, behaviour patterns and net outcome, the second outcome of this study, it is assumed that they can be inferred to a certain extent to countries that share the theoretically relevant characteristics, as Senegal has been identified as a representative for this small homogenous universe of cases, namely Gambia, Mauritania, Ghana, and Comoros. Of course, this should be verified by further research.

In conclusion, this study derived two main outcomes: the development of an integrative model structure of the migration-development interaction, and the elaboration of several insights concerning the relevant feedbacks between the two variables, behaviour patterns of the system and the net effect of changes in migration on development, considering those internal feedbacks. Although these outcomes can be criticised they are found to be relevant. In addition, the application of SD could be justified despite the fact that its use was accompanied by huge efforts. Finally, it has been supposed that the model structure could be transferable to other developing countries, while the inference of the results of the analysis seems rather appropriate to the other four countries of the small homogenous universe of cases that has been elaborated.

### **5.3 Implications for General Policy Trend**

From the above summarised and discussed results several implications for the general policy direction can be derived. However, before outlining them, it is important to point out that detailed policy implications cannot be derived from the result of this study, as the study had the purpose of exploring the general feedbacks and the generated behaviour and did not model comprehensive policy structures. However, of course, the results give an indication as to which policy direction appears promising. Nevertheless, the results should not be confused with elaborated, detailed policy implications. Instead, their results can be used to review the general policy trend. Five starting points are outlined.

The first starting point is the finding that migration generates higher development levels, in the sense of HDI. It can be understood as a request to OECD countries to allow more migration, since a declared target of those countries is to engage in poverty reduction and the achievement of the Millennium Development Goals (MDG). In addition, this result increases the moral obligation of improving the status of economic refugees as they contribute to this target of the world community. Finally, acknowledging that migration is a similar adjustment mechanism as trade, only that trade is of benefit to industrial countries, while developing countries rather benefit from migration (Drinkwater et al. 2003, 14), the finding could strengthen the plea to focus on the liberalisation of migration instead of trade liberalisation.

The second starting point, the discovery that a push in development, indicated by HDI, augments development levels, even if the changes are reset due to an enduring strong self-reinforcement of development, implicates that even a temporarily restricted increase of emigration is followed by positive, self-reinforcing long term effects. Hence, on the one hand, this stresses the plea for the permission of more immigration by the potential receiving countries, as they have a relevant impact even if they are non-permanent. On the other hand, it could be argued that this insight lowers the danger of high dependency levels, as the stopping of favourable migration policies would reduce the positive effects from that moment on,

but cannot unmake the positive impacts from the time before, which already activated the self-reinforcement of development.

Thirdly, the insight that there is a dominant counteracting feedback relationship between migration and development allows two general implications. It uncovers that migration is a transitional development strategy. Accordingly, migration would facilitate the development process and it will not be a never-ending situation, as once the development situation in the sending country improves, the rush of emigrants will decrease. However, of course, this is only true for a long-term horizon. Nevertheless, the second implication of the discovery of the counteracting relationship refers to the exposure that the restriction of migration, implemented in the OECD countries, is followed by a relative increase of migration as development levels are relatively declined feeding back in a counteracting way, if not registered than unregistered. Hence, the restriction policy is not improving but worsening both problems, the poor development levels in developing countries as well as high migration levels (presuming that migration is seen as a problem).

The fourth starting point for implications is the insight that an increase in the selectivity regarding the education level of immigration policies by the potential receiving countries is two-fold harmful, as it decreases not only the stock of educated people, but also impedes the emigration of uneducated people. Hence, this implicates that the actual immigration policy of OECD countries is oppositional to the declared goals of reducing poverty. Furthermore, if this is to be changed than the immigration of uneducated people should be supported, in the best case including appropriate education programs, increasing their education levels.

The final starting point is the discovery of the limitations of education and remittances. It reveals that those initiatives in Senegal that force brain gain through the increase of exchange between the Diaspora and the home country, such as MIDA or TOKTEN (Melde/Ndiaye-Coïc 2009, 31; Zoomers/van Naerssen 2006, 29), have a positive effect, but that this strategy exhibits a lot of limitations. Similarly, it discloses that the strategy to increase remittances by decreasing transaction costs (e.g. Ghosh 2006, 39) is highly restricted, as the money that is sent cannot be increased infinitely. Instead, a strategy with a larger impact on remittances is to increase the stock of emigrants living abroad.

## **5.4 Implications for Further Research**

This study investigated the feedback relationships between development and migration, deriving some insights into the general behaviour patterns and the net effect of changes in migration on development considering those feedbacks. The following section outlines some ideas for options for further research that could be derived from this study.

The first area for further research is the increase of external validity of the presented results. As a first step, it can be proven whether the assumption of this study, that the results can be generalised to the homogenous universe of cases, holds true. This can be done by carrying out a comparison between the results of this study with those of another country out of these cases. In a second step, the results could be compared to cases with other criteria, such as medium HDI, lower emigration rates, or a non-African country, to examine the possibilities of generalisations.

A second area of further research concerns the aspects that could not be included into the model concerning migration and development, as has been mentioned before. Some of them are not incorporated at all (excluded), some are included exogenously but without comprising the detailed consequences, and some are exogenous variables already significantly influencing the system behaviour. The inclusion of some of those aspects could improve the model and allow checking as to whether the simulation results and consequently the results of analysis differ from those derived by this study. One of those aspects is the endogenous representation of income inequality and distribution. Although the Gini coefficient already highly impacts the system behaviour it is an exogenous variable. Hence, effects of emigration to its change are not included into the model so far and it would be enlightening to implement its causation into the model to improve the understanding of the effects on poverty. Similarly, brain drain (the higher education level of emigrants compared with the education level of the average population), and the different aspects of brain gain (the proportion of emigrants abroad that gain knowledge, the proportion of educated people that return, and the proportion of time that educated emigrants abroad spend to transfer their knowledge) affect the system, but are assumed exogenously. Their inclusion could further enhance the insights on these aspects. Furthermore, the emigration of men vs. women influences the model, but is exogenous. Its endogenous explanation could allow the investigation of the gender aspect of migration. Another aspect concerns the integration of the effects of dependency. While for this variable the causation is integrated, its consequences could be further investigated and incorporated into the model and its analysis to improve the understanding of the side effects of remittances. Regarding other negative effects of remittances, such as inflationary effects, possible declines of agricultural production, overvalued exchange rate, or decreasing competitiveness, which have not been integrated as the literature review revealed a controversial picture, it could be interesting to investigate the results of a model structure that incorporates these negative consequences and in which areas they differ from those generated by the presented model. An aspect that is nearly ignored in the presented model, but presumably of high relevance for the behaviour of the system, is unregistered emigration. Here, neither its causation nor its consequences are represented. Its

endogenous inclusion could derive insights into the impact of exogenous changes in migration on unregistered emigration, but also the reverse effect of changes in unregistered emigration on the whole migration-development behaviour. Finally, the impact of social change induced by emigration, concerning for example gender roles or the psychology of a nation, is excluded so far. Although it is also doubtful whether these aspects can be integrated endogenously as it is probably hard to find quantitative data that could allow some kind of quantification, the research if this is possible would already contribute to the state of knowledge. For all these variables, either causes or consequences or both need to be investigated and implemented in the model, as it has been done for migration within this study. As a result, these variables are not excluded or assumed exogenously anymore, but driven by the model structure and influencing this model structure, closing further feedback loops of the system and possibly deriving further insights into the behaviour of the system.

A third area for further research refers to the elaboration of detailed policy structures that allow a comprehensive policy analysis. While the scenarios analysed in this study generated the model behaviour for unrealistic exogenous changes to investigate the general feedbacks and the overall behaviour, policy scenarios derive the behaviour generated by realistic exogenous changes from which it is assumed that they can be produced by policies. However, a comprehensive policy structure includes possible side effects of those strategies, which possibly oppose the desired outcome, allowing the analysis of the overall behaviour. For example, it has been mentioned that the restriction of migration is often accompanied by an increase in unregistered emigration. Hence, a policy structure would include this aspect, instead of assuming that total restriction of migration is possible as has been done in one of the portrayed scenarios of this study. For such a research it would be desirable to represent unregistered emigration endogenously to be able to gain insights into the overall impact of this strategy. Other possible policy structures could be developed for the enlargement of remittances, the decrease of brain drain, or the increase of the different elements of brain gain. Doing that could, for example, shed light on the impact of different brain gain policies and disclose which one is the most productive strategy.

Generally, this study investigated only the emigration from a developing country to OECD countries, and it could be interesting to explore the feedback relations between migration and development concerning migration within African countries and migration in emerging economies or industrialised countries.

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## Appendices

### A. Case Selection Criteria and Their Fulfilment by Sub-Saharan Countries with Low HDI

	✓ or X <sup>a</sup> for all criteria	HDI group <sup>b</sup>	HDI value <sup>b</sup>	WB classifi- cation <sup>c</sup>	UN classifi- cation <sup>d</sup>	Emigration rate in % <sup>e</sup>	Remittance inflows by continent of origin in % <sup>f,1</sup>	Political Stability and absence of violence score 0 to 5, 5 being highest stability <sup>g</sup>													
						Value for 2000- 2002	Europe and Northern America														
	✓ or X <sup>a</sup>					✓ or X <sup>a</sup>	✓ or X <sup>a</sup>	2009	2008	2007	2006	2005	2004	2003	2002	2000	1998	1996			
Senegal	✓	low	0.411	LIC	LDC	✓	4.4	20.0	79.7	✓	2.35	2.39	2.30	2.23	2.32	2.48	2.21	2.20	2.00	1.54	1.89
Gambia	✓	low	0.390	LIC	LDC	✓	3.8	5.4	94.5	✓	2.76	2.54	2.49	2.48	2.76	2.78	2.88	3.18	2.96	3.11	2.81
Mauritania	✓	low	0.433	LIC	LDC	✓	4.1	37.1	62.4	✓	1.33	1.59	2.20	2.46	2.12	2.47	2.51	2.67	2.80	2.72	3.06
Comoros	✓	low	0.428	LIC	LDC	✓	7.7	10.8	89	✓	1.49	1.46	1.49	2.33	2.33	2.57	1.92	2.84	2.32	2.97	3.54
Ghana	✓	low	0.467	LIC		✓	4.5	29.7	69	✓	2.66	2.62	2.68	2.64	2.64	2.37	2.41	2.35	2.31	2.40	2.44
Togo	X	low	0.428	LIC	LDC	✓	3.7	38.1	61.8	X	2.29	2.24	2.06	1.82	0.90	2.13	2.17	2.51	2.33	1.79	1.97
Guinea-Bissau	X	low	0.289	LIC	LDC	✓	8.6	17.7	82.3	X	2.01	1.91	2.23	2.10	1.97	2.16	2.06	1.80	1.89	0.71	1.92
Angola	X	low	0.403	LMC	LDC	✓	5.5	n/a	n/a	X	2.26	2.24	1.91	1.99	1.87	1.59	1.42	1.08	0.11	0.27	0.25
Benin	X	low	0.435	LIC	LDC	✓	7.5	81.2	18.8	X	2.94	2.83	2.84	2.99	2.80	2.71	3.14	3.21	3.16	3.11	3.54
Burkina Faso	X	low	0.305	LIC	LDC	✓	9.9	91.6	8.5	✓	2.38	2.48	2.62	2.50	2.45	2.44	2.56	2.17	2.57	2.42	2.26
Mali	X	low	0.309	LIC	LDC	✓	12.5	74.1	26.8	✓	2.23	2.52	2.52	2.59	2.75	3.02	2.75	2.79	2.82	2.61	3.16
Mozambique	X	low	0.284	LIC	LDC	✓	4.2	83.7	35.8	✓	2.98	2.81	2.80	2.95	2.48	2.29	2.54	2.62	2.52	2.45	2.02
Niger	X	low	0.261	LIC	LDC	✓	4.0	82.7	17.3	✓	1.33	1.81	1.95	2.12	2.01	1.94	2.50	2.25	2.35	2.02	2.47
Guinea	X	low	0.340	LIC	LDC	✓	6.3	85.8	34	X	0.80	0.45	0.24	0.65	1.38	1.50	1.76	0.99	0.71	1.92	1.08
Burundi	X	low	0.282	LIC	LDC	✓	5.4	100.0	0	X	1.08	0.89	1.14	1.05	0.95	0.01	0.27	0.09	0.28	0.09	0.51
Zambia	X	low	0.395	LIC	LDC	X	2.2	n/a	n/a	✓	3.01	2.91	2.85	2.84	2.50	2.50	2.43	2.17	2.12	2.49	2.00
Malawi	X	low	0.385	LIC	LDC	X	1.2	28.0	69.9	✓	2.44	2.41	2.49	2.50	2.53	2.55	2.42	2.42	1.94	2.37	2.25
Sierra Leone	X	low	0.317	LIC	LDC	X	2.0	1.5	98	X	2.10	2.15	2.26	2.04	2.11	2.16	1.39	1.61	0.81	0.33	0.24
Ethiopia	X	low	0.328	LIC	LDC	X	0.4	4.7	99.7	X	0.77	0.77	0.70	0.78	0.97	1.36	1.15	1.26	1.23	1.66	1.54
Liberia	X	low	0.300	LIC	LDC	X	2.7	n/a	n/a	X	1.51	1.24	1.25	1.20	1.09	1.02	0.27	0.24	0.42	0.77	-0.10
Chad	X	low	0.295	LIC	LDC	X	3.2	n/a	n/a	X	0.75	0.42	0.57	0.65	1.20	1.06	1.10	0.90	1.23	1.13	1.81
Congo (Dem. Rep.)	X	low	0.239	LIC	LDC	X	1.5	n/a	n/a	X	0.37	0.22	0.13	0.02	0.13	0.17	0.20	0.17	-0.14	-0.56	0.83
Central African Rep.	X	low	0.315	LIC	LDC	X	2.7	n/a	n/a	X	0.47	0.70	0.68	0.65	1.12	1.16	0.99	0.73	1.18	1.36	2.30
Rwanda	X	low	0.385	LIC	LDC	X	2.7	40.8	59	X	2.17	2.29	2.21	1.88	1.84	1.33	1.34	0.71	0.89	0.35	0.61
Côte d'Ivoire	X	low	0.397	LIC		X	1.0	13.9	85.8	X	0.97	0.42	0.35	0.31	-0.03	0.21	0.61	0.71	1.70	2.29	2.49
Kenya	X	low	0.470	LIC		X	1.4	5.6	98.2	✓	1.20	1.26	1.42	1.50	1.42	1.50	1.33	1.30	1.34	1.53	1.78
Cameroon	X	low	0.460	LMC		X	1.0	30	69.9	✓	2.09	1.96	2.13	2.14	2.09	1.78	1.80	1.77	1.97	1.72	1.23
Madagascar	X	low	0.435	LIC	LDC	X	0.9	5.8	94	✓	1.83	2.07	2.49	2.58	2.46	2.64	3.02	2.23	2.64	2.53	2.58
Lesotho	X	low	0.427	LMC	LDC	X	2.6	98.3	1.6	✓	2.86	2.44	2.31	2.47	2.56	2.66	2.66	2.55	2.51	2.28	3.06
Nigeria	X	low	0.423	LIC		X	0.8	15.2	82.4	X	0.55	0.52	0.41	0.44	0.70	0.77	0.94	0.87	0.96	1.71	0.86
Uganda	X	low	0.422	LIC	LDC	X	0.7	4.3	94	X	1.44	1.51	1.44	1.26	1.22	1.17	0.95	0.86	0.86	1.27	1.29
Tanzania, United Rep.	X	low	0.498	LIC		X	0.8	11	86.6	✓	2.58	2.45	2.34	2.32	2.10	2.03	1.85	2.27	1.99	2.36	2.27
Sudan	X	low	0.379	LIC	LDC	X	1.7	16.7	25.6	X	-0.15	0.07	0.17	0.39	0.40	0.69	0.35	0.48	0.12	0.45	-0.06
Zimbabwe	X	low	0.140	LIC		X	2.5	n/a	n/a	X	1.06	1.12	1.22	1.47	0.89	0.98	1.01	0.78	1.09	1.70	1.88
Average			0.37			3.64		36.91	59.40		1.73	1.70	1.73	1.77	1.72	1.78	1.73	1.67	1.62	1.70	1.80

#### Notes

- The symbol indicates whether the theoretically relevant characteristics for this study are fulfilled or not. The first row shows which countries meet all relevant criteria, therewith forming the homogenous universe of cases.
- HDR-Report (UNDP 2010, 145f)
- The subdivision, published in WDR 2007 (World Bank 2007, 347), refers to the pc gross national income (GNI) of 2005 according to the World Bank atlas method. They divide between LIC (low income countries), LMC (lower middle income countries), UMC (upper middle income countries), and countries with high income.
- Emigration rate is defined in the HDR 2009 as "[t]he stock of emigrants from a country at a particular point in time expressed as a percentage of the sum of the resident population in the country of origin and the emigrant population" (UNDP 2009a, 209). The source of the values are the statistical tables of this HDR (UNDP 2009b, Table A). Countries with a lower emigration rate than the average of the listed countries (3.6%) do not fulfil the criteria of exhibiting a significant level of emigration and are therefore excluded from the case selection.
- Remittances are defined in the HDR 2009 as earnings and material resources transferred by international migrants or refugees to recipients in their country of origin or countries in which the migrant formerly resided (UNDP 2009a, 212). The source of the values are the statistical tables of this HDR (UNDP 2009b, Table E). Countries whose remittance inflows from Europe and Northern America are lower than 50% do not fulfil the criteria of exhibiting a considerable emigration to OECD countries and are therefore excluded from the case selection.
- Other continents listed in the original source but not adopted in this table due to their small values for African countries are Asia, Latin American and the Caribbean, and Oceania. The only exception is Ethiopia, receiving 24.1% from Asia.
- Political Stability and absence of violence captures "perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including domestic violence and terrorism" (Kaufmann et al. 2009a, 6). In the original source (World Governance Indicators (WGI) by Kaufmann et al. 2009b), this indicator ranges from -2.5 to 2.5. For this table the values are transferred to a scale ranging from 0 to 5 for reasons of clarity. 0 indicates no political stability, whereas 5 represent very high political stability. Countries that were assessed with a value below one in one of the last 15 available years, do not fulfil the criteria of exhibiting a basic level of political stability and are therefore excluded from the case selection.

## B. List of Interviewees / Expert Input

### Ndioro Ndiaye, 26.6.2010

President of the 'Alliance for Migration, Leadership and Development' (AMLD)<sup>190</sup>

Interview on June 26<sup>th</sup>, 2010 in Dakar, Senegal.

### Senegalese Expert Commission, 18.6.2010

List of Participants, see below

Group discussion on June 18<sup>th</sup>, 2010 in Dakar, Senegal.

List of Participants of the Group discussion about Migration

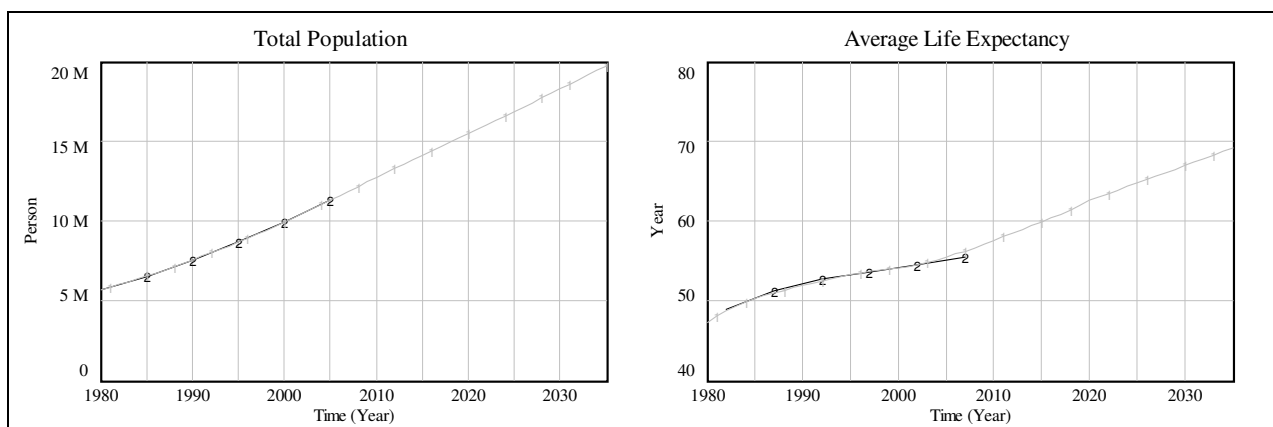
Number of persons	Structure
7	Direction des Stratégies du Développement
2	Alliance for Migration, Leadership and Development
2	Ministère de Finance
1	Budget
1	Ministère d'Éducation
1	Ministère de la Santé et de la Prévention / Le Service National de l'Information
1	Ministère d'Agriculture
1	Ministère d'Environnement
1	Banque Centrale des Etats de l'Afrique de l'Ouest
1	Agence Nationale de la Statistique et de la Démographie
1	Direction de la Population et de la Planification du Développement Humain
1	Development Grants Program
1	Direction des Parcs Nationaux
1	Centre De Recherches Océanographiques Dakar-Thiaroye
1	Télécommunication
1	Direction des Mines et de la Géologie
1	Cellule des études, de la planification et du suivi
1	Consultant
2	Millennium Institute

<sup>190</sup> Before being President of AMLD, Mrs Ndioro Ndiaye filled numerous high-level positions. Before working ten years as Deputy Director General of IOM, she was appointed to the post of Minister for Social Development, and Minister for Women's, Children's and Family Affairs of Senegal. She contributed to several high-level conferences, such as the World Summit for Children (1990), the World Summit on the Economic Advancement of Rural Women (1992), the International Conference on Population and Development (1994), the Fourth UN Conference on Women (1995), and the World Summit for Social Development in Copenhagen (1995). In addition, she is a founding member of the Scientific Commission for Women and Development. She worked at the Cheikh Anta Diop University of Dakar amongst others as Head of the Department of Odontology and Stomatology, and published numerous scientific papers and studies (UN 2004).



### C. Simulation Behaviour of 'Base Run' Compared to Data for Selected Variables

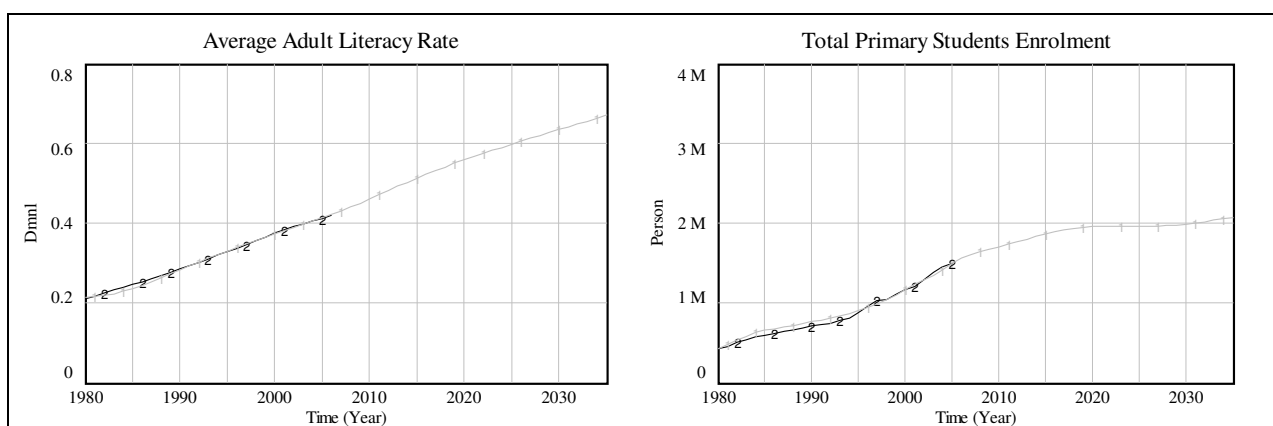
#### a Data and Base Run for 'Total Population' and 'Average Life Expectancy'



'Base run': grey line 1 / 'Data': black line 2

Data Source for 'Total Population' and 'Average Life Expectancy': UNDESA 2009

#### b Data and Base Run for 'Average Adult Literacy Rate' and 'Total Primary Students Enrolment'

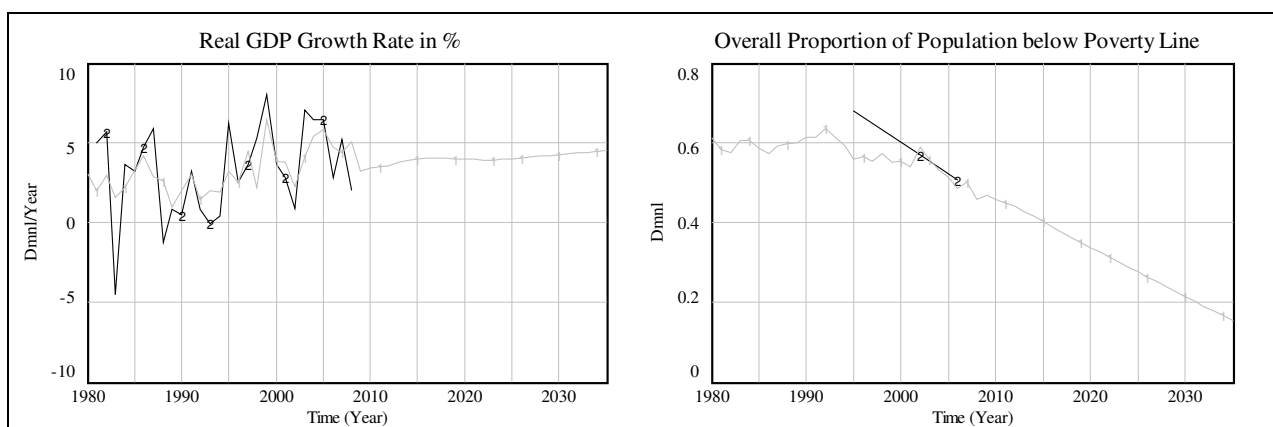


'Base run': grey line 1 / 'Data': black line 2

Data Source for 'Average Adult Literacy Rate': ANSD (2006, 174);

Data Source for 'Total primary students enrolment': ANSD (2006, 112)

#### c Data and Base Run for 'Real GDP Growth Rate in %' and 'Overall Proportion of Population below Poverty Line'

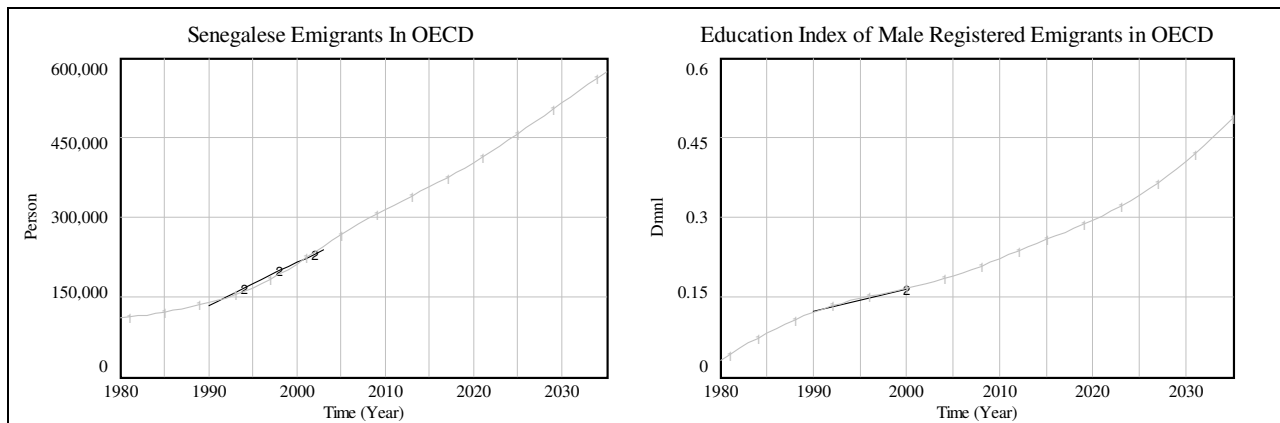


'Base run': grey line 1 / 'Data': black line 2

Data Source for 'Real GDP Growth Rate in %' for 1980-2002: ANSD (2005); for 2003-2008 (ANSD 2011).

Data Source for 'Overall Proportion of Population below Poverty Line': ANSD/Banque Mondiale (2004, 12)

d Data and Base Run for 'Senegalese Emigrants in OECD' and 'Education Index of Male Registered Emigrants in OECD'

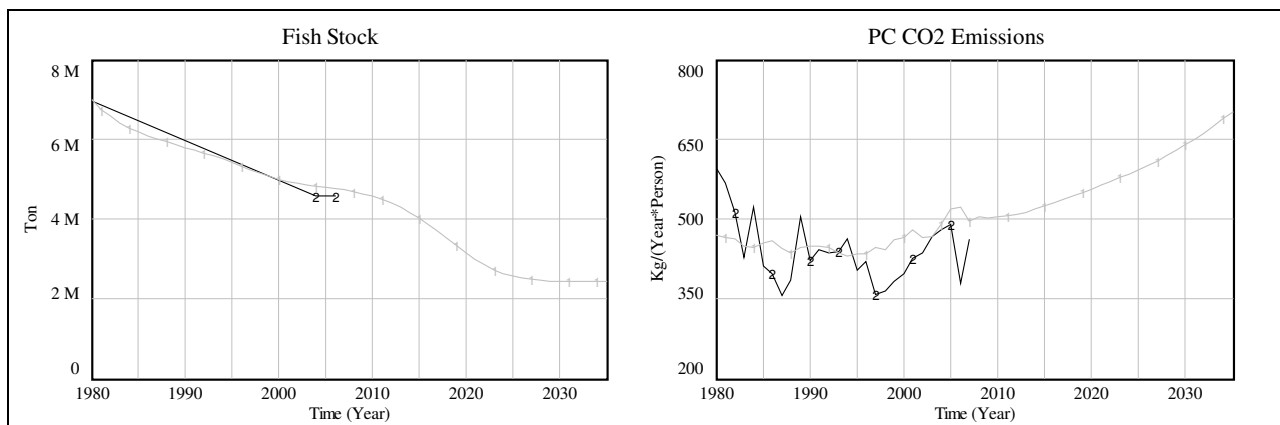


'Base run': grey line 1 / 'Data': black line 2

Data Source for 'Senegalese Emigrants in OECD': own calculation based on IOM (2009, 53) as proxy and Docquier et al. (2008) for development

Data Source for 'Education Index of Male Registered Emigrants in OECD': Docquier et al. (2008)

e Data and Base Run for 'Fish Stock' and 'Pc CO2 Emissions'

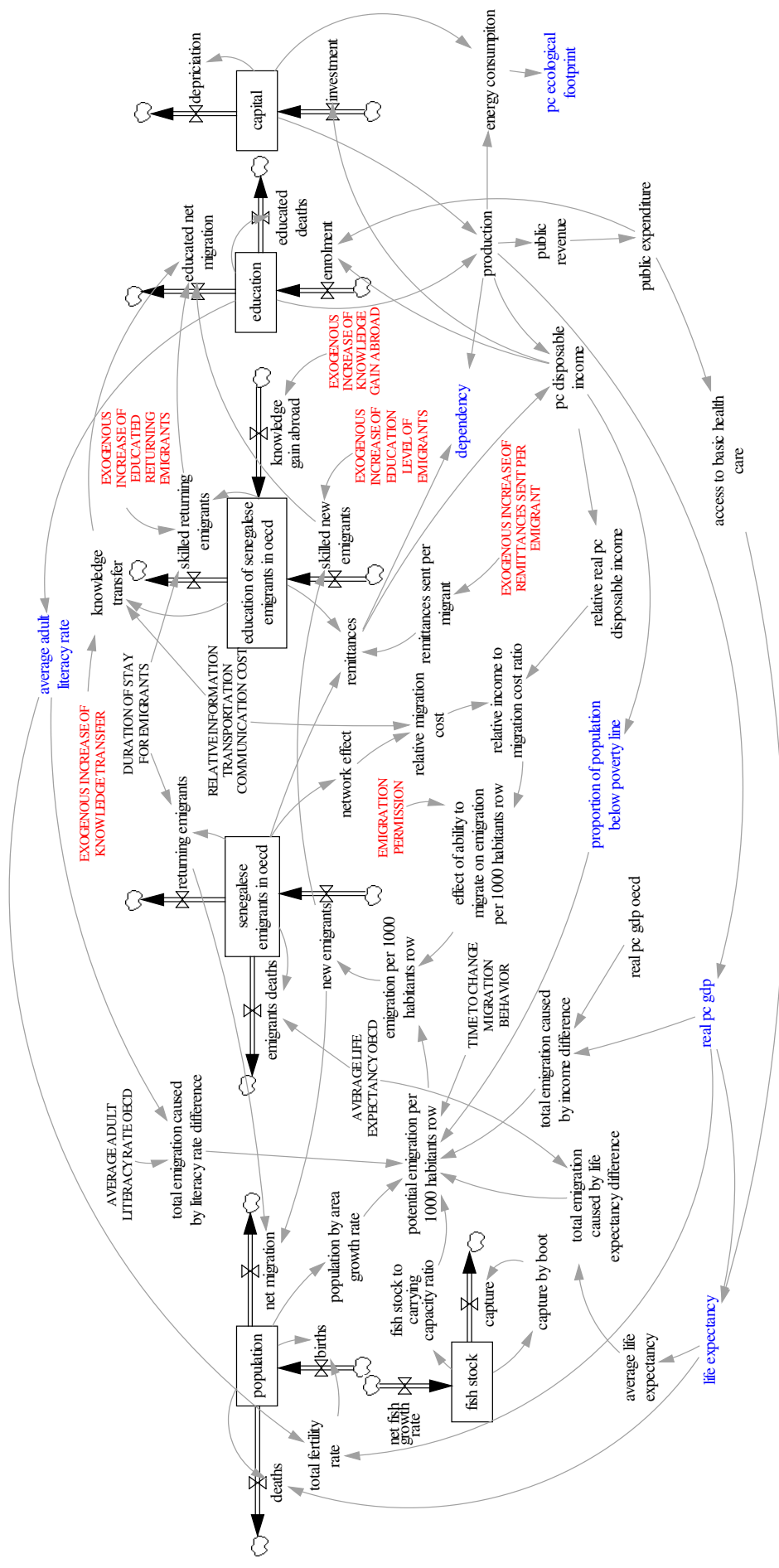


'Base run': grey line 1 / 'Data': black line 2

Data Source for 'Fish Stock': Estimation by CRODT (M. Diallo)

Data Source for 'PC CO2 Emissions': World Bank (2011)

## D. Simplified Stock and Flow Representation of the Migration-Development Structure



## E. Summary of the Gained Insights of the Simulated Scenarios

Scenarios	Gained Insights
<b>Base run</b>	<ol style="list-style-type: none"> <li>1. HDI increase due to reinforcement through development loops (R6-8) [net outcome 4]</li> <li>2. Will to emigrate declines for all variables except lack of rural resources (due to education) and pc income (because growth for OECD is higher)</li> <li>3. Non-linear reinforcement through R1-R3 (network, means for migration)</li> <li>4. Counteraction of emigration due to population growth rate (C1) diminishes over time, while reinforcement due to ability to migrate (R1-3) increases</li> </ol>
<b>Migration</b>	<ol style="list-style-type: none"> <li>1. Dominant influence of emigration on development is positive ('influencing in the same direction')</li> <li>2. Worse-before-better behaviour for education in the case of high emigration due to the change of dominance from 'R4 brain drain' to 'C5 brain gain' and 'R7 education productivity' caused by delays of the system</li> <li>3. High emigration decreases emigration will (C2-4, due to increasing development indicators) but increases the ability to migrate (R1-3, due to increasing network and means to migrate). The dominance of the two cannot be defined due to the strong exogenous influence of this scenario.</li> </ol>
<b>Brain drain</b>	<ol style="list-style-type: none"> <li>1. Strong activation of development loops (R6-8) through brain drain.</li> <li>2. Increase of HDI through no brain drain although remittances smaller.</li> <li>3. Lack of rural resources contradicts the general more development less emigration trend, but only for a certain period.</li> </ol>
<b>Brain gain</b>	<ol style="list-style-type: none"> <li>1. Impact of brain gain immediately on education (R7) and only delayed for the other development loops (R6,8) due to the opposing effect of remittances caused by counteracting effects of education levels of emigrants living abroad (C5 and C8).</li> <li>2. Activation of development reinforcement through investment (R6) by education (R7) is weaker than the activation through remittances</li> <li>3. Affirmation of lack of rural resources behaviour</li> <li>4. The impact of brain gain on tertiary education is higher than on primary and secondary education (impact visible for productivity but not that much for HDI).</li> <li>5. As brain gain is not very high up to now, there is more possibility to increase it than to decrease it.</li> </ol>
<b>Remittances</b>	<ol style="list-style-type: none"> <li>1. Improvement of HDI through the increase of proportion of remittances sent per emigrant by increasing incentives is restricted.</li> <li>2. Remittance impact on ability to migrate R3 exceeds impact by network (R1) and population (R2)</li> <li>3. Dominant influence of development on emigration is negative ('influencing in the opposite direction'), even if the ability to migrate (R3) opposes this outcome</li> <li>4. Dominant feedback relationship between migration and development is a counteracting loop exhibiting policy resistance [logical inference of migration 1 and remittances 3]</li> </ol>
<b>Dependency</b>	<ol style="list-style-type: none"> <li>1. Stop of remittances worsens development levels (immediately for GDP and health, and with a delay and not as strong for education)</li> </ol>

Scenarios	Gained Insights
	<ol style="list-style-type: none"> <li>2. C2 and C3 play an important role presuming high emigration rates (population effect can enhance pc GDP levels even if overall GDP is worse)</li> <li>3. Affirmation of the overall impact of development on emigration is negative (in the sense of opposite direction), even if opposed by the ability to migrate.</li> <li>4. A push in development (e.g. through remittances or other migration policies) activates development reinforcement (R6-8), which will further work, even when the reason for their activation (e.g. migration policy) is reset.</li> <li>5. Therefore changes in migration affect the system in the long run, even if the initial changes are counteracted by the system [logical inference of remittances 4, dependency 4]</li> </ol>
<b>Comparison</b>	<ol style="list-style-type: none"> <li>1. High positive correlation between HDI and the ecological footprint (high HDI correlated to high ecological footprint, being negative for the assessment of development level) due to capital intensity (correlation is strong when amelioration of HDI is based on remittances, not so strong when based on education)</li> <li>2. Amelioration of education is limited due to the achievement of maximal enrolment rates, hampering further development reinforcement (R6-8).</li> <li>3. Education inert due to existing stocks of educated and uneducated adults. These stocks can be changed more effectively by reducing the stock of uneducated (e.g. migration of uneducated) and increasing the stock of educated (e.g. preventing migration of educated) people (no brain drain scenario) than by more brain gain (only increasing stock of educated people).</li> <li>4. Affirmation of worse-before-better behaviour of education in the case of high emigration due to the change of loop dominance from 'R4 brain drain' to 'C5 brain gain' and 'R7 education productivity' caused by delays of the system</li> <li>5. Impact of population on pc disposable income and subsequently emigration (C2-3) is smaller than that of remittances (C4).</li> <li>6. High negative influence of remittances on poverty (high remittances cause low poverty levels, being positive for assessment of development)</li> <li>7. High positive influence of remittances on dependency (high remittances cause high dependency levels, being negative for assessment of development)</li> <li>8. High negative correlation between dependency and poverty (high dependency correlated to low poverty levels) due to impact of remittances. Correlation can be declined when HDI amelioration is mainly based on development reinforcement (R6-8) or on education (without reducing remittances).</li> <li>9. Oppositional effects of two extremes: a) High remittances, low poverty, strong R6-8 (less limits than with education) but high ecological footprint, lower dependency levels vs. b) High education increase, lower ecological footprint, lower dependency levels, but higher poverty levels and more limits and opposing effects</li> </ol>

**F. Contents of Digital Appendix (CD that accompanies the printed version of the thesis)\***

- Digital Version of the Thesis
- Simulation Model of the Thesis
  - T21-Senegal with amplified Migration Sector
  - Simulation Runs of the Thesis (base run + 10 explorative scenarios)
  - Data File for the Simulation Model
- Audio File of the Interview with Ndioro Ndiaye

\* For the reader interested in these technical details, please consult the author at: [gunda.zuellich@gmx.net](mailto:gunda.zuellich@gmx.net)