Migration, Education and Work Opportunities

PRELIMINARY AND INCOMPLETE

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May 7, 2014

Abstract

Most developing countries feature large differences between urban centers and rural regions in terms of economic opportunities, schooling facilities and infrastructure. These considerable disparities and varying local returns to education create differential incentives for education and migration decisions. This paper studies migration, education and work choices in Burkina Faso in a dynamic life cycle model. It is estimated exploiting long panel data of migrants and non-migrants combined with cross-section data on permanent emigrants. We find that the seemingly large returns to migration from rural regions to urban centers or abroad dwindle away once the risk of unemployment, risk aversion, living cost differentials and migration costs are factored in. Similarly, we can also show that returns to education are not as large as measures on wage earners would suggest. While education substantially increases the probability of finding a well-paid job in a medium-high-skilled occupation rather than in a low-skilled occupation, we also find that the risk of unemployment for labour market entrants is inverse U-shaped in education, peaking at secondary schooling. Finally, we also shed light on the self-selection pattern of migrants. Both educated and unschooled individuals migrate; educated individuals migrate to urban centers where they can reap returns to education (positive selection) while unschooled migrants choose to go to Côte d'Ivoire where they are likely to find work in a low-skilled occupation (negative selection).

JEL: J61, O15, R58

1 Introduction

Most developing countries are characterised by large economic and infrastructural disparities between rural regions and urban centers. But despite substantial locational differences, observed rural-urban migration rates are relatively low. As precise numbers for income difference and rural-urban migration for different countries are hard to come by, we provide rule-of-thumb estimates for several Sub-Saharan countries to illustrate our claim. The blue bars in Figure 1 display the ratio of average (urban) wages to the value added in agriculture per worker in year 2005 (unless otherwise noted). The orange line depicts a rule-of-thumb estimate of yearly rural-urban net migration between 2000 and 2010.[1]

[1]The figure was produced by the author. It uses data on the Labour Market Indicators by the ILO (KILM) for wages, and World Bank Development Indicators on the value added in agriculture per worker, urban population

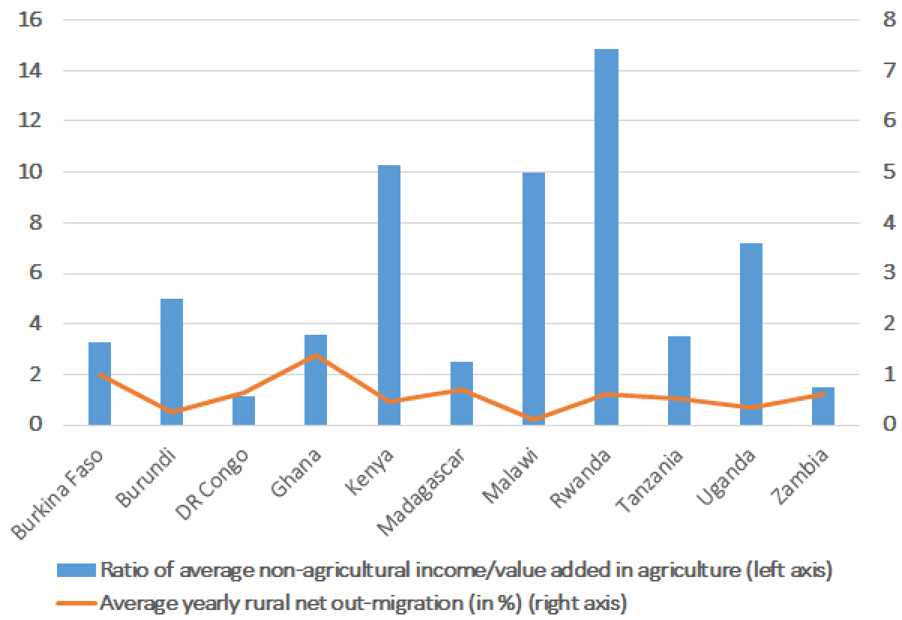

Figure 1: Income differences and estimated rural-urban migration in Sub-Saharan countries

In spite of large income differences of factor 1.5 and more, we find that estimated net rural-urban migration rates are very low and do not exceed 1.5%. The estimated net rural-urban migration rate is largest in Ghana with 1.5%, followed by Burkina Faso with 1%. All other Sub-Saharan countries have even lower rural-urban net migration rates. Why do so few individuals migrate if rural-urban migration seems to have promising returns in terms of income (not to speak of amenities and infrastructural benefits)? We shall call this finding the 'migration puzzle'. Possible explanations include substantial migration costs, a strong preference for staying with one's family or clan, rural-urban living cost differentials, income risk and risk aversion. Dissecting returns to migration into returns to income, amenity values and migration costs will shed light on the 'migration puzzle'.[2]

A similarly puzzling picture is obtained when comparing schooling attainment for the same Sub-Saharan countries and private returns to education. Figure 2 displays the adult literacy rate in year 2000 (orange line) and estimates of private annual returns to primary schooling in the 1990s or early 2000s (blue bars).[3]

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and rural population. Rural-urban net migration was calculated assuming that rural and urban population grow at the same rate. According to Potts [30] and [31], this assumption is plausible for Sub-Saharan Africa. Urban centers have lower fertility rates and lower death rates than rural areas, these cancel each other out. Thus, any 'excess' population growth in urban centers can be roughly attributed to net rural-urban migration. The income ratio for Burkina Faso is from year 2001, for Burundi and Tanzania from year 2006.

[2] Lessem [20] finds rural-urban wage differences in Malaysia between 0 and 100%, with 25% of the population (urban and rural confounded) moving within the last 10 years.

[3] The figure was produced by the author. It uses data from the World Bank Development Indicators on the adult literacy rate in 2000. The estimated private returns to primary education of men are from: Kazianga [14] for Burkina Faso in 1994/1998, Schultz [37] for Ghana in 1991 and Kenya in 1994, Nordmand and Roubaud [27] for Madagascar in 1998, Chirwa and Matita [6] for Malawi in 2004/2005, Lassibille and Tan [11] for Rwanda in 1999-2001, Colclough *et al.* [7] for Tanzania in 2001, and Appleton [2] for Uganda in 1992. The methodology and data sources of these different studies are not directly comparable but the numbers give an impression of the size of private returns to primary education in several Sub-Saharan countries.

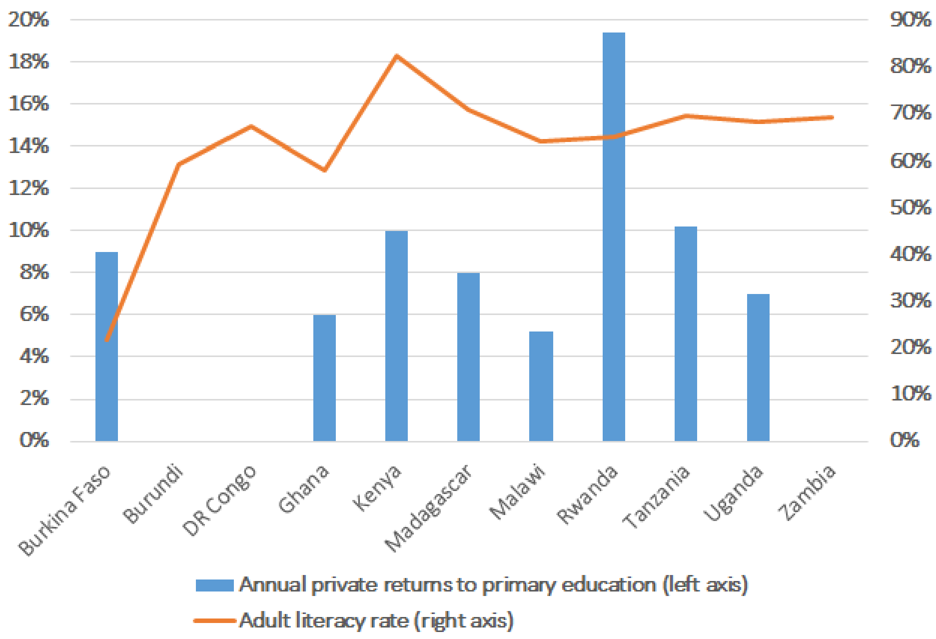

Figure 2: Adult literacy and private returns to education in Sub-Saharan countries

Figure 2 indicates that despite considerable private returns to primary education of 5% to 10% (leaving the Rwandan 19% aside), the literacy rate of the adult population in year 2000 varies between an extremely low 22% in Burkina Faso and a moderate 80% in Kenya. Rephrasing the numbers, we can pose the following question: Why have 20% to 75% of the population never gone to school when private returns to primary education of 5% and more are awaiting? We shall call this second finding the 'schooling puzzle'. The 'schooling puzzle' is especially pronounced in Burkina Faso where private returns to education are in line with other Sub-Saharan countries but the rate of illiteracy among adults is significantly larger.

Migration in developing countries has received much attention in the literature since the seminal contribution of Harris and Todaro [12] in 1970. An uncountable number of papers have studied internal and international migration in Sub-Saharan African countries. Empirical studies using individual or household data have mostly focued on explaining a static binary decision variable, such as the mover-stayer decision of rural residents. Migration in the mover-stayer framework could be defined as rural out-migration, rural-urban migration or migration abroad. A different framework based on several locations is adopted in a recent paper by Fafchamps and Shilpi [10]. Fafchamps and Shilpi study destination choices in Nepal conditional on migration. Their main result is that factors such as distance, population density and social proximity explain destination choices better than income or consumption differentials. While the first framework allows to study why someones decides to migrate (i.e. explaining the probability of migration) but not her destination, the second framework explains destination choices conditional on migration, taking the migration decision as given. None of these studies simultaneously explain both the stayer-migration decision and the destination choice. Additionally, they also fail to explain the dynamic aspect of migration decisions, such as circular and return migration which are potentially important. Net rural-urban migration rates are likely to grossly underestimate the phenomenon of internal migration.

Recent contributions by Kennan and Walker [17], Kennan [16] and Lessem [20] develop structural life-cycle models in which migration is modelled as an optimal job search problem in different locations. These models capture both the locational and the dynamic aspect of migration decisions. Kennan and Walker [17] and Lessem [20] focus on work migrants in the U.S. and Malaysia, while Kennan [16] extends the Kennan and Walker model to include a college decision. All three studies find evidence of migration decisions being mainly driven by income prospects, however, large migration costs prevent most individuals from migrating despite potential income gains. Lessem also highlights that individuals in Malaysia exhibit a strong preference for staying in their home location. They experience low wage growth over their life cycle because they refrain from migrating away from their home location. As the framework of these papers allows to dissect returns to migration in the U.S. and in Malaysia into its various components, a similar framework will be developed to study the Sub-Saharan 'migration puzzle'.

Not quite as vast as the literature on Sub-Saharan migration but still extensive is the literature on returns to education in Sub-Saharan Africa. Following a widely cited and repeatedly updated cross-sectional study by Psachoropolous on the private returns to education (see Psachoropolous [32]), many studies have since estimated private returns to education in Sub-Saharan countries using a Mincerian' framework. Recent contributions are: Schultz [37] for Burkina Faso, Côte d'Ivoire, Ghana, Kenya, Nigeria, South Africa; Kazianga [14] for Burkina Faso, Nordmand and Roubaud [27] for Madagascar, Chirwa and Matita [6] for Malawi, Oyelere [28] for Nigeria, Lassibille and Tan [11] for Rwanda, Appleton [2] for Uganda, and Kuepie *et al.* [18] for seven West African capitals. Oyelere finds low private returns to education in Nigeria of around 2 to 5% by using an IV estimation approach. However, it is impossible to conlude from her analysis whether Nigeria represents a special case of low returns to education in Sub-Saharan Africa or if discrepancies with other Sub-Saharan estimates arise from different estimation methods (usually OLS)[4]. However, Oyelere highlights the importance of low returns to education leading to lower schooling attainment or emigration of highly educated individuals. Dissecting returns to education in Sub-Saharan Africa into its various components- such as returns in terms of income (which are likely differ between rural areas and urban centers) and schooling costs- will offer valuable clues to understanding the Sub-Saharan 'schooling puzzle'.

Using a similar framework as Kennan and Walker [17], I first develop a life cycle model where individuals jointly and repeatedly choose location, education and work opportunities. The individual trades off current and future income opportunities and amenities with costs related to schooling and migration in different urban, rural and international locations. The model is especially designed to capture crucial location differences in labour markets, schooling facilities, other public facilities and infrastructure. Modelling these differences is necessary for studying the effect of location characteristics on migration and education decisions in a Sub-Saharan context. In addition, the model also recognises the importance of individual heterogeneity, both observed

[4]Schultz [37] uses the same methodology for all six countries (OLS) and finds that Nigeria has on average the lowest returns to education.

and unobserved, as well as the dynamic nature of the migration process. The heterogeneity in locations and individuals allows us to evaluate the effect of income opportunities, amenities and schooling facilities on migration behaviour in a multi-location set-up rather than just analysing rural versus urban differences. Dissecting returns to migration and returns to education will eventually shed light on the 'migration puzzle' and the 'schooling puzzle'.

A second contribution of the paper is empirical. I use detailed retrospective migration, education and employment histories of male individuals in Burkina Faso and an extensive corresponding community data set to estimate the structural model. Overall, I find that returns to migration are not as large as returns to (nominal) income would suggest. Returns to migration are smaller because individuals are moderately risk-averse and face unemployment risk in urban centers and - to a lesser extent- abroad, sizeable living cost differentials between urban centers and rural regions, and finally, large migration costs. Returns to education are small for similar reasons. The probability of unemployment of labour market entrants is inverse U-shaped in education (peaking at secondary education), thus considerably reducing returns to education for secondary and tertiary education. Attaining secondary and tertiary education is also costly because of foregone income while studying. Direct schooling cost are J-shaped, probably reflecting large fixed costs for starting primary school and high real cost for university. Individuals from rural areas have lower opportunity cost of going to school, but at the same time their direct schooling cost are larger. In order to reap the returns to education, they have to migrate to urban areas. Large migration costs and the loss of the home premium are for most individuals not compensated by risk-adjusted returns to education, thus explaining the extremely low educational attainment of rural residents.

The remaining part of this paper is structured as follows. Section 2 presents and discusses empirical evidence on the relationship between migration, education and labour market outcomes in Burkina Faso. It highlights the need for a dynamic structural model when studying migration decisions. Section 3 develops a dynamic structural model which features risk-averse and forward-looking individuals who maximise expected lifetime utility by choosing an optimal sequence of locations and activities. Section 4 discusses the estimation procedure and presents the estimation results. The following two sections use the estimated model to provide an in-depth-analysis of returns to migration and returns to education in Burkina Faso. It also discusses the interaction of migration and education decisions. The final section concludes.

2 Data and empirical evidence

Long panel data on migrants and non-migrants is, by the nature of migration itself, usually hard to come by. In order to track the complete migration path of an individual over years or decades, retrospective life history interviews provide an elaborate but rewarding strategy to collect such data. A nationally representative sample of individual life histories allows to gain insight into *internal* migration patterns. One of the main downsides of nationally representative and retrospective panel data is, however, the lack of information on permanent emigrants and thus on *international* migration patterns. If the purpose is to study both internal and international migration patterns, as is appropriate in the case of Sub-Saharan Africa where both internal and international migration are common, one needs to complement retrospective life history data by another data source on permanent emigrants.

This paper uses an exceptionally rich retrospective panel data set on never-migrants, internal migrants, and temporary international migrants in Burkina Faso and complements it with cross-sectional data on permanent emigrants. Both data sets come from the research project *'Migration Dynamics, Urban Integration and Environment Survey of Burkina Faso'* (henceforth, EMIUB[5]). The EMIUB collected nationally representative data on 3'500 households, their current 20,000 male and female members, and 1'260 male and female permanent emigrants who lived in the household prior to emigration (see Poirier *et al.* [29]). The empirical analysis in this paper is based on location, schooling, work and marriage histories since age 6 until year 2000 of approximately 3'130 Burkinabe men and cross-sectional data on 670 permanent emigrants. It also draws on a retrospective community survey which was designed as a complement to the EMIUB. The community survey collected data on 600 communities in Burkina Faso (see Schoumaker, Dabiré and Gnoumou-Thiombiano [34]) and retrospectively recorded the availability of schools and health centers, employment opportunities, agricultural characteristics, transportation, natural disasters and conflicts since 1960.

As was shown in figures 1 and 2, both the 'migration puzzle' as well as the 'schooling puzzle' hold also for Burkina Faso. While the 'migration puzzle' is less pronounced than in other Sub-Saharan countries such as Kenya, Malawi or Uganda[6], the 'schooling puzzle' is most distinct in Burkina Faso. The empirical analysis of Burkina Faso will provide very valuable insight on the Sub-Saharan 'migration puzzle' and 'schooling puzzle, even if not all detailed findings hold for any other Sub-Saharan African country.

2.1 Descriptive statistics

Table 1 presents sample statistics on migration[7], education and work situation of 3,804 men who were born between 1952 and 1985 and who lived in Burkina Faso at age 6. Of these 3,804 male individuals, 671 are permanent emigrants[8] while the rest are never-migrants, internal migrants or emigrants who have returned to Burkina Faso. This data is subsequently used for estimating the structural model.

[5]The EMIUB survey was conducted in year 2000 by the 'Institut Supérieur des Sciences de la Population' (ISSP, formerly UERD (Unité d'Enseignement et de Recherche en Démographie)) at the University of Ouagadougou, the 'Département de Démographie' of the University of Montreal and the 'Centre d'Etudes et de Recherche sur la Population pour le Développement ' (CERPOD) in Bamako. The author would like to thank the ISSP for granting access to the data and Bruno Schoumaker for providing the data.

[6]Due to the genocide in 1994, the Rwandan case is treated as a 'special' case and not mentioned when comparing other Sub-Saharan countries.

[7]A migration movement is defined as such if the individual has stayed at least 3 months and experienced a year change in the new location. For example, seasonal migration (migrating and returning within the same year) and continuous wandering about are not included in this definition.

[8]Notice that permanent emigrants are those emigrants who had not returned to Burkina Faso in year 2000 or at age 38 (the last observation considered).

[9]Migration movements for permanent emigrants are not complete as many permanent emigrants do not have full panel data but only cross-sectional data on the period before their emigration.

Table 1: Sample data

		Panel		Perm. emigrants	
	All	**Urban**	**Rural**	**Urban**	**Rural**
Summary statistics (by origin)					
Number of individuals	3,804	833	2,300	86	585
Person-years		17,231	56,579		
Mean age in 2000	28.44	25.68	29.60	27.52	27.99
Migration statistics in 2000 (by origin)					
Never-movers (in %)	37.1%	69.6%	36.1%	0%	0%
Avg. migrations/migrant		2.42	2.22		
Avg. yearly migration rate		3.84%	6.22%		
Total migrations, of which[9]		612	3,262		
- urban destination		353	1,257	2	12
- rural destination		167	1,202	6	33
- international destination		91	803	89	632
Education statistics in 2000/at emigration (by origin)					
Never-students (in %)		13.6%	66.5%	39.5%	84.6%
Avg. years of schooling/student		9.92	10.04		
Labour market statistics in 2000/at emigration (by residence)					
Students (in %)		15.5%	1.7%	24.4%	2.1%
Labour force (in %)		84.0%	96.7%	66.3%	97.6%
Nonworking (in %)		0.5%	1.6%	9.3%	0.3%
Labour force statistics in 2000/at emigration (by residence)					
Rural lf: Share of home farming			92.4%		96.1%
Rural lf: Share of salaried or non-agricultural occupation			7.6%		3.9%
Urban lf: Share of low-skilled occupation		78.5%		94.7%	
Urban lf: Share of medium-high-skilled occupation		17.8%		2.3%	
Urban lf: Share of unemployed		3.7%		3.2%	

The representative sample data presented in table 1 shows that 63% of the analysed Burkinabe population have migrated at least once (71% among those from a rural origin). Migrations towards an urban center are quantitively important (35% of all migrations have an urban destination) but so are migrations abroad (also 35%), and towards rural regions (30%)[10]. Many migrations with a rural destination are in fact return migrations (not shown in the table). These numbers point out that the rule-of-thumb estimate of rural-urban net migration of 1.5% presented in figure 1 significantly underestimates the phenomenon of migration in Burkina Faso. A meaning full analysis of migration must include not only rural-urban migration but also other forms of internal and international migration movements.

As for educational attainment, we observe that men from a rural origin are far less likely to have ever gone to school than those from an urban origin (67% versus 14%). The schooling puzzle presented in figure 2 seems to be mainly a rural concern. It is likely to be linked to the 'migration puzzle'. Interestingly, the sample data also indicates that among permanent emigrants the share of never-schoolers is about 20pp higher than in the rest of the population. Similarly, the share of men from low-skilled occupation (95%) are overrepresented among permanent emigrants as compared to the remaining population (79%). International migration from Burkina Faso seems

[10]This fact has already been pointed out by Lucas [21] in a survey on internal migration in developing countries published in 1997. Lucas also pointed out that (representative) evidence on different forms of internal and international migration in developing countries is relatively scarce.

to attract the less educated and those from lower occupations, contrary to expectations based on the classic brain drain hypothesis.

2.2 Empirical evidence on the link between migration and education

Table 2 presents migration statistics split by education level: No education (none), some primary education (P), some secondary or tertiary education (S + T). In order to reduce potential time effects on changing education and migration patterns, it focuses on men born between 1952-1971. The upper part of the table displays statistics by the *final* education level reached in year 2000[11], while the lower part shows migration statistics conditional on the *current* education level.

Table 2: Migration statistics by origin and education level

	Urban origin			**Rural origin**		
	None	P	S + T	None	P	S + T
Summary migration statistics by *final* education level						
Number of individuals	89	117	125	1,110	229	210
Never-movers (in %)	56.2%	41.9%	35.2%	26.9%	12.2%	2.9%
Avg. migrations/migrant[12]	1.82	2.01	2.72	2.04	2.14	2.91
Migration destinations by *current* education level						
First out-migration from origin ...						
to urban (in %)	9.4%	21.0%	29.0%	29.3%	62.2%	80.8%
to rural (in %)	37.5%	43.5%	31.9%	12.4%	12.2%	5.3%
to international (in %)	53.1%	35.5%	39.1%	58.2%	25.5%	13.9%
Total	100%	100%	100%	100%	100%	100%

In terms of migration patterns by education level, table 2 reveals three features for Burkina Faso. First, we observe that the probability of migrating even without any education is fairly large. It further increases with education. This holds true for both rural and urban originated men. Secondly, conditional on being a mover, individuals with secondary schooling or more migrate on average more often than their less educated peers. Last and most intriguingly, migration destinations change with education level. While the share of out-migration to rural locations remains approximately constant over different education levels, the share going to an urban (international) location increases (decreases) with the education. This pattern could indicate different returns to education, with the international location being relatively more attractive for individuals with no/low education and urban locations being relatively more attractive for highly educated individuals.

In addition to the 'migration puzzle' and the 'schooling puzzle' presented in the motivation section, these statistics give rise to further questions: Why are educated individuals migrating to urban centers rather than going abroad as suggested by the brain drain hypothesis? Why are

[11]For permanent emigrants, the final education level attained in year 2000 is in most instances not known. If this is the case, they are assigned by their education level at emigration. Most permanent emigrants have completed their education by the time they emigrate. A small fraction of individuals go abraod in order to pursue university education which was not available in Burkina Faso until the mid-1970s. Their education level changes abroad from secondary to tertiary which is summarised as S + T.

[12]These numbers underestimate the avg. number of migrations per migrant as it only considers known migration movements of permanent emigrants. For some permanent emigrants not the full location history before emigration is known.

other than rural-urban migration movements so important? Do individuals with better education migrate more because they have higher expected returns to migration? Or have those with high final schooling level (especially in rural areas) achieved their level because they have migrated to locations with better schooling opportunities? What effect has had school building in rural areas on migration patterns in Burkina Faso? What effect have expected future migration prospects on current education decisions?

As the preceding empirical evidence has illustrated, we need a model which captures both the dynamic and complex patterns of observed migration behaviour and which allows for interaction of migration, education and work decisions[13]. A structural framework is best adapted to meet these requirements. Therefore, I opt for a structural model of individual life-cycle utility maximisation which features several locations, which differ in education and work opportunities, and heterogenous individuals with observed characteristics and unobserved ability. An appropriate model is developed in the next section.

3 Structural model

In order to study the interaction of migration and education decisions and the effect of regional disparities, I develop a life-cycle model of endogenous location, education and activity choice. Two main characteristics of the model should be mentioned. First of all, the model features several urban, rural and one international location which differ greatly in terms of labour markets, schooling facilities, geographical and infrastructural indicators[14]. Given these sizeable locational differences, returns to migration are potentially large. Secondly, the locational specificities provide distinct incentives to heterogeneous individuals, leading to various self-selection patterns such as educated individuals migrating to urban certners. The unequal dispersion of schooling facilities across regions and locational differences in returns to education also create migration incentives.

At the beginning of each period, the individual maximises expected lifetime utility by trading off current and future income opportunities and amenities with costs of schooling and migration in different urban, rural and international locations. He chooses where to locate and, depending on the choices available in this location, in which activity (school, work, farm, nonwork) to engage[15].

[13]Dustman and Glitz [8] extensively discuss the interaction of migration and education choices.
[14]Recent papers developing a life-cycle model of endogenous migration with multiple locations include Kennan and Walker [17], Kennan [16] and Lessem [20].
[15]As men and women have very different roles in Burkinabe society, their (and their parents') decision regarding education, work and migration are driven by very different factors. In order to keep the structural model as tractable as possible, this paper restricts its analysis to men.

3.1 Locations and activities

The proposed model features 5 rural (Sahel, East, Center, West, South-West), 2 urban (Ouagadougou, Bobo-Dioulasso[16]) and an international (Côte d'Ivoire[17]) location[18]. Table 3 provides some statistics on how rural and urban locations in Burkina Faso differ in terms of economic, geographical and infrastructural characteristics[19]. These regional differences will be key in explaining observed migration, education and work choices.

Table 3: Geographical, economic and infrastructural indicators by location

	Ouaga	**Bobo**	**Sahel**	**East**	**Center**	**West**	**SWest**
Economic Indicators							
Employment share agriculture 2005	7.1%	8.4%	90.9%	93.0%	89.7%	90.5%	86.2%
Share of villages/towns with							
- salaried agric. employment 2000			85.5%	72.7%	67.6%	79.0%	91.9%
- salaried non-agric. employm. 2000			41.1%	25.8%	51.2%	53.9%	31.3%
Geographical Indicators							
Avg. rainfall 1960-1990 (in mm)	500-900	> 900	250-500	500-900	500-900	500-900	> 900
Population of largest town 2000	1,288t	447t	22t	38t	84t	37t	68t
Main ethnic group (> 50%)	Mossi	-	Peul	Gourm.	Mossi	-	-
Avg. distance to Ouaga (in km)	0	329	242	244	113	219	334
Avg. distance to Bobo (in km)	329	0	533	554	352	185	110
Avg. distance to CI (in km)	743	490	969	897	760	667	509
Share of villages/towns with							
- public transportation 2000			34.7%	53.1%	50.2%	62.2%	63.5%
Infrastructural Indicators							
Weighted share: villages/towns with							
- primary school 1960	100%	100%	12%	26%	37%	40%	37%
- primary school 2000	100%	100%	64%	70%	89%	80%	81%
- secondary school 1960	100%	90%	0%	0%	3%	0%	1%
- secondary school 2000	100%	100%	13%	19%	32%	25%	28%
University since	1974	1995	-	-	1996	-	-
Development indicator 1960	0.94	0.95	0.22	0.25	0.28	0.26	0.27
Development indicator 2000	0.97	0.99	0.46	0.57	0.58	0.57	0.58

We note that the two urban locations differ substantially from the five rural regions in several aspects. Ouagadougou and Bobo-Dioulasso are characterised by comparatively low employment shares of agriculture, existence of primary and secondary schooling facilities since 1960 and a high development level indicator which aggregates data on the presence of health centers, infrastructure, leisure facilities, and the absence of diseases and local conflicts.

[16] In 2000, Ouagadougou and Bobo-Dioulasso had at least 5 times more inhabitants than other large towns such as Kaya, Koudougou or Ouahigouya which have been classified as rural. From 1960 to 2000, the structure of these later towns was 'rural' in the sense that they accommodated little industry and had high employment shares of agriculture. Despite being of similar size as Koudougou and Ouahigouya, Banfora has an 'urban' economic structure. Given its geographical closeness, it was integrated into Bobo-Dioulasso. This increases the number of observations in this subsample.

[17] Approximately 80% of all international migration movements observed in the EMIUB data are destined to/originating from Côte d'Ivoire. A large part of the remainder is destined/originating from other neighbouring countries (Ghana, Mali, Niger, Togo, Benin). Only a negligeably small fraction concerns other African or non-African countries as destination or origin.

[18] For a map of Burkina Faso, its urban centers, rural regions and geographical position among neighbours, please refer to figure 3 in the appendix

[19] For definitions of the indicators and data sources, see table 21 in the appendix.

The contrast between rural regions is less stark than with urban centers but nonetheless, important differences emerge. Average rainfall increases from North (Sahel region) to South (South-West region), changing the climatic conditions for agriculture and thus shifting the relative importance from cattle to crop farming. In terms of development and schooling facilities, the rural regions have lessened the gap to urban centers between 1960 and 2000, while *grosso modo* preserving the regional ranking. Overall, the Sahel region is lagging behind the other regions in all dimensions: its development level is lower, it has fewer primary and secondary schools, it is far from the urban center and badly connected by public transportation. The Center and South-West are characterisied by their closeness to an urban center and by better schooling facilities than the other rural regions.

As opposed to Kennan [16] who models the U.S. states differing in wages, tuition cost and amenity, this model assumes that locations differ in a more profound way. Similar to Keane and Wolpin [15], individuals choose an activity from a set of discrete and exclusive activity choices. This activity set is location-specific. In urban/international locations, it includes schooling, working in the urban/international sector and nonworking, while in rural locations it includes schooling, home farming, working in the rural sector and nonworking.

Working in the urban/international sector, home farming and working in the rural sector differ in their income distribution. Choosing to work in an urban/international location can result in unemployment[20], or being offered a job in a low- or medium-high-skilled occupation. Current occupation will affect the probability of being unemployed, being hired in a low- or medium-high-skilled occupation next period. Home farming corresponds to engaging in agricultural production as a self-employed worker who faces the risk of bad weather (i.e. harvests). Rural work involves the risk of not finding paid work or finding only seasonal work.

Going to school may increase an individual's next-period schooling level. Schooling costs differ across locations. Additionally, secondary and university education are not available in every location (at any time). Nonworking comprises all individuals who neither farm, work nor go to school. Like students and unemployed, they get a minimal subsistence income.

3.2 Maximisation problem

At the beginning of every year, an individual has to decide where to locate and, depending on the local activity set, in which activity to engage.

Let l denote location in the current year (after migration) where $l \in L = [1, ..., 8]$. Locations 1 and 2 stand for urban locations, 3 to 7 for rural locations and 8 for the international location. Let y denote activity in the current period given activity set $Y(l)$ in location l. Activity sets $Y(l)$ are given by:

[20] According to ILO information, Burkina Faso does not provide unemployment insurance. (See http://www.ilo.org/dyn/ilossi/ssimain.schemes?p_lang=en&p_geoaid=854) Other forms of social security are either restricted to public employees or have only recently been planned/put into practice.

$$Y(l) = \begin{cases} \{S, W_{UI}, N\} & \text{if } l = 1, 2, 8, \\ \{S, HF, RW, N\} & \text{if } l = 3, ..., 7. \end{cases} \tag{1}$$

where S stands for schooling, W_{UI} for working in the urban/international sector, HF for home farming, RW for working in the rural sector and N for nonworking.

Let m denote each alternative which combines a location and an activity choice, i.e. $m = l \times y$. An individual older than 6 years has 29 alternatives available each period. At age 6, an individual can only choose his activity but not location. Location at age 6 is the initial location, referred to as home location.

Variable x is used to designate the current state vector and x' next period's. The state vector includes information about last location, age and other time-varying states and initial conditions (see section 3.3 for more details). The expected current utility flow of an individual who chooses alternative m is given by $u(x, m) + \zeta_m$. ζ_m is an alternative-specific preference shock. Preference shocks are a random variable which is assumed to be independently and identically distributed (i.i.d.) across alternatives and periods. Preference shocks are further assumed to be independent of the state vector x. Notice that ζ denotes the M-dimensional vector of preference shocks, i.e. $\zeta = \{\zeta_1, ..., \zeta_M\}$. The value function of the recursive decision problem $V(x, \zeta)$ can thus be written as:

$$V(x, \zeta) = \max_m \left[u(x, m) + \beta \sum_{x'} p(x'|x, m) \, \mathrm{E}_{\zeta'} \left[V(x', \zeta') \right] + \zeta_m \right] \tag{2}$$

where β is the discount rate, $p(x'|x, m)$ the transition probability from state x to state x' if alternative m is chosen and $\mathrm{E}_{\zeta'}$ the expectation over next period's preference shocks[21]. Using the independence assumption of ζ' with respect to ζ and x, we know that the expectation of the future value function $\mathrm{E}_{\zeta'} \left[V(x', \zeta') \right]$ only depends on the future state x' and can hence be written as $\bar{v}(x')$.

The sum of the current utility flow of alternative m and the discounted continuation value of alternative m excluding the idiosyncratic shock ζ_m can be referred to as the 'fundamental value' of alternative m. We denote it by $v(x, m)$ as in equation 3.

$$v(x, m) = u(x, m) + \beta \sum_{x'} p(x'|x, m) \, \bar{v}(x') \tag{3}$$

We further assume that all ζ_m are drawn from an extreme value type I distribution, with location parameter μ_G and scale parameter σ_G[22]. It can be shown that the expectation of next-

[21] Notice that the individual has to form expectations about future preference shocks. However, he has perfect foresight with respect to the evolution of geographical variables such as the development level, schools and transportation. Deriving from this assumption would further complicate an already complex model.

[22] Following McFadden [24], we know that the maximum of several iid extreme value type I variables is distributed according to a conditional logit distribution. Therefore, the derivation of the expected value of the maximum of

period's value function $\mathrm{E}_{\zeta'}\left[V(x',\zeta')\right]$ can be written as:

$$\mathrm{E}_{\zeta'}\left[V(x',\zeta')\right] = \bar{v}(x') = \mu_G + \sigma_G\,\bar{\gamma} + \sigma_G \ln\left(\sum_{m'=1}^{M'} \exp\left(\frac{v(x',m')}{\sigma_G}\right)\right) \tag{4}$$

where $\bar{\gamma}$ refers to the Euler-Mascheroni constant $\bar{\gamma} \approx 0.57722$, and e denotes Euler's number $e \approx 2.7183$. Let prob$(m|x)$ designate the probability of choosing alternative m when the state vector is x. Notice that this probability does not include the preference shock vector ζ. However, prob$(m|x)$ relies on the distributional assumptions on ζ. Performing some algebra, using equation 4 backset by one period and setting $\mu_G = -\sigma_G\bar{\gamma}$ to ensure identification, it can further be shown that prob$(m|x)$ is given by:

$$\text{prob}(m|x) = \frac{\exp\left(\frac{v(x,m)}{\sigma_G}\right)}{\sum\limits_{j=1}^{M}\exp\left(\frac{v(x,j)}{\sigma_G}\right)} = \exp\left(\frac{v(x,m)}{\sigma_G} - \frac{\bar{v}(x)}{\sigma_G}\right) \tag{5}$$

By assuming that individuals only live for a finite number of years A, it is possible to solve the individual's maximisation problem by backward induction. The value function v is computed iteratively starting from $A+1$. Given that the continuation value at age $A+1$ is 0 (the individual is assumed retired or dead), we can calculate the value function as a function of state vector x and alternative choices m at age A. Successive iterations of this procedure allow us to finally arrive at the value function of an individual who is aged 6.

3.3 State variables

In every year an individual is characterised by a set of varying and time-invariant state variables. The large set of state variables is motivated by the objective to explain different migration patterns of individuals with distinct characteristics and by a lack of wage/income data. As we do not observe income directly, we have to infer it from observed occupation data. In order to predict occupations well, it is necessary to control for several individual characteristics. The varying state variables include age a, location l, activity y, occupation o, level of schooling s. Invariant state variables (initial conditions) are unobserved ability τ, home location h_l, father's occupation o_F and birth-year cohort by.

Age goes from 6 to A, where A is determined by calibration. Location l and home location h_l can take on discrete values from 1 to 8 and activities are location-dependent (see subsection 3.1). Occupation o can take on 4 values: 1 for medium-high-skilled occupations, 2 for low-skilled occupations, 3 for unemployment and 4 otherwise. Unless an individual is working in the urban/international sector, he has $o = 4$. The level of schooling s spans no schooling, some primary, some secondary and some tertiary schooling.

several iid Gumbel variables is straightforward as it has a closed form solution. Instead of explicitly introducing shocks into the state space (which would further increase our already large state space), we can derive probabilistic policy functions with almost no additional computational burden.

Ability τ can either be high or low. Father's occupation o_F indicates if the father's coccupation is/was medium-high-skilled or not. Birth-year cohort by groups individuals according to their birth year into 5-year-cohorts. There are 7 cohorts: 1952-1957, 1958-1962, ..., and 1982-1985.

3.4 Utility flow

The state vector x includes at the beginning of a period (before location and activity choices are made) the following states: Age a, last period's location l_{-1}, last period's occupation o_{-1}, level of schooling s, ability τ, home location h_l, father's occupation o_F and birth-year cohort by.

The current utility flow of an individual characterised by state vector x and who chooses alternative m is given by:

$$\begin{aligned} u(x,m) + \zeta_m &= \left[\mathrm{E}_{\tilde{w}(x,m)}\left[\tilde{w}(x,m)^{1-\rho}\right]\right]^{\frac{1}{1-\rho}} + b(x,m) - c_{school}(x,m)\mathbf{1}(v=S) \\ &\quad - c_{mig}(x,m)\mathbf{1}(l \neq l_{-1}) + \zeta_m \end{aligned} \tag{6}$$

where $\tilde{w}(x,m)$ denotes stochastic income of alternative m, $b(x,m)$ is the amenity value associated with location l, c_{school} represents the cost of schooling if the individual decides to go to school and c_{mig} the cost of migration if the individual migrates. $\mathrm{E}_{\tilde{w}(x,m)}$ denotes the expectation operator over the distribution of $\tilde{w}(x,m)$ which is stochastic for some alternatives and deterministic for others. Because income shocks are only known after choosing an alternative m, the current utility flow is not conditioned on income shocks. The following subsections will discuss all elements of equation 6 in more detail.

As opposed to most other studies on rural-urban migration in developing countries (see for example, Todaro [40], Harris and Todaro [12], and more recently, Lessem [20]), this paper assumes that individuals are risk-averse (as argued in Stark [38], Stark and Levhari [39]). In order to capture the (potential) effect of risk on individual migration decisions, I assume that individuals have a constant relative risk aversion utility function (CRRA). The coefficient of relative risk aversion ρ is jointly estimated with all other parameters.

3.5 Income distributions

The EMIUB data set does not report wages or income but it contains detailed information on employment histories, including occupation and employment status (independent, salaried, family worker or apprentice). Combining this panel data on occupations with macroeconomic occupation-specific wage data and putting structure on the link between individual characteristics and outcomes in occupations, I can estimate occupation probabilities and hence, infer the expected income for each individual.

Let $\tilde{w}(x,m)$ denote the income distribution of alternative m. Students and nonworkers get the minimal subsistence income w_{00} (independent of location and state x). Income from working in the urban/international sector, from home farming or working in the rural sector is stochastic and described in what follows. For the calibration of these income distributions, please refer to section 4.1.

3.5.1 Home farming

Income obtained from home farming $\tilde{w}_{HF}(x,l)$ is stochastic because of unforeseen weather shocks which cause bad harvests. As shown in equation 7, home farming income is modelled as a two-state income process where either a good (GS) or a bad state (BS) occurs. Individuals below 18 receive only a fraction $0 < \psi_{child}(a) < 1$ of an adult worker's income.

$$\tilde{w}_{HF}(x,l) = \begin{cases} \psi_{child}(a) \cdot w_{HF}(GS,l) & \text{with probability } \pi(GS|l) = 1 - \pi(BS|l), \\ \psi_{child}(a) \cdot w_{HF}(BS,l) & \text{with probability } \pi(BS|l). \end{cases} \tag{7}$$

3.5.2 Working in the rural sector

The income from working in the rural sector $\tilde{w}_R(x,l)$ is stochastic because an individual might not find work, might find seasonal work (from May to September) or be employed for a full year. Let w_R denote the average income from rural salaried full-time work, $\pi(RW|l)$ the probability of finding rural work, and $\pi(NS|l)$ the probability of non-seasonal work. Individuals below 18 receive a fraction $0 < \psi_{child}(a) < 1$ of rural working income.

$$\tilde{w}_R(x,l) = \begin{cases} \psi_{child}(a) \cdot w_R & \text{with probability } \pi(RW|l) \cdot \pi(NS|l), \\ \psi_{child}(a) \cdot \frac{5}{12} w_R & \text{with probability } \pi(RW|l) \cdot (1 - \pi(NS|l)), \\ w_{00} & \text{with probability } 1 - \pi(RW|l). \end{cases} \tag{8}$$

Note that neither income from home farming nor from working in the rural sector depend on schooling, thus not allowing for returns to schooling[23]. The only incentive of rural individuals to get schooling can come from a positive probability of migrating to urban/international locations where schooling has potentially positive returns.

3.5.3 Working in the urban/international sector

Income from working in the urban/international sector $\tilde{w}_{UI}(x,l)$ is stochastic because of the risk of unemployment and the random assignment of the occupation level. An individual who has decided to work in the urban/international sector and who is not hit by unemployment will be offered either a 'low-skilled' or a 'medium-high-skilled' occupation. The urban/international work income distribution is thus given by:

[23] Schultz [36] reviews several studies which find positive albeit small returns to schooling for farming productivity in low-income countries. In absence of more detailed data, I cannot identify these returns and must assume that they are close to 0 in Burkina Faso.

$$\tilde{w}_{UI}(x,l) = \begin{cases} \psi_{child}(a) \cdot w_{mh}(s,l) & \text{with probability } (1-p(U|x,l)) \cdot p(MH|x,l), \\ \psi_{child}(a) \cdot w_{low}(l) & \text{with probability } (1-p(U|x,l)) \cdot (1-p(MH|x,l)), \\ w_{00} & \text{with probability } p(U|x,l). \end{cases} \quad (9)$$

where $w_{mh}(s,l)$ is the calibrated monthly wage of medium-high-skilled occupations in location l for schooling level s, $w_{low}(l)$ the respective wage in low-skilled occupations. $p(U|x,l)$ denotes the probability of being unemployed, $p(MH|x,l)$ the probability of getting into a medium-high-skilled occupation given individual characteristics x. Again, individuals aged below 18 receive a fraction $0 < \psi_{child}(a) < 1$ of urban/international working income.

Due to high (but imperfect) persistence in unemployment and occupation levels, it is important to distinguish labour market (re-)entrants[24], urban/international workers in a low- or medium-high-skilled occupation and those unemployed. Equations 10 to 12 describe the unemployment probability for these different groups, while equations 13 to 14 model the occupation assignment conditional on employment. The probability of unemployment and the probability of medium-high-skilled occupation assignment are modelled by two independent latent variables o^*_U and o^*_{MH}[25]

Unemployment

The unemployment probability is modelled differently for labour market (re-)entrants, urban/international workers and unemployed. For labour market (re-)entrants, the unemployment probability is modelled with a latent variable o^*_U as shown in equation 10. If $o^*_U > 0$, we observe that the individual is unemployed.

$$o^*_U = \omega_{U,l} + \omega_{U,1} SY(s) + \omega_{U,2}(SY(s))^2 + \eta_U \quad (10)$$

The unemployment probability equation of labour market (re-)entrants is parsimoniously parametrised. $\omega_{U,l}$ represents location-specific constants. They reflect local differences in average unemployment rates. $\omega_{U,1}$ and $\omega_{U,2}$ captures the quadratic effect of school years $SY(s)$ which are a function of schooling level s[26]. In fact, descritpive statistics reveal that unemployment rates of labour market entrants are first increasing in schooling years, peaking at secondary education and then decreasing. Brilleau *et al.* [5] report a similar pattern in unemployment rates for Bamako (Mali), Dakar (Senegal), Niamey (Niger) and Ouagadougou, while Cotounou and Lomé have unemployment rates which increase in schooling for all levels of education. In Abijan (Côte d'Ivoire) the unemployment rate for secondary and tertiary education is approximately on the

[24] We refer to labour market entrant if an individual enters the urban/international labour force for the first time. Re-entrants are those who did not belong to the urban/international labour force in the last period but who had done so in the past.

[25] Independence of unemployment and occupation assignment is motivated by the fact that the occupation variable does not 'behave' like an ordered variable. For example, an individual with more education is more likely to get a medium-high-skilled occupation but is not necessarily less likely to be unemployed than a less educated peer.

[26] Following Kabore *et al.* [13], $SY(s)$ denotes schooling in terms of years, where $SY(s=1)=0$ (no schooling), $SY(s=2)=3.5$ (some primary), $SY(s=3)=10$ (some secondary) and $SY(s=4)=16$ (some tertiary).

same level.

Equation 11 models the employment-unemployment (EU) transition, i.e. the probability of becoming unemployed of a worker with a low- or medium-high-skilled occupation. Latent variable o^*_{EU} is used to desribe the EU transition. If $o^*_{EU} > 0$, we observe that the previously employed individual becomes unemployed.

$$o^*_{EU} \quad = \quad \omega_{EU,l} + \eta_{EU} \tag{11}$$

Due to few observations of EU transitions, the probability of becoming unemployed after working in a low- or medium-high-skilled occupation is location-dependent but does not depend on individual characteristics.

Finally, equation 12 refers to the probability of unemployed individuals of staying in unemployment. The latent variable o^*_{UU} describes these unemployment-unemployment (UU) transitions. If $o^*_{UU} > 0$, the individual is observed to stay in unemployment.

$$o^*_{UU} \quad = \quad \omega_{UU} + \eta_{UU} \tag{12}$$

Similar to EU transitions, the number of UU transitions is very limited (especially in the international sector), so that we model the probability of staying in unemployment of an unemployed person to be independent of location and individual characteristics.

Occupation assignment

Conditional on employment, the occupation level is stochastically assigned. The probability of a medium-high-skilled occupation of a labour market entrant or a previously unemployed person is modelled as in equation 13. If the latent variable $o^*_{MH,E} > 0$, the individual is observed working in a medium-high-skilled occupation. Otherwise he is assigned a low-skilled occupation. 'E' stands for 'labour market entry'.

$$o^*_{MH,E} \quad = \quad \omega_{E,l} + \omega_{E,1}\mathbf{1}(\tau = \tau_{high}) + \omega_{E,2}SY(s) + \omega_{E,3}a + \omega_{E,4}o_F + \omega_{E,5}by + \eta_E \tag{13}$$

$\omega_{E,l}$ are location-specific constants, capturing local differences in the likelihood of being assigned a medium-high-skilled occupation. $\omega_{E,1}$ captures the effect of high ability on being offered a medium-high-skilled occupation. The probability of a medium-high-skilled occupation (supposedly) also depends on age a, the average years of schooling for schooling level s $SY(s)$ and father's occupation o_F, capturing potential network effects. Finally, $\omega_{E,5}$ is a linear trend over birth year cohorts. It can account for time trends in changing occupation requirements due to, for example, increasing average schooling and/or later entry into the labour market.

Occupation assignment of individuals who were previously employed in a low- or medium-high-skilled occupation and who continue to be employed (such employment-employment transition are abbreviated as 'EE') is described in equation 14. If the latent variable $o^*_{MH,EE} > 0$, the individual is assigned to a medium-high-skilled occupation.

$$o^*_{MH,EE} \;=\; \omega_{EE,l} + \omega_{EE,1}SY(s) + \omega_{EE,2}\mathbf{1}(o_{-1} = mh) + \omega_{EE,3}by + \eta_{EE} \tag{14}$$

Most variables of the occupation transition equation are equivalent to the ones of the labour entry equation. However, one important difference is that the transition probability depends on past occupation o_{-1}. As the EMIUB data reveals high (but imperfect) persistence in occupation levels, we expect to estimate $-\omega_{EE,2}$ close to the location-specific constants.

Assuming that η_U, η_{EU}, η_{UU}, η_E and η_{EE} are independent idiosyncratic i.i.d. standard logistic occupation shocks, we can derive closed-form probabilities of unemployment and low- and medium-high-skilled occupation assignment.

3.6 Amenity value

The amenity value represents non-pecuniary and activity-independent benefits obtained by being in location l. Kennan and Walker [17] model amenity value to include a home premium and climate, Lessem [20] accounts for in-kind-payments. The amenity value $b(x, m)$ is given in equation 15.

$$b(x, m) = \gamma_1\mathbf{1}(l = h_L) + \gamma_2 DI(x, l) \tag{15}$$

$b(x, m)$ includes a home premium and a single-valued index of development level $DI(x, l)$. The development level index is an (unweighted) average[27] of eight indicators. They include health centers/pharmacies, infrastructure (water, electricity, telephones), leisure facilities (bar, cinema), the absence of diseases and internal conflicts[28]. It ranges from 0 to 1, with 1 being the highest development level.

3.7 Schooling cost

Similar to Attanasio, Meghir and Santiago [3], schooling cost c_{school} reflects monetary and non-monetary costs of attending school for one year. c_{school} can be written as in equation 16.

[27] A principal component analysis of these eight indicators yielded results which only differ marginally from an unweighted average.

[28] The development level computed from the community survey is location- and time-dependent. As the state space of this model does not include a year variable, the year-dimension of the development index was mapped into the age and birth-cohort dimension of the state space.

$c_{school}(x,m) =$

$$\begin{cases} \delta_{0,P} + \delta_1(1 - S_P(x,l)) + \delta_2 a - \delta_3 by - \delta_4 \mathbf{1}(\tau = \tau_{high}) & \text{if } s = 1 \\ \delta_{0,S} + \delta_1(1 - S_S(x,l)) + \delta_2 a - \delta_3 by - \delta_4 \mathbf{1}(\tau = \tau_{high}) & \text{if } s = 2 \text{ and } p(s' = 3|x,l) \cdot S_S(x,l) > 0 \\ \delta_{0,T} + \delta_2 a - \delta_3 by - \delta_4 \mathbf{1}(\tau = \tau_{high}) & \text{if } s = 3 \text{ and } p(s' = 4|x,l) \cdot S_T(x,l) > 0 \\ 0 & \text{if } s = 2,3 \text{ and } p(s' = s+1|x,l) = 0 \\ \infty & \text{if } s = 2,\ p(s' = 3|x,l) > 0 \text{ and } S_S(x,l) = 0 \\ \infty & \text{if } s = 3,\ p(s' = 4|x,l) > 0 \text{ and } S_T(x,l) = 0 \\ \infty & \text{if } s = 4 \text{ and } S_T(x,l) = 0 \end{cases} \tag{16}$$

The schooling cost $c_{school}(x,l)$ is the cost of attending school in location l given individual characteristics x. It includes a fixed cost depending on the schooling level sought, and a variable component which depends on the share of schools $S_i(x,l)$ offering schooling level i[29], age, birth-year cohort and ability. Remember that s takes on values from 1 (no schooling) to 4 (some tertiary schooling) and that transition from one schooling level to the next higher schooling level is stochastic. $p(s' = i|x,l)$ designates the probability of achieving schooling level i in location l given individual characteristics x. Schooling transition rates are calibrated from the EMIUB data (see subsection 4.1.2).

Individuals who attend school in a location offering schooling level i and who have a positive probability of attaining level i at the end of the period pay schooling cost as given in lines 1 to 3 of equation 16. This schooling cost is composed of a fixed cost by schooling level (e.g. tuition) $\delta_{0,i}$ and a variable cost δ_1 which is a function of the share of schools of type i in location l at a specific time. The intuition is that the fewer schools of level i are found in location l, i.e. the lower $S_i(x,l)$, the higher are the indirect costs of attending school such as transportation, social or psychological costs (see, for example, Lalive and Cattaneo [19]). Schooling cost (potentially) also depends on age, the birth year cohort (capturing a linear time trend) and ability.

Line 4 of equation 16 states that individuals who have a zero probability of achieving the next-higher schooling level do no pay any schooling cost. For example, an individual who has reached primary school but is too old to be promoted to secondary school can continue to attend primary school for free. Finally, the last three lines ensure that individuals do not choose to go to school if there is no school in location l offering their appropriate schooling level.

3.8 Migration cost

The migration cost c_{mig} accrues whenever an individual changes his location. It reflects monetary and non-monetary costs of migrating. The cost of migrating from the beginning-of-period location

[29] As for the development level index, the availability of schools is location- and time-dependent. Hence, the year-dimension of the original series has been mapped into the age and birth-cohort dimension of the state space.

l_{-1} to a new location j is given by equation 17. The structure builds on Kennan and Walker [17] and Schultz [35][30].

$$c_{mig}(x,m) = \left[\phi_0 + \phi_1 D(l_{-1}, j) - \phi_2 T(x) - \phi_3 a + \phi_4 a^2\right] \tag{17}$$

The cost of moving from location l_{-1} to j includes a fixed moving cost and a variable cost which depends on distance, public transportation in l_{-1} and age. Due to the inclusion of public transportation $T(x)$, migration cost c_{mig} is not symmetric between locations.

Distance $D(l_{-1}, j)$ is measured as the average great circle distance between all department capitals in location l_{-1} and all department capitals in location j. Public transportation $T(x)$ in location l_{-1} captures the effect of remoteness on out-migration cost.

Further, I allow migration cost to depend on age a. The age terms reflect non-monetary costs of migration, such as psychological or family-related costs, which are not explicitly modelled. These costs might decrease for a certain ages but increase for others, consequently a quadratic term for age. However, we expect the estimated coefficients ϕ_3 and ϕ_4 to be close to 0 if equation 17 is fully specified and returns to migration are well captured in the life cycle framework.

3.9 Transition probabilities

For an individual who has chosen location j and decided to engage in home farming, rural work or nonworking, transition from x to x' is trivial as it is deterministic. Age increases by one year, his location is updated to j, he gets no occupation and keeps his previous schooling level. His invariant characteristics obviously also remain the same.

Students face a stochastic assignment of their schooling level, as their schooling level might increase by one level or remain the same. Equation 18 gives the transition probabilities of an individual going to school in location j.

$$p(x'|x,m) = \begin{cases} p(s+1|x,j) & \text{if } a' = a+1, l = j, o = 4, s' = s+1 \\ p(s|x,j) & \text{if } a' = a+1, l = j, o = 4, s' = s \\ 0 & \text{otherwise} \end{cases} \tag{18}$$

A student's schooling level may or may not increase at the end of a period. $p(s+1|x,j)$ denotes the probability of passing from schooling level s to $s+1$ in location j given individual characteristics x. In contrast, $p(s|x,j)$ denotes the probability of keeping the same schooling level s. His age increases by one year, his location is updated to j and his occupation is set to 'none'.

Finally, workers of the urban/international sector face stochastic assignment of their occupation level. Their transition probabilities are given in equation 19.

[30] In the literature, distance between two locations is often used as a proxy for migration cost (see, for example, Beauchemin and Schoumaker [4]). I assume that migration cost does not only comprise transportation cost from location l_{-1} to location j but it includes any cost which accrues when relocating, namely expenses incurred to find a place to live, opportunity costs (time/money) of finding a job, psychic/social costs of relocating.

$$p(x'|x,m) = \begin{cases} p(o=1|x,j) & \text{if } \; a'=a+1, l=j, o=mh, s'=s \\ p(o=2|x,j) & \text{if } \; a'=a+1, l=j, o=low, s'=s \\ p(o=3|x,j) & \text{if } \; a'=a+1, l=j, o=unemployed, s'=s \\ 0 & \text{otherwise} \end{cases} \tag{19}$$

With probability $p(o|x,l)$ the individual will get occupation level o which can be unemployment, low- or medium-high-skilled occupation. The probabilities of unemployment and occupation levels can be derived from euqations 10 to 12. Other from the updating of this occupation level, the individual's age will increase by one year, his location is set to j and his schooling level remains the same.

4 Calibration and Estimation

Given the combined use of panel data on local migrants and non-migrants, and cross-sectional data on permanent emigrants, I estimate the proposed life-cycle model by Simulated Method of Moments[31].

Several preparatory steps are required before proceeding with estimation. These steps are presented in the first part of this section. Namely, I discuss the calibration of the income distributions and schooling transition rates, followed by explaining which parameters were exogenously set to achieve identification[32]. In the second part, the identification scheme used for the estimation of the structural parameters is outlined. The last part describes the numerical implementation and estimation.

4.1 Calibration

4.1.1 Income distributions

Due to the lack of income and wage data in the EMIUB data set, I calibrate the various income distributions from macroeconomic data. Table 4 summarises urban and international work income by occupation level, the home farming income distribution, the rural work income distribution and the subsistence income w_{00}. The appendix gives more detail about the calibration of these distributions.

Overall, we find that home farming and rural work income are substantially lower than urban and international income of employed workers. For example, a home farmer in the Center earns on average between 3'300 to 4'700 CFA per month, while a worker in Ouagadougou in a low-skilled occupation would earn 32'000 CFA. If an individual finds employment in a medium-high-skilled occupation, his income will lay between the lower and upper bound of medium-high-skilled income (53'000 CFA, 79'000 CFA). Students, nonworking or unemployed individuals have a minimal

[31] If it was not for the use of cross-sectional data on permanent emigrants, the model could also be estimated by maximum likelihood.

[32] See Magnac and Thesmar [22] for a discussion of identification in discrete choice models.

Table 4: Calibrated income distributions (1'000 CFA/month)

	Ouaga	**Bobo**	**Sahel**	**East**	**Center**	**West**	**South-West**	**Côte d'Ivoire**
Urban/international work income								
$w_{low}(l)$	31.0	29.9						36.1
$\min(w_{mh}(l))$	52.6	52.6						72.2
$\max(w_{mh}(l))$	79.2	79.2						110.0
Home farming income								
$w_{HF}(GS, l)$			5.33	5.71	4.69	6.54	5.84	
$w_{HF}(BS, l)$			4.09	4.16	3.31	4.53	4.00	
$\pi(BS\|l)$			10.81%	8.08%	6.86%	6.88%	3.77%	
Rural work income								
w_R			14.49	14.49	14.49	14.49	14.49	
$\pi(RW\|l)$			84.02%	30.88%	61.73%	77.10%	82.63%	
$\pi(NS\|l)$			5.26%	48.66%	56.00%	7.85%	15.27%	
Income of students, nonworking and unemployed								
w_{00}	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40

subsistence income of 400 CFA per month. Côte d'Ivoire's income level is between 15% and 40% higher than the one in Ouagadougou and Bobo-Dioulasso. In the light of these large rural-urban and urban-international income differentials, observed migration rates are moderate. This might be due to high migration costs, a large home premium, considerable living cost differentials or a high degree of risk-aversion.

4.1.2 Schooling transition rate

Schooling level is modelled as a categorical variable which can take on four values: No schooling, primary, secondary, tertiary. Transition from one level to the next higher schooling level is stochastic. The calibrated transition rates are displayed in table 5. Note that they are independent of unobserved ability τ (by assumption).

Table 5: Calibrated transition probabilities of students

	Future schooling level			
Current schooling	$s' = 1$	$s' = 2$	$s' = 3$	$s' = 4$
No schooling: $s = 1$	0.70	0.30	0	0
Some primary: $s = 2$	0	0.86	0.14	0
Some secondary: $s = 3$	0	0	0.835	0.165
Some tertiary: $s = 4$	0	0	0	1

Getting primary education requires on average 3.33 years. Attaining secondary education takes on average another 7.14 years, and tertiary education another 6.10 years. These numbers match the education system in Burkina Faso: Primary education is from grade 1 to 6, secondary from grade 7 to 13, followed by another 4-6 years of tertiary education (see Kabore *et al.* [13]).

If no school offers the next-higher schooling level in a certain location, then the probability of keeping schooling level s is equal to 1. There is also an upper age limit of moving from primary to secondary (17 years) and from secondary to tertiary (25 years). Beyond these age limits, individuals keep their current education level.

4.1.3 Distribution of ability τ

Ability τ is known by the individual and the (potential) employer but it is not reported in the data. To solve the proposed model, it is necessary to make assumptions about the ability distribution. For reasons of parsimonity, ability is modelled as an independent and identically distributed random variable with a Bernoulli distribution. Most importantly, it is assumed to be independent of other initial conditions such as home location. The probability of being of high ability $\pi(\tau = \tau_{high})$ is estimated as a structural parameter. Identification of π is discussed in subsection 4.2.

4.1.4 Final age, discount factor and scale parameter

Final age A is calibrated using remaining life expectancy at age 5 (conditional on reaching this age)[33]. It is set to 55 which corresponds to 50 years of active work life, with active work life starting at age 6. Final age is assumed to be constant over time.[34]

The estimation of the discount factor β poses a challenge. According to Attanasio, Meghir and Santiago [3], in a model without borrowing and saving β does not only capture how much individuals disregard the future but it may also reflect liquidity constraints which are potentially important in a developing country. Magnac and Thesmar [22] point out that in dynamic discrete models, structural parameters are often not identified unless the discount factor is set[35]. Like Kennan and Walker [17], Kennan [16] and Lessem [20], I fix the discount factor at 0.95.[36]

The scale parameter σ_G of the extreme value type I distribution is fixed at $\sigma_{G,rural} = 0.17$ for individuals with a rural home location and at $\sigma_{G,urban} = 0.22$ for individuals with an urban home location. $\sigma_{G,rural}$ is derived using the fact that home farming, rural work and nonwork alternatives in rural locations differ in their income riskiness but are the same in terms of amenity value and continuation value. Thus, the shares of these work alternatives pin down the scale parameter and the relative risk aversion coefficient (For a rigorous derivation of this identification scheme, see subsection 9.2 in the appendix). Using different values between 1.5 and 5 for the relative risk aversion coefficient, we find that a scale parameter of 0.17 reasonably explains the observed shares of home farming, rural work and nonworking. The scale parameter for urban individuals

[33] This indicator was calculated using the Work Development Indicator data base of the World bank on life expectancy at birth, infant and child mortality (before age 5). While life expectancy at birth has increased by almost 25% between 1960 and 1985, remaining life expectancy at age 5 conditional on reaching age 5 has only increased by approximately 6.5% during the same period. The substantial increase in life expectancy at birth can be almost uniquely attributed to lower infant and child mortality rates.

[34] This assumption slightly overestimates expected work life for the few individuals born before 1960 and underestimates it for individuals born after 1960.

[35] An exception present Attanasio, Meghir and Santiago who manage to estimate the discount factor by grid search. They find a discount factor of 0.89 for Mexico.

[36] In development and environmental economics, many studies (see Markandya and Pearce [23], and Mosley [26]) use a 'social' discount rate of 10% which results in a discount factor of $\beta = 0.91$. Earlier versions estimated the model using $\beta = 0.91$. Due to the high discount factor, the estimated model failed in explaining the observed education choices.

was set at 0.22 because their basic life-cycle value is slightly higher and thus larger shocks are needed to explain their migration, education and work patterns.

4.2 Identification

In what follows, I present the identification scheme of the 34 structural parameters. The proposed moment conditions are in general conditional means or ratios of means on migration behaviour, educational attainment and labour market performance. All moments relying on migration behaviour use both the panel data of the EMIUB data set (abbreviated as 'PS') and the cross-section data on permanent emigrants (abbreviated as 'CS'), while moments related to education attainment and labour market performance use solely the panel data set. Due to the low number of observations of older individuals, the moments consider only men aged 6 to 38. After age 38, migration is relatively low (below 2%), no one goes to school and the work situation remains stable (no new labour market entries)[37].

Table 6 and table 7 summarise the identification scheme applied. Each parameter to be estimated (column 1) is identified by one or several corresponding moments given in column 2. The number of moments used is given in parenthesis. The last column states which data sets were used to compute the moments.

To identify the amenity, schooling and migration cost parameters, we compute means, conditional means and ratios of means of migration and education outcomes, respectively. Migration moments include the proportion of returned migrants, net migration shares, the proportion of never-migrants and out-migration rates by age. Education moments include the proportion of never-schoolers, different measures of educational attainment and the proportion of students by age.

As ability is unobserved, identification of ability-related parameters relies on self-selection patterns by ability: Individuals with low ability tend to select into the international labour market while highly able individuals tend to select into the urban labour market (Ouagadougou, mostly). The reason for this self-selection is that the probability of finding work in medium-high-skilled occupations is significantly lower in Côte d'Ivoire than in Burkina Faso[38]. Thus, to reap the benefits of higher ability or higher education, individuals can only do so in urban labour markets and hence, positively self-select into the Burkinabe labour market.

For example, to identify the effect of ability on schooling cost I propose the ratio of educational attainment of individuals migrating to urban centers to the one of emigrants. While a general decrease in schooling cost affects education decisions of all individuals, a decrease of schooling costs for high ability individuals only translates into changed education behaviour of individuals migrating to urban centers.

[37]We solve a simplified model for age 39 to 55 and compute recursively the continuation value for age 38. This continuation value is then inserted into the full problem of men aged 6 to 38 as presented in section 3.)

[38]Results from a reduced form regression, using as instrumental variables the interaction of migrant-status and origin (rural/urban) for ability, suggest that the probability of obtaining a medium-high-skilled occupation in Côte d'Ivoire is significantly lower than in Ouagadougou and Bobo-Dioulasso/Banfora.

Table 6: Moments identifying amenity, schooling cost, migration cost, high ability parameters

Parameter	**Moment**	**Data set**
Amenity value		
Home premium: γ_1	Proportion returned migrants in 2000 by home location (7)	PS + CS
Development level: γ_2	Share of net migration in 70s, 80s, 90s by location (21)	PS + CS
Schooling cost parameters		
Primary: δ_P	Proportion never-schoolers in 2000 by home location (7)	PS
Secondary: δ_S	Proportion secondary conditional on primary in 2000 by home location (7)	PS
Tertiary: δ_T	Proportion tertiary conditional on secondary in 2000 by home location (7)	PS
Schools: δ_1	Proportion primary + at age 10 in 60s by home location (7)	PS
	Proportion primary + at age 10 in 70s, 80s, 90s in rural (3)	PS
Age: δ_2	Proportion students at age 7, 12, ..., 27 in urban, rural (10)	PS
Birth year: δ_3	Proportion primary + at age 10 in 70s, 80s, 90s in urban (3)	PS
Ability: δ_4	Ratio of avg school years of emigrants, urban migrants to avg school years of locals by home location, cohort group (10)	PS
	Avg school years of locals by home location, cohort group (4)	PS
Migration cost parameters		
Fixed cost: ϕ_0	Proportion never-migrants in 2000 by home location (7)	PS + CS
Distance: ϕ_1	Ratio of migrations to closest to farthest destination by location (7)	PS + CS
Transportation: ϕ_2	Out-migration rates (aged 17 to 26) in 70s, 80s, 90s by rural location (15)	PS + CS
Age, age^2: ϕ_3, ϕ_4	Migration rates at age 7, 12, ..., 37 in urban, rural (14)	PS + CS
Probability of high ability		
Probability: π	Ratio urban migrants to emigrants in 2000 by home location (7)	PS + CS

To identify the labour market parameters related to unemployment and occupation assignment as well as the relative risk aversion coefficient and living cost differentials, we use conditional means, ratios of means and transition rates of labour market choices, unemployment and occupation outcomes. As entry into employment/unemployment is assumed to be orthogonal to unobserved ability, the parameters of the unemployment equation and the transition equation can be identified without bias by using conditional means and transition rates of those unemployed or employed.

Due to the relatively low number of unemployment-unemployment and employment-unemployment transitions (especially in Côte d'Ivoire), the parameters are not estimated along with the other structural parameters but calibrated ex-ante to match the observed transition rates.

As for occupation assignment of labour market entrants, we follow the same line of argument of self-selection as for the ability parameter in schooling cost. Positive self-selection in urban labour markets allows us to determine the ability parameter in occupation assignment upon labour market entrance by comparing occupation assignment of locals and with occupation assignment of migrants from a rural home location.

Table 7: Moments identifying labour market, risk aversion, living cost parameters

Parameter	Moment	Data set
Unemployment upon labour market entry		
BF: $\omega_{U,l12}$	Proportion unemployed in BF by education level (4)	PS
CI: $\omega_{U,l8}$	Proportion unemployed in CI by education level (2)	PS
Schooling: $\omega_{U,1}$	Same as above	
Schooling^2: $\omega_{U,2}$	Same as above	
Occupation assignment upon labour market entry (conditional on employment)		
Ouaga: $\omega_{E,l1}$	Proportion MH among local entrants in Ouaga by education (3)	PS
	Same moments for rural migrants (3)	PS
Bobo: $\omega_{E,l2}$	Proportion MH among local entrants in Bobo by education (2)	PS
	Same moments for rural migrants (3)	PS
CI: $\omega_{E,l8}$	Proportion MH among rural migrants without schooling in CI (1)	PS
Ability: $\omega_{E,1}$	Same as above	
Schooling: $\omega_{E,2}$	Same as above	
Age: $\omega_{E,3}$	Proportion MH among local entrants of older cohorts with secondary education in BF by age group (3)	PS
Father's occ.: $\omega_{E,4}$	Proportion MH among 17-26 aged local entrants with secondary education by cohort group, father's occupation (4)	PS
Birth year: $\omega_{E,5}$	Same as above	
Occupation assignment upon transition (conditional on employment)		
BF: $\omega_{T,l12}$	Low-MH transition rate in BF by education (3)	PS
CI: $\omega_{T,l8}$	Low-MH transition rate in CI by education (2)	PS
Schooling: $\omega_{T,1}$	Same as above	
Occupation: $\omega_{T,2}$	MH-MH transition rate in BF if secondary education (1)	PS
Birth year: $\omega_{T,3}$	Low-MH transition rate in BF with secondary education by cohort group (3)	PS
Employment-unemployment transition (calibrated)		
BF/CI: ω_{EU}	Employment-unemployment transition rate = 0.00506	PS
Unemployment-unemployment transition (calibrated)		
BF/CI: ω_{UU}	Unemployment-unemployment transition rate = 0.732	PS
Relative risk aversion coefficient		
Risk aversion: ρ	Ratio of log shares of home farming to rural work by rural location (5)	PS
Living cost differentials		
Living cost: λ	Same moments as above: Rural-urban differences in migration, education	

4.3 Numerical implementation and estimation

The proposed model features a large but manageable state space. At each age, the time-variant characteristics of an individual are given by 68 variant states: 17 past location-occupation alternatives lo_{-1} $\times$ 4 schooling levels s = 68 variant states. Apart from time-varying states, an individual is also characterised by a set of initial conditions, namely, unobserved ability, home location, father's occupation and birth-year cohort: 2 ability levels τ $\times$ 7 home locations h_l $\times$ 2 levels of father's occupation o_F $\times$ 7 birth-year cohorts by = 196 types.

In total, for every age the value function is of size: 68 $\times$ 196 = 13,328 states.

The fully specified structure of the model (described in equations 6 to 17) and the distributional assumptions made about the idiosyncratic preference shocks ζ, labour market shocks η and ability τ allow estimation by Simulated Method of Moments (SMM). This approach is composed of several steps.

First, given the finite horizon of individuals, the model can be solved by backward induction starting from the last period moving forward to age 6. To numerically solve the model (i.e. obtain the value function and decision rules), we need to make an initial guess of all structural parameters. Second, based on the value function and decision rules obtained under step 1, we can simulate the model to produce the simulated data set. In a third step, we use this simulated data set to construct the moment conditions outlined previously and compare them to the same moment conditions from the observed data set to calculate the value of the loss function.

Using the Nelder-Mead algorithm, we repeat steps 1 to 3 with new parameter sets until the loss function meets the convergence criteria. The optimal parameter estimates $\hat{\theta}_{SMM}$ solves:

$$\hat{\theta}_{SMM} = \arg\min \left(\hat{\mu}(\theta) - \hat{m}\right)' W \left(\hat{\mu}(\theta) - \hat{m}\right) \tag{20}$$

where $\hat{m}$ is the vector of empirical moments (i.e. the sample estimate of the unknown population moments), $\hat{\mu}(\theta)$ are the simulated moments which are an estimate of the model's true unconditional moments $\mu(\theta)$, and W is the weighting matrix. In our case, we employ a diagonal weighting matrix where the inverse elements are the estimated variance of the empirical moments.

5 Estimation results

5.1 Amenities, schooling and migration cost estimates

Table 8 and table 9 display the parameter estimates (column 2) and the corresponding asymptotic standard errors (column 3). Table 8 presents estimation results for amenities, schooling cost and migration cost, as well as the probability of high ability. The estimated parameters (except for the high-ability probability) are given in 10'000 CFA per month and can be directly compared to the income data shown in table 4. For instance, the home premium is estimated at 5'200 CFA per month, being approximately equivalent to 90% of home farming income in rural locations.

All estimated parameters have the expected sign and are significant at the 95% confidence level. Amenities are much valued, especially staying with one's family. Staying in one's home location is worth an additional (risk-free) 5'200 CFA income, while a high development level of 1 (like in urban locations in 2000) is evaluated only at 480 CFA extra income. Fixed schooling cost are J-shaped in schooling level: Primary costs are around 3'100 CFA, secondary around 400 CFA and those of tertiary education are 15'400 CFA. However, once the variable schooling cost and the negative effect of birth year cohort and, potentially, ability are taken into account, primary

Table 8: Parameter estimates 1: Amenities, schooling and migration cost (1'000 CFA per month)

	$\hat{\theta}$	$\hat{\sigma}_\theta$
Home premium: γ_1	5.225	1.53E-06
Development level: γ_2	0.484	3.37E-06
Primary: δ_P	3.107	2.30E-07
Secondary: δ_S	0.404	2.74E-07
Tertiary: δ_T	15.406	1.60E-07
Schools: δ_1	5.567	2.60E-07
Age: δ_2	0.010	1.63E-05
Birth year: δ_3	-0.774	2.56E-06
Ability: δ_4	-2.872	3.46E-08
Fixed cost: ϕ_0	15.115	4.23E-07
Distance: $\phi_1/100$	0.575	4.78E-06
Transportation: ϕ_2	-4.900	6.90E-07
Age: ϕ_3	-0.907	1.74E-05
Age^2: $\phi_4/1000$	1.826	2.32E-07
Probability: π	0.200	1.05E-08

schooling costs for a 10-year old amount to approximately 2'050 CFA in urban centers and 4'340 in rural locations in 1965, and -2'200 CFA in urban centers and -670 CFA in rural locations in 1995, respectively. The negative schooling cost in 1995 can be seen as a net overall benefit of going to school (instead of cost), for example because of non-financial pay-offs such as status gain. It seems that financial returns to education in the 1990s are not sufficient to explain the relatively 'high' schooling attainment.

We also find evidence of migration cost which vary greatly over the life-cycle, reaching a minimum for 25-years-old individuals. The quadratic migration cost mirrors the hump-shaped migration rates (present in the data, but not shown here). The significant coefficient on age squared ϕ_4 shows that the 'migration as investment' argument does not fully explain lower migration rates of older individuals by lower expected returns from migration. In terms of numbers, migration abroad would cost for an individual aged 25 in the late 70s between 1'760 CFA if originating from Bobo and 8'480 CFA if originating from the Sahel. Migrating to Ouagadougou would cost between 880 CFA (from Bobo) and 4'190 CFA (from Sahel). We observe two specificities by comparing these migration costs. First, migrating is relatively costly, especially if going to distant locations. For rural individuals, migration cost may amount to almost 2 times their home farming income. Second, migrating from the remote Sahel and East is far more costly than migrating from the well-connected and central rural regions like the Center, West or South-West.

Last, we find that around 20% of all individuals are of high ability. Ability significantly decreases schooling costs and has a significant and positive effect on the probability of being assigned a medium-high-skilled occupation (see next section).

5.2 Labour market estimates

If ability was observed and didn't impact schooling decisions, equations 10 to 14 could be separately estimated by OLS and would yield unbiased estimates[39]. However, ability is unobserved and assumed to affect schooling costs, hence, unemployment and occupation assignment coefficients ω_U, ω_E and ω_{EE} must be jointly estimated with the other structural parameters.

Table 9 presents the estimation results for the labour market parameters. The upper section of the table refers to the unemployment/employment assignment parameters of labour market entrants. It is followed by the occupation assignment parameters of labour market entrants who have been offered employment. The third section of the table presents the parameter estimates of the occupation assignment of previously employed individuals who remain employed. Notice that these parameters are from a logistic latent variable specification and their sign can be directly interpreted. Finally, the last section of this table gives the estimate of the relative risk aversion coefficient and the living cost parameter.

Table 9: Parameter estimates 2: Labour market outcome parameters

	$\hat{\theta}$	$\hat{\sigma}_\theta$
BF: $\omega_{U,l12}$	-3.1440	1.00E-07
CI: $\omega_{U,l8}$	-5.5310	6.88E-08
Schooling: $\omega_{U,1}$	0.3221	1.22E-06
Schooling^2: $\omega_{U,2}$	-0.0182	4.82E-06
Ouaga: $\omega_{E,l1}$	-7.5246	9.22E-08
Bobo: $\omega_{E,l2}$	-7.6615	9.44E-08
CI: $\omega_{E,l8}$	-9.4280	3.01E-08
Ability: $\omega_{E,1}$	1.2856	2.61E-07
Schooling: $\omega_{E,2}$	0.2947	1.12E-06
Age: $\omega_{E,3}$	0.1256	3.64E-06
Father's occ.: $\omega_{E,4}$	0.8729	3.63E-08
Birth year: $\omega_{E,5}$	-0.0226	1.45E-06
BF: $\omega_{T,l12}$	-6.6819	3.52E-08
CI: $\omega_{T,l8}$	-8.3339	3.28E-08
Schooling: $\omega_{T,1}$	0.1503	1.18E-06
Occupation: $\omega_{T,2}$	8.3909	5.96E-08
Birth year: $\omega_{T,3}$	-0.2651	4.20E-07
Risk aversion: ρ	1.65	fixed
Living cost: λ	3.263	3.48E-07

We find that all parameters are significant at the 95% confidence level and have the expected sign. In general, we observe that *ceteris paribus* it is significantly more difficult to be assigned a medium-high-skilled occupation in Côte d'Ivoire than in Burkina Faso. However, the probability of unemployment is also lower.

The probability of unemployment upon labour market entrance increases with schooling,

[39] OLS estimates were used as starting values.

reaching a maximum for secondary education and decreasing for tertiary education. This inverse U-shaped form of unemployment in schooling is a feature also found for other West African capitals such as Abidjan, Bamako, Niamey and Dakar (see Brilleau, Roubaud and Torelli [5]). The estimated unemployment proability of unschooled individuals is 4.1% in Burkina Faso and 0.39% in Côte d'Ivoire. Having primary schooling (versus no schooling) increases the unemployment probability in Burkina Faso by 5.5pp, secondary schooling by 10.6pp and tertiary schooling by 2.4pp (see table 23 in the appendix).

For labour market entrants, the probability of being offered a medium-high-skilled occupation (conditional on being employed) in the urban/international labour market increases with ability, age, schooling and if the father of the entrant has also worked in a medium-high-skilled occupation. The negative coefficient of birth year cohort means that younger cohorts are less likely to be offered a medium-high-skilled occupation than older cohorts. This coefficient could capture decreasing returns to schooling (potentially because of general equilibrium effects) or higher requirements over time.

For example, an individual of low ability, without any schooling, born in an older cohort and entering the labour market at age 18 has a conditional probability of being assigned a medium-high-skilled occupation in Ouaga of 0.6% (see table 24 in the appendix). An individual with the same characteristics but secondary schooling would have a probability of 10.0%. This probability increases further to 39.3% with tertiary schooling, and to 51.7% if entering at age 22 instead of at age 18. Higher schooling substantially increases the probability of being offered a medium-high-skilled occupation. The corresponding probabilities in Côte d'Ivoire would be 0.1%, 1.3% and 7%, thus substantially lower than in Burkina Faso. Nonetheless, overall returns from schooling are a non-linear function of schooling and entrance age, because the probability of unemployment is quadratic in schooling.

For labour market transitions (see table 25 in the appendix), we find that the current occupation is mainly determined by the previous occupation. Occupational changes from medium-high-skilled to low-skilled occupations are unlikely[40], while the converse transition is slightly more likely (in Burkina Faso) but still very little probable. The probability of such an 'upward' occupational transition increases with schooling level and for older birth cohorts. For instance, an individual without any schooling belonging to an older cohort has a 0.5% probability of moving from a low occupation to a medium-high-skilled occupation, the probability is 5.0% for someone of the same cohort with tertiary education.

Estimating the proposed model for several fixed values of risk aversion ρ, we find that the model with $\rho = 1.65$ has the lowest value for the loss function. This finding is in line with Aldermann and Paxson [1] for other developing countries. The living cost differential of 3.26 indicates large living cost differences between urban/international and rural locations. In fact,

[40] The predicted probability of staying in a medium-high-skilled occupation increases for the baseline individual from 95.4% without schooling to 99.6% for someone with tertiary education. In Côte d'Ivoire, the corresponding numbers would be 80.0% and 97.8%.

urban and international incomes given in table 4 need to be adjusted by this factor, leaving real income in urban low-skilled occupations approximately 30-80% larger than (real) rural home farming income (50-110% for real income in international low-skilled occupations).

5.3 Goodness of fit

The estimated model fits the sample moments fairly well. Using only 34 parameters, we cannot reject equality of the observed sample moments and the moments computed from the simulated data set for 46% of the 180 moments fitted at the 95% confidence level (55% at the 99% confidence level). In general, the model does slightly better in matching labour market moment conditions than migration and education moments. Notice that despite not including any location constants (except for the labour market specifications) and featuring only global time trends (in schooling costs and labour market assignment), the model does remarkably well in explaining the observed pattern of migration, education and labour market outcomes over time and regions.

Tables 26 to 42 in the appendix show detailed results of matched observed and simulated moments.

6 Returns to migration

An important objective of this paper is to estimate returns to migration and decompose them into their various components. In order to quantify the overall gains due to migration (ex-ante), we compare the average net present value (NPV) of individuals at age 6 in two different scenarios. In the baseline scenario, migration is infinitely costly, forcing individuals to stay in their home location and to choose among the locally available work and education alternatives. The alternative scenario corresponds to the estimated specification where individuals face potential income and amenity gains, and pay migration costs when changing their location. The results are shown in table 10.

Table 10: Migration gains (ex-ante)

	Ouaga	**Bobo**	**Sahel**	**East**	**Center**	**West**	**South-West**
Net present value (1'000 CFA)							
No migration	284.83	278.88	208.54	213.45	203.55	224.13	217.26
Estimated model	286.22	281.05	210.70	215.66	211.93	225.93	220.48
Estimated average migration gains							
Gains	0.485%	0.773%	1.022%	1.026%	3.955%	0.797%	1.457%

We find that overall ex-ante gains from migration vary substantially across locations, in line with different net migration rates. Average net gains of migration are moderate at 4.0% in the Center and small at 0.5% in Ouagadougou. As these numbers are *average gains* (i.e. gains in NPV of a randomly picked individual from home location j), they do not necessarily reflect *realised gains* of migrants (ex-post). Nonetheless, compared to rough estimates of income gains as shown in figure 1 and table 4, these overall average gains seem rather small. Because of perfect foresight about never-migration and re-optimisation, these estimates present a lower bound to returns to migration. In order to fully evaluate returns to migration, we need to study who migrates and how their returns to migration can be decomposed into gains in income and amenity, differences in schooling cost and migration costs paid.

6.1 Realised migration gains

Table 11 presents *realised* average cumulative (discounted) returns to migration until year 2000 (or age 38) of migrants (ex-post). Realised returns are computed as the difference between the current utility flow in the estimated model (with migration) and the current utility flow of the best activity alternative in the individual's home location[41]. The current utility flow is composed of risk-adjusted income, amenities, possible schooling costs, migration costs and the preference shock (see equation 6). The first line gives the overall realised average cumulative returns, while the second panel refers to individuals of the older 3 cohorts (aged on average 37.3 years in 2000) and the third line of younger cohorts (aged on average 25 years in 2000).

Table 11: Cumulative realised migration gains of migrants

	Ouaga	**Bobo**	**Sahel**	**East**	**Center**	**West**	**South-West**
Cumulative realised migration gains of migrants until year 2000 (age 38)							
Full sample	1.13%	1.04%	-0.98%	-2.16%	2.06%	-1.49%	-0.61%
Cumulative realised migration gains (old cohorts)							
Migration gains	0.80%	0.72%	0.75%	0.67%	3.25%	0.92%	1.29%
Share migrants	0.6453	0.7987	0.6605	0.4632	0.9996	0.5526	0.9004
Years of education	7.40	6.85	1.20	2.62	1.83	2.04	1.77
Destination of first migration (old cohorts)							
Urban destination	0.5171	0.4505	0.6094	0.6576	0.4868	0.7263	0.4643
Rural destination	0.3045	0.2205	0.0714	0.0528	0.0423	0.0443	0.0238
Abroad	0.1784	0.3290	0.3192	0.2896	0.4709	0.2293	0.5119
Cumulative realised migration gains (young cohorts)							
Migration gains	1.35%	1.28%	-3.23%	-4.81%	0.70%	-3.68%	-2.68%
Share migrants	0.3852	0.4448	0.3997	0.3390	0.7906	0.4103	0.6053
Years of education	9.93	9.20	5.17	6.09	5.61	4.97	4.81
Destination of first migration (young cohorts)							
Urban destination	0.4302	0.4185	0.6856	0.7238	0.5947	0.7689	0.5204
Rural destination	0.3592	0.2734	0.0847	0.0689	0.0532	0.0454	0.0562
Abroad	0.2106	0.3080	0.2297	0.2073	0.3521	0.1857	0.4235

Overall, we would expect that returns to migration are higher for older individuals as they have had time to accumulate benefits which have compensated incurred migration costs. Indeed, younger migrants from rural areas (except for those from the Center region) still have a negative overall benefit from migration in year 2000, incurred migration cost have not yet been compensated by higher returns to income and amenity value. Migrants from urban areas have seen their

[41] In this restricted scenario, the individual is not aware of the fact that he will never migrate. Hence, we abstract from re-optimisation gains which arise if an individual changed his schooling decisions because he knows that he will never migrate in the future. These returns to migration would represent an upper bound estimate if we could compute them until the end of an individual's lifetime.

returns to migration increase over time: young cohorts have higher realised returns to migration despite a shorter time span to have paid off migration costs.

We also observe that younger cohorts have on average more years of education, translating in a shift of first migration destinations. For individuals from a rural orgin, higher educational attainment has led to a decrease in international migration and to an increase in urban migration. The contrary is true for individuals from an urban origin. This analysis seems to indicate that migrating abroad is attractive for individuals with very little schooling and those with high educational attainment, but less so for those with an intermediate level of education (5 to 7 years of education).

6.2 Decomposing realised returns to migration

Table 12 gives the decomposition of realised returns to migration from the previous subsection into its income, amenity, schooling cost, migration cost and preference shock component.

Table 12: Decomposition of realised migration gains of migrants (old cohorts)

	Ouaga	**Bobo**	**Sahel**	**East**	**Center**	**West**	**South-West**
Total	0.80%	0.72%	0.75%	0.67%	3.25%	0.92%	1.29%
Avg. moves	3.14	3.86	3.90	3.47	4.91	3.49	4.49
Avg. years away from home, of which	2.25	2.31	9.94	6.56	17.04	4.24	6.05
in urban center	0.88	0.95	3.37	2.89	4.10	2.35	2.60
in rural region	0.50	0.52	0.20	0.13	0.18	0.09	0.09
abroad	0.87	0.84	6.37	3.55	12.75	1.79	3.36
Income	0.43pp	0.19pp	10.44pp	8.23pp	22.04pp	4.40pp	6.82pp
Home premiun	-2.23pp	-2.39pp	-10.79pp	-7.84pp	-18.67pp	-4.89pp	-7.12pp
Development level	-0.03pp	-0.03pp	0.60pp	0.41pp	0.91pp	0.26pp	0.36pp
Schooling cost	0.15pp	-0.08pp	-0.11pp	-1.26pp	-0.54pp	-0.54pp	-0.45pp
Migration cost	-1.34pp	-1.47pp	-3.31pp	-2.83pp	-4.04pp	-1.98pp	-2.54pp
Preferences	3.82pp	4.51pp	3.91pp	3.96pp	3.55pp	3.67pp	4.23pp

We find that for individuals from a rural origin, income differences constitute a sizeable component of returns to migration. This holds especially true for low-income rural regions such as the East and the Center. As a rule-of-thumb, per year living away from one's home location, individuals of rural origin increase their welfare from higher income by 1% to 1.3%. For those from urban origin, income gains are smaller (0.2% if originating from Ouaga, 0.08% from Bobo). However, income increases are almost fully washed away by the loss of the home premium when migrating from one's home location. As for income gains, the home premium loss is directly related to the number of years spent from home.

Returns from better development level or lower schooling costs are relatively small, while migration costs are quantitatively important. Individuals from rural origin migrate on average only slightly more often than those from urban origin, yet their incurred migration costs make up a larger (negative) fraction in returns to migration. Due to the remoteness (in terms of fewer transportation and distance to urban centers/abroad) of the Sahel and the East, and to a lesser degree the other rural regions, migration costs are larger and thus returns from migration lower.

Finally, preference shocks are an important component in explaining migration decisions. In absence of positive preference shocks for a new location, it is unlikely that an individual will migrate. Risk- and living cost adjusted income differences are in most cases not enough to compensate for home premium loss and migration costs.

Individuals from an urban origin face lower migration costs but also smaller gains from income differences than those from a rural origin. Overall, their returns to migration are relatively small, mostly driven by preference shocks. This pattern is also reflected in the average number of years which migrants spend from their home location. A migrant of urban origin spends on average only 2.3 years away from his home location, while rural-originated migrants spend on average 6 to 17 years in a location different from their home location.

6.3 The importance of risk aversion, unemployment and living cost differentials

The contribution of rural-urban and rural-international income differences to returns to migration is quantatively important, however, the numbers seem rather small compared to nominal income differences shown in table 4. Table 13 displays real income differences after correcting for living cost differentials between rural regions and the closest urban center, and abroad, respectively.

Table 13: Real rural-urban income differences

	Sahel	**East**	**Center**	**West**	**South-West**
Home farming income (GS)	5.33	5.71	4.69	6.54	5.84
Closest urban living cost-adjusted low wage	9.50	9.50	9.50	9.16	9.16
International living cost-adjusted low wage	11.06	11.06	11.06	11.06	11.06
Real rural-urban income differential	78.23%	66.37%	102.56%	40.10%	56.90%
Real rural-international income differential	107.56%	93.74%	135.88%	69.16%	89.43%

Even after correcting for living cost differentials between rural regions and urban centers/Côte d'Ivoire, real income differences remain large at 40% to more than 130%. Living cost differentials explain only some part of the rural-urban migration puzzle. We thus also need to investigate the effect of risk aversion and unemployment on the evaluation of income prospects in urban centers and abroad.

Tables 14 displays the value of income gains of migrants in the estimated model (where individuals are moderately risk-averse) and in an alternative scenario of risk-neutral individuals. The table reports income gains due to migration by origin. Notice that reported income gains of individuals are calculated while keeping schooling and migration decisions fixed.

Risk-aversion has a significant effect on the evaluation of income returns from migration. Especially individuals from an urban origin have low returns in terms of income because of their risk-aversion. Under risk-neutrality, returns to migration would jump from below 1% to 6% for

Table 14: Effect of risk aversion on cumulative income differences

	Ouaga	Bobo	Sahel	East	Center	West	South-West
Risk-adjusted income gains	1.05	0.46	20.43	16.12	41.62	9.02	13.79
Contribution of income to RTM	0.43pp	0.19pp	10.44pp	8.23pp	22.04pp	4.40pp	6.82pp
Estimated RTM	0.80%	0.72%	0.75%	0.67%	3.25%	0.92%	1.29%
Income gains if risk-neutral	14.02	11.11	24.21	20.87	47.68	12.65	17.52
Estimated RTM if risk-neutral	6.10%	5.07%	2.68%	3.09%	6.45%	2.69%	3.14%

those from Ouagadougou and 5% for those from Bobo-Dioulasso, respectively. Notice that these returns are calculated on the basis of staying on average 2.3 years away from one's home location. Under larger returns, risk-neutral individuals would be more likely to stay longer in a new location because of larger income gains (and not only because of preference shocks), thus potentially increasing returns to migration even further. Table 15 shows that the differences in average educational level between rural- and urban-originated individuals is at the core of this finding.

Table 15: Effect of risk aversion on cumulative income differences (by education)

	none	primary	secondary	tertiary
Urban origin				
Risk-adjusted income gains	0.08	0.00	0.01	23.03
Unadjusted income gains	6.50	9.07	16.99	58.33
Loss due to risk aversion	-6.40	-9.07	-16.98	-35.30
Loss in % of realised life-cycle value	-2.65%	-3.73%	-6.64%	-12.39%
Rural origin				
Risk-adjusted income gains	26.23	24.53	61.39	131.93
Unadjusted income gains	29.48	29.74	83.74	170.15
Loss due to risk aversion	-3.25	-5.21	-22.35	-38.22
Loss in % of realised life-cycle value	-1.62%	-2.63%	-12.85%	-16.45%

We observe that the effect of risk-aversion in the presence of unemployment (in an environment without unemployment insurance) plays a crucial role. Risk-neutral individuals would have higher returns to migration in the order of magnitude of 1.6pp to 16pp as compared to the returns shown in table 12. The higher an individual's education level, the higher the 'risk-adjusted income losses' as compared to a risk-neutral individual. The reason is that better educated individuals face more risk in terms of income: First, the unemployment level of labour market entrants is inverse U-shaped in education, peaking at secondary education. This leads to a depression of risk-adjusted returns in income of higher educated individuals. Secondly, the dispersion of income levels increases with higher education level. Even though home farming might seem a risky income option due to unpredictable weather shocks, working in the urban or international wage sector is even more so because of unemployment and occupation assignment risk. In the absence of unemployment insurance, being unemployed is much worse than having a low home farming income.

The relative increase of income losses due to risk adjustment over education levels could indicate that risk aversion is an important factor in explaining the (relatively) low schooling attainment in Burkina Faso. Especially the large unemployment risk of well educated labour market entrants may deter individuals from getting higher schooling.

6.4 Shedding light on the migration puzzle

Several factors contribute to the migration puzzle found for Burkina Faso. The first factor is a measurement issue: As seen in the descriptive analysis, rural-urban net migration underestimates rural out-migration and remains silent on other quantitatively important phenomena of internal and international migration. As shown in table 2, rural-international migration movements are about 1.5 times more common in the analysed time span than rural-urban migrations. However, with rising educational attainment in rural areas, the relative importance has shifted from rural-international to rural-urban migration. In recent years, this factor has become less important in explaining the migration puzzle.

A second important insight of this analysis is that income differentials between rural regions and urban centers (and abroad) are not as large as nominal income differences would suggest. Indeed, urban centers are estimated to have living costs which are approximately 3 times larger than those in rural regions. This significantly reduces the urban-rural income gap.

The main contribution to explaining the migration puzzle comes from risk-averse individuals in an environment with unemployment. Unemployment in the urban and international labour market in absence of unemployment insurance and with high persistence poses a serious threat, especially to better educated individuals who are more likely to become unemployed. A risk-neutral individual would have higher returns to migration of order 2 to 7.

Finally, focussing only on income differences as an explanatory factor for migration movements leaves aside other factors which also have a sizeable impact on migration movements. An important factor in explaining moderate migration rates (and relatively high return rates) is the preference for staying with one's family and clan. The value of the home premium is estimated close to rural home farming income. Migration cost are also sizeable, further decreasing returns to migration. They are relatively high for rural regions like the Sahel, East and, to a lesser degree, the West which are distant from urban centers and abroad.

7 Returns to education and the link to migration (incomplete)

Returns to education are most often estimated using Mincerian wage equations (see Mincer [25]) which assume that (1) the only cost of education are foregone earnings and that (2) individuals start working right after leaving school. Kazianga [14] estimates returns to education for wage earnerns in Burkina Faso [42]. He finds annual returns of 9% for an additional year of primary

[42] Kazianga [14] presents estimation results for different specifications: An OLS specification using only wage earners, a sample selection estimation controlling for entry into the wage sector, and a last specification which combines selection into the wage sector and endogenous choice between public and private wage sector. Apart from returns to tertiary schooling, the results for men are fairly robust across these three specifications. The results cited in this paper refer to the specification with selection into the wage sector.

schooling, 14% for secondary schooling and 23% for tertiary schooling.

As our data set does not feature income or wage data, we can only produce a rough estimate of returns to education by using the structural model to predict income. Table 16 presents wage equations and returns to education using simulated income of wage earners, i.e. individuals working in the urban or international wage sector. We also use two different measures of experience. Post-school experience corresponds to current age minus years spent in school minus 6 (the supposed entry age into school or the labour market), real work experience measures years employed in the urban or international work sector.

Table 16: Returns to education on male wage earners in 1998

	Urban		Urban + CI	
	(1)	(2)	(3)	(4)
Post-school experience	0.0068**			
	[0.0019]			
Post-school experience^2	0.0001**			
	[0.0001]			
Real work experience		0.0086***	0.0078***	0.0054***
		[0.0017]	[0.0013]	[0.0012]
Real work experience^2		−0.0005***	−0.0006***	−0.0002***
		[0.0001]	[0.0001]	[0.0001]
Primary schooling	0.0229***	0.0129***	0.0070***	0.0166***
	[0.0014]	[0.0013]	[0.0010]	[0.0010]
Secondary schooling	0.0612***	0.0593***	0.0678***	0.0688***
	[0.0021]	[0.0021]	[0.0017]	[0.0016]
Tertiary schooling	0.0702***	0.0815***	0.1658***	0.1285***
	[0.0082]	[0.0082]	[0.0058]	[0.0056]
Age		0.0143***	0.0156***	0.0080***
		[0.0009]	[0.0006]	[0.0006]
Constant	0.9749***	0.7555***	0.7846***	0.8864***
	[0.0144]	[0.0208]	[0.0149]	[0.0147]
Bobo				−0.0342***
				[0.0053]
Abroad				0.1551***
				[0.0055]
Observations	6,000	6,000	10,319	10,319
R-squared	0.389	0.400	0.614	0.653

Equation (1) uses data on male wage earners in Ouagadougou and Bobo-Dioulasso in 1998 (or at age 38) and is therefore -in terms of sample composition- closest to Kazianga's analysis. Estimated returns to education in this paper are convex in schooling like Kazianga's estimates but they are significantly lower with 2% for primary education, 6% for secondary and 7% for tertiary education. Equation (3) and (4) include Burkinabe who have migrated to Côte d'Ivoire, thus it displays returns to education measured on the whole population of wage earners, not only on those working in Ouagadougou or Bobo-Dioulasso. Equation (4) (our preferred specification) uses real work experience, and controls for age and location differences in wages. In this specification, we find returns to education of 2% for primary education, 7% for secondary and 13% for tertiary education. Wages in Bobo-Dioulasso are on average 3% lower than in Ouagadougou, abroad they are approximately 16% higher.

The disparity between Kazianga's and our estimates might be explained by two main factors. First, the underlying samples differ in age, schooling attainment and residence composition as well as in its definition of 'wage earners'[43]. We define as 'wage earners' all individuals working in the urban or international sector while Kazianga only includes salaried individuals (both in urban and rural locations). Secondly, our analysis uses predicted wages based on the structural model instead of realised wages as in Kazianga. Given that the model features only three different wage levels in each location, it might underestimate the effect of schooling on realised wages (especially for those in low-skilled occupations). This might bias our estimates downwards.

Nonetheless, it is important to stress the qualitative results of convex returns to schooling (in line with Schultz [37]) and the effect of including wage earners abroad which slightly decreases returns to primary education and increases returns to tertiary education. This result suggests that migration prospects influence returns to education and thus should be taken into account when explaining education decisions.

7.1 Decomposing returns to education

As already highlighted in previous sections, the unemployment rate of labour market entrants is inverse U-shaped in education, peaking at secondary education. If one estimates returns to education on wage earners, one is likely to overestimate returns to education, especially for those with higher education. Furthermore, education is costly (not only in terms of foregone income) and thus we need to take these costs into account when evaluating returns to education.

Analogous to returns to migration, we can compute *realised* gains from education and decompose them into their various components. Table 17 presents *realised* average cumulative (discounted) gains from education until year 2000 (or age 38). Gains from education are computed as the difference between the discounted utility flow in the estimated model and the discounted utility flow of the best non-school alternative[44].

As shown in table 17, average cumulative gains from education until year 2000 are substantially higher in urban centers than in rural regions. Three factors are likely to contribute to this results: First, returns to education are convex, thus higher average educational attainment in urban centers translates into higher average cumulative gains. Second, as reported in table 8, because of fewer schooling facilities, schooling costs are higher in rural regions, lowering gains from education in rural locations. Third, educated individuals from a rural origin need to make a costly migration move in order to reap potential returns to education. Table 18 splits average cumulative gains from education by cohorts, education level reached and origin.

[43] While the average age of wage earners is 25.2 years in this sample, it is supposedly around 32 years in Kazianga's sample. Average years of schooling are 6.2 years in this sample versus 4.2 in Kazianga's.

[44] In this restricted scenario, the individual is not aware of the fact that he will never go to school. Hence, we abstract from re-optimisation gains which arise if an individual changed his migration decisions because he knows that he will never attend school.

Table 17: Cumulative realised gains of those who have gone to school

	Ouaga	Bobo	Sahel	East	Center	West	South-West
Cumulative realised gains from education until year 2000 (age 38)							
Full sample	6.14%	8.12%	-1.14%	-0.55%	-2.09%	0.67%	-0.03%
Share gone to school	99.60%	99.45%	52.23%	63.17%	67.53%	66.18%	67.02%
Distribution of education level attained in year 2000 (age 38) of those gone to school							
None|school attendance	15.06%	14.80%	48.16%	44.48%	35.69%	46.45%	42.31%
Primary|school attendance	36.47%	39.23%	35.68%	39.33%	37.78%	40.21%	41.28%
Secondary|school attendance	38.68%	43.19%	9.39%	10.00%	14.40%	9.35%	10.44%
Tertiary|school attendance	9.78%	2.78%	6.77%	6.18%	12.13%	4.00%	5.98%
Cumulative realised gains from education (old cohorts)							
Avg. gains from education	3.98%	3.88%	-0.34%	-0.53%	-0.87%	0.71%	0.34%
Share gone to school	98.22%	97.62%	27.99%	39.67%	40.99%	38.16%	41.33%
Cumulative realised gains from education (young cohorts)							
Avg. gains from education	7.09%	10.17%	-1.45%	-0.55%	-2.67%	0.66%	-0.18%
Share gone to school	100%	100%	66.92%	75.61%	86.63%	80.82%	81.63%

Gains from education have increased from older to younger cohorts of urban originated individuals despite fewer years in the labour market. This is most likely due to lower schooling costs as already suggested by table 8. For individuals from rural origin we find that their cumulative education gains have varied little over cohorts, the effect of shorter labour market presence due to lower age and more schooling on income being counter-balanced by lower schooling cost.

Table 18: Cumulative realised gains by education level

	Urban				Rural			
	No	P	S	T	No	P	S	T
Cumulative realised gains from education (old cohorts)								
Avg. gains from education	0.35%	1.90%	8.02%	20.63%	0.40%	-1.10%	-13.43%	20.27%
Years in school	2.72	6.58	6.39	7.48	1.56	4.24	8.38	8.04
Migrants, of which	67.87%	70.13%	75.52%	95.85%	84.75%	86.85%	100%	100%
Urban destination	74.81%	74.69%	68.15%	49.62%	43.72%	50.12%	57.32%	49.46%
Rural destination	9.56%	12.21%	20.64%	8.31%	25.21%	26.74%	20.32%	19.06%
Abroad	15.62%	13.10%	11.21%	42.07%	31.07%	23.14%	22.35%	31.48%
Cumulative realised gains from education (young cohorts)								
Avg. gains from education	4.34%	10.93%	6.86%	10.67%	1.79%	2.26%	-19.12%	-7.42%
Years in school	5.26	8.10	6.91	7.68	2.00	4.53	7.71	8.12
Migrants, of which	41.56%	39.27%	43.58%	55.02%	53.60%	52.39%	60.81%	99.13%
Urban destination	68.25%	70.10%	67.74%	51.54%	41.67%	46.75%	64.15%	54.25%
Rural destination	14.36%	13.66%	21.65%	20.08%	27.06%	26.78%	21.89%	21.45%
Abroad	17.38%	16.25%	10.61%	28.38%	31.27%	26.48%	13.96%	24.29%

The convex pattern of returns to education with respect to school years is only found for individuals from the older cohorts originating from an urban center. Their rural peers instead exhibit negative returns to education for primary and secondary education. By the age of 37, individuals with primary schooling still seem to not have been able to compensate their extra schooling costs for 2.8 years and corresponding foregone income by higher risk-adjusted income due to schooling.

Table 18 also shows that independent of origin, migrating abroad is attractive for those without schooling and those with tertiary schooling. Migrating towards urban centers loses its attractiveness with increasing education level for individuals from urban origin, while its relatively most attractive for rural originating individuals with secondary schooling.

Analogous to returns to migration, we can dissect *realised* gains from education into its various components. We decompose it into gains in risk-and living cost-adjusted income (foregone income while in school, income gains while working due to higher education), amenities, possible schooling costs, migration costs and the preference shock (see equation 6). We present results for the oldest 3 cohorts in table 19.

Table 19: Decomposition of realised gains due to education (old cohorts)

	Urban				Rural			
	No	**P**	**S**	**T**	**No**	**P**	**S**	**T**
Cumulative realised gains from education (old cohorts)								
Avg. gains from education	0.35%	1.90%	8.02%	20.63%	0.40%	-1.10%	-13.43%	20.27%
Years in school	2.72	6.58	6.39	7.48	1.56	4.24	8.38	8.04
Share of migrants	67.87%	70.13%	75.52%	95.85%	84.75%	86.85%	100%	100%
Foregone income	-0.68pp	-2.88pp	-2.75pp	-4.24pp	-0.41pp	-1.56pp	-5.80pp	-3.91pp
Income premium	-0.24pp	-0.03pp	7.23pp	32.40pp	0.02pp	-0.24pp	20.85pp	59.82pp
Home premium	0.02pp	0.11pp	-0.26pp	-6.93pp	-0.04pp	-1.15pp	-13.60pp	-19.09pp
Development level	0.00pp	0.00pp	-0.01pp	-0.02pp	0.00pp	0.07pp	0.74pp	1.01pp
Schooling cost	-1.46pp	2.46pp	1.11pp	-1.81pp	-2.12pp	-1.74pp	-15.38pp	-12.97pp
Migration cost	0.05pp	0.12pp	-0.09pp	-1.46pp	-0.01pp	-0.62pp	-2.41pp	-2.60pp
Preferences	2.67pp	2.11pp	2.79pp	2.69pp	2.96pp	4.14pp	2.18pp	-1.96pp

Returns to education are mainly driven by the income premium, i.e. the higher risk- and living-cost-adjusted income obtained with secondary/tertiary education as compared to one with primary education or less. Welfare from real income increases by 7% for individuals with secondary education originating from an urban center and 30% for tertiary schooling. With 21% and 60%, respectively, these returns are especially large for individuals from a rural origin. Getting education however entails two major costs: First, going to school means foregoing an income opportunity in the labour market or as a farmer. For few years of schooling (i.e. at young ages), the opportunity cost of going to school is relatively low because of low child wages/income. However, after 6 to 7 years of education, going to school for an additional year becomes costly. For example, going to school for 8 years entails a reduction in cumulative lifetime income of approximately 4% to 6% for individuals from a rural origin. Second, the large schooling costs for secondary and tertiary schooling for individuals from rural origin can be intepreted from using the estimation results shown in table 8. Given these results, we know that direct schooling costs are large for tertiary education because of large fixed costs and for secondary education in rural regions because of relatively few schooling facilities.

In order to reap returns to education in form of higher income, both urban and rural individuals need to migrate. Migration costs are relatively small but the loss of home premium is substantial. For individuals originating from a rural region, average income gains of 20% until age 37 are not enough to compensate for direct and indirect schooling costs.

Contrary to migration decisions which were partly explained by preference shocks, education decisions are less driven by preference shocks. Some individuals might indeed decide to go to school for a few years because of preference shocks. However, those who attain secondary and tertiary education do so because of expected returns to education in terms of income and not because of preference shocks.

7.2 The effect of unemployment under risk aversion (incomplete)

Table 15 showed that the effect of risk aversion in combination with unemployment on returns to migration is largest for those with tertiary education. Table 20 give insight on the effect of risk aversion (RA) and unemployment (UE) on returns to education (RTE). Panel 2 presents the results of returns to education in an alternative scenario with risk-neutral individuals. In order to evaluate the differential effect of varying unemployment rates by education level, we fix in the alternative scenario the unemployment rate at the same level as for those without any schooling (panel 3).

Table 20: Effect of risk aversion and unemployment on returns to education (old cohorts)

	Urban				**Rural**			
	No	**P**	**S**	**T**	**No**	**P**	**S**	**T**
Cumulative realised gains from education (old cohorts)								
Risk-adjusted income gains	-2.19	-6.86	10.53	66.18	0.79	-2.20	-26.28	38.74
RTE under risk aversion (RA)	0.35%	1.90%	8.02%	20.63%	0.40%	-1.10%	-13.43%	20.27%
Unadjusted income gains	4.09	1.89	27.15	100.66	1.84	0.68	51.30	144.58
RTE under risk neutrality (RN)	2.98%	5.60%	15.09%	35.30%	1.71%	1.04%	-2.26%	40.03%
Income gains under constant UE	-2.19	-4.96	15.66	70.48	-0.78	-2.50	36.57	110.11
RTE under constant UE	0.35%	2.71%	10.20%	22.46%	0.40%	-0.56%	-9.79%	21.99%
Income gains constant UE + RN	4.09	2.35	28.77	101.80	1.84	0.92	53.56	145.39
RTEconstant UE + RN	2.98%	5.79%	15.78%	35.78%	1.71%	1.16%	-1.11%	40.46%

Indeed, we find that risk aversion in the presence of unemployment and random occupation assignment substantially reduces returns to education. Risk-neutral individuals would have higher returns to education of order 2pp (no education completed) to 15pp (tertiary education) for those from urban origin, and 1pp to 20pp for those from a rural origin. The estimates of returns to education of risk-neutral individuals from an urban origin are relatively close to those reported by Kazianga [14]. The effect of unemployment on returns to education is smaller than the one of risk aversion. The effect of inverse U-shaped unemployment rates in schooling has a moderate effect of 2pp to 4pp on returns to education for those with secondary and tertiary education.

7.3 Shedding light on the education puzzle

Returns to education of 9% for primary to 23% for tertiary education estimated on Burkinabe wage earners seem very promising (Kazianga [14]) but hard to reconcile with effective schooling choices. Indeed, potential income gains from better education are substantial but measuring returns to education on wage earners hides the risk of unemployment which risk averse individuals face. Unemployment upon labour market entry is found to be inverse U-shaped for education levels in Burkina Faso, peaking at approximately 14% for secondary education. Forward-looking individuals take into account the risk of remaining without employment in an environment of absent unemployment insurance, thus net overall returns to education are lower at higher education levels.

Risk aversion also matters for better educated individuals in how they evaluate income from medium- or high-skilled occupation with respect to low-skilled occupations. They are afraid of being unemployed or on low income, thus valueing little the large potential returns to be gained with high education.

Another important factor in lowering education returns are direct and indirect schooling costs. Direct schooling costs are large for tertiary education (because of high fixed costs, i.e. tuitition fees) and secondary education in rural areas because of few schooling facilities. However, indirect schooling costs also considerably lower returns to education. Studying entails foregoing income opportunities in the labour market. These opportunities increase with higher age (and thus education level). It might also lead to migration, either for continuing higher studies or for finding a job. Migration is not mainly costly because of large migration costs but because it requires leaving one's home location and giving up the home premium.

8 Discussion and conclusion

In this paper, I develop and estimate a dynamic life-cycle model of endogenous location, education and work choices using rich panel and cross-section data on Burkina Faso. The analytical context allows us to estimate returns to migration and returns to education, dissecting them into their various components. Hereby we shed light on the migration and education puzzle.

Regarding the 'migration puzzle', our analysis shows that urban/international-rural income differences appear at first sight larger than they really are, explaining why rural out-migration rates are only moderate. Two main factors greatly contribute to the re-evalutation of urban/international incomes. First, the model estimates living cost differences of around factor 3, shrinking observed urban-rural income differences from factor 6 to factor 2. Even when correcting for living cost differences, income differentials remain high enough to attract rural-urban migration. A second factor explains the remaining puzzle: Urban and international labour markets harbour the possibility of unemployment, in which case 'income' is substantially lower than home farming income when bad weather occurs. Given a moderate degree of risk aversion, individuals try to avoid the risk of unemployment even if it occurs only with a probability of 3 to 14%. The strong preference for staying in one's home location and large migration costs (especially from remote rural regions) also contribute to reducing migration movements.

As for the 'education puzzle', I show that measuring returns to education only on wage earners might be problematic and deliver biases estimates of real net returns. Indeed, the model identifies two opposed factors in returns to schooling. On the one hand, in urban centers or abroad higher education substantially increases the probability of being offered a well-paid medium-high-skilled occupation instead of a low-skilled occupation. This probability jumps from 0.5% without schooling to above 60% with tertiary education, seemingly indicating very large returns to education. On the other hand, we also find that the probability of unemployment upon labour market entrance is inverse U-shaped in schooling, reaching a maximum for secondary education. Given that unemployment is very persistent and no unemployment insurance exists, this risk greatly lowers returns to education. Additionally, tertiary education is very costly, both in terms of direct costs as well as indirect costs such as opportunity costs of foregone income, direct and indirect migration costs (i.e. moving away from one's home region). These factors explain why educational attainment is relatively low despite large income differences between low-skilled and medium-high-skilled occupations.

A question remains as to if and how these results found for Burkina Faso may be applicable to other Sub-Saharan African countries. Indeed, the economic, social and ethnic interwovenness between Côte d'Ivoire and Burkina Faso is particular. According to De Vreyer *et al.* [41], Abijan was in 2000 the West African capital among those of the West African Economic and Monetary Union with the largest share of migrants among its urban population (15.9%), of which 30.8% were Burkinabe (the second largest group were the Malian with 17.7%). In terms of self-selection of emigrants as compared to its natives, De Vreyer *et al.* report negative self-selection in terms of education also for Benin, Mali, Niger, Senegal and Togo. The negative self-selection pattern of Nigerian and Senegalese emigrants is similarly pronounced as the one of Burkinabe. As for educational attainment and the inverse U-shape of unemployment rates, we find comparable numbers for these 5 West African capitals. Of course, overall schooling attainment and the overall unemployment level vary but the pattern remains similar. We can thus infer that reported findings for Burkina Faso hold also qualitatively (if not necessarily quantitatively) for Mali and Niger, and to a lesser extent also for Benin, Senegal and Togo.

We conclude that as long as individuals from rural West Africa can migrate relatively easily to Côte d'Ivoire who has a high demand for low-skilled workers, these individuals have few incentives to get (higher) education. Policy makers should thus investigate the possibility of rendering migration to certain areas more expensive (i.e. to Côte d'Ivoire) while facilitating rural-urban migration. This might provide the necessary economic incentive to stay longer in school and get better education.

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9 Appendix

Table 21: Data sources of location indicators

Indicator	**Data sources**
Employment share of agriculture 2005	Computed by the author, using RPGH-06 data published by INSD (Institut national de la Statistique et Démographie), Burkina Faso
Share of villages/towns with	
- agric./non-agric. paid employment	Community survey data set
- primary/secondary schools	Community survey data set
- public transportation	Community survey data set
Avgerage rainfall 1960-1990 (in mm)	SDRN-FAO, Rome
Population of largest town 2000	Interpolated by author, using demographic statistics of towns provided by INSD (Institut national de la Statistique et Démographie), Burkina Faso
Main ethnic group (> 50%)	Community survey data set, RPGH-06
Avgerage distance to Ouaga/Bobo	Computed by the author
University since	University websites
Development indicator	Computed by the author, using community survey data set It includes health centers, infrastructure (water, electricity, telephone), leisure facilities (bar, cinema), diseases and internal conflicts.

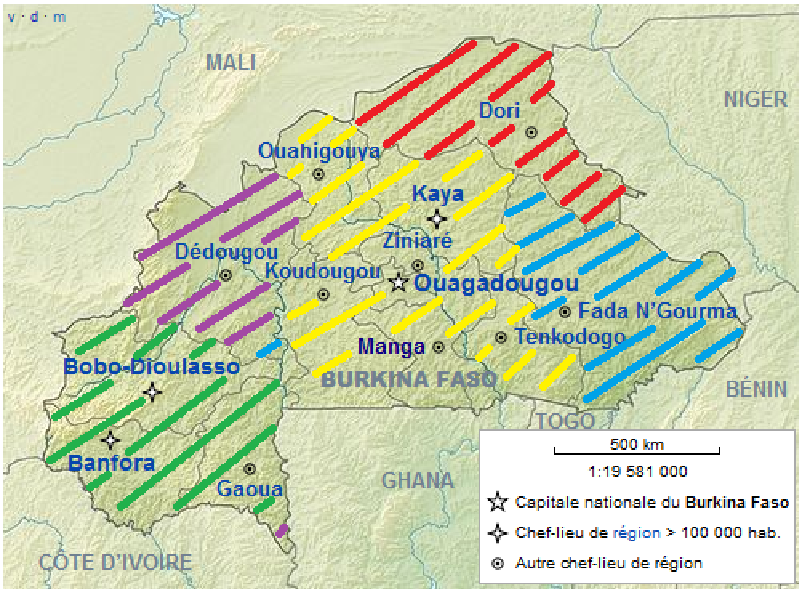

Figure 3: Map of Burkina Faso: rural and urban locations

The two urban centers in the model are:

- Ouagadougou, the capital in the center of the country
- Bobo-Dioulasso/Banfora, the two urban centers in the South-West of the country.

The five rural regions in the model are:

- Sahel, the administrative region in the North of the country with regional capital Dori (in red)
- East, the administrative region in the East of the country with regional capital Fada N'Gourma (in blue)
- Center, the central region composed of several administrative regions with corresponding capitals (among which Ouagadougou). In the analysis, we will use Koudougou as the regional capital (in yellow)
- West, the administrative region of the Boucle du Mouhon in the West of the country with Dédougou as regional capital (in purple)
- South-West, the administrative regions of the Hauts-Bassins, Cascades, South-West and their corresponding regional capitals (among which Bobo-Dioulasso and Banfora). In the model, we will use Orodara as regional capital (in green)

The international location in the model is:

- Côte d'Ivoire, Burkina Faso's neighbour to the South-West, with capital Yamoussoukro

9.1 Appendix: Calibrated income distributions

9.1.1 Urban and international work income

Urban and international work income $w_{low}(l)$ and $w_{med}(l)$ are computed as the (weighted) average monthly wage paid in low- and medium-high-skilled occupations in Ouagadougou, Bobo-Dioulasso and Côte d'Ivoire. It uses ILO data on prevailing occupational wages in Burkina Faso and minimum/maximum occupational wages in Côte d'Ivoire in 1990/1991[45].

Monthly wages of approximately 110 occupations are regrouped into low-skilled and medium-high-skilled[46]. The weight of an occupational wage within each skill group corresponds to its relative employment share as observed in the (representative) EMIUB data in 1991[47]. The first part of table 4 displays the calibration results for monthly urban and international work income (in 1'000 CFA).

9.1.2 Home farming income

Home farming income $\tilde{w}_{HF}(l)$ is average income per worker from agricultural activity in rural regions. It is location-specific and subject to unforeseen harvest (weather) shocks. Agricultural activity includes crop farming, market gardening and livestock farming. The relative importance of these farming activities varies between regions, not least because of differences in climatic conditions.

To calculate the contribution of each agricultural activity to home farming income by region, I combine different data sets provided by the FAO and the 'Direction Générale des Prévisisons et des Statistiques Agricoles du Burkina Faso' (DGSPA) on production and market prices[48]. Table 22 gives an overview over the value of these different agricultural activities by location. The first line in the second part of table 4 displays the calibration results for total monthly home farming income in year 1991 (in 1'000 CFA).

As the incidence of bad harvests in 1991 is negligibly small, the average home farming income is used as an estimate for home farming income in a good state, $w_{HF}(GS, l)$[49]. The pattern of

[45] It would be preferable to have time series data on wages, in order to analyse how changing wage dynamics have impacted migration decisions. Unfortunately, occupational wages in Burkina Faso are only widely available for year 1991. Some limited data is available for years 1985 and 2000. This data might be used in a later stage of the project to investigate the effect of wage dynamics. In this first step, I must work with the - arguably strong - assumption that the evolution of real wages in different occupations, rural working and home farming have been subject to the same trend.

[46] 'Low-skilled' refers to agricultural and non-agricultural occupations including artisans, domestic services, transportation and other unskilled workers. 'Medium-skilled' refers to non-agricultural occupations including clerks, public employees, security forces, administrative and technical personnel. 'High-skilled' refers to non-agricultural occupations including liberal professions, managers, directors and executives in the public and private sector.

[47] The EMIUB data is not representative for low-skilled occupations in Côte d'Ivoire (i.e. agricultural sector is over-represented). Instead of using employment shares as weights to determine $w_{low}(l = 8)$, I have used an average ratio of Ivorian to Burkinabe low-skilled occupational wages equal to 1.2.

[48] These include: crop farm production by regions (DGPSA), national vegetables production (FAO), national livestock production (FAO), prices of crops, vegetables and livestock (FAO), regional shares for vegetables and livestock production (DGPSA) and agricultural workers by regions (DGPSA).

[49] In each rural region, 5% of villages/towns or less declare having had a bad harvest in 1991. Further, inspecting production of all main crops for each rural region in 1991 does not reveal any incidence of bad harvests either.

Table 22: Monthly home farming income per worker 1991 (1'000 CFA)

	Sahel	East	Center	West	S-West
Main crops	2.19	3.38	3.12	5.01	4.53
Main vegetables	0.02	0.03	0.32	0.16	0.35
Livestock	3.12	2.29	1.26	1.37	0.96
Total	**5.33**	**5.71**	**4.69**	**6.54**	**5.84**

(relatively) high per capita income in the South-West, medium per capita income in the Sahel and low income in the Center is in line with Fafchamps [9] who uses detailed data of per capita income of agricultural households in Burkinabe villages from the Sahel, Center and South-West area from 1981 to 1983.

The probability of bad harvest shocks is obtained from the community survey data. Each village/town in the sample reports in which years they suffered bad harvests. The data allows to compute an indicator of average incidence of bad harvests as shown in line 3 in the second part of table 4. It is used as the probability of bad harvest $\pi(BS, l)$ in the home farming income equation. Notice that the probability of bad harvests is inversely related to the average rainfall shown in table 3.

Using the community survey information on bad harvests and the DGPSA data on crop production, it is possible to find an approximate value of home farming income in a bad state $w_{HF}(BS, l)$. I find that the main crops' production decreases by approximately 35% in years of bad harvest. In times of bad harvest, livestock breeding is also affected by a shortage in grass. According to FAO data, livestock production decreased by approximately 20% in 1973 (a year of very bad harvests) but in recent years of bad harvests it was left almost unaffected. For lack of better data, I set the negative effect of bad harvests on livestock breeding to 15%. This yields estimates of home farming income in bad states $w_{HF}(BS, l)$ as shown in line 2 of the second part of table 4.

9.1.3 Rural work income

The income from rural work w_{rural} is calibrated from ILO hourly wage data and average hours worked on crop field farm workers in 1987. Crop field farm workers earned approximately 14,490 CFA per month. However, availability of agricultural employment varies between regions and is often only seasonal (from May to September). The availability of paid employment observed in the community data set is used to approximate $\pi(RW|l)$ and the share of non-seasonal employment is used for $\pi(NS|l)$.

9.1.4 Subsistence income

The subsistence income w_{00} is calibrated from the work shares of home farming and nonworking in rural areas. Its identification is analogous to the one of the relative risk aversion coefficient and the scale parameter as described in section 9.2 of the appendix.

9.2 Appendix: Identification of the relative risk aversion coefficient and the scale parameter

In rural locations, individuals face two different work alternatives, home farming and rural work, with known but differing income distributions. Rewriting the choice probabilities of home farming HF and rural work RW in location l from equation 5, we find that the difference in logarithms of the probabilities of these work choices is equal to the difference of the fundamental values of each choice:

$$\ln(\text{prob}(HF \times l|x)) - \ln(\text{prob}(RW \times l|x)) = \frac{v(x, HF \times l) - v(x, RW \times l)}{\sigma_G} \tag{21}$$

Given that the continuation value of home farming and rural work in location l are the same[50], as well as the corresponding amenity value and potential migration costs (which are location-dependent but activity-independent, see equations 15 and 17), the difference in the fundamental values of home farming and rural work in location l reduces to the difference in the certainty equivalent value of the stochastic income of each work alternative:

$$\begin{aligned} &\ln(\text{prob}(HF \times l|x)) - \ln(\text{prob}(RW \times l|x)) = \\ &\frac{\left[\mathrm{E}_{\tilde{w}(x,HF\times l)}\left[\tilde{w}(x, HF \times l)^{1-\rho}\right]\right]^{\frac{1}{1-\rho}} - \left[\mathrm{E}_{\tilde{w}(x,RW\times l)}\left[\tilde{w}(x, RW \times l)^{1-\rho}\right]\right]^{\frac{1}{1-\rho}}}{\sigma_G} \end{aligned} \tag{22}$$

In a large sample, the choice probability $\text{prob}(m|x)$ can be approximated by the share of individuals choosing m given x. The moment conditions for the relative risk aversion coefficient are thus the difference of the logarithms of the shares of home farming and rural work of individuals aged 16 to 38 in location l. Using the same identification scheme, one can also identify the scale parameter. For values of risk aversion ρ (between 1 and 5), I find that σ_G should be between 0.015 and 0.02. For this first estimation, I adopt $\sigma_G = 0.017$. Translating this approach to the differences in shares between home farming and nonworking in rural areas, we can derive the level of subsistence income $w_{00} = 400$ CFA/month.

[50] From subsection 3.9 it follows that transition rates of home farming and rural work in location l are deterministic and identical, thus implying the same continuation value (see equation 3).

9.3 Appendix: Predicted probabilities and marginal effects of labour market estimates

This section presents additional tables regarding predicted probabilities of the labour market (LM) estimates from section 5.2.

Table 23: Predicted unemployment probabilities of LM entrants

	BF	CI
No education	0.041	0.0039
Primary	0.096	0.0097
Secondary	0.148	0.0157
Tertiary	0.065	0.0063

Table 24: Predicted medium-high-skilled occupation probabilities of LM entrants

Baseline: Ouaga, τ_{low}, low father, age 18				
	Base	CI	τ_{high}	age 22
No education	0.006	0.001	0.016	0.009
Primary	0.016	0.002	0.044	0.026
Secondary	0.099	0.013	0.237	0.154
Tertiary	0.393	0.070	0.646	0.517

Table 25: Predicted medium-high-skilled occupation probabilities of LM transitions

Baseline: BF, low occupation				
	Base	CI	BF high occ.	CI high occ.
No education	0.005	0.001	0.954	0.799
Primary	0.008	0.002	0.972	0.871
Secondary	0.021	0.004	0.989	0.947
Tertiary	0.050	0.010	0.996	0.978

9.4 Appendix: Goodness of fit

This section contains detailed tables on the goodness of fit of the model.

Table 26: Fit: Migration moments identifying amenity parameters

	Ouaga	Bobo	Sahel	East	Center	West	South-West
Return migration							
Observed	0.7317	0.4457	0.5789	0.4855	0.1375	0.3571	0.2494
Std. Err.	0.0347	0.0377	0.0342	0.0427	0.0108	0.0273	0.0220
Simulated	0.8649	0.8612	0.4695	0.5836	0.1243	0.7341	0.7012
Net share of migration in 70s, 80s, 90s							
Observed	0.1267	0.048	-0.0147	-0.004	-0.24	-0.0427	-0.0547
Std. Err.	0.0211	0.0153	0.0118	0.0081	0.0239	0.0142	0.014
Simulated	0.0749	0.0368	-0.0283	-0.0103	-0.2098	-0.0122	-0.0325
Observed	0.1299	0.0318	-0.0146	-0.0051	-0.1617	-0.0178	-0.0477
Std. Err.	0.0149	0.0116	0.0077	0.0067	0.0154	0.0102	0.0106
Simulated	0.0171	0.0116	-0.0135	-0.0043	-0.1059	-0.0052	-0.0089
Observed	0.1097	0.0203	-0.0187	-0.0187	-0.1669	-0.0520	-0.0671
Std. Err.	0.0122	0.0108	0.0075	0.0065	0.0128	0.0087	0.0102
Simulated	-4.60E-04	0.0040	-0.0072	-0.0047	-0.0653	-0.0033	-0.0072

Table 27: Fit: Schooling moments identifying schooling cost parameters 1

	Ouaga	Bobo	Sahel	East	Center	West	South-West
Share of never-schoolers							
Observed	0.1324	0.1871	0.8694	0.7656	0.5919	0.6712	0.6694
Std. Err.	0.0153	0.0211	0.0178	0.0257	0.0161	0.0245	0.0247
Simulated	0.1563	0.1527	0.7375	0.6726	0.3224	0.6649	0.6453
Share secondary conditional on primary							
Observed	0.6150	0.5899	0.1915	0.4843	0.589	0.438	0.65
Std. Err.	0.0236	0.0296	0.058	0.0630	0.0252	0.0453	0.0437
Simulated	0.5640	0.5389	0.2246	0.1921	0.4480	0.1734	0.2098
Share tertiary conditional on secondary							
Observed	0.0802	0.0976	0.1111	0.0645	0.1467	0.0943	0.1026
Std. Err.	0.0168	0.0232	0.1111	0.0449	0.0236	0.0405	0.0346
Simulated	0.1790	0.0485	0.1388	0.1299	0.2600	0.0888	0.1533
Share primary at age 13 in 1960s							
Observed	0.6506	0.6154	0.0843	0.08	0.281	0.3077	0.2125
Std. Err.	0.0527	0.0681	0.0307	0.0388	0.029	0.0526	0.0460
Simulated	0.6094	0.6047	0.0360	0.0801	0.4122	0.0840	0.0633

Table 28: Fit: Schooling moments identifying schooling cost parameters 2

Share primary at age 13						
	1970s		1980s		1990s	
	urban	**rural**	**urban**	**rural**	**urban**	**rural**
Observed	0.7414	0.2670	0.8740	0.3300	0.9224	0.2511
Std. Err.	0.0288	0.0172	0.0170	0.0177	0.0181	0.0286
Simulated	0.7364	0.1545	0.8476	0.3741	0.8499	0.5631

Table 29: Fit: Schooling moments identifying schooling cost parameters 3

Students by age										
	age 7		age 12		age 17		age 22		age 27	
	urban	**rural**	**urban**	**rural**	**urban**	**rural**	**urban**	**rural**	**urban**	**rural**
Observed	0.8235	0.2808	0.6879	0.2297	0.4010	0.1090	0.1553	0.0269	0.0207	0.0056
Std. Err.	0.0131	0.0094	0.0152	0.0090	0.0151	0.0075	0.0115	0.0048	0.0050	0.0025
Simulated	0.7152	0.2141	0.6113	0.2115	0.1315	0.0749	0.0534	0.0484	0.0175	0.0162

Table 30: Fit: Schooling moments identifying schooling cost parameters 4

Avg years of education, by cohorts				
	Emig/ local	**OMig/ emig**	**BMig/ emig**	**Local**
	rural origin			
Observed	1.6082	3.5906	3.2528	1.0821
Std. Err.	0.2665	0.3748	0.3826	0.1486
Simulated	2.7198	1.6431	1.2313	0.6705
Observed	0.8793	4.7681	4.858	1.618
Std. Err.	0.1142	0.4698	0.5278	0.1536
Simulated	2.1675	1.4268	1.0824	2.2605
	Emig/ local	**UMig/ emig**		**Local**
	urban origin			
Observed	1.1291	1.5314		6
Std. Err.	0.1598	0.1975		0.5182
Simulated	1.2235	0.8256		6.3284
Observed	0.7451	1.4505		8.6238
Std. Err.	0.0642	0.1653		0.2843
Simulated	1.0561	0.9124		8.9697

Table 31: Fit: Migration moments identifying migration cost parameters 1

	Ouaga	**Bobo**	**Sahel**	**East**	**Center**	**West**	**South-West**	**CI**
Never-migrants by home location								
Observed	0.6840	0.5625	0.5071	0.5577	0.1314	0.3475	0.2417	
Std. Err.	0.0204	0.0248	0.0243	0.0281	0.0099	0.0219	0.0189	
Simulated	0.5567	0.4729	0.5019	0.6180	0.1220	0.5409	0.2877	
Migrants from ... to farthest location by migrants to closest location								
Observed	0.9608	0.0702	7.36	3.6563	0.7700	3.1013	0.0296	1.3656
Std. Err.	0.1111	0.0363	1.5716	0.7313	0.0472	0.4017	0.0134	0.1865
Simulated	1.2562	0.0790	0.4540	0.3258	0.8558	0.6653	0.0056	0.0246

Table 32: Fit: Migration moments identifying migration cost parameters 2

	Sahel	East	Center	West	South-West
Out-migration rate 17-26 years old in 70s					
Observed	0.0589	0.0368	0.1484	0.1233	0.0917
Std. Err.	0.0098	0.0097	0.0105	0.0147	0.0124
Simulated	0.0701	0.0369	0.2378	0.0633	0.1423
Out-migration rate 17-26 years old in 80s					
Observed	0.0590	0.0486	0.1730	0.0923	0.1155
Std. Err.	0.0079	0.0076	0.0101	0.0094	0.0112
Simulated	0.0720	0.0471	0.2268	0.0813	0.1287
Out-migration rate 17-26 years old in 90s					
Observed	0.0680	0.0760	0.2052	0.1111	0.1562
Std. Err.	0.0076	0.0096	0.0102	0.0095	0.0118
Simulated	0.0612	0.0629	0.2045	0.0984	0.1324

Table 33: Fit: Migration moments identifying Migration cost parameters 3

Migration rate at age 7, 12, 17, 22, 27, 32, 37							
	urban origin						
Observed	0.0137	0.0121	0.0250	0.0573	0.02	0.0105	0.0090
Std. Err.	0.0039	0.0038	0.0060	0.0109	0.0081	0.0074	0.0090
Simulated	0.0010	0.0100	0.0481	0.0822	0.0970	0.0468	0.0062
	rural origin						
Observed	0.0125	0.0216	0.0844	0.1116	0.0821	0.0345	0.0359
Std. Err.	0.0022	0.0030	0.0065	0.0093	0.0097	0.0078	0.0098
Simulated	0.0002	0.0085	0.0558	0.1276	0.1148	0.0701	0.0217

Table 34: Fit: Migration moments identifying share of high-ability

	Ouaga	Bobo	Sahel	East	Center	West	South-West
Ratio permanent urban migration vs. permanent emigration							
Observed	0.5	0.5517	0.2656	0.7179	2.5526	0.7692	0.88
Std. Err.	0.1638	0.1216	0.0726	0.1781	0.1995	0.1145	0.1051
Simulated	0.7144	0.6128	0.5271	1.0812	0.2145	1.4291	0.7476

Table 35: Fit: Rural labour market shares identifying risk aversion coefficient

	Sahel	East	Center	West	South-West
Logarithm share HF - logarithm share RW					
Observed	2.3548	2.3724	1.7609	2.3117	2.0615
Std. Err.	0.0533	0.0611	0.0388	0.0553	0.0540
Simulated	2.2097	2.7671	2.0060	2.8774	2.4801

Table 36: Fit: Labour market moments identify labour market entrance parameters 1

Probability of MH occupation of local LM entrants by education level								
	Ouaga	**Bobo**	**Ouaga**	**Bobo**	**Ouaga**	**Bobo**	**Ouaga**	**Bobo**
	no educ.		primary		secondary		tertiary	
Observed	0.0246	0.0124	0.0294	n.a.	0.1946	0.1805	0.8333	n.a.
Std. Err.	0.0173	0.0088	0.0168	n.a.	0.0325	0.0456	0.1124	n.a.
Simulated	0.0058	0.0375	0.0401	n.a.	0.1935	0.1724	0.5140	n.a.

Table 37: Fit: Labour market moments identify labour market entrance parameters 2

Probability of MH occupation of rural migrant entrants by education									
	Ouaga	**Bobo**	**CI**	**Ouaga**	**Bobo**	**Ouaga**	**Bobo**	**CI**	**Ouaga**
	no educ.			primary		secondary			tert.
Observed	0.0447	0.1094	0.0152	0.1085	0.0612	0.4428	0.475	0.0769	0.9032
Std. Err.	0.013	0.0277	0.0050	0.0275	0.0346	0.0351	0.0562	0.0533	0.0540
Simulated	0.0274	0.0279	0.0045	0.1626	0.1281	0.3754	0.3655	0.0508	0.4507

Table 38: Fit: Labour market moments identify labour market entrance parameters 3

Probability of MH occupation of locals by age			
	age 12-16	**age 17-21**	**age 22-26**
Observed	0.1579	0.3333	0.2105
Std. Err.	0.0859	0.0765	0.0961
Simulated	0.1468	0.2232	0.3283

Table 39: Fit: Labour market moments identify labour market entrance parameters 4

Probability of MH occupation by cohort & father's occ.				
	cohort 1 & 2	**cohort 3 & 4**	**cohort 5 & 6**	**cohort 5 & 6**
	$o_F = low$			$o_F = mh$
Observed	0.4167	0.1875	0.125	0.2917
Std. Err.	0.1486	0.0701	0.0446	0.0948
Simulated	0.2646	0.2558	0.1809	0.3137

Table 40: Fit: Labour market moments identify labour market transition parameters 1

Probability of MH occupation by education, prev. occ.							
	BF	**CI**	**BF**	**CI**	**BF**	**BF**	**BF**
	no educ.		primary		sec.	tert.	tert.
	$o_{-1} = low$						$o_{-1} = MH$
Observed	0.0035	0.0029	0.0031	0.0081	0.0192	0.125	0.9813
Std. Err.	0.0007	0.0029	0.0008	0.0081	0.0029	0.0690	0.0038
Simulated	0.0057	0.0015	0.0067	0	0.0126	0	0.9835

Table 41: Fit: Labour market moments identify labour market transition parameters 2

Probability of low-MH transition by cohort			
	cohort 1 & 2	**cohort 3 & 4**	**cohort 5 & 6**
Observed	0.0351	0.0162	0.0131
Std. Err.	0.0081	0.0039	0.0044
Simulated	0.0254	0.0134	0.0084

Table 42: Fit: Unemployment moments

	no educ	**prim**	**sec**	**tert**
Unemployment share in BF				
Observed	0.0401	0.0639	0.1468	0.0541
Std. Err.	0.0088	0.0126	0.0178	0.0377
Simulated	0.0394	0.0763	0.1488	0.0723
Unemployment share in CI				
Observed	0.0067	0.0395		
Std. Err.	0.0034	0.0225		
Simulated	0.0050	0.0145		