Direction des bibliothèques

AVIS

Ce document a été numérisé par la Division de la gestion des documents et des archives de l'Université de Montréal.

L'auteur a autorisé l'Université de Montréal à reproduire et diffuser, en totalité ou en partie, par quelque moyen que ce soit et sur quelque support que ce soit, et exclusivement à des fins non lucratives d'enseignement et de recherche, des copies de ce mémoire ou de cette thèse.

L'auteur et les coauteurs le cas échéant conservent la propriété du droit d'auteur et des droits moraux qui protègent ce document. Ni la thèse ou le mémoire, ni des extraits substantiels de ce document, ne doivent être imprimés ou autrement reproduits sans l'autorisation de l'auteur.

Afin de se conformer à la Loi canadienne sur la protection des renseignements personnels, quelques formulaires secondaires, coordonnées ou signatures intégrées au texte ont pu être enlevés de ce document. Bien que cela ait pu affecter la pagination, il n'y a aucun contenu manquant.

NOTICE

This document was digitized by the Records Management & Archives Division of Université de Montréal.

The author of this thesis or dissertation has granted a nonexclusive license allowing Université de Montréal to reproduce and publish the document, in part or in whole, and in any format, solely for noncommercial educational and research purposes.

The author and co-authors if applicable retain copyright ownership and moral rights in this document. Neither the whole thesis or dissertation, nor substantial extracts from it, may be printed or otherwise reproduced without the author's permission.

In compliance with the Canadian Privacy Act some supporting forms, contact information or signatures may have been removed from the document. While this may affect the document page count, it does not represent any loss of content from the document.

Université de Montréal

Understanding Economic Decision-making under Social Norms Prescribing Behaviours

par

Ewoudou Jacques

Département de sciences économiques
Faculté des arts et des sciences

Thèse présentée à la Faculté des études supérieures
en vue de l'obtention du grade de
Philosophiae Doctor (Ph.D.)
en sciences économiques

Novembre 2007

Université de Montréal

Faculté des études supérieures

Cette thèse intitulée:

Understanding Economic Decision-making under Social Norms Prescribing Behaviours

présentée par

Ewoudou Jacques

a été évaluée par un jury composé des personnes suivantes:

André Martens
président -rapporteur

Michel Poitevin
directeur de recherche

Marc Henry
codirecteur de recherche

Sylvain Eloi Dessy
codirecteur de recherche

Baris Kaymak
membre du jury

Joost De Laat
examinateur externe

André Martens
représentant du doyen de la FES

Thèse acceptée le 14 mars 2008

Sommaire

Notre thèse apporte des éclairages nouveaux sur le rôle que joue le contexte socioculturel–i.e., les us et coutumes– dans les processus de prise de décisions microéconomiques. Le premier chapitre s'interresse à la problématique émancipation socioéconomique des femmes via la microfinance dans des environnement où elles font face à des limitations et des complications humaines. Le deuxième chapitre porte une attention particulière à la difficile modernisation des activités agricoles en Afrique Subsaharienne (ASS) où certaines pratiques sociales– comme la solidarité africaine– incitent les individus à mettre de côté leurs intérêts pour le bien des autres. Dans un troisième chapitre, notre thèse contribue à la littérature sur les retours à l'éducation en Afrique en estimant les taux de rendement privés à l'éducation au Cameroun.

De façon plus précise, le premier chapitre vise à démontrer que la difficile émancipation socioéconomique de la plupart des femmes vivant dans les pays où de nombreuses institutions de microfinance (MFIs) les ciblent, serait le résultat d'une incapacité des MFIs à mettre en place des réseaux d'entrepreneures capables de surmonter les obstacles socioculturels qui limitent l'accès des femmes aux activités économiques les plus lucratives dans le secteur informel. Pour ce faire, nous construisons un modèle de théorie de jeux non coopératifs dans lequel le choix par une entrepreneure du type d'activité économique qu'elle projette d'opérer informellement ainsi que sa taille sont conjointement déterminés par: (i) la quantité de capital qu'elle a empruntée à une MFI de son choix; (ii) sa capacité à atténuer les coûts de transaction qui limitent son accès à des activités économiquement plus rentables. Dans notre environnement, l'opération d'une activité économique informelle plus lucrative nécessite que l'entrepreneure établisse des liens avec ses consoeurs opérant le même type d'activité qu'elle. Une telle initiative leur permet de mobiliser des ressources collectives capables de toutes les aider à surmonter les obstacles créés par les normes sociales régissant les affaires dans le secteur informel et qui par conséquent freinent leur émancipation. Nombreuses seront les entrepreneures membres d'un tel réseau, plus à même sera ce dernier de garantir le succès des femmes opérant des activités informelles plus lucratives. Une caractéristique essentielle de l'environnement entourant l'entrepreneuriat des femmes dans l'économie informelle est par conséquent la complémentarité de leurs stratégies d'affaires respectives: la décision d'une entrepreneure

de s'orienter vers la gamme d'activités hautement productives augmente le gain marginal d'autres entrepreneures qui prennent la même décision qu'elle. Nous démontrons qu'en absence d'un mécanisme de coordination pouvant inciter les femmes à établir des liens au sein d'un tel réseau, le jeu non coopératif que celles-ci jouent admet deux équilibres de Nash en stratégies pures : un équilibre de hauts revenus où toutes les entrepreneures opèrent des activités informelles à haute productivité, et un équilibre de bas revenus où elles demeurent toutes confinées dans des activités à faible rentabilité, nonobstant l'accès non contraint au crédit d'affaire. L'obtention de l'équilibre de faibles revenus malgré la facilitation de l'accès des femmes au crédit par les MFIs pourrait signifier qu'en assistant financièrement les entrepreneures, la microfinance n'a pas été capable d'agir comme un mécanisme de coordination nécessaire à l'émergence de vastes réseaux d'entrepreneures opérant des activités à haute productivité. Nous affirmons que soumettre l'accès des femmes au crédit abordable à leur adoption d'activités plus lucratives agira comme une condition suffisante pour que leur émancipation s'opère au moyen de la microfinance. Ceci parce qu'une telle conditionnalité pourrait induire l'émergence de réseaux d'entrepreneures suffisamment vastes pour atténuer l'importance des us et coutumes qui occasionnent des coûts supplémentaire lors d'opération d'activités plus lucratives dans le secteur informel lorsqu'on est une femme.

Dans le deuxième chapitre, nous proposons un modèle offrant une nouvelle lecture des piètres performances agricoles de l'ASS, région où l'offre de produits agricoles contraint très souvent la demande. Dans notre modèle, les agents économiques sont de petits exploitants agricoles (ou fermiers) qui doivent constituer une épargne afin de financer l'achat d'un niveau recommandé d'engrais nécessaire à l'augmentation de la productivité agricole. Pour constituer cette épargne, ces fermiers doivent recourir aux revenus issus des récoltes de la saison précédente. Nous supposons cependant qu'en raison de la présence des traditions de solidarité et de partage qui obligent les individus innovateurs à se départir de leurs avoirs d'une façon improductive, un petit exploitant agricole agissant en autarcie pourrait avoir du mal à économiser en vue de la prochaine saison d'ensemencement (environ quatre à six mois d'attente), à moins qu'un un nombre suffisamment élevé de fermiers ne fasse pareil. Un fermier qui anticipe une telle situation peut donc renoncer à se constituer une épargne et choisir plutôt de partager ses revenus avec les autres membres de sa communauté, tel que le veulent

les pratiques sociales en vigueur dans son univers. Plus nombreux seront les autres fermiers qui se distanceraient de cette tradition en s'engageant fermement à constituer une épargne productive, plus vraisemblable sera la possibilité qu'un fermier qui épargne en autarcie puisse protéger cette épargne contre la prédation sociale. Conséquement donc, la décision d'un fermier de constituer une épargne augmente le gain marginal d'autres fermiers qui choisissent d'épargner. Nous démontrons que le jeu non coopératif auquel se livrent ces fermiers admet deux équilibres de Nash en stratégies pures: un équilibre de modernisation où tous les fermiers choisissent d'épargner afin de financer l'achat d'engrais, et un équilibre traditionnel (ou de statut quo) dans lequel ils choisissent tous de ne pas épargner, et renoncent ainsi aux avantages économiques procurés par la modernisation des activités agricoles. L'obtention de l'équilibre de statut quo en dépit du fait que l'ASS réunit l'ensemble des conditions identifiées par les théoriciens néo-classiques (ou néo-Boserupiens) comme étant nécessaires et suffisantes pour l'introduction des innovations en agriculture (notamment des sols très pauvres et des opportunités d'affaire) suggère que ces conditions sont uniquement nécessaires dans des environnements dominés par des institutions informelles comme la solidarité. Pour devenir suffisant, nous suggérons que cet ensemble de conditions comprenne la création d'une technologie d'épargne capable d'atténuer les effets de la prédation sociale sur la décision du fermier de constituer une épargne productive.

Une grande emphase été mise sur la nécessité d'augmenter le niveau du capital humain par le biais de la vulgarisation de l'éducation, afin de soutenir une croissance économique plus forte en Afrique. Cette emphase a généré un intérêt sans cesse renouvelé pour l'estimations des taux de rendement privés à l'éducation (TDRE) en Afrique, afin de comprendre les motivations et les contraintes auxquelles les individus font face dans leur analyse coûts-bénéfices des investissements en éducation et d'être ainsi en mesure d'informer les décisionnaires. Bien qu'il existe actuellement une vaste littérature empirique sur l'analyse des taux de rendement à l'éducation (voir, par exemple, Psacharopoulos,1994; Psacharoupoulos et Patrinos ,2002), la plupart des publications concernant l'Afrique reposaient jusqu'à un passé très récent, sur des enquêtes non représentatives de la population cible. Comme conséquence, les résultats issues de telles analyses ne pouvaient en aucune façon être généralisés à la population toute entière. Dans le troisième chapitre de notre thèse, nous

prenons en compte cette limite tout en contribuant à la littérature sur les retours à l'éducation en Afrique. Pour conduire notre analyse, nous nous servons de l'enquête sur les conditions de vie des ménages, réalisée en 2001 par l'institut national de la statistique du Cameroun auprès de 20,000 ménages. Nous comparons les TDRE des individus ayant fréquenté un cycle d'éducation sans y avoir gradué à ceux de personnes qui ont reçu un diplôme dudit cycle d'éducation. Nous permettons également aux individus d'être choisis de manière endogène dans le secteur informel, le secteur privé formel ainsi que dans le secteur public. Comme résultats probants, nous démontrons que les TDRE sont fortement convexes et élevés dans tous les secteurs d'activité. De plus, nos résultats indiquent que ceux qui n'ont pas reçu de diplôme de l'école primaire n'engrangent aucun retour à l'éducation comparés à ceux qui ne sont jamais allés à l'école. Nous montrons aussi que les individus ayant reçu un diplôme d'un cycle d'éducation ont des rendements à l'éducation statistiquement significatifs et plus élevés que ceux qui n'ont pas de diplôme dudit cycle. Nous trouvons également que les personnes qui ont suivi une formation professionnelle enregistrent des retours à l'éducation plus élevés en travaillant dans le secteur informel qu'ailleurs. Étant donné que nos estimations sont robustes à l'utilisation des informations statistiques pondérées (par les poids d'échantillonnages), nous pouvons donc argumenter qu'elles restent valables pour la population camerounaise toute entière. Nos résultats militent en faveur d'une approche intégrée de l'éducation dans laquelle l'accent est mis non seulement sur la scolarisation mais aussi sur la graduation de sorte que beaucoup plus d'élèves puissent atteindre l'université et y graduer . Notre étude milite également en faveur d'un accroissement des budgets alloués à l'éducation à tous les niveaux pour que le nombre et à la qualité de diplômés universitaires africains puissent augmenter. (Classification JEL : D13, J16, O14, C72, O13,Q12, I21, J31).

Mots clés: microfinance, femmes, esprit d'entreprise, jeux super modulaires, Afrique Subsaharienne, modernisation agricole, adoption de fertilisants, Cameroun, rendements, éducation, secteurs d'activité.

Summary

Our dissertation provides behavioural economics literature with new theorizations of how social context matters a great deal in decision-making and the decision-making process itself, especially in regions where agents display human limitations and complications. The first chapter develops a theory of female empowerment through access to business loans in an environment where informality is the only affordable venue for operating a business venture. In Sub-Saharan Africa, many social institutions arise either from lack of access to formal insurance mechanisms or from the imperfection of financial markets. One such institution is the traditional sharing obligation whereby individuals must spread their wealth around. In chapter 2 , we show that integrating such institutions into the standard neo-Boserupian framework can improve our understanding of the causes of poor agricultural performances in Sub-Saharan Africa. In chapter three, our thesis also contributes to the literature on returns to education in Africa by using the 2001 Cameroon household survey to estimate private rates of returns to education.

In a more precise presentation, chapter one uses the non-cooperative game theory to highlight coordination failure that hinders the emergence of networks of female entrepreneurs necessary to overcome patriarchal business practices that limit female entrepreneurs' access to high-productivity informal activities. In our model, women's entrepreneurship is assisted by microfinance institutions (MFIs) which provide loan and training to all their clients. We focus on women's demand for venture capital and choice of activity as jointly determined by their ability to mitigate the transaction costs that limit their access to more productive business activities. In our framework, a female entrepreneur must jointly choose the type of business activity she plans to operate informally and its size as determined by the amount of capital borrowed from the MFI of her choice. Operating a high-productivity informal activity puts a higher demand on a woman to link up with other women operating the same type of activity in order to generate collective resources necessary to overcome obstacles created by patriarchal business practices. The more there are female entrepreneurs operating in such a network, the more able will this network be in enhancing women's success at operating high-productivity activities. Consequently, an essential feature of the environment underlying women's entrepreneurship in the informal economy is the complementarity of

their respective business strategies: a female entrepreneur's decision to tap into the range of high-productivity activities increases other female entrepreneurs' marginal gain from following suit. We demonstrate that in absence of a mechanism for inducing coordination of women's decision to link up in a such a network, the non-cooperative game these women play admits two pure-strategy Nash-equilibria: a high-income equilibrium where all of them operate high-productivity informal activities, and a low-income equilibrium where they all remain confined into low-productivity ones, despite access to credit. We argue that conditioning women's access to credit to their adoption of high-productivity activities acts as a sufficient condition for MFIs to nurture female empowerment. This is because such conditionality may induce the emergence of networks of female entrepreneurs large enough to mitigate patriarchal practices that raise the costs of operating such activities in the informal economy.

In the second chapter, we develop a game-theoretic model of fertilizers use to explain poor agricultural outcomes in Sub-Saharan Africa (hereafter referred to as SSA). In our model, agents are smallholder farmers who must build up their savings so as to finance the purchase of a recommended level of fertilizers. To build up their savings, farmers in our model must draw on the proceeds from the previous harvesting season. However, a smallholder acting in autarky may find it hard to commit to saving for the next growing season (some four to six months away), if enough other farmers do not follow suit, because of traditional sharing obligations that put pressure on innovation-minded individuals to part with their assets in an unproductive manner. A farmer who anticipates this may renege on her commitment to save, and instead partake in the tradition to share his income with others. The more there are other farmers who break away from this tradition by firmly committing to saving, the higher the likelihood that a farmer who saves in autarky will be able to protect her savings from social predation. Consequently, a farmer's decision to save raises other farmers' marginal gain from saving. We show that the non-cooperative game these farmers play admits two pure-strategy Nash-equilibria: a modernization equilibrium where all of them choose to save in order to finance the purchase of fertilizers, and a traditional equilibrium where they all elect not to save, and thus forfeit the benefits of farming modernization. Our game-theoretic model is consistent with the observed coexistence, in SSA, of low-fertilizer consumption with economic conditions which neo-

Boserupian theories identify as essential for the onset of technological innovations in agriculture—namely poor soil fertility and market opportunities. Indeed, in our model, conditions identified by neo-Boserupian theories as necessary and sufficient for the onset of agricultural innovation are shown to be only necessary. To be sufficient, this set of conditions must be enlarged to include the creation of a savings technology capable of mitigating the effects of social predation on farmer's decision to save.

Much emphasis is placed on the need to increase the level of human capital through improved education access, to sustain high economic growth in Africa. This emphasis has given rise to renewed interest in obtaining estimates of private rates of returns to education (RORE) in Africa so as to understand the motivations and constraints which individuals face in their education cost-benefit analysis and thus be in a position to inform policy makers. While there is a large empirical literature on analysis of rates of returns to education, until recently, most analysis for Africa relied on non-representative surveys. As a result, their findings cannot be generalized to the whole population. The third chapter addresses that issue and contributes to the literature on returns to education in Africa by using the 2001 Cameroon household survey to estimate RORE. We compare RORE for those who attended an education cycle with those who have graduated from that education cycle. We also allow individuals to be endogenously selected into the informal sector, the formal private sector or in the public sector. We find strong convex and high RORE in all sectors of employment. Interestingly, those who did not graduate from primary school earn no returns compared to those who never attended school. As expected, those who graduated from an education cycle earn statistically significant and higher returns than those who have not. We also find higher returns to having attended vocational school when working in the informal sector than elsewhere. As our estimates are robust to using population-weighted data we can therefore argue that they hold for the whole population of Cameroon. Our results militate in favour of an integrated education approach whereby emphasis is placed: (i) not only on school attendance but on graduation so that more students can reach and complete university; and (ii) a scaling-up of the education budget at all levels for the number and the quality of African university graduates to increase (JEL Classification : D13, J16, O14, C72, O13,Q12, I21, J31).

Contents

List of Tables

List of Figures

À mon oncle, Toumba,

à feu mon père, Kingue,

à ma mère, Ndjandjo,

et à mon fils, Ludovic.

Remerciements

Cette thèse n'aurait jamais pu voir le jour sans la volonté, la disponibilité, la patience et surtout la grande contribution de mon directeur de thèse, i.e., Michel Poitevin et de mes co-directeurs de thèse, i.e., Marc Henry et Sylvain Eloi Dessy. En plus d'avoir accepté d'encadrer ma thèse de doctorat, ils ont su orienter et guider mes recherches de manière fructueuse. Plus encore, ils n'ont jamais cessé de m'encourager à ne pas baisser les bras et les conseils qu'ils m'ont généreusement prodigués durant toute la période qu'à durée la rédaction de ma thèse continuent aujourd'hui encore d'avoir à mes yeux une valeur inestimable. Mille fois merci!

Je voudrai remercier Désiré Vencatachellum pour sa collaboration très significative et hautement appréciée. Je tiens par la même occasion à lui exprimer ma profonde et sincère gratitude car j'ai beaucoup appris sur les plans humain et intellectuel pendant tout le temps que j'ai eu l'immense plaisir de passer à ses côtés. Désiré, tu m'avez beaucoup appris et je t' en suis immensément reconnaissant.

J'aimerai remercier le CRDE/CIREQ ainsi que le Département de sciences économiques de l'Université de Montréal pour leur soutien logistique et financier. Mes remerciements vont aussi à toutes les personnes que j'ai eu le plaisir de côtoyer tout au long de mon programme de doctorat à l'université de Montréal, à savoir le corps professoral, le personnel administratif et les étudiants du département de sciences économiques. Un grand merci à la direction nationale de la statistique et de la comptabilité nationale du Cameroun (DSCN) qui nous a généreusement fourni l'enquête camerounaise auprès des ménages.

À feu mon père Kingue Otto, à ma mère Esther Ndjandjo ainsi qu'à mon oncle Anatole Toumba, j'adresse une mention spéciale pour leur supports indéfectibles sans lesquels je n'aurai pas pu entreprendre des études et encore moins aspirer à devenir un jour docteur en sciences économiques. Tonton Toumba, mille fois merci d'avoir cru en mes potentialitées et de m'avoir donner la chance de réussir ma vie d'adulte. Reçois à travers cette thèse, toute ma gratitude la plus immense.

Je ne saurai terminer ces propos sans adresser ma reconnaissance infinie à Amélie qui a non seulement été à mes côtés dans mes moments de doute et de frustration, mais m'a toujours maintenu motivé grâce à ses encouragements, sa grande capacité d'écoute et sa grande générosité.

Introduction générale

La plupart des pays pauvres continuent encore aujourd'hui de crouler sous l'écrasant poids de multiple institutions informelles comme l'hospitalité, la générosité et la solidarité. Conséquemment à cet état des choses, la grande majorité des comportements individuels qui sont issus de ces régions sont loin de traduire sur le plan pratique l'un des postulats fondamentaux de la théorie néo-classique selon lequel un agent économique rationnel fait généralement des choix qui l'orientent vers l'utilité espéreé la plus élevée, étant donné ses préférences et l'ensemble d'informations dont il dispose. En effet, les choix économiques issus de bon nombre de pays pauvres dépendent largement des régularités comportementales que l'agent économique observe ou qu'il a initialement pris en compte (Platteau, 2002). Malgré cela, le rôle du contexte socioculturel reste largement sous-estimé dans notre représentation formelle des comportements des agents économiques vivants dans les pays pauvres. Dans cette thèse, nous démontrons que des facteurs sociaux pertinents peuvent être responsables de comportements microéconomiques qui, bien qu'étant rationnels, ne sont pas nécessairement néo-classiques. Pour ce faire, nous proposons des théories de choix individuels qui non seulement tiennent compte explicitement des pratiques sociales, mais dérivent en même temps les conditions sous lesquelles ces dernières pourront générer des conséquences économiquement positives pour l'ensemble des agents économiques.

En caractérisant l'idée selon laquelle un agent économique rationnel optimise ses choix en tenant compte du comportement collectivement admis, nous apportons une double contribution à la littérature croissante sur le rôle du contexte social dans la formation des comportements individuels propres aux pays pauvres. Premièrement, nous démontrons à l'aide des jeux super modulaires qu'en raison de la présence de normes sociales dans la plupart des environnements sous développés, les préférences portent en priorité sur les conséquences sociales des actions engagées par les agents économiques et non sur les actions ou sur les décisions qu'ils prennent. Notre deuxième contribution consiste à mettre en évidence l'importance de prendre en compte les facteurs socioculturels dans l'implémentation de projets sociaux destiner à améliorer le niveau de vie des populations pauvres.

Dans un premier essai, nous relançons le débat sur les capacités réelles de la microfinance à

conférer aux femmes vivant dans les régions où elles continuent d'être considérées comme des agents économiques de seconde importance, un meilleur statut socioéconomique. En effet, bien qu'elles représentent plus de la moitié de la population active dans beaucoup de pays en développement, les femmes continuent d'être victimes de violence conjugale, de pauvreté et de discrimination sur le marché du travail. Par exemple, plus de 70% sur approximativement 1.3 milliards de personnes vivants sous le seuil de pauvreté sont des femmes. Ces dernières bénéficient d'une part dispro-portionnellement faible du crédit des instituions bancaires·(c'est le cas en Afrique par exemple, où seulement 10% du crédit bancaire est octroyé aux femmes); les femmes occupent de manière globale, seulement 10% de tous les sièges parlementaires et seulement 6% des postes de direction (voir conférences de Beijing en 1995 et 2005).[1]

La microfinance qui cible prioritairement les femmes et qui par conséquent élimine l'imperfection des marchés financiers, est considérée depuis plusieurs décennies par les principaux intervenants en matière de développement international (i.e., experts, organisations non gouvernementales, États, institutions financières) comme l'instrument par excellence d'amélioration du statut socioé-conomique de la femme dans les régions pauvres. L'importance de la microfinance dans le processus d'émancipation des femmes réside principalement sur l'idée selon laquelle l'octroi de microcredits à des conditions économiquement avantageuses aux femmes peut leur procurer une autonomie fi-nancière. Mues de cette nouvelle indépendance économique, celles-ci pourront alors améliorer leur bien être, leur pouvoir de négociation dans le ménage ainsi que leur influence dans la vie de leur communauté.

Sur le plan pratique cependant, les inégalités socioéconomiques entre hommes et femmes con-tinuent de perdurer dans plusieurs pays ayant une longue histoire d'intervention des institutions de microfinance visant en priorité les femmes. Une telle tendance indique probablement que la pratique des microcredits à des conditions avantageuses pour l'emprunteuse ne suffit pas à elle seule pour améliorer la situation socioéconomique des femmes pauvres. Pour que l'émancipation financière des

---

[1]Pour plus d'information, voir la Convention sur l'élimination de toutes les Formes de Discrimination contre les Femmes; la Déclaration de Beijing et Plate forme pour l'Action ; ainsi que d'autres documents sur le site Web : www.undp.org/unifem.

femmes se matérialise à travers la microfinance, cet essai démontre que les institutions de micro-finance doivent conditionner l'accès de ces femmes au microcredit à leur adoption d'activités plus lucratives. Nous montrons qu'à l'aide d'un tel mécanisme de coordination, ces institutions pour-ront organiser un réseau d'affaire (à l'image par exemple des coopératives) suffisamment large pour faire face avec succès aux pratiques sociales qui accroissent considérablement les coûts d'opération d'activités plus productives lorsqu'on est une femme, et qui par conséquent les confinent dans des activités moins rémunératrices que celles dans lesquelles opèrent habituellement les hommes.

Dans le deuxième essai, nous nous intéressons à la persistance de piètres performances du secteur agricole africain, comparativement à celui d'autres régions en développement comme l'Amérique Latine, l'Asie du Sud Est, les Caraïbes et la région du pacifique. Dans leur très grande majorité, les membres de la communauté scientifique (comme les agronomes et les économistes agri-coles) et les agriculteurs admettent que la modernisation des activités agricoles, indépendamment de la forme qu'elle peut prendre (fertilisants, nouvelles semences, machines plus performantes ou de nouvelles techniques agricoles), est généralement garante d'une productivité plus élevée. De plus, plusieurs facteurs socioéconomiques militent largement en faveur d'une augmentation significative de la productivité agricole en Afrique. Tout d'abord, l'agriculture continue de représenter plus de 50% du produit intérieur brut dans la majorité de pays africains et d'y employer près de 70% de la population active (WDI, 2006). De plus, la malnutrition y est encore persistance et l'autosuffisance alimentaire reste dans beaucoup de pays africains, un vœux pieux. Malgré cela, plusieurs études empiriques (voir Duflo, Kremer and Robinson, 2005; Duflo, 2006) démontrent que l'agriculture de beaucoup de pays africains reste une agriculture faiblement productive car étant très peu dévelop-pée, nonobstant la présence de nombreuses incitations à accroître les rendements dans le secteur agricole.

Que l'Afrique continue malgré tous ces incitatifs socioéconomiques, d'être l'endroit où l'on en-registre les plus mauvaises performances du secteur agricole montre indiscutablement que la rareté et les opportunités économiques ne représentent que des conditions nécessaires à la modernisa-tion des pratiques agricoles dans cette partie du monde. Dans cet essai, nous démontrons que la

présence de certaines institutions informelles (comme la solidarité africaine), qui incitent les individus à mettre de côté leurs intérêts pour le bien des autres, peut être à l'origine de la très faible productivité agricole qui caractérise la majorité des pays africains. Comme conditions suffisantes, cet essai démontre qu'on doit accompagner les prescriptions de la théorie néo-Boserupienne (i.e., rareté et opportunités économiques) d'un mécanisme de coordination (l'épargne sécuritaire serait un exemple) qui protègerait les moyens financiers des agriculteurs contre toute pression sociale qui les empêcherait de réaliser des investissements visant à accroître la rentabilité de leur principale activité économique qu'est l'agriculture.

Nous terminons notre thèse en analysant la rémunération du capital humain dans un pays (i.e. le Cameroun) où des facteurs socioculturels exercent encore une influence considérable sur la formation des préférences parentales concernant l'éducation des enfants. Dans plusieurs régions camerounaise par exemple, l'éducation des filles reste encore considérée comme une perte de temps puisque ces dernières sont généralement destinées aux activités qui ne requièrent aucune connaissance académique particulière (comme les travaux domestiques ou à l'agriculture de subsistance). Dans d'autres, l'enfant continue de représenter : (i) un bien de consommation parce qu'il procure une certaine utilité à ses parents; (ii) un facteur de production car il accompli des travaux domestiques et participe des activités productives nécessaire à la survie de toute la famille; (iii) un actif financier contre le risque du fait qu'il constitue l'unique garantie de survie de ses parents lorsque ces derniers deviendront vieux et ne pourront par conséquent plus travailler. Un tel contexte socioculturel contribue inévitablement à créer un niveau sous optimal d'investissements privés en éducation. Conséquemment donc, la rémunération du capital humain au Cameroun ne suivra nécessairement pas le même sentier de croissance que celui qui a été observé et documenté pour la plupart des pays riches (voir Psacharopoulos, 1994).

En plus d'enrichir notre connaissance de la rentabilité des investissements en éducation au Cameroun, cet essai est intéressant pour l'Afrique subsaharienne parce que le Cameroun partage un certain nombre de similitudes avec d'autres pays de cette région. Tout comme plusieurs autres pays africains au sud du Sahara en effet, le Cameroun dépend fortement des produits primaires, a

un taux de chômage relativement élevé et est assujetti aux mêmes chocs sur les termes de l'échange. De plus, puisqu'il a été colonisé par la France et la Grande-Bretagne, le Cameroun a hérité des deux systèmes d'éducation qui sont présents dans le reste de l'Afrique.

Nous nous distinguons des précédentes études portant sur la rentabilité des investissements privés en éducation au Cameroun, et dans beaucoup d'autres pays africains au sud du Sahara de trois manières. Tout d'abord, notre échantillon inclut simultanément les travailleurs du secteur formel et ceux du secteur informel, puisque que l'emploi informel représente environ 65% de l'emploi global au Cameroun. Dans notre échantillon, près de deux tiers des participants au marché du travail qui ont fréquenté l'école primaire n'y ont pas reçu de diplôme. Deuxièmement donc, nous comparons la rémunération du capital humain issu de la fréquentation d'un cycle d'études sans y avoir gradué à celle du capital humain issu de la graduation du même cycle d'éducation. Troisièmement, nous tenons compte dans notre stratégie d'estimation, de l'existence possible d'un biais de sélection grâce à l'utilisation de la méthode de correction du biais d'échantillonnage proposée par Trost and Lee (1984). Finalement , nous produisons des estimations qui résistent à la critique de Bourguignon, Fournier and Gurgand (2004) et qui sont représentatives de la population active du Cameroun.

Nous montrons que les rendements privés en éducation au Cameroun sont convexes dans tous les secteurs d'activité, indépendamment de l'utilisation du niveau de scolarité ou du diplôme comme variable explicative des revenus d'activité. Nous démontrons aussi que ces rendements sont beaucoup plus élevés pour les diplômés universitaires, et même pour ceux qui ont fréquenté l'université mais n'y ont pas reçu de diplôme, que pour n'importe quel autre niveau d'éducation. De plus, nous montrons que les individus vivant dans des régions rurales gagnent moins que les résidents de milieux urbains et que l'équité salariale entre hommes et femmes n'est présente que dans les secteurs public et parapublic.

Chapter 1

Microfinance and Female Empowerment[†]

† This chapter is based on a paper coauthored with Sylvain Dessy.

1.   Introduction

This paper offers a new perspective on the empowerment potential of microfinance institutions targeted at women.[1] It develops a theory of female empowerment through access to business loans in an environment where informality is the only affordable venue for operating a business venture. Its aim is to examine the choices of activities informal female entrepreneurs make when faced with patriarchal forms of business regulations that substitute for the absence of legal means for enforcing contracts in the informal economy.

Basic economic theory supporting the empowerment potential of microfinance targeted at women emphasizes access to credit and the resulting opportunity for earning an independent income as the theoretical links to female empowerment through microfinance. In other words, involvement in income-generating activities should translate into greater empowerment for women. But, female empowerment is about improved ability to bring about changes that enhance women's well-being at the household, community, and national levels.[2] Bringing about such well-being requires that women first acquire the power to change their social environment.[3] Whether women can gain such power at individual, community or national levels obviously depends on a number of factors, including social, political, institutional, as well as purely economic factors, such as access to micro-finance services. How these factors interact to affect female empowerment, therefore, warrant due consideration. Here is why.

First, in many developing countries, business formalization in order to access legal means for enforcing contracts is often a privilege available only to politically powerful entrepreneurs, given

---

[1] A 2001 survey by the Special Unit on Microfinance of the United Nations capital Development Fund (SUM/UNCDF) reveals that approximately 60% of the clients of the 29 microfinance institutions surveyed were women, and six of the 29 focused entirely on women. Furthermore, according to USAID's annual *Microenterprise Results Report* for 2000, approximately 70% of USAID-supported microfinance institutions were women.

[2] Duflo (2005) offers an alternative definition. She defines female empowerment as the improvement in the ability of women to access the constituents of development—in particular health, education, earning opportunities, rights, and political participation.

[3] According to Carter and Fletschner (2004, p.3), in some developing countries, women who work away from the family environment have a bad reputation and men don't want people talking about their spouses.

the prevalence in these countries of high costs of legality.[4] Figure 1 below presents a comparative illustration of these costs for a sample of countries, including Sub-Saharan African countries and OECD countries. In terms of days lost dealing with licensing, Figure 1 shows clearly that in average, a potential formal sector entrepreneur in Sub-Saharan Africa loses about three times as many days dealing with licensing as does his counterpart from any advanced industrialized country.

Figure 1 : Days of dealing with licence: time spent in days
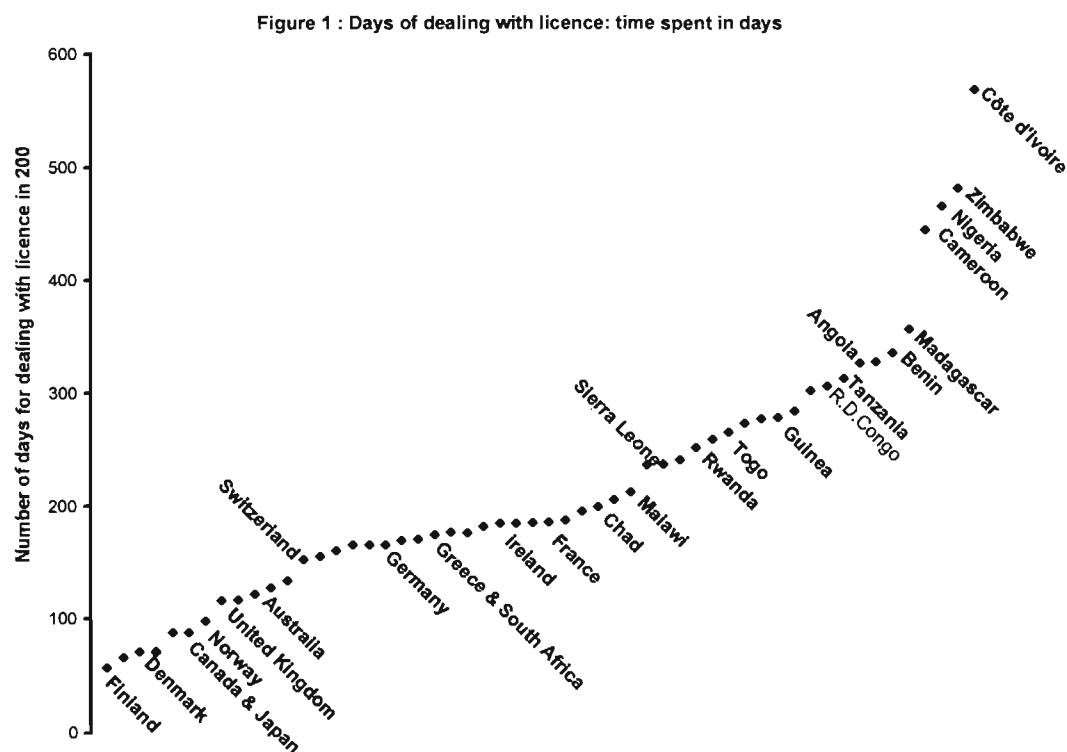
Source: World Bank (2005)

For the vast majority of these countries' micro-entrepreneurs–including women– who cannot afford these high cost of legality (bribes collection by public officials are an example), the informal

---

[4] De Soto (1989) finds evidence that the process of legally registering a small business is to expensive for any person of small means in Peru. Fortin, Marceau and Savard (1997) find evidence of high costs of legality in a case study of Cameroon. Johnson, Kaufmann, McMillan and Woodruff (2000) find that bribes and corruption are reasons why firms hide in the unofficial economy. Djankov, La Porta, Lopez-De-Silanes and Shleifer (2002) also provide evidence that countries with heavier regulation of entry have larger informal sectors. They argue that such entry barriers are deliberately set by politicians who seek to create extractable rents by restricting entry into formal markets.

economy becomes a "getaway"—a framework for producing and/or selling legal goods albeit using illegal means.[5]

Second, in the informal economy, patriarchal forms of business regulations substitute for the absence of legal means for enforcing business contracts,[6] and often emphasize the use of threat and violence as an enforcement mechanism (de Soto, 1989). Relative to men, this institutional feature of the informal economy put women at a comparative disadvantage for accessing certain lucrative markets (Gibbons, 1995; Kabeer, 2001). For example, relative to male entrepreneurs, women may face limited access to crucial input markets necessary to effectively operate a high-productivity business venture. This includes labour markets— where lack of legal mechanisms for resolving contract disputes may exposed female micro-entrepreneurs to male employees' violence—, and fertilizers markets—which are often controlled by male-only cooperatives. Due to these patriarchal practices, developing countries women still face trade-off that cause them to make decisions that are arguably disempowering, such as clustering in low-productivity activities, and/or relying on male family members (often their husband) as contract enforcers (Kabeer, 2001).[7]

Third, notwithstanding the above, intrahousehold bargaining models have demonstrated that female empowerment is positively associated with the level of a woman's fall-back option, which, in turn, is shown to rise with her relative earned-income (e.g., Anderson and Eswaran, 2005; Basu, 2005). Yet, in the informal economy of developing countries, women continue to earn less than

---

[5] According to a 2002 survey sponsored by the *International Labour Organization* (ILO), excluding South Africa, the share of informal employment in non-agricultural employment is 78 per cent in sub-Saharan Africa.

[6] Business contracts are usually defined as means for organizing and transfering property rights (De Soto, 1989).

[7] Lost of bargaining power may, for example, force her to surrender a fraction of her venture capital to her husband in exchange for his services as her informal contract enforcer (Goetz and Sen Gupta, 1996). Or, it may take the form of lost of control over her fertility (Kritz, Makinwa-Adebusoye and Gurak, 2000), which may raise the costs of operating a relatively high-risk, high-return business venture, thereby reducing her earned income. In particular, Kritz, Makinwa-Adebusoye and Gurak (2000) studied women's status and fertility within married couples in five Nigerian ethnic groups (The Hausa, Ibo, Yoruba, Ijaw and Kanuri). They look at several dimensions of women's decision-making and spousal communication on the desire for more children, and wife say on family planning. Among other things, their study finds that spouses from groups in which women's status is lowest (e.g. Kanuri and the Hausa) have higher disagreement on fertility desires than those from ethnic groups in which women's status is higher (Yoruba, Ibo, and Ijaw).

men, even when controlling for differences in literacy and education. In Bangladesh—a country that pioneered MFIs targeted at women—, there is evidence that self-employed men earn more than three times the income earned by self-employed women, while male informal micro-entrepreneurs earn about four times more than their female counterparts (Dasgupta and Barbattini, 2003). In Figure 2 below, this gender disparity in earnings among self-employed agents is shown to be apparent in other developing countries as well:

Figure 2. Informal Economy: Women's earnings as a % of Men's among Self-Employed, by Country
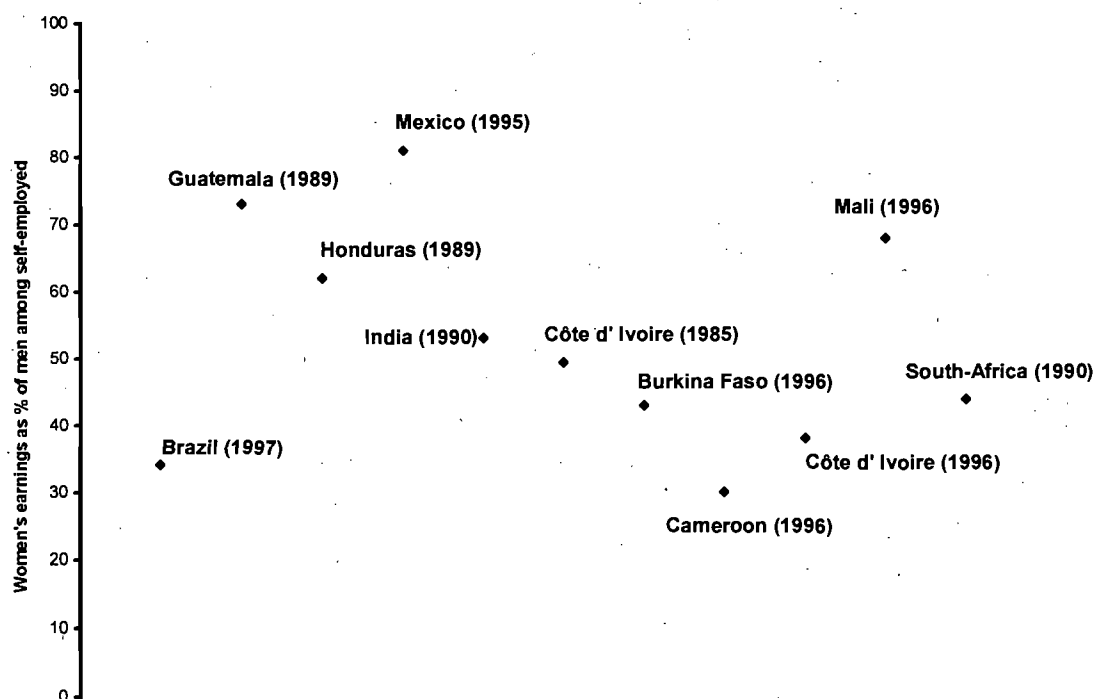
Source: Sethuraman (1998)

Most of these disparities reflect the extent to which women enterprises differ from men's in terms of scale, items sold by traders, extent of diversification, access to effective networking (Kabeer, 2001).[8] Given the prevalence of patriarchal practices in the informal economy, networking among

[8] According to Charmes (2000), in the informal sector of many developing countries, levels of income in metal working or wood processing (typical male activities) are always higher than levels of income in textiles (a typical

female entrepreneurs may play an essential role in overcoming transaction costs induced by compliance with such practices. Understanding constraints to the emergence of large enough networks of female entrepreneurs can therefore shed light on the issue of female empowerment through microfinance.

In this paper, we use a game-theoretic model to highlight coordination failure that hinder the emergence of networks of female entrepreneurs necessary to overcome patriarchal business practices that limit female entrepreneurs' access to high-productivity informal activities. In our model, women's entrepreneurship is assisted by an MFI which provides loan and training to all their clients. We focus on women's demand for venture capital and choice of activity as jointly determined by their ability to mitigate the transaction costs that limit their access to more productive business activities. In our model, a female entrepreneur must jointly choose the type of business activity she plans to operate informally and its size as determined by the amount of capital borrowed from the MFI of her choice. Operating a high-productivity informal activity puts a higher demand on a woman to link up with other women operating the same type of activity in order to generate collective resources necessary to overcome obstacles created by patriarchal business practices. The more there are female entrepreneurs operating in such a network, the more able will this network be in enhancing women's success at operating high-productivity activities. Consequently, an essential feature of the environment underlying women's entrepreneurship in the informal economy is the complementarity of their respective business strategies: a female entrepreneur's decision to tap into the range of high-productivity activities increases other female entrepreneurs' marginal gain from following suit.

In absence of a mechanism for inducing coordination of women's decision to link up in a such a network, the non-cooperative game these women play admits two pure-strategy Nash-equilibria: a high-income equilibrium where all of them operate high-productivity informal activities, and a low-income equilibrium where they all remain confined into low-productivity ones, despite access to credit. Therefore, when the low-income pure-strategy Nash-equilibrium obtains despite women's

female activity).

improved access to credit, it must be that microfinance assistance to female entrepreneurship has failed to act as a coordination mechanism for the emergence of large enough networks of female entrepreneurs operating high-productivity activities

From an empirical point of view, there is a case that women's attempt to access high-productivity business activities may be subject to strategic complementarities. Available evidence reveals that most women who receive loans from microfinance institutions tend to be confined into low-productivity, low-capital activities, despite access to credit, and often despite having equal managerial credentials as men. In a case study of Bangladesh, Kabeer (2001) reports that while access to credit succeeded in increasing the rate at which women participated in economic activities, it failed, however, to increase the range of economic activities they have access to. Lairap-Fonderson (2002), in a case study of Cameroon and Kenya, finds similar evidence. She argues that women micro-entrepreneurs are clustered within a narrow range of activities that offer virtually no opportunity for innovation, or for upgrading to more-lucrative ventures. This includes street-vending, operating food kiosks, selling second-hand clothes and unprocessed food, which are relatively low-capital, low-productivity activities, and which, in addition, face strong competition from cheap imports. She concludes that microfinance fail to lift women out of the confine of such low-capital activities. In a case study of Zimbabwe, Gibbon (1995) finds that rural women business activities tend to remain at a survival level, despite assistance from microfinance institutions. Mayoux (1998b) reports that in some micro finance programmes, women have expressed a clear preference for compulsory savings and directed loans to enable them to protect their incomes from men.

Our research is related to a growing theoretical literature focusing on women's empowerment through participation in income-generating activities. Anderson and Eswaran (2005) develop an intrahousehold bargaining model which demonstrates the relative ability of earned income to nurture empowerment for women within the household. The model is tested to rural Bangladeshi data, which provides support for their model's prediction. McIntosh and Wydick (2005) develop a model of competition among potential entrants in the microfinance industry that highlights the misgivings of increased competition in terms of the performance and viability of microfinance institutions.

Carter and Fletschner (2004) build a model of women's demand for entrepreneurial capital that explicitly incorporates into women's decision-making the effect of social norms prescribing gender behavior. They use this model to argue that microcredit programs that relax women's capital supply constraints may have benefits that extend well beyond the direct beneficiaries. Our research builds around this literature by emphasizing the need to explicitly organize female entrepreneurs in large enough business networks capable of mitigating patriarchal business practices that confine women in low-productivity activities.

The rest of this paper is organized as follows. The model is presented and solved in section 2. Section 3 offers concluding remarks.

2. The Environment

There are $N > 0$ ex ante homogenous female entrepreneurs. Each female entrepreneur has a choice between a range of business activities indexed each by its degree of productivity, $p \in [0,1]$.[9] To start up a business venture of any type, women in this environment can borrow venture capital from an MFI of their choice.[10] Borrowed capital determines the size of the venture. Denote as $k \in \left[\underline{k}, \bar{k}\right]$ the loan obtained by a female entrepreneur, with $0 < \underline{k} < \bar{k} < +\infty$.

All business operations take place in the informal economy. In that economy, owing to the prevalence of patriarchal forms of business regulations, each female informal entrepreneur may face gender-specific transaction costs, unless she can joint a network of business women large enough to overcome these costs. Let $n \in [0, N]$ denote the cardinality of the subset of female informal entrepreneurs who are connected with one another through a business network (say a cooperative or any business association). Each female entrepreneur member of that network will face a level,

$$t_c = \varphi\left(n,p\right)pk, \qquad (2.1)$$

of transaction costs reflecting the extent to which the network she belongs to is unable to eliminate

---

[9]Examples of activities including the vending of perishable goods (such as fruits and vegetables), and the vending of non- perishable goods (such as household appliances, furnitures, and other consumer durables).

[10]Microfinance programs generally foster self-employment.

her comparative disadvantage for being a female informal entrepreneur. These transactions costs are assumed to increase with size, k, and the degree of productivity, p, of the business venture.

Assumption 1. *The function φ satisfies the following properties:*

$$\varphi(n,p) = \begin{cases} 0 & \text{if } n > \tilde{n}(p) \\ \delta & \text{if } n \leq \tilde{n}(p) \end{cases} \tag{2.2}$$

where $\tilde{n}(p) \in (1, N]$ denotes the critical mass of connected female informal entrepreneurs above which networking becomes successful in eliminating gender-specific transaction costs in the informal economy.

Assumption 1 implies that unless the size of the network of female informal entrepreneurs is large enough, transaction costs induced by the prevalence of patriarchal forms of business regulations will not disappear.

Assumption 2. *The function $\tilde{n}(.)$ is strictly increasing and satisfies the following boundary conditions: (i) $\tilde{n}(0) = 0$; (ii) $1 < \tilde{n}(1) < N$.*

That $\tilde{n}(p)$ is bounded below by 0 means that a female entrepreneur who elects to capitalize a business venture with the lowest degree of productivity (i.e., $p = 0$) faces no transaction cost whether or not she operates in autarky. However, that $\tilde{n}(1) > 1$, means that no female informal entrepreneur acting in autarky can avoid gender-specific transaction costs when she chooses to informally operate a business venture with the highest degree of productivity (i.e., $p = 1$).

Next, denote as $\phi(p, k)$ the gross revenue generated by a female informal entrepreneur who uses her loan, k, to invest in a business activity with degree of productivity, p. We make the following Assumption:

Assumption 3. *The function ϕ satisfies the following properties: for all p, and all k,*

$$(i) \qquad \phi_p > 0, \quad k \text{ given};$$

$$(ii) \qquad \phi_k > 0, \quad p \text{ given};$$

$$(iii) \qquad \phi_{pk} = \phi_{kp} > 0$$

$$(iv) \qquad \phi_{kk} < 0.$$

Assumption 3 states that the function ϕ is strictly increasing in p (property i) and in k (property ii). It also states that the function ϕ has increasing differences in (p,k) on the feasible domain (property iii), and that ϕ is strictly concave in k (property iv).

2.1 Choice of Business Size

In this subsection, we are interested in characterizing·female entrepreneurs' choice of business size. Let r denote the rental rate of capital pre-determined by the assisting MFI. Denote as $\pi\left(k,p,\widetilde{r}\right)$ the residual claimed by a female entrepreneur who operates an informal business venture with degree of productivity, p, and size, k, when the marginal cost of borrowing an additional unit of capital is

$$\widetilde{r} = r + \varphi\left(n,p\right)p, \tag{2.3}$$

where equation (2.3) makes use of equation (2.1). Therefore we can write $\pi\left(k,p,\widetilde{r}\right)$ as follows:

$$\pi\left(k,p,\widetilde{r}\right) = \phi\left(p,k\right) - \widetilde{r}k. \tag{2.4}$$

Next, consider a female informal entrepreneur decision problem. Given the pair (n,r), a typical female informal entrepreneur sequential decision problem is to choose (i) the degree of productivity, p, of the business she plans to run, and (ii) the loan level, $k \in \left[\underline{k},\bar{k}\right]$, necessary to capitalize the venture. Her objective is to maximize her residual claim defined in (2.4). It will be assumed that each female entrepreneur solves her two-stage problem by backward induction.

Let $K\left(p,\widetilde{r}\right) \equiv \arg\max_{k} \pi\left(k,p,\widetilde{r}\right)$ be the optimal loan size chosen by a female informal entrepreneur when the state of the world is described by the pair $(p,\widetilde{r})$. And suppose that this optimal loan size is interior. The *Implicit function theorem* may be applied to establish the following result:

Lemma 1. *Let Assumption 3 hold. Then*

$$(i) \qquad \frac{\partial}{\partial p} K\left(p,\widetilde{r}\right) > 0.$$

$$(ii) \qquad \frac{\partial}{\partial \widetilde{r}} K\left(p,\widetilde{r}\right) < 0.$$

Part (i) of Lemma 1 states that if a female entrepreneur plans to run a more productive activity, it is optimal for her to increase her demand for capital, otherwise she will not maximize the

return to entrepreneurship. Part (ii) states that a return-maximizing female entrepreneur will always reduce her demand for capital as a result of an exogenous increase in the marginal cost of capital. Lemma 1 will prove useful for characterizing a female informal entrepreneur's choice of the degree of productivity of the business venture she plans to operate. Since all women in this environment have access to credit, we characterize this choice as dependent upon relevant socioeconomic characteristics of the environment in which these women live.

2.2 Choice of Business Activity by Female Informal Entrepreneurs

In this subsection, we study a female informal entrepreneur's choice of the degree of productivity, p, of the business venture she plans to operate in an environment where a collective action by women entrepreneurs is necessary to eliminate gender-specific transaction costs that severely constrain this choice. We assume that the objective pursued through such a choice is the maximization of the return to entrepreneurship.

Let $\hat{\pi}(n, p) \equiv \pi[K(p, \tilde{r}), p, \tilde{r}]$ denotes the return to entrepreneurship earned by a female entrepreneur who joins a business network of size n when she chooses an activity with degree of productivity, p. Then

$$\hat{\pi}(n, p) = \phi[p, K(p, \tilde{r})] - \tilde{r}K(p, \tilde{r}) \tag{2.5}$$

with $\tilde{r}$ as defined in (2.3). The following proposition formalizes the incentive for female entrepreneurs to operate business ventures with a high degree of productivity.

Proposition 1. *Let Assumptions 1-3 hold. If $n > \tilde{n}(p)$, for all $p \in [0, 1]$, then $1 = \arg\max_p \hat{\pi}(n, p)$.*

Proof. Observe that if $n > \tilde{n}(p)$, for all $p \in [0, 1]$, then $\varphi(n, p) = 0$, and, using (2.5), it can be shown that the return to entrepreneurship earned by a typical female informal entrepreneur reduces to

$$\bar{\pi}(p) \equiv \phi[p, K(p, r)] - rK(p, r). \tag{2.6}$$

Therefore, it suffices to establish that $\bar{\pi}(.)$ is a strictly increasing function : $\bar{\pi}'(p) > 0$, for all p. The proof follows directly from the application of the *envelope theorem* to (2.6) given that Assumptions 1-3 hold simultaneously·

Proposition 1 states that if gender-specific transaction costs were to be eliminated (i.e., $n = N$), access to credit would provide female entrepreneurs with an incentive to tap into the range of highly productive informal activities usually controlled by men. In other words, a return-maximizing female informal entrepreneur will always select a business activity with degree of productivity, $p = 1$. Proposition 1 therefore highlights the importance for women, as a group, to overcome patriarchal forms of business regulations that put them at a comparative disadvantage in managing highly productive informal activities. When such forms of business regulations are overcome by women, the optimal return to entrepreneurship is given by

$$\bar{\pi}(1) = \phi[1, K(1,r)] - rK(1,r). \tag{2.7}$$

Now, suppose instead that for some reasons, no female entrepreneur can link up with enough other female entrepreneurs in a business network when she chooses to run an activity with a degree of productivity, $p \in [0,1]$. In other words, $n \leq \tilde{n}(p)$, for all $p \in [0,1]$. How would this fact affect her optimal decision on the level of p? The following proposition provides an answer to that question:

Proposition2. *Let Assumptions 1-3 hold simultaneously. Suppose in addition that for all feasible pairs (p,k)*

$$\phi_p \leq \delta\underline{k}. \tag{2.8}$$

If

$$n \leq \tilde{n}(p), \tag{2.9}$$

for all $p \in [0,1]$, then $0 = \arg\max_p \hat{\pi}(n,p)$.

Proof. Observe from (2.5) that if $n \leq \tilde{n}(p)$, the return to entrepreneurship becomes

$$\underline{\pi}(p) \equiv \phi[p, K(p, r + \delta p)] - [r + \delta p] K(p, r + \delta p). \tag{2.10}$$

It then suffices to show that $\underline{\pi}(.)$ is a strictly decreasing function: $\underline{\pi}'(p) < 0$, for all p. The proof follows as an implication of the *envelope theorem,* using condition (2.8). Hence the maximum obtains at the corner $p = 0$.

Condition (2.8) states that, when they exist, gender-specific transaction costs, as measured by the lower bound, $\delta \underline{k}$, are sufficiently high. We draw from anthropological and economic studies of developing countries, in assuming that in area where women display human limitations and complications, a typical informal female entrepreneur faces prohibitive transaction costs that lead her to cluster in business venture that are less lucrative than those operated by male entrepreneurs, unless there are a sufficient number of other female entrepreneurs who have chosen a more productive project. For instance, Shilue (2003) reveals that in the Guinean city of Guekedou where tax collectors are mostly men, business taxes are levied every day on about five percent of the income earned by female traders while male traders pay approximately one percent of their total earnings. As a result, male traders in this area earn $3,500 per annum in comparison with $ 820 for their female counterparts. According to Shilue, a woman who refuses to pay such a higher gender-specific business cost either will lose her space in the market or will be spending some times in prison. Likewise, Gonzalez Aguilar (2006) reports that, because developing countries' women have had to fight against an adverse environment, which traditionally had been minimising and exploiting their capacities, in some cases, as a consequence of this reality, women are just satisfied with the non-financial benefits, such as the psychological satisfaction of "social contact".

Proposition 2 formalizes the observed overrepresentation of women entrepreneurs in low-productivity informal activities. It explains this overrepresentation by the prevalence in the informal economy of patriarchal forms of business regulations that substitute for the absence in that economy of legal means for enforcing contracts. A very important remark follows from Proposition 2 As an implication of Proposition 2, the optimal return to entrepreneurship when $\tilde{n}(p) \geq n$, for all p is

$$\underline{\pi}(0) = \phi[0, K(0, r)] - rK(0, r) \tag{2.11}$$

To highlight the empowerment potential of microfinance, it is important to obtain a ranking of the returns $\bar{\pi}(1)$ and $\underline{\pi}(0)$ as defined by Equations (2.7) and (2.11), respectively. The following result is obtained as a corollary to Proposition .

Corollary 1. *Given r as pre-determined by the microfinance institution, the following inequality*

obtains:

$$\underline{\pi}(0) < \bar{\pi}(1). \qquad\qquad (2.12)$$

Corollary 1 formalizes female entrepreneurs' incentive to use their access to credit in order to capitalize informal activities with a high degree of productivity. In other words, if all female entrepreneurs knew that enough other female entrepreneurs will choose to capitalize an activity of type $p = 1$—which is the informal activity with the highest degree of productivity—they will each elect to capitalize that activity because it maximizes their return to entrepreneurship: $\bar{\pi}(1) > \underline{\pi}(0)$. However, since each woman is anonymous, she may not know, prior to choosing any activity p, how many other women will link up with her in the business network spanned by that activity. If she chooses $p = 1$, on the basis that $\underline{\pi}(0) < \bar{\pi}(1)$, she may indeed earn a return $\bar{\pi}(1)$, if the total number, n, of female entrepreneurs in the business network spanned by activity $p = 1$ is large enough: $n > \tilde{n}(1)$. However, if $n \leq \tilde{n}(1)$, then she will earn a return

$$\underline{\pi}(1) = \phi\left[1, K\left(1, r + \delta\right)\right] - \left(r + \delta\right) K\left(1, r + \delta\right), \qquad\qquad (2.13)$$

which, by proposition 2, is less than $\underline{\pi}(0)$:

$$\underline{\pi}(1) < \underline{\pi}(0)$$

since $\underline{\pi}(p)$ is a decreasing function of p.

Whether or not $n > \tilde{n}(1)$ becomes crucial for the optimality of the business strategy of choosing $p = 1$. Thus, a typical female entrepreneur's decision whether or not to capitalize an activity of type $p = 1$ becomes a strategic reaction to what other female entrepreneurs choose as their business strategy. In other words, women's activity choice strategies are complement. How many women will choose to use their access to credit in order to tap into activities of type p can therefore be viewed as the outcome of a non-cooperative game between the N women living in the targeted environment. In what follows, we analyze the women's activity choice game in its normal form.

2.3 The Activity Choice Game

Each woman entrepreneur is indexed by i, with $i \in I$, where $I = \{1, ..., N\}$ denotes the set of women living in this environment. On the basis of Propositions 1 and 2, women in this environment have a choice between two types of informal activities: either a low-productivity one indexed by 0, or a high-productivity one indexed by 1. Thus, we can define $P_i = \{0, 1\}$ as the strategy set for woman $i \in I$, with generic element $p_i \in P_i$. We interpret p_i as woman i's activity choice strategy.

Let $P = \times_{i \in I} P_i$ denote the strategy space, whose elements $p = (p_i, p_{-i}) \in P$ define a strategy profile of the activity choice game. Let $P_{-i} = \times_{\{j \in I; \, j \neq i\}} P_j$ be the set of feasible joint strategies for all women other than woman i, with generic element $p_{-i} \in P_{-i}$. Observe that since P_i is finite for all i, P is also finite and contains a total of 2^N elements.

2.3.1 The Payoff Function

To construct each player's payoff function, we make use of expressions (2.7), (2.11), and (2.13). On the basis of Propositions 1 and 2, if player i selects the activity choice strategy $p_i = 0$, she will earn a payoff $\underline{\pi}(0)$ as specified by (2.11), irrespective of the activity choices of other players, because $\underline{\pi}(0) = \bar{\pi}(0)$. In contrast, if she plays the strategy $p_i = 1$, she will earn a return $\Pi(n)$ depending upon the strategy profile selected by her rivals, where

$$\Pi(n) = \begin{cases} \bar{\pi}(1) & \text{if } n > \tilde{n}(1) \\ \underline{\pi}(1) & \text{if } n \leq \tilde{n}(1) \end{cases} \qquad (2.14)$$

Observe that since $\underline{\pi}(1) < \underline{\pi}(0) < \bar{\pi}(1)$, clearly playing the strategy $p_i = 1$ is never a dominant strategy for any player of this game.

Now, let $V_i : P \to \Re$ denote woman i's payoff function. Therefore, we can define a typical woman-entrepreneur payoff as follows:

$$V_i(p_i, p_{-i}) = p_i \Pi(n) + (1 - p_i) \underline{\pi}(0) \qquad (2.15)$$

where

$$n = \sum_{i=1}^{N} p_i \qquad (2.16)$$

denotes the size of the network of female entrepreneurs who choose to play the activity choice strategy $p_i = 1$. Thus, if woman i plays the strategy $p_i = 0$, she will gain a payoff

$$V_i(0, p_{-i}) = \underline{\pi}(0),$$

irrespective of what other women do. However, if she plays $p_i = 1$, she will gain a payoff

$$V_i(1, p_{-i}) = \Pi(n),$$

which is dependent upon the level of n as determined by the the strategy profile p_{-i} selected by players other than player i, where $\Pi(n)$ is as defined in (2.14).

A *non-cooperative normal-form game* is the triple $\Omega = \langle I, P, \{V_i : i \in I\} \rangle$, consisting of a non-empty set of players I, a set P of feasible joint decision strategies, and a collection of payoff functions $\{V_i : i \in I\}$. Since all players have identical strategy spaces $(P_1 = P_2 = ... = P_N)$ and for all $i, j \in \{1, ..., N\}$, $V_i(p) = V_j(p)$, for all $i \neq j$, the normal-form game Ω is symmetric.

2.3.2 Pure-Strategy Nash-equilibria.

In this sub-section, we characterize the set of pure-strategy Nash-equilibria when all women make their business-activity decision simultaneously. We define a pure-strategy Nash equilibrium in terms of the payoffs players receive from various strategy profiles:

Definition 1. *A pure-strategy profile* $p^* \in P$ *is a Nash equilibrium of* Ω *if and only if* $V_i(p^*) \geq V_i(p_i, p_{-i}^*)$ *for all* $p_i \in P_i$ *and all* $i \in I$.

Let $\aleph_\Omega$ denote the set of pure-strategy Nash-equilibria of the game. Let $p^L \in P$ and $p^H \in P$ be feasible pure-strategy profiles, where p^L (respectively p^H) is the pure-strategy profile such that each woman $i \in I$ chooses an activity of type $p_i = 0$ (respectively $p_i = 1$). The following proposition is proved in Appendix A:

Proposition 3. *Let Assumptions 1-3 hold simultaneously. Then,* $\{p^L, p^H\} \in \aleph_\Omega$.

Proposition 3 states that the pure-strategy profile where all women elect to stay within the confine of low-capital, less productive economic activities (i.e., the profile p^L) and the one where

all of them elect to tap into high-capital, high-productivity activities (i.e., the profile p^H) belong to the set of pure-strategy Nash-equilibria of the women's business-decision game, Ω.

Before we proceed to derive further policy implications from the above result, we must address the question of whether the pure-strategy profiles p^L and p^H are indeed the only stable equilibria of the symmetric game, Ω. To address this issue, we first show that Ω is a supermodular game (Milgrom and Roberts, 1990), also known as a game characterized by strategic complementarities.

Definition 2. (Milgrom and Roberts, 1990) Ω *is a supermodular game, if for all i,*

(i) P_i *is a compact subset of $\Re$;*

(ii) V_i *is upper semi-continuous in p_i, for each fixed p_{-i};*

(iii) V_i *is continuous in p_{-i}, for each fixed p_i;*

(iv) V_i *has a finite upper bound;*

(v) V_i *has increasing differences in (p_i, p_{-i}) on $P_i \times P_{-i}$.*

In particular, property (v) of Definition 2 implies that for a player i, the incremental gain from taking her highest action is higher when players other than herself also take their highest action: for all $p'_i > p_i$ and all $p'_{-i} > p_{-i}$,

$$V_i\left(p'_i, p'_{-i}\right) - V_i\left(p_i, p'_{-i}\right) \geq V_i\left(p'_i, p_{-i}\right) - V_i\left(p_i, p_{-i}\right).$$

Our interest in supermodular games stems from several crucial properties these games have. First, the main characteristic of models with strategic complementarities is the possible presence of multiple equilibria, creating the possibility for coordination failures (Cooper and John, 1988; Diamond, 1982). Second, with a supermodular game, there is no need to rely on mixed-strategies for the existence of a Nash equilibrium, as existence of equilibrium of such game does not require continuity of best response functions (i.e., application of Tarski's fixed point theorem). Third, as an implication of supermodularity, we can restrict the search for equilibria to pure-strategy Nash-equilibria only, since mixed-strategies equilibria, when they exist, are unstable (Echenique (2002); Echenique and Edlin (2004)).

To show that the women's business-decision game, Ω, is supermodular, it suffices to prove that properties $(i) - (v)$ above are satisfied. The following Proposition, which is proved in Appendix B, establishes this result.

Proposition 4. *Under Assumptions 1-3, the symmetric game Ω, is supermodular.*

Proposition 4 implies that conditions underlying Topkis' theorem apply so that for the game Ω, women's best replies are increasing in opponents' actions: for each

$$\beta_i \left(p_{-i} \right) \in \arg \max_{p_i} V_i \left(p \right),$$

and for all $p'_{-i} > p_{-i}$, $\beta_i \left(p'_{-i} \right) \geq \beta_i \left(p_{-i} \right)$, all i.

Now, since the $\beta_i \left(p_{-i} \right)$ are increasing, to rule out asymmetric pure-strategy Nash equilibria, we show in the following Lemma—which we prove in Appendix C—, that women's best reply are single-valued correspondences (i.e., each β_i is a function):

Lemma 2. *Let $\beta_i \left(p_{-i} \right) = \{p_i : p_i \in \arg \max_{p_i \in P_i} V_i \left(p_i, p_{-i} \right)\}$, for all i, given p_{-i}. Then, under Assumptions 1-3, $\beta_i \left(p_{-i} \right)$ is a singleton.*

Lemma 2 states that players best replies are single-valued. This result, combined with our above application of Topkis' theorem rules out the existence of asymmetric pure-strategy Nash-equilibria for the women's occupational choice game. Hence the following Proposition:

Proposition 5. *Under Assumptions 1-3, $\left\{ p^L, p^H \right\} = \aleph_\Omega$.*

Proposition 5 states that the pure-strategy profile where all women elect to stay within the confine of low-productivity economic activities and the one where all of them elect to tap into high-productivity activities are the only pure-strategy Nash-equilibria of the activity-choice game, Ω. This multiplicity of equilibria suggests a potential role for a deliberate action to select one of the equilibria. Such deliberate action is desirable, however, only if the two equilibria can be ranked according to the Pareto principle. The following Proposition establishes this ranking.

Proposition 6. *Under Assumptions 1-3, the symmetric pure-strategy profile p^H Pareto dominates the profile p^L.*

Proof. To prove this Proposition, it suffices to show that for all $i \in I$, and for all $p_i \in P_i$, $V_i\left(p^H\right) - V_i\left(p^L\right) > 0$. Let $\Delta_i \equiv V_i\left(p^H\right) - V_i\left(p^L\right)$. From the definition of the payoff function V_i, the difference Δ_i reduces to

$$\Delta_i = \bar{\pi}\left(1\right) - \underline{\pi}\left(0\right)$$

Since $\tilde{n}\left(1\right) \in \left(1, N\right)$, by Assumption 2, the result simply follows from Corollary 1. This completes the proof.

Proposition 6 states that the pure-strategy profile where all women elect to operate high-productivity business ventures in the informal economy is strictly preferred to the one where all women elect to stay within the confine of low-productivity activities. Because the high-income equilibrium (i.e., p^H), is counter-intuitive in many poor countries where women are generally confined to low-productivity business activities,[11] our analysis therefore suggests that in these societies, coordination failures in women's activity choice decisions are to be blamed. Such a coordination failure prevents women from creating large enough business networks likely to enable them to overcome patriarchal forms of business regulations that put them at a comparative disadvantage, relative to men, at managing high-productivity business ventures in the informal economy.

We have posited that for all values p, the marginal revenue from increasing p is always smaller than or equal to the marginal increase in transaction costs, provided there are not a sufficient number of other female entrepreneurs undertaking the same project which would have made transaction cost zero. This assumption guarantees the existence of only two possible equilibriums: (a) a corner solution whereby all female entrepreneurs opt for the less productive project $p = 0$; or

---

[11] Gonzalez Aguilar (2006) documents five characteristics that are pervasive among business women of the developing world: (i) their business are smaller than other, employing less than five employees; (ii) they use traditional and low-productive technologies; (iii) they are concentrated in market sectors that have low barriers to entry and low levels of outside communication, ie., transfer to other markets; (iv) they are often home based; (v) their business growth strategies are affected by household responsibilities.

(b) a corner solution whereby all female entrepreneurs opt for the most productive project $p = 1$ (and transaction costs are zero). It is worth noticing however that, relaxing condition (2.8) would lead to a stable interior solution with all women choosing projects of medium productivity $p > 0$. This, in turn, would generate a sufficient network size and have transaction costs drop to zero for that productivity level. This possible interior equilibrium will imply that informal business women living in areas where their empowerment is generally seen as a threat to male hegemony need more than a large enough social network to gain social and politic powers as well as economic power. So as to run highly productive business ventures, these women will need strong support in negotiating the complex changes in gender roles that must ultimately take place in order for them to succeed as micro entrepreneur especially. To put it more precisely, they will need a very diversified help to reduce gender disparities that constrain the sets of choices available in many aspects of life. Otherwise these women will continue to have systematically poorer command over a range of productive resources, including education, land, information and financial resources, despite their access to microfinance services and their ability to mitigate gender-specific transaction costs that lead them to make economic decision that are arguably disempowering.

3. Concluding Remarks

This paper had two important related goals. The first was to explore the implications for women's choice of activity and demand for capital, of the interaction between economic and social factors. Improved access to credit and informality were the main economic factors underlying women's business decision in our model, while the prevalence in the informal economy of patriarchal forms of business regulations highlighted the social context underlying this decision. The second goal was to investigate necessary and sufficient conditions for microfinance services to nurture empowerment for women. We drew from the existing literature in assuming that women's earned income from entrepreneurship was a determining factor of their empowerment. To achieve that goal, we used a game-theoretic model featuring a supermodular game of activity choice between ex ante homogenous female entrepreneurs. We demonstrated that this game admits two Pareto-ranked

Nash-equilibria, all of which are symmetric in pure strategies. The equilibrium where all women elect to operate high-productivity business ventures in the informal economy is more empowering for women, and therefore preferred to the one where all of them elect to stay within the confine of low-productivity activities. Because of this multiplicity of equilibria, we concluded that access to credit was only necessary, but not sufficient for female empowerment. Indeed coordination failures in women's activity choices may prevent women from creating business networks large enough to mitigate patriarchal forms of business regulations that put them at a comparative disadvantage, relative to men, at managing high-productivity business ventures. We found that a sufficient condition for MFIs to succeed in nurturing female empowerment is that women's access to credit be conditioned to their adoption of high-productivity informal activities. Such conditionality may help the MFIs to organize these women in a business network (cooperatives are an example) large enough to mitigate patriarchal practices that raise women's cost of operating high-productivity activities in the informal economy. Finally, our analysis shows the importance of including the social context underlying the implementation of development projects targeted at women.

4. Appendix

A. Proof of Proposition 3.

The proof is divided in two claims:

Claim 1 *The strategy profile $p^L = \left(p_1^L, \ldots p_i^L, \ldots p_N^L\right)$ such that $p_i = 0$ for all $i \in I$, is a pure-strategy Nash equilibrium of Ω.*

Proof: Using (2.15) and the definition of a Nash-equilibria, it follows from definition 1 that, the profile p^L is a pure-strategy Nash equilibrium of Ω if and only if the following condition is always satisfied for all i:

$$\underline{\pi}(0) - \Pi(1) \geq 0 \tag{4.1}$$

Since $\tilde{n}(1) > 1$, the result then clearly follows from the strictly decreasing property of the function $\underline{\pi}$ (as an implication of proposition 2), i.e., $\underline{\pi}(0) > \underline{\pi}(1)$. Hence the result

Claim 2. *The strategy profile $p^H = \left(p_1^H, \ldots p_i^H, \ldots p_N^H\right)$ such that $p_i = 1$ for all $i \in I$, is a pure strategy Nash equilibrium of Ω*

Proof: With inequality (2.12) in hands, the proof follows in the same manner as in claim 1. This completes the proof of proposition 3.

B. Proof of Proposition 4.

To prove proposition 4, first, observe that for all i, $P_i = \{0, 1\}$, is clearly a compact subset of $\Re$, since p_i is closed and bounded. Therefore property (i) of a supermodular game is trivially satisfied. Second, to establish property (ii) and (iii), it suffices to prove the following claim:

Claim 1. *For all $i \in I$, the function $V_i : P \to \Re$, is continuous on P, where $P = \times_{i \in I} p_i$.*

Proof. Since p_i is finite for all i, therefore P is also finite, as the Cartesian product of a finite number of finite sets. Indeed, P has cardinal equal to 2^N, which is finite, since N is a finite number.

Therefore, by theorem[12], V_i is continuous on P. This establishes property (ii) and (iii) of a strictly supermodular game.

Third, to establish property (iv), it suffices to prove the following claim:

Claim 2. *For all $i \in I$, the function $V_i : P \to \Re$, attains a maximum on P.*

Proof. Since the set of feasible joint strategies reduced to P is finite and has no more than 2^N elements, we also have that $V_i(P) \subset \Re$ is also finite; and finite subsets of $\Re$ always contain their upper and lower bounds. It therefore follows that, V_i has a finite upper bound on P. This completes the proof of this claim.

Fourth, the following claim establishes property (v).

Claim 3. *Under assumptions 1-3, the function $V_i : P \to \Re$ has increasing differences in (p_i, p_{-i}) on $P_i \times P_{-i}$: for all $i \in I$, for all $p'_i > p_i$ and $p'_{-i} > p_{-i}$,*

$$V_i\left(p'_i, p'_{-i}\right) - V_i\left(p_i, p'_{-i}\right) \geq V_i\left(p'_i, p_{-i}\right) - V_i\left(p_i, p_{-i}\right) \tag{4.2}$$

Proof. Let $p'_i > p_i$ and $p'_{-i} > p_{-i}$ and suppose,

$$V_i\left(p'_i, p'_{-i}\right) - V_i\left(p_i, p'_{-i}\right) < V_i\left(p'_i, p_{-i}\right) - V_i\left(p_i, p_{-i}\right). \tag{4.3}$$

Observe that inequality (4.3) can also be written as follow:

$$V_i\left(p'_i, p'_{-i}\right) - V_i\left(p'_i, p_{-i}\right) < V_i\left(p_i, p'_{-i}\right) - V_i\left(p_i, p_{-i}\right). \tag{4.4}$$

all $i \in I$.

Since $p_i \in \{0, 1\}$, take $p'_i = 1$ and $p_i = 0$. Then, using the definition of $V_i(.)$, it can be shown that the strict inequality (4.4) reduces to

$$\Pi\left(n'\right) - \Pi\left(n^*\right) < 0. \tag{4.5}$$

---

[12]**Theorem** (continuity with opened sets): Any function defined on a finite set is continuous.

where

$$n' = 1 + \sum_{j \neq i} p'_j$$
$$n^* = 1 + \sum_{j \neq i} p_j$$

Since $p'_{-i} > p_{-i}$, its follows that $n' > n^*$ by construction. Now, if $n' \leq \tilde{n}(1)$, then from (2.14), it follows that $\Pi(n') - \Pi(n^*) = 0$ and we reach a contradiction. If $n^* \leq \tilde{n}(1) < n'$ instead, then (4.5) reduces to

$$\bar{\pi}(1) - \underline{\pi}(1) < 0. \tag{4.6}$$

By using the *Envelope theorem,* one can easily show that inequality (4.6) leads to a contradiction, since $\delta > 0$ (i.e., since $r < \tilde{r}$, by construction). Finally, if $\tilde{n}(1) < n^*$, then inequality (4.5) never holds. Hence the result. This completes the proof of proposition 4.

C. Proof of Lemma 2.

To prove Lemma 2, it suffices to show that given $p_{-i} \in P_{-i}$, and for all pairs $\left(p_i^L, p_i^H\right) \in P_i \times P_i$ such that $p_i^L \neq p_i^H$, $V_i\left(p_i^L, p_{-i}\right) \neq V_i\left(p_i^H, p_{-i}\right)$. Suppose by way of contradiction that for some $i \in I$ and for some $\hat{p}_{-i} \in P_{-i}$, we have

$$V_i\left(p_i^L, \hat{p}_{-i}\right) = V_i\left(p_i^H, \hat{p}_{-i}\right). \tag{4.7}$$

Since $P_i = \{0, 1\}$, take $p_i^L = 0$ and $p_i^H = 1$. Then, we can rewrite (4.7) as follows:

$$V_i\left(0, \hat{p}_{-i}\right) = V_i\left(1, \hat{p}_{-i}\right),$$

which, using the definition of function V_i, reduces to

$$\underline{\pi}(0) = \Pi(\hat{n}), \tag{4.8}$$

where

$$\widehat{n} = 1 + \sum_{j \neq i} \widehat{p}_j$$

Now, if $\widehat{n} \leq \widetilde{n}(1)$, then equality (4.8) reduces to

$$\underline{\pi}(0) = \underline{\pi}(1), \qquad (4.9)$$

which is a contradiction since by Proposition 2, $\underline{\pi}(.)$ is a decreasing function, i.e., $\underline{\pi}(0) > \underline{\pi}(1)$. If $\widehat{n} > \widetilde{n}(1)$, then (4.8) reduces to

$$\underline{\pi}(0) = \bar{\pi}(1),$$

which contradicts inequality (2.12). Hence the result.

References

[1] Anderson Siwan and Eswaran Mukesh (2005). "What Determines Female Autonomy? Evidence from Bangladesh". Manuscript, Department of Economics, University of British Columbia.

[2] Anderson, Siwan, and Jean-Marie Baland (2002), "The Economics of Roscas and Intrahousehold Resource Allocation, *The Quarterly Journal of Economics*, vol. 117, no. 3, pp. 963-995(33).

[3] Basu, Kaushik (2005), "Gender and Say: A Model of Household Behavior with Endogenously-determined Balance of Power, *Economic Journal*, forthcoming.

[4] Charmes, Jacques (2000) " Informal sector, Poverty and Gender: A Review of Empirical Evidence", Background paper for the World Development Report 2001.

[5] Carter Michael and Fletschner Diana (2004). "Constructing and Reconstructing Gender: Credit Supply and Women's Demand for venture Capital". CSDE Working Paper No. 04-10.

[6] Cooper, Russell and Andrew John (1988), "Coordination Failures in A Keynesian Models", *The Quarterly Journal of Economics*, vol. 103(3): 441-463.

[7] Dasgupta, Sukti and Barbattini Smita (2003). "Own Account Work as Work Status: Learning from the PSS in Bangladesh and Tanzania". In Martha Chen, Renana Jhabvala and Guy Standing (eds). Rethinking Informality and Work.

[8] De Soto, Hernando. (1989). The Other Path: the invisible revolution in the third world. Harper and Row, NY.

[9] Deshpanda Rani (2001):. "Increasing Access and Benefits for Women: Practice and Inovations among Microfinance Institutions–Survey Results" New York: UNCDF, 2001, 3.

[10] Diamond, Peter A. (1982) " Aggregate Demand Management in Search Equilibrium", Journal of Political Economy, Vol. 90, 881-94.

[11] Djankov Simeon., La Porta Rafael., Lopez-de-Silanes Florencio, Shleifer Andrei.(2002). "The regulation of entry". *Quarterly Journal of Economics* 117, 1 –37.

[12] Doing Business-Custom Query (2005), The World Bank Group. http://www.doingbusiness.org/CustomQuery/ (acessed on December 2005).

[13] Duflo, Esther (2005) " Gender Equality and Development". Working Paper, MIT Department of Economics.

[14] Echenique, Frederico (2002) " Comparative Statics by Adaptative Dynamics and the Correspondence Principle", *Econometrica*, Vol.70, No. 2, 833-844.

[15] Echenique, Frederico. and Aaron S. Edlin (2004) "Mixed Strategy Equilibria are Unstable in Games of Strategic Complements". Journal of Economic Theory, 118: 61-79.

[16] Fortin, Bernard, Nicolas Marceau, and Luc Savard (1997), "Taxation, Wage Controls and the Informal Sector", Journal of Public Economics, vol. 66: 293-312.

[17] Gibbon, Peter (1995). Structural Adjustment and the Working Poor in Zimbabwe. (Eds), Nordiska Afrikainstitutet.

[18] Goetz, Anne-Marie and Rina Sen Gupta (1996), "Who Takes the Credit?: Gender, Power, and Control over Loan Usein Rural Credit Programs in Bangladesh", World Development vol 24(1): pp. 45-63.

[19] Gonzalez Aguilar Véronica (2006) "Women's Participation in Microfinance" , http://www.globenet.org/horizon-local/ada/9905w.pdf (acessed on October 2006).

[20] International Labour Office (2002b). Women and Men in the Informal Economy: A Statistical Picture. Geneva: Employment Sector, International Labour Office.

[21] Johnson Simon, Kaufmann Daniel, McMillan John and Woodruff Christopher.(2000). "Why do firms hide? Bribes and unofficial activity after communism". *Journal of Public Economics* 76, pp. 495–520.

[22] Kabeer, Naila (2001), "Conflicts Over Credit: Re-Evaluating the Empowerment Potential of Loans to Women in Rural Bangladesh", *World Development*. 29(1), pp. 63-84.

[23] Kritz Mary M., Makinwa-Adebusoye Paulina and Gurak Douglas T.(2000) "The Role of Gender Context in Shaping Reproductive Behavior in Nigeria"... In Harriet B. Presser and Gita Sen eds.,Women's Empowerment and Demographic Processes. Oxford University Press, pp. 239-260.

[24] Lairap-Fonderson, Josephine (2002). The Disciplinary Power of Micro-Credit, in Parpart, J.L. eds, Rethinking Empowerment: Gender and Development in a Global/Local World. Routledge, chapter 11.

[25] Mailloux, Linda (1998b) "Participatory programme learning for women's empowerment in microfinance programmes: negotiating complexity, conflict and change". *IDS Bulletin*, 29, 39-50.

[26] McIntosh, Craig and Bruce Wydick (2005). "Competition and microfinance". Journal of Development Economics 78(2), pp. 271-298.

[27] Milgrom, Paul and Roberts John (1990). "Rationalizability and Learning in Games with Strategic Complementarities". Econometrica, 58, 1255-1278.

[28] Sethuraman S. V. (1998) "Gender, Informality, and Poverty: A Global Review".World Bank, Poverty Reduction and Economic Management Department, and WIEGO, Washington, D.C.

[29] Shilue, J (2003). "Cultural Cynicisms & Market Forces-Women Empowerment Struggle in Liberia and West African Countries" , The Perspective, Atlanta, Georgia. http://www.theperspective.org/womenempowerment.html (acessed on March 2008).

[30] Tarski, Alfred (1955) "A Lattice Theoretical FixPoint Theorem and its Applications", *Pacific Journal of Maths*, 5, 285-309.

[31] Topkis, Donald M. (1968) Ordered Optimal Decisions. PhD. Dissertation, Stanford University.

[32] USAID. Microenterprise Development in a Changing World: U.S. Agency for International Development Microenterprise Results Reporting for 2000 (Arlington, Va.: Weidmann Associates, 2000), 22

Chapter 2

Why Are Agricultural Performances So Poor in Sub-Saharan Africa?[†]

1. Introduction

Poor agricultural performances and rapid population growth have combined to keep improvements in agricultural productivity at the top of the policy agenda of Sub-Saharan African countries. Indeed, Sub-Saharan Africa (hereafter SSA) has long been an arena for persisting food insecurity and poverty, and does not look on track to achieve the new millennium development goals. Experts strongly recommend immediate action. Here is why.

On one hand, available evidence shows that agriculture is the main source of economic growth in SSA (Diagana, 2003)[1], and that the majority of it's population derives its livelihood from agricultural activities (Feder, Just and Zilberman, 1985; Resnick, 2004). Yet, a 2004 report from the *United Nations Conference on Nutrition* reveals that 33 percent of SSA's population was undernourished in 2000, among which children were reported as particularly vulnerable (*UNSCN*, 2004). On the other hand, as shown in the graphs below, labour productivity and output growth in SSA rank well below that of other developing regions. First, Figure 3 shows that SSA's average agricultural value-added per worker persistently lags behind that of all other developing regions, including East Asia and Pacific, Latin America and the Caribbean, and South Asia.[2]

---

[1]In SSA, the agricultural sector accounted in 1997 for about 35% of Gross Domestic Product, 40% of its exports and about 70% of employment (World Bank, 1997). It is also estimated in 1993 that, due to its stimulating effects on industry, transport and services, a 1% growth in agriculture generates an overall economic growth of 1.5% (Word Bank, 1993).

[2]Available data also indicate that during this period, SSA's average agricultural value added per worker was 84 percent of the average for East Asia and Pacific; 77 percent of the average for South Asia and, only 12 percent of that of the Latin America and the Caribbean region (*World Development Indicators* 2005).

Figure 3: Agricultural value added per agricultural worker (constant 2000 US$)
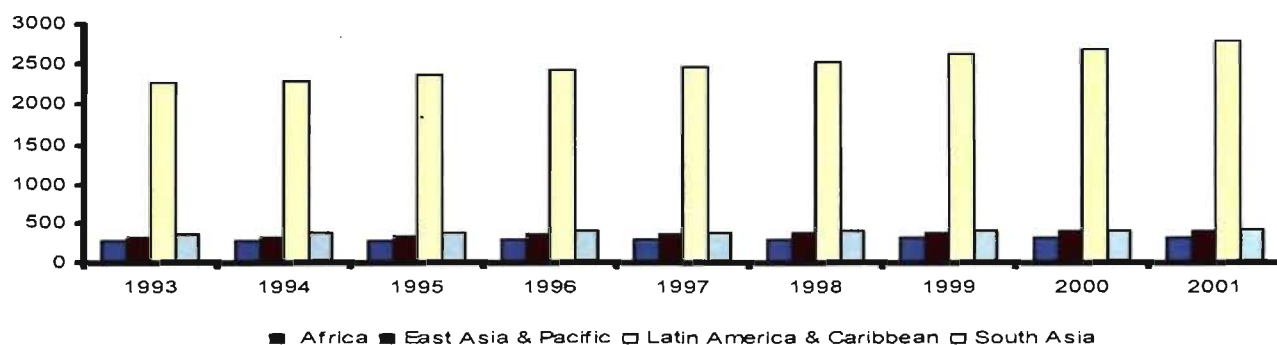
Source: World Development Indicators 2005

Second, as shown in Figure 4 below, agricultural productivity has been the lowest in SSA during the 1993-2001 period, when compared to other developing regions, including East Asia and Pacific, Latin America and the Caribbean, and South Asia.

Figure 4: Regional trend in agricultural value-added (constant 2000 billion US$)
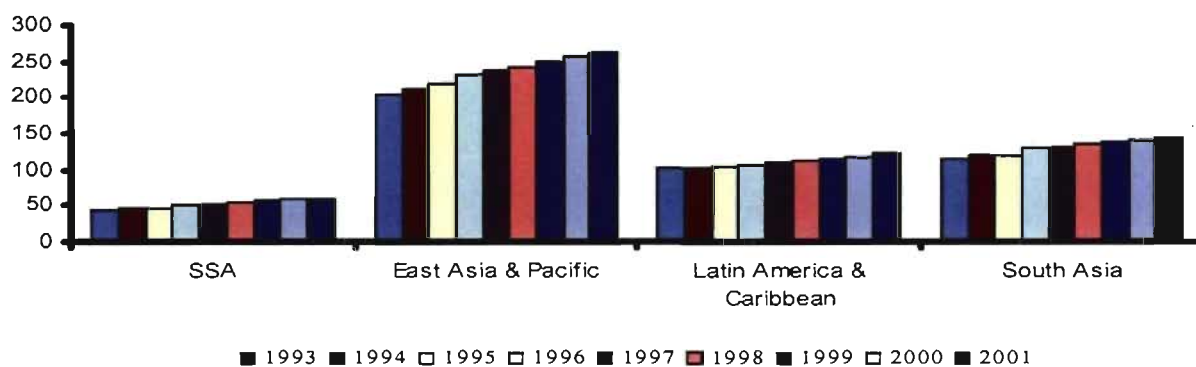
Source: World Development Indicators 2005

Without deliberate action, this trend will not reverse and the vast majority of small scale food-insecure rural households will be definitively doomed to a life poverty.

Third, according to agricultural experts worldwide, short term increases in agricultural production can be achieved through the combination of several factors, including fertilizer application (Gabre-Madhin and Johnston, 2002; Johnston and Kilby, 1975; Mellor, 1976). The Green Revolution of the 1960s and 1970s which led to spectacular increases in food production in several Asian countries, e.g. in India, Pakistan and, to a lesser extent, Bangladesh and Nepal directly speaks for this.

Unlike Asia, and Latin America however, SSA has a persistent idiosyncrasy: not only is soil fertility very poor (Crawford, Jayne, and Kelly, 2006), but, in addition, at least 90% of its agriculture is controlled by poor smallholder farmers farming less than 5 hectares usually with over two thirds having less than one hectare and who have restricted access to large enough financial assets (Spencer, 2001). There is a consensus in the literature on agricultural development that, given SSA agroecological idiosyncrasies, the best remedy for poor agricultural performances lies in efficient use of fertilizers (see Banerjee and Duflo, 2006). In other words, for financially constrained, smallholder SSA' farmers, relying on fertilizer consumption to increase on-farm yield is a viable alternative to mechanization of agriculture. Yet, as Figure 5 reveals, SSA persistently ranks last in fertilizer consumption compared to other developing regions, with the gap increasing overtime.[3]

---

[3] According to the *Word Bank Report 1999*, the observed trend of low fertilizer use in Africa continues to raise concerns about the continent's ability to overcome it food problems because these low application rates have severe consequences for the fertility of the soil and the sustanability of agricultural production.

Figure 5: Regional Trends in fertilizer consumption (100 gram per hectar of arable land)
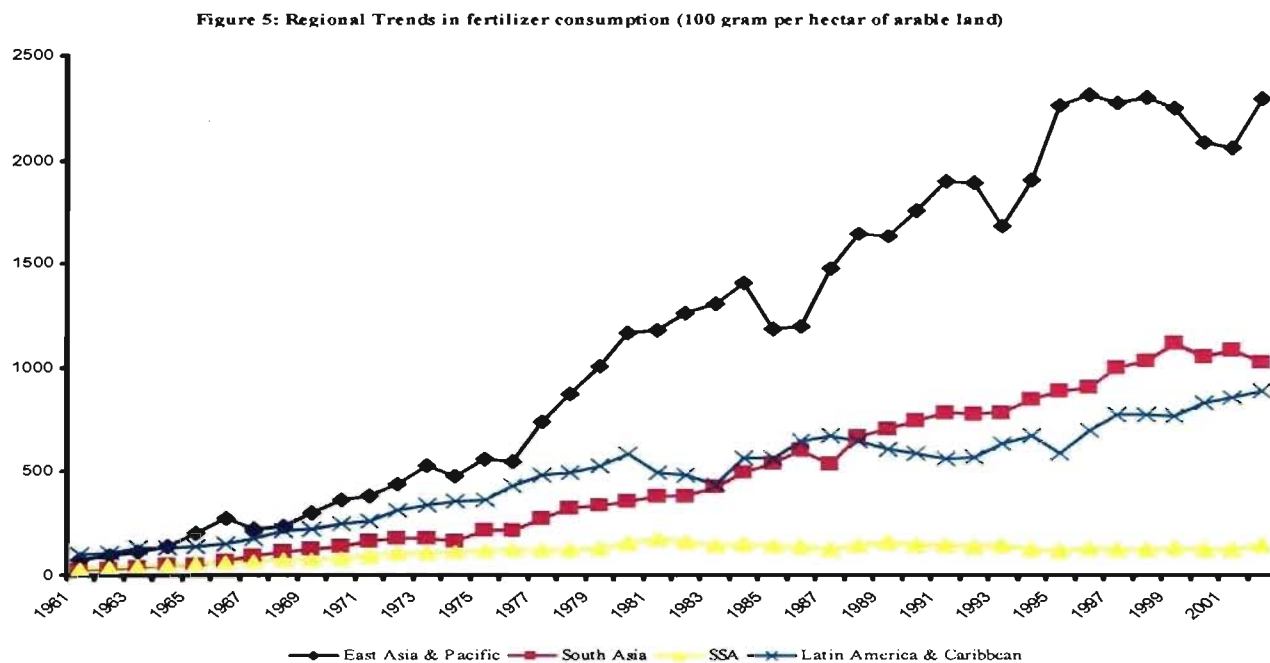
Source: World Development Indicators 2005

Arguably, given the empirical evidence on the high productivity effect of fertilizer consumption[4], the small size of their farming operations, their difficulties to accessing credit and insurance markets, and the availability of fertilizer in small packs, smallholders need not rely on loans in order to finance fertilizer's consumption. Instead, they may need to rely upon their own savings, which they can build up using the proceeds from the previous harvesting season (Duflo, 2006).

---

[4] Conservative estimates suggest an average return to using fertilizer that exceed 100 percent, while the median return is above 75 percent (Banerjee and Duflo, 2006). Further, in tables not reported here to save space, we also estimate the productivity effect of production-enhancing technologies such as agricultural machinery, land irrigation, fertilizer use, agricultural labour. Using on a Cobb-Douglas production function with data from a sample of 152 countries- members of the World Bank for the 1990 to 2005 time period , we show that for agricultural outcomes such as food production, crop production, cereal yields, and agricultural productivity, fertilizer application has the highest productivity effect in the set of agricultural inputs. These evidence therefore suggest that even when smallholder farmers in SSA cannot afford to buy the full package of production-enhancing technologies, poor agricultural performances in that sub-region have more to do with low fertilizer consumption, than any other factor among all agricultural inputs.

Standard economic theory predicts that a rational farmer will choose to build up savings and purchase the recommended quantity of fertilizer if provided with the incentive to do so. In other words, demand for fertilizer is induced by economic incentives. This conclusion is the corner stone of neo-Boserupian theories of *induced innovation*, in the tradition of seminal works by Binswanger and Ruttan (1978), Hayami and Ruttan (1985), and McGuirk and Mundlak (1991).[5] Works in that tradition emphasize factor scarcity (fertile soils, in this case) and market opportunities as the main determinants of the demand for fertilizers. For instance, Goldman (1993) finds a relation between low fertilizer consumption and low population density in Kenya, implying that measures aiming at improving transportation and marketing infrastructure in rural areas are the means by which crop prices can be raised so that fertilizer use becomes more profitable for smallholders (Crawford, Jayne and Kelly, 2006). Poulton, Kydd, and Dorward (2006) argue that enhancing affordability of fertilizer for smallholders may be important to increase fertilizer use in Sub-Saharan Africa, even where fertilizer use is profitable. In a review of the existing literature on the demand for fertilizer in SSA, Kelly (2006) finds that price stabilization in output markets is seen as providing a high incentive for SSA smallholders to increase fertilizer consumption.

In this paper, we argue that these poor agricultural outcomes are caused by the failure of SSA's farmers to intensify agriculture through efficient use of fertilizers, and develop a game-theoretic model to explain low fertilizer consumption in SSA. In our model, agents are smallholder farmers who must build up their savings so as to finance the purchase of a recommended level of fertilizers. To build up their savings, farmers in our model must draw on the proceeds from the previous harvesting season. However, a smallholder acting in autarky may find it hard to commit to saving for the next growing season (some four to six months away), if enough other farmers do not follow suit, because of traditional sharing obligations that put pressure on innovation-minded individuals to part with their assets in an unproductive manner. A farmer who anticipates this may renege on her commitment to save, and instead partake in the tradition to share his income with others. The more there are other farmers who break away from this tradition by firmly committing to saving,

---

[5] Neo-Boserupian theories are those that build around the seminal work of Boserup (1965).

the higher the likelihood that a farmer who saves in autarky will be able to protect her savings from social predation. Consequently, a farmer's decision to save raises other farmers' marginal gain from saving. We show that the non-cooperative game these farmers play admits two pure-strategy Nash-equilibria: a modernization equilibrium where all of them choose to save in order to finance the purchase of fertilizers, and a traditional equilibrium where they all elect not to save, and thus forfeit the benefits of farming modernization.

Our game-theoretic model is consistent with the observed coexistence, in SSA, of low-fertilizer consumption with economic conditions which neo-Boserupian theories identify as essential for the onset of technological innovations in agriculture—namely poor soil fertility and market opportunities. Indeed, in our model, conditions identified by neo-Boserupian theories as necessary and sufficient for the onset of agricultural innovation are shown to be only necessary. To be sufficient, this set of conditions must be enlarged to include the creation of a savings technology capable of mitigating the effects of social predation on farmer's decision to save.

Apart from assuming that all farmers are smallholders who must rely on fertilizer consumption to improve on-farm yield, two additional key assumptions provide the theoretical foundations of our model. First, farmers face a savings problem due to social pressures to part with their savings in an unproductive manner. Second, despite the fact that all farmers face this savings problem, they do not cooperate in solving it. In what follows, we provide evidence that motivates these two assumptions.

1.1   Social Predation and Bounded Rationality

That economic incentives alone dictate smallholders' behavior is the main implication of neo-Boserupian theories. In the context of SSA, this is rather puzzling, given decades of intervention by both African governments and the international donor community.[6] Indeed, this puzzle found a

---

[6] At the international level, key bilateral donors, including the Department for international Development (DFID), the Canadian International Development Agency (CIDA), and the US Agency for international Development (US-AID) have developed extensive agricultural and rural development programs such as micro-credit programs and, extensive fertilizer aid to small African farmers (Resnick, 2004). In 1996 for instance, Africa received the largest amount worldwide of Japan's Grant Aid for the Increase of Food Production (41%), while the remaining aid was dis-

resounding echo in a recent series of field experiments undertaken by Duflo, Kremer and Robinson (2005) in Busia, a rural district in Western Kenya where agriculture is the main income-generating activity and mostly operated by smallholder farmers growing corn on their own field mainly for consumption. Their experiments seek to understand why so many people in Busia do not use fertilizer to enhance soil-fertility even though it appears to have the potential to generate high on-farm yield increases, which in turn may improve farmers' well-being as well as food security in the region. Before their experiments, only 10% of farmers used fertilizer at any point in time, despite there being market opportunities for their crop, while fertilizer were available in small packs that required no large investment. For instance, Duflo, Kremer, and Robinson reveal that it costs 8 shillings, less than the price of 1 kilogram of maize–the main staple cereals in the region– to apply fertilizer on an area of 30 square meters. Furthermore, Duflo, Kremer, and Robinson also reveal that 80% of Busia farmers who received training on how to use fertilizer were still not using it. According to Duflo (2006), 98% of these farmers reported facing a savings problem, that hindered their ability to finance the purchase of fertilizers. So when, in another experiment, farmers were presented the option of buying a non-refundable, non-transferable voucher for fertilizer delivery in the growing season, Duflo, Kremer, and Robinson (2005) notice that 83% of them accepted the voucher-for-fertilizer scheme. Thus, despite the presence of economic incentives to increase fertilizer's consumption, unresolved savings problems reflecting the social context that shapes farmers' behavior appeared to have introduced a constraint on farmers' ability to respond to these incentives.

Evidence of social predation does not stop at Busia, or in Kenya. Indeed such evidence abounds

---

tributed to Asia (28%), Central and South America (15%), the middle East (8%) and East Europe (8%). The largest recipient include Kenya–with one billion yen worth of agricultural inputs, Tanzania, Ethiopia and Zambia (*The World Bank*,1999). At the domestic level, fertilizer subsidies were adopted by almost all African countries' governments and farmers were often freely trained and largely sensitized to its use. In the early 1980s, explicit fertilizer subsidies were widespread, and reached 25 percent in Malawi, 60 percent in Tanzania, 50 percent in Cameroon, 46 percent in Senegal and 85 percent in Nigeria. In addition, many African governments also adopted macroeconomic policies that include currency overvaluation, budgetary constraints and foreign exchange restrictions aimed at reducing fertilizers prices (*The World Bank*, 1999).

throughout SSA. For example, James (1999) argues that in community with social norms and codes prescribing behaviors, people may publicly disapprove those who accumulate wealth without sharing it with the community. Fafchamps (1999) claims that in poor agrarian communities where people continuously interact in close proximity with another, private wealth accumulation is perceived as an anti-social behavior precisely because it is an attempt to break away from traditional solidarity networks. Based on a field research conducted in Southern provinces of Zambia between January and August 2000, Verstralen (2001) documents the presence of sociocultural factors such as traditional ceremonies–e.g., marriage, initiation rites and funerals– that affect savings behavior because they often involve the generation and the redistribution of social payments. Chao-Béroff (2003) reports increased daily social pressures in rural African areas where banking services are generally inaccessible and concludes that without a savings discipline amongst rural populations, it is difficult for an individual in this environment to resist social pressures that make savings fungible. Ambec and Treich (2003) argue that in rural societies of African countries, traditional values press investment-minded individuals to spread their money within their community. Platteau (2006) reports that as a rule, generosity and hospitality are highly praised behaviors in traditional rural communities and successful individuals therefore gain social prestige and esteem when they redistribute their surplus. All the above facts suggest the presence, in SSA, of social institutions that put a bound on farmers' rationality. In other words, unlike the traditional *homo economicus*, a farmer's rationality, in SSA, is not unbounded, and our model takes explicit consideration of this fact.

1.2 Why Don't Smallholders Cooperate?

Given that a farmer's decision to save raises other farmers' marginal gain from saving, one may expect that this strategic complementarity in farmers savings decisions pave the way for mutual cooperation in solving this savings problem. Yet, such cooperation is unlikely to emerge endogenously, unless farmers, as a group, have access to a savings mobilization technology that satisfies the constraint that all farmers access their savings at the same time, due to identical calendar

events. Obviously, such a requirement rules out informal saving-by-lending mechanisms of mutual cooperation such as those suggested by Ligon, Thomas, and Worrall (2000). There are two main reasons for this. First, all farmers earn their income at the same time (harvesting season). Second, they all need their savings at the same period (growing season). Existing saving-by-lending mechanisms, however, emphasize rotating credit among members throughout time. Consequently, we conjecture that an essential feature of the environment underlying farmers' decision to save in a smallholder agrarian community is the absence of cooperation among farmers in finding solutions to their savings problems. Hence the non-cooperative game these farmers play.

Our paper is also related to the literature on strategic complementarities in agriculture. For example, Besley and Case (1994) show that in India, adoption of high-yield variety (HYV) seeds by an individual is correlated with adoption among their neighbors. Foster and Rosenzweig (1995) study the use of fertilizer during the early years of the Green Revolution in India. They find that the profitability of HYV seeds increased with past experimentation, of either the farmers or others in the village. Conley and Udry (2005) show that pineapple farmers in Ghana imitate the choice of fertilizer quantity of their neighbors when the latter have a good shock, and move further away from these decisions when they have a bad shock. We build around this literature by emphasizing access to a savings technology as another source of strategic complementarities among farmers living in the same community. The rest of this paper is organized as follows. The model is presented and solved in section 2. Section 3 offers concluding remarks.

2. The Framework

Consider an agrarian community consisting of N ex ante homogenous self-employed farmers, each endowed with a plot of farm land in which she grows a single agricultural crop. As essential means for boosting on-farm yield, assume a land-saving biotechnology is introduced in this region.[7] For the sake of simplicity, assume this agrarian community lasts for four periods representing two identical

---

[7] One can think of this bio-technology as an input package including, for example, high yielding varieties, and assorted fertilizer.

cropping cycles. Each cycle consists of two seasons, a sowing season (i.e., season 1) and a harvest season (i.e., season 2). The farmer's harvest is entirely sold in a competitive market by the end of the season.

During the first cropping cycle, it is assumed all farmers use a traditional method of production at sowing–combining land with own labor as the only essential inputs. However, at the end of the first cycle, i.e., after the first harvest is sold, each farmer may consider modernizing her farming practices, by combining recommended commercial biotechnology with land and own-labor. The purchase of the recommended commercial input package must be self-financed, which requires a period of savings.

2.1 Informal Savings and Social Pressures

Let $k > 0$, denote the savings level required to purchase the recommended quantity of commercial biotechnology. Therefore, at the end of the first harvest season, a typical self-employed farmer $i \in I$, (where $I = \{1, 2, ..., N\}$) faces a binary decision in preparation for the next cropping cycle: either she saves a part of the proceeds of the sale of her first harvest (i.e., k), in order to modernize her farming practices during the next cycle, or she does not save, in which case she maintains a traditional production method throughout the two cycles. In other words, at the end of the first agricultural cycle, each farmer either takes an action $s_i = 1$, meaning she commits to saving the amount of money needed to purchase the recommended input package at the opening of the next cropping period; or she takes an action $s_i = 0$, meaning she commits to maintaining the status quo for next cycle, in which case she does not save.

However, in this community with no alternative formal individual savings commitment technologies, it is assumed traditional values can press those who decide to save to spread their money within their community.[8] Therefore, denote as

$$\kappa_n = \alpha\left(n\right)k, \tag{2.1}$$

---

[8] For empirical evidences of this feature, see Platteau (2000) and Wendy (1979).

the net savings entirely controlled by a self-employed farmer who decide to modernize her farming practices, when $n = \sum_i s_i$, farmers elected to save. Thus, $\alpha(n) \in [0,1]$, represents the fraction of her savings a typical farmer is able to protect from traditional sharing obligations.

Assumption 1. *The function α satisfies the following property:*

$$\alpha(n) = \begin{cases} \underline{\alpha} & \text{if } n < n^* \\ 1 & \text{if } n \geq n^* \end{cases} \tag{2.2}$$

where $\underline{\alpha} \in (0,1)$, and $n^* \in (1, N)$ denotes the threshold number of self-employed farmers involved in a farming modernization activity, above which choosing to save entails no traditional sharing obligation for a farmer.

Assumption 1 highlights the importance for smallholder farmers, as a group, to overcome social pressures that give rise to savings predation, preventing them from modernizing their farming activities. That n^* is bounded below by 1 means that by privately accumulating savings alone, a typical farmer will suffer from the highest social pressures from doing so.[9]

2.2 Farmer's Welfare

Denote as $\underline{\pi}$, the gross earned-income a typical farmer claims, when she remains trapped into the agricultural status quo during the next cropping cycle. By contrast, let

$$\pi(\kappa_n) = \begin{cases} \underline{\pi} & \text{if } n < n^* \\ \overline{\pi} & \text{if } n \geq n^* \end{cases} \tag{2.3}$$

---

[9]As therefore implied by condition (2.2), that $n < n^*$, means that a higher demand of others will undermine farmer i's incentive to adopt a high-productive technology, In this case, all farmers will stagnate and remain poor. By contrast however, that $n \geq n^*$, means that the higher is the ability for farmers to use land-saving biotechnologies introduced in their region. This may be done through the implementation of a savings discipline in this community, by offering farmers an instrument to save through for instance the creation of a *all-farmers new commercial inputs purchasing association* enabling participants to purchase commercial inputs immediately after the first harvest. Hence, that $n \geq n^*$, can thus be interpreted as implying that in order for an inputs purchasing association to be a viable collective barrier against traditional sharing obligations, there must be a higher number of self-employed farmers participants.

denote a farmer's returns to cropping when she chooses to modernize her agricultural activities. The term κ_n is as defined in (2.1) and $\underline{\pi} < \bar{\pi}$ by construction.

Therefore, when a typical farmer chooses to play $s_i = 0$, she only claims $\underline{\pi}$, after the second harvest. But, when she chooses to play $s_i = 1$, she claims the residual $\underline{\pi}$ if $n < n^*$, and $\bar{\pi} > \underline{\pi}$, if individual savings was to be totally secured from traditional sharing obligations, i.e., if $n \geq n^*$.

Next, assume each farmer $i \in I$, enjoys a level of seasonal consumption of a numeraire good, as proxied by c_j^i, at the end of each cycle j ($j = 1, 2$). Thus, a typical farmer i's budget constraint in cycle j is then given as follows:

$$c_1^i + s_i k \leq \underline{\pi}, \qquad\qquad j = 1 \qquad\qquad (2.4)$$

$$c_2^i \leq (1 - s_i)\,\underline{\pi} + s_i \pi\,(\kappa_n) \qquad j = 2 \qquad\qquad (2.5)$$

where $\pi\,(\kappa_n)$ is as defined in (2.3).

Let $u : C \to \Re$, denote a typical farmer's periodic utility function, where $u\left(c_j^i\right)$ represents the periodic utility level she attains when she consumes an amount, c_j^i.

Assumption 2. *The function $u : C \to \Re$ has the following property for all $c' > c$, $u\,(c') - u\,(c) > 0$.*

Assumption 2 implies that more consumption is always better for all farmers in this environment.

Let $V : \{0, 1\} \times [0, N]$ be a real valued function with typical argument (s_i, n), where $s_i \in \{0, 1\}$, and $n \in [0, N]$. We denote as

$$V\,(s_i, n) = \begin{cases} (1 + \beta)u\,(\underline{\pi}) & \text{if } s_i = 0 \\ u\,(\underline{\pi} - k) + \beta\widetilde{\vartheta}\,(n) & \text{if } s_i = 1 \end{cases} \qquad\qquad (2.6)$$

where

$$\widetilde{\vartheta}\,(n) = \begin{cases} u\,(\underline{\pi}) & \text{if } n < n^* \\ u\,(\bar{\pi}) & \text{if } n \geq n^* \end{cases}$$

and $\beta \in (0, 1)$ denotes the usual intertemporal discounting factor.

As implied by assumption 2, if $s_i = 1$ and $n < n^*$, $V\,(1, n) < V\,(0, n)$. Thus, in a state where $n < n^*$, social pressures will become so harmful to a typical farmer that she will be inclined to reject agricultural innovations introduced in her community.

Assumption 3. *The parameters $\bar{\pi}$, $\underline{\pi}$ and k satisfy the following condition:*

$$\beta \left[u \left(\bar{\pi} \right) - u \left(\underline{\pi} \right) \right] > u \left(\underline{\pi} \right) - u \left(\underline{\pi} - k \right) \tag{2.7}$$

Assumption 3 simply guarantees that all farmers in this environment have the incentive to use the commercial biotechnology. It implies that neo-Boserupian policy prescriptions aimed at inducing agricultural innovations are materialized in this environment. First, the left-hand term of condition (2.7) (i.e., $\beta \left[u \left(\bar{\pi} \right) - u \left(\underline{\pi} \right) \right]$) states that fertilizer's use boosts post-harvest income. According to neo-Boserupian induced innovation theory, this effect arises from public investment in storage and transportation infrastructures that create market opportunities for farmers' products. Indeed, as farmers in SSA often live in low-population density rural areas, the profitability of farming modernization is essentially linked to their ability to find market opportunities for their products in consumption centers located in urban areas. Without adequate transportation and storage infrastructures, such opportunities would not exist.

Second, the right-hand term (i.e., $u \left(\underline{\pi} \right) - u \left(\underline{\pi} - k \right)$) denotes the cost, in utils, of modernizing farming methods. If fertilizer's costs (i.e., k) are too high, condition (2.7) may become violated. This violation would imply that modernization costs are at least as high as it benefits, if not higher. Therefore, in order for assumption 3 to hold, it is necessary that the costs of using fertilizers be reduced, so as to create an incentive for modernization. This too, is a neo-Boserupian policy prescription. Yet, because the incentive to modernize also depends on the farmer being able to secure her entire savings, and this, in turn, depends on how many other farmers will choose to build up their savings for this purpose, whether modernization will actually take place in our model agrarian community depends on the outcome of a non-cooperative game between the N farmers.

2.3 The Modernization Game

Let $I = \{1, ..., N\}$ be the finite set of self-employed farmers. The strategy set for each farmer $i \in I$, is denoted as $S_i = \{0, 1\}$, with a generic element $s_i \in S_i$. In addition, we adopt the following notations. Let $S = \times_{i \in I} S_i$ denote the strategy space, whose elements $s = (s_i, s_{-i}) \in S$ define a

strategy profile.[10] Let $S_{-i} = \times_{\{j \in I; \; j \neq i\}} S_j$ be the set of feasible joint strategies for farmers other than farmer i, with $s_{-i} \in S_{-i}$. Observe that since S_i is finite for all i, $S = S_i \times S_{-i}$ is also finite and contains a total of 2^N elements.

2.3.1 Payoff Functions

Continuing our description of the normal-form of the farming modernization game, we now turn our attention to the players' utility payoff functions. Let $U_i : S \rightarrow \Re$, denote farmer i's payoff function associated with a strategy profile $S_i = (s_i, s_{-i})$, where $U_i(s) \equiv V(s_i, n)$ represents farmer i's payoff. The number $n = \sum_i s_i$, denotes the cardinality of the subset of farmers who choose to play the strategy $s_i = 1$.

Thus, as an implication of (2.6), if farmer i plays the strategy $s_i = 0$, she will gain a payoff

$$U_i(0, s_{-i}) = (1 + \beta)u(\underline{\pi}),$$

irrespective of what other farmers do.

In contrast, if she plays the strategy $s_i = 1$, she will gain a payoff

$$U_i(1, s_{-i}) = u(\underline{\pi} - k) + \beta u(\underline{\pi}),$$

if $n < n^*$; while she will gain a payoff

$$U_i(1, s_{-i}) = u(\underline{\pi} - k) + \beta u(\bar{\pi}),$$

if $n \geq n^*$.

A *non-cooperative normal-form of the farming modernization game* is the triple $\Gamma = \langle I, S, \{U_i : i \in I\} \rangle$, consisting of a nonempty set of players I, a set S of feasible joint farming modernization strategies, and a collection of payoff functions $\{U_i : i \in I\}$. As players all have identical strategy sets i.e.,

---

[10] s_i may represent the message a typical farmer sends to his collectivity, while S may denote the set of messages within the same population of farmers.

$S_1 = S_2, ... = S_N$ and for all $i, j \in \{1, ..., N\}$, $U_i(s) = U_j(s)$, for all $i \neq j$, the normal-form game Γ is symmetric.[11]

2.3.2 Nash Equilibria in Pure Strategies

The problem set out in this subsection– that of determining farmers' choice of the type of agricultural practices– is characterized here through the set of Nash equilibria when all farmers make their agricultural innovation's decision simultaneously. We define a pure-strategy Nash equilibrium (NE) in terms of the payoffs players receive from various strategy profiles:

Definition 1. *A pure-strategy profile $s^* \in S$ is a NE of Γ if and only if $U_i(s^*) \geq U_i(s_i, s^*_{-i})$ for all $s_i \in S_i$ and all $i \in I$.*

Let $\mathcal{L}_\Gamma$ denote the set of pure Nash equilibria of the game Γ. Let $s^1 \in S$ and $s^0 \in S$ be feasible strategy profiles, where s^1 (respectively s^0) is the strategy profile such that all farmers choose to purchase and to use the recommended commercial inputs package during the opening of the next cropping cycle, i.e., $s_i = 1$ for all i (respectively opt for the agricultural status quo at sowing, i.e., $s_i = 0$, for all i). First, we obtain the following result proved in Appendix A.

Proposition 1. *Under Assumptions 1-3, $\{s^0, s^1\} \in \mathcal{L}_\Gamma$.*

Proposition 1 states that the strategy profile where all farmers choose the agricultural status quo ($s_i = 0$, all i) and the strategy profile where they all use the recommended level of biotechnology in their agricultural activities (i.e., $s_i = 1$, all i) are both Nash equilibria of the non-cooperative game Γ.

Before we proceed to derive further policy implications from the result outlined in Proposition 1, we must address the question of whether the strategy profiles s^0 and s^1 are indeed the only stable equilibria of the symmetric game, Γ. After all, there is no a priory guarantee that a symmetric game with strategic complementarities only has symmetric equilibria. Therefore to address this issue of whether $\{s^0, s^1\}$ are indeed the only equilibria of the modernization game, we first show

---

[11]Hence, the identity of the players does not matter and we do not need to consider strategy profile separately.

that Γ is indeed a supermodular game (as this concept is defined and used in Milgrom and Roberts, 1990), also known as a game characterized by strategic complementarities.

Definition 2. (Milgrom and Roberts, 1990) Γ is a supermodular game, if for all i,

    (i) S_i is a compact subset of $\Re$;

    (ii) U_i is upper semi continuous in s_i, for each fixed s_{-i};

    (iii) U_i is continuous in s_{-i}, for each fixed s_i;

    (iv) U_i has a finite upper bound;

    (v) U_i has (strictly) increasing differences in (s_i, s_{-i}) on $S_i \times S_{-i}$.

In particular, property (v) of Definition 2 implies that, for a typical small self-employed farmer i, the incremental gain from taking a higher action is higher, when other farmers also play their highest action: for all $s'_i > s_i$ and $s'_{-i} > s_{-i}$,[12]

$$U_i \left(s'_i, s'_{-i}\right) - U_i \left(s_i, s'_{-i}\right) \geq U_i \left(s'_i, s_{-i}\right) - U_i \left(s_i, s_{-i}\right).$$

The theory of supermodular games provides rigorous analytical tools for eliciting both the cardinality and the structure of the set of Nash-equilibria of a non-cooperative game with strategic complementarities. In particular, the importance of this theory in the present paper lies in several crucial properties these games have. First, the major characteristic of games with strategic complementarities is the presence of Pareto-ranked equilibria, which creates the possibility for coordination failures (Cooper and John, 1988; Diamond, 1982). Second, with a supermodular game, there is no need for mixed-strategies to ensure the existence of a Nash equilibrium, as the existence of equilibrium of such game does not require continuity of best response function (i.e., application of Tarski's fixed point theorem). Third, as an implication of supermodularity, we can easily restrict

---

[12] As an implication of property (v) of Definition 3, each player will therefore choose a higher action when other players increase their action.

our analysis to NE in pure strategies, because when a supermodular game has mixed strategy equilibria, these equilibria are always «unstable» under a variety of dynamic adjustment process (Echenique, 2002; Echenique and Edlin, 2004).

To show that the farming modernization game, Γ, is supermodular, it suffices to prove that properties $(i) - (v)$ above are satisfied. We prove the following proposition in Appendix B.

Proposition 2. *Under assumptions 1-3, the symmetric farming modernization game Γ, is super-modular.*

Proposition 2 implies that conditions underlying *Topkis' theorem* apply, so that for the game Γ, each small self-employed farmer's best response function $\zeta_i : S_{-i} \to S_i$, where

$$\zeta_i(s_{-i}) \in \arg\max_{s_i} U_i(s),$$

is strictly increasing in the strategy profile chosen by players other than herself: for all i, and for all $s'_{-i} > s_{-i}, \zeta_i(s'_{-i}) > \zeta_i(s_{-i})$. Indeed, given the properties of the function ζ_i, a pure-strategy Nash-equilibrium of Γ always exists, by the application of Tarski's *fixed-point theorem*.

Now, since the best replies, $\zeta_i(s_{-i})$, are increasing, players' strategies are complements, implying that Γ indeed admits multiple pure-strategy Nash equilibria. Thus, to rule out asymmetric pure-strategy Nash equilibria, we show in the following Lemma –which we proved in Appendix C–, that farmers' best responses are single-valued correspondences (i.e., each ζ_i is a function):

Lemma 1. *Let $\zeta_i(s_{-i}) = \{s_i : s_i \in \arg\max_{s_i \in S_i} U_i(s_i, s_{-i})\}$, for all i, given s_{-i}. Then, under Assumptions 1-3, $\zeta_i(s_{-i})$ is a singleton.*

Lemma 1 states that given $s_{-i} \in S_{-i}$, $U_i(., s_{-i})$ has a unique maximizer in S_i. In other words, players best replies are single-valued. This result combined with the application of Topkis' theorem rules out the existence of asymmetric pure-strategy Nash equilibria for the farming modernization game, Γ. Hence the following proposition:

Proposition 3. *Under Assumptions 1-3 , $\{s^0, s^1\} = \mathcal{L}_\Gamma$.*

Proposition 3 states that the strategy profile where all farmers elect to maintain the status quo and the one where they all elect to save and therefore modernize their agricultural practices are the only pure-strategy Nash-equilibria of the farming modernization game, Γ.

As an implication of Proposition 3, it follows that, in an environment with strategic complementarities, individual (farm-level) adoption of high-productive land-saving biotechnologies introduced in the community is strongly determined by the aggregate behavior. In other words, "when in Rome", it pays to "do as the Romans do".

The multiplicity of equilibria outlined in Proposition 3 suggests that there is a role for public policy in enhancing farming modernization, beyond what is prescribed by neo-Boserupian theories of induced innovation. Such additional policy would help coordinate farmers' decisions toward the modernization equilibrium. But such an action is desirable only if the two equilibria can be ranked according to the Pareto principle. The following Proposition therefore establishes the needed ranking.

Proposition 4. *Under Assumptions 1-3, the symmetric pure-strategy profile s^1 Pareto dominates the profile s^0.*

Proof. To prove this Proposition, it suffices to show that for all $i \in I$, and for all $s_i \in S_i$, $U_i\left(s^1\right) - U_i\left(s^0\right) > 0$. To proceed, let $\Lambda_i \equiv U_i\left(s^1\right) - U_i\left(s^0\right)$. From the definition of the payoff function U_i, the difference Λ_i reduces to

$$\Lambda_i = \beta\left[u\left(\bar{\pi}\right) - u\left(\underline{\pi}\right)\right] - \left[u\left(\underline{\pi}\right) - u\left(\underline{\pi} - k\right)\right]$$

The result simply follows from condition (2.7). This completes the proof.

Proposition 4 states that the strategy profile where all farmers elect to modernize their farming practices by adopting high-productive land-saving biotechnologies is strictly preferred to the one where they all elect to maintain the status quo.

Because the modernization equilibrium (i.e. s^1) is counter-intuitive for SSA economies characterized by a timelessly low performance of the agricultural sector, our analysis suggests that SSA's

persistent poor record of agricultural modernization reflects a coordination failure in farmers' savings strategies. Our analysis also suggests that the creation of new, less-fungible savings products by helping SSA farmers overcome social pressures that prevent them from firmly committing to saving, may indeed boost modernization of SSA agriculture.

As the optimal intertemporal decision depends the more on the discount function utilized, a growing body of the time-inconsistent-literature (see, for instance, Ackerlof,1991; Brocas and Carrillo, 2001; Strotz, 1956) argues that in a case of a behavioural regime where decision makers discount rather hyperbolically than exponentially (i.e., the discount rate is not a constant but declining over time), it can be optimal from an ex-ante point of view to postpone technological changes from traditional agricultural practices to modern agricultural practices into the future. Clearly, with hyperbolic preferences, the potential problem of time-inconsistency generally occurs, implying that an ex ante optimal intertemporal consumption and investment strategy, obtained from the maximization of farmer's welfare in the first sowing season, will not be optimal if reassessed at the second sowing season when no mandatory commitment can be enforced. The model in this paper differs from much of the time-inconsistent-preference explanation for saving difficulties in two main ways. First, its makes a clear case that savings commitment problem is plausibly related to social obligations. Second, its shows that it is more important to protect the farmer from others and not from herself, as suggested by the literature linking saving commitment problems with time inconsistent preferences.[13]

3. Conclusion

This paper had two principal goals. The first was to show how the sociocultural context impacts farmers' decisions to modernize their agricultural activities. The sociocultural context we considered was highlighted by the prevalence, in African rural communities, of traditional sharing

---

[13] The later literature supports the idea that institutions such as Rotating Savings and Credit Associations can help their members to overcome inconsistent preferences problems preventing them to manage their money in a way that help them better coping with poverty they are trapped in (see, for instance, Banerjee and Duflo, 2006; Rutherford, 1999).

obligations that present innovation-minded individuals with self-control problems on their private financial and non financial assets. The second goal was to investigate necessary and sufficient conditions for farmers to modernize their farming practices in such a context. We drew from the existing literature in assuming that the introduction of high-productivity, land-saving biotechnologies in agriculture was a determining factor of on farm productivity increase. We also maintain that the African environment, with the exception of war-torn countries, potentially offers profitable economic opportunities for smallholder farmers, which, according to neo-Boserupian theorists accounts for the decision to introduce technological innovations in agriculture. To achieve these two goals, we used a game-theoretic framework featuring a non-cooperative game of farming modernization decision between ex ante homogenous self-employed farmers. We demonstrated that this game admits two pure-strategy, Pareto-ranked, symmetric Nash-equilibria. The equilibrium where all farmers choose to modernize their farming methods is preferred to the one where all of them choose to remain trapped in the agricultural status quo. Because of the multiplicity of equilibria, we concluded that there is a role for public policy in enhancing farming modernization in SSA, beyond what is prescribed by neo-Boserupian theories of induced innovation. In other words, scarcity and economic opportunities for farmers, which have been put forward by neo-Boserupian agricultural economists as determinants for the onset of technological innovations in agriculture, are, in the context of SSA, only necessary, but not sufficient, to generate modernization of farming methods. Indeed, coordination failures in farming modernization choices may prevent farmers from mitigating traditional sharing obligations that hinder their saving efforts. We argued that in SSA, to obtain necessary and sufficient conditions, one must supplement neo-Boserupian policy prescriptions with the creation of savings products—say, non-refundable and non-transferable vouchers as argued by Duflo (2006). Such savings technology may help mitigate social pressures that prevent SSA's smallholder farmers from firmly committing to building their savings necessary to finance fertilizer consumption.

4. Appendix

A. Proof of Proposition 1.

The proof is divided in two claims:

Claim 1 *The strategy profile* $s^0 = \left(s_1^0, ... s_i^0, ... s_N^0\right)$ *such that* $s_i = 0$, *for all* i, *is a pure-strategy Nash equilibrium of* Γ.

Proof: Using the definition of a payoff function, it follows from definition 1 that the profile s^0 is a pure-strategy NE of Γ if and only if the following condition is always satisfied for all i:

$$u\left(\underline{\pi}\right)\left(1+\beta\right) - V\left(1,0\right) \geq 0 \tag{4.1}$$

Since $n^* > 1$, the result then clearly follows from the definition of function V, and the strictly increasing property of the function u i.e., $u\left(\underline{\pi}\right) > u\left(\underline{\pi} - k\right)$.

Claim 2. *The strategy profile* $s^1 = \left(s_1^1, ... s_i^1, ... s_N^1\right)$ *such that* $s_i = 1$, *for all* i, *is a pure-strategy Nash equilibrium of* Γ.

Proof: With inequality (2.7) in hands, the proof follows in the same manner as in claim 1. Hence the result.

B. Proof of Proposition 2.

To prove proposition 2, first, observe that for all i, $S_i = \{0,1\}$, is clearly a compact subset of $\Re$, since S_i is closed and bounded. Therefore property (i) of a supermodular game is trivially satisfied. Second, to establish property (ii) and (iii), it suffices to prove the following claim:

Claim 1. *For all* $i \in I$, *the function* $U_i : S \to \Re$, *is continuous on* S, *where* $S = \times_{i \in I} S_i$.

Proof. Since S_i is finite for all i, it follow that S is also finite, as the Cartesian product of a finite number of finite sets. Indeed, S has cardinal equal to 2^N, which is finite, since N is a finite number. Therefore, by theorem[14], U_i is continuous on S. This establishes property (ii) and (iii) of a strictly supermodular game.

---

[14]**Theorem** (continuity with opened sets): Any function defined on a finite set is continuous.

Third, to establish property (iv), it suffices to prove the following claim:

Claim 2. *For all $i \in I$, the function $U_i : S \to \Re$, attains a maximum on S.*

Proof. Since the set of feasible joint strategies reduced to S is finite and has no more than 2^N elements, we also have that $V_i(S) \subset \Re$ is also finite; and finite subsets of $\Re$ always contain their upper and lower bounds. It therefore follows that, U_i has a finite upper bound on S. This completes the proof of this claim.

Fourth, the following claim establishes property (v).

Claim 3. *Under assumptions 1-3, the function $U_i : S \to \Re$ has increasing differences in (s_i, s_{-i}) on $S_i \times S_{-i}$: for all $i \in I$, for all $s'_i > s_i$ and $s'_{-i} > s_{-i}$,*

$$U_i\left(s'_i, s'_{-i}\right) - U_i\left(s_i, s'_{-i}\right) \geq U_i\left(s'_i, s_{-i}\right) - U_i\left(s_i, s_{-i}\right) \tag{4.2}$$

Proof. Suppose that for all $i \in I$, $s'_i > s_i$ and $s'_{-i} > s_{-i}$ but,

$$U_i\left(s'_i, s'_{-i}\right) - U_i\left(s_i, s'_{-i}\right) < U_i\left(s'_i, s_{-i}\right) - U_i\left(s_i, s_{-i}\right). \tag{4.3}$$

We will show that inequality (4.3) leads to a contradiction. First, observe that inequality (4.3) can be written as follows:

$$U_i\left(s'_i, s'_{-i}\right) - U_i\left(s'_i, s_{-i}\right) < U_i\left(s_i, s'_{-i}\right) - U_i\left(s_i, s_{-i}\right). \tag{4.4}$$

Next, since $s_i \in \{0,1\}$, for all $i \in I$, take $s'_i = 1$ and $s_i = 0$. Then, it can be shown that (4.4) reduces to

$$V\left(1, n'\right) - V\left(1, \tilde{n}\right) < 0 \tag{4.5}$$

where

$$\begin{aligned}
n' &= 1 + \sum_{j \neq i} s'_j \\
\tilde{n} &= 1 + \sum_{j \neq i} s_j
\end{aligned}$$

Since $s'_{-i} > s_{-i}$, its follows by construction that $\widetilde{n} < n'$. Now, If $n' < n^*$ then from (2.6), it follows .that $V(1, n') - V(1, \widetilde{n}) = 0$ and we reach a contradiction. If $\widetilde{n} < n^* \leq n'$ instead, then (4.5) reduces to

$$u(\bar{\pi}) - u(\underline{\pi}) < 0.$$

Contradiction again, since by Assumption 2, the function $u(.)$ is strictly increasing in its argument, i.e., $u(\bar{\pi}) > u(\underline{\pi})$. Finally, if $\widetilde{n} \geq n^*$, then inequality (4.5) never holds once more. This completes the proof of proposition 2.

C. Proof of Lemma 1.

Proof. To prove Lemma 1, it suffices to show that given $s_{-i} \in S_{-i}$, and for all pairs $\left(s_i^0, s_i^1\right) \in S_i \times S_i$ such that $s_i^0 \neq s_i^1$, $U_i\left(s_i^0, s_{-i}\right) \neq U_i\left(s_i^1, s_{-i}\right)$. Suppose by way of contradiction that for some $i \in I$, and for some $\widehat{s}_{-i} \in S_{-i}$, we have

$$U_i\left(s_i^0, \widehat{s}_{-i}\right) = U_i\left(s_i^1, \widehat{s}_{-i}\right) \tag{4.6}$$

Since $S_i = \{0, 1\}$, for all $i \in I$, take $s_i^0 = 0$ and $s_i^1 = 1$. Then, we can rewrite (4.6) as follow:

$$U_i\left(0, \widehat{s}_{-i}\right) = U_i\left(1, \widehat{s}_{-i}\right),$$

which, using the definition of function U_i, reduces to

$$(1 + \beta) u(\underline{\pi}) = V(1, \widehat{n}) \tag{4.7}$$

where

$$\widehat{n} = \sum_i \widehat{s}_i$$

Now, suppose that $\widehat{s}_j = 0$, *for all* $j \neq i$. Then, since $1 < n^*$, equality (4.7) reduces to

$$u(\underline{\pi}) = u(\underline{\pi} - k) \tag{4.8}$$

which is a contradiction of Assumption 2 implying that $u(\underline{\pi}) > u(\underline{\pi} - k)$. Likewise, suppose that $\widehat{s}_j = 1$, *for all* $j \neq i$. If $\widehat{n} < n^*$, then, equality (4.7) reduces again to (4.8) and we also reach a contradiction once more. If $\widehat{n} \geq n^*$, then (4.7) reduces to

$$(1 + \beta) u(\underline{\pi}) = u(\underline{\pi} - k) + \beta u(\bar{\pi}) \tag{4.9}$$

which contradicts condition (2.7) implying that $(1 + \beta) u(\underline{\pi}) < u(\underline{\pi} - k) + \beta u(\bar{\pi})$. Hence the result.

References

[1] Ackerlof, G. (1991) "Procrastination and Obedience", *American Economic Review*, 81: 1-19.

[2] Ambec, Stefan and Treich, Nicolas. (2003) "Roscas as financial agreements to cope with social pressures", working paper 2003-01, Institut National de la Recherche Agronomique-Université Pierre Mendès France.

[3] Banerjee V., Abhijit and Esther Duflo (2006). " The Economic Lives of the Poor ", Mimeo, MIT.

[4] Besley, Timothy. and Case, Anne (1994) Diffusion as a Learning Process: Evidence from HYV Cotton, RPDS, Princeton University, Discussion Paper No. 918.

[5] Banerjee V., Abhijit and Esther Duflo (2006): " The Economic Lives of the Poor", Mimeo, MIT.

[6] Binswanger, Hans and Ruttan, Vernon W. (1978): Induced Innovation. Johns Hopkins University Press, Baltimore.

[7] Boserup, Esther (1965) *The Conditions of Agricultural Growth*. Chicago: University of Chicago Press.

[8] Brocas, I and J.D. Carillo. (2001) " Rush and Procrastination under Hyperbolic discounting and Independent Activities", *Journal of Risk and Uncertainty*, 22:141-44.

[9] Chao-Béroff Rénée. (2003): "Rural Savings Mobilization in West Africa: Guard Against Shocks or Build an Asset Base?", *MicroBanking Bulletin,* July 2003.

[10] Conley, Timothy and Udry, Christopher (2005). "Learning About a New Technology: Pineapple in Ghana", mimeo, Yale.

[11] Cooper, Russell and Andrew John (1988), "Coordination Failures in A Keynesian Models", *The Quarterly Journal of Economics*, vol. 103(3): 441-463.

[12] Crawford Eric W., Jayne T. S. , and Kelly Valerie A. (2006) "Alternative Approaches for Promoting Fertilizer Use in Africa", Agriculture and Rural Development discussion paper No 22, World Bank.

[13] Diagana, Bocar. (2003) "Land Degradation in Sub-Saharan Africa: What Explains the Widespread Adoption of Unsustainable Farming Practices?", mimeo, Department of Agricultural Economics and Economics, Montana State University.

[14] Diamond Peter A (1982) " Aggregate Demand Management in Search Equilibrium", *Journal of Political Economy*, Vol. 90, 881-94.

[15] Duflo, Esther (2006) "Poor but Rational?", forthcoming in *Understanding Poverty*, A. Banerjee, R. Benabou, and D. Mookherjee (eds), Oxford University Press.

[16] Duflo, Esther, Kremer, Michael., and Robinson, Jonathan. (2005) "Understanding Technology Adoption: Fertilizer in Western Kenya. Preliminary Results from Field Experiments", Mimeo, MIT, Harvard and Princeton.

[17] Echenique, Frederico (2002) " Comparative Statics by Adaptive Dynamics and the Correspondence Principle", *Econometrica*, Vol.70, No. 2, 833-844.

[18] Echenique, Federico. and A. Edlin (2004) "Mixed Strategy Equilibria are Unstable in Games of Strategic Complements". *Journal of Economic Theory*, 118: 61-79.

[19] Fafchamps Marcel (1999) "Rural Poverty, Risk and Development", FAO Economic and Social Development Paper, No 144, Rome.

[20] Feder Gershon, Just Richard and Zilberman David (1985) "Adoption of Agricultural Innovations in Developing Countries:A Survey", *Economic Development and Cultural Change*, 33 (2), 255-98.

[21] Foster, Andrew D. and Rosenweig, Mark R. (1995) "Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture", Journal of Political Economy, 103, 1176-1209.

[22] Gabre-Madhin, Eleni Z.. and Johnston , Bruce F. (2002) "Accelerating Africa's Structural Transformation:Lessons from Asia". In 2002 Perspectives on Agricultural Transformation:A view from Africa, eds. T.S. Jayne, Isaac Minde, and Gem Arwing-Kodhek. New York:Nova Science.

[23] Gladwin, Christina (2002). "Gender and Soil Fertility in Africa: An Introduction." African Studies Quarterly 6, no. 1&2: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a1.htm.

[24] Goldman, Abe (1993) "Agricultural Innovation in Three Areas of Kenya: Neo-Boserupian Theories and Regional Characterization", *Economic geography*, 69(1), African development, 44-71.

[25] Hayami, Yujiro and Ruttan, Vernon M (1985) *Agricultural Development: An international Perspective*, Johns Hopkins University Press, Baltimore.

[26] Johnston , Bruce.F and Peter Kilby (1975). Agriculture and Structural Transformations:Economic Strategies in Late-Developing Countries. New York: Oxford University Press.

[27] Kelly, Valerie A. (2006). "Factors Affecting Demand for Fertilizer in Sub-Saharan Africa". *Agriculture and Rural Development Discussion Paper 23*, The World Bank, Washington, D.C..

[28] Ligon, Ethan. and Thomas Jonathan P. and Worall Tim (2000) "Mutual Insurance, Individual Savings and Limited Commitment", *Review of Economic Dynamics*, 3(2) pp. 216-246.

[29] McGuirk, Anya and Yair Mundlak (1991) *Incentives and Constraints in the Transformation of Punjab Agriculture*, Research Report 87. *International Food Policy Research Institute*, Washington, DC.

[30] Mellor, John, W. (1976). The Economics of Growth: A Strategy for India and the Developing World. Ithaca, NY:Cornell University Press.

[31] Milgrom, Paul and Robert John (1990). "Rationalizability and Learning in Games with Strategic Complementarities". *Econometrica*, 58, 1255-1278.

[32] Platteau, Jean Phillipe. (2000) *Institutions, Social Norms and Economics Development.* Harwood Academic Publisher, U.S.A

[33] Platteau, Jean Phillipe (2006) "Solidarity Norms and Institutions in Agrarian Societies: Static and Dynamic Considerations", in S. Kolm, J. Mercier-Ythier, and G. Varet (eds.), Handbook on Gift-Giving, Reciprocity and Altruism, North-Holland and Elsevier, Amsterdam (forthcoming).

[34] Poulton, Colin, Jonathan Kydd, and Andrew Dorward (2006). *Increasing Fertilizer Use in Africa: What Have We Learned?.* Agriculture and Rural Development Discussion Paper 25. The World Bank.

[35] Resnick, Danielle. (2004) "Smallholder African Agriculture: Progress and Problems in Confronting Hunger and Poverty". DSGD Discussion Paper 9, *International Food Research Institute* (IFPRI).

[36] Rutherford Stuart (1999). " The Poor and Their money. An essay about financial services for poor people ", Mimeo, Institute for Development Policy and Management, University of Manchester.

[37] Spencer, Dunstan (2001) "Will they survive? Prospects for Small Farmers in Sub-Saharan Africa," presented at the Sustainable Food Security for all by 2020 Conference in Bonn, Germany, September 4-6.

[38] Strotz, R.H. (1956) "Myopia and Inconsistency in Dynamic Utility Maximization", *Review of Economic Studies*, 23: 165-180.

[39] Tarski, Alfred (1955) "A Lattice Theoretical Fixed-point Theorem and its Applications", *Pacific Journal of Maths*, 5, 285-309.

[40] Topkis, Donald M. (1968) Ordered Optimal Decisions. PhD. Dissertation, Stanford University.

[41] United Nations Standing Committee on Nutrition (UNSCN). 2004. *Fifth Report on the World Nutrition Situation: Nutrition for Improved Development Outcomes.* Geneva, Switzerland.

[42] Verstralen Karin. (2001) "Rural Livelihood Strategies: savings for survival, protection or accumulation? Manuscript, presented at the Livelihood, Savings and Debt in a Changing World: Developing Anthropological and Sociological Perspectives Conference, Wageningen, Netherlands, May 14-16.

[43] Wendy James (1979) *Kwanim Pa, The Making of the Uduk People.* Clarendon Press, Oxford, United Kingdom.

[44] World Bank (1993) *A Strategy to Develop Agriculture in Sub-Saharan Africa and a Focus for the World Bank.* Technical Dept, Africa Region. Washington, DC.

[45] World Bank (1997) *World Development Report, 1980-1997.* Washington, DC.

[46] World Bank (1999) Agricultural Incentives in Sub-Saharan Africa: *Policy Challenges,* Washington, DC.

[47] World Bank (2006) Alternative Approaches for Promoting Fertilizer Use in Africa, Washington, DC.

[48] The World Bank (2005 & 2006). *World Development Indicators.*

Chapter 3

An Empirical Analysis of Private Rates of Returns to Education in Cameroon[†]

[†] This chapter is based on a paper coauthored with Désiré Vencatachellum.

1. Introduction

A rational individual invests in education if the expected private benefits exceed the cost. A government which aims at increasing school enrollment should adopt policies to reduce the cost of schooling and to increase the private benefits of education. Consequently, estimates of private rates of return to education (RORE), defined as the increase in a worker's earnings following additional schooling (or as the average effect on labour income of one year increase in educational attainment), are of interest as they allow us to understand the education process of individuals and to inform education policies. Recently, some studies have estimated RORE for a number of countries in sub-Saharan Africa.[1] Psacharopoulos and Patrinos (2002), who summarize the literature, conclude that RORE are positive but decrease with the level of schooling (concave RORE) across countries. However, more recently, Schultz (2004) finds that RORE increase with the level of schooling (convex RORE) in six sub-Saharan Africa countries. While the survey for each country in Schultz's analysis is representative of the population, this is not true for many countries in Psacharopoulos and Patrinos (2002).[2]

We contribute to that literature by using the 2001 Cameroon Household Survey (CHS) to estimate the RORE and the determinants of employment in Cameroon. We differ from previous studies of RORE in Cameroon, and many others for sub-Saharan Africa in three ways. First, our sample includes formal and informal sector workers as those in the informal sector account for sixty-five per cent of workers.[3] Second, we compare returns to attending an education cycle with returns from graduating from that education cycle. Indeed, in our sample, close to two thirds of

---

[1] See Kazianga (2004); Michaud and Vencatachelum (2001); Mwabu and Schultz (1996, 2000) ; Schultz (2002, 2004); Siphambe Kufigwa (1999);

[2] In a critical review of the RORE literature in sub Saharan Africa, Bennell (1996) remarks "empirical shortcomings which seriously undermine the credibility of aggregate RORE estimates for the continent as a whole".

[3] The 2001 CHS documents if a respondent's employer, or the respondent if self-employed, was registered for tax purposes. Such individuals are assumed to be in the formal sector, while the others are in the informal sector. According to this definition therefore, twenty-four per cent of workers are in the formal private sector and the remainder, i.e. a small minority, work in the public sector. The importance of the informal sector in Africa also stems from the fact that its created six million jobs between 1980 and 1986, while only 500,000 were created in the formal sector over the same period (ILO, 2002).

labour market participants who attended primary school did not graduate. Using schooling at a particular level as an explanatory variable means that we cannot distinguish between those who have completed the education cycle from those who have not. *Ceteris paribus*, we expect graduates to earn higher incomes than non-graduates. Third, we account for sample selection by using Trost and Lee's (1984) correction and verify if our results are robust to population weights. Finally, in addition to understanding the realities of Cameroon, our analysis is of interest for sub-Saharan Africa because Cameroon shares a number of similarities with other countries of that region. It depends heavily on primary commodities, has a relatively high unemployment rate and suffered from similar terms of trade shocks.[4]

We know of two studies which estimate RORE for Cameroon. The first one by Lanot and Muller (1997) uses data from a sample of women in Yaounde (the capital of Cameroon). They find convex RORE in all sectors. However, their sample contains fewer than 200 individuals when they estimate the wage equation, includes only women, and is not representative of the population. Moreover, while they distinguish between the formal and informal sectors, they do not treat those who work in the public sector separately. In a second study, Bigsten and Al. (2000) also find convex RORE for a sample of workers from 170 companies in the manufacturing sector. Unfortunately, they can neither account for sample selection, nor inform us about RORE in the non-manufacturing (formal or informal) sectors.

We start by noting that the unweighted and population-weighted estimates differ. For example, not using the population-weighted estimates would wrongly lead one to conclude that primary school graduates who are in the public sector earn positive returns and that in the public sector, men with primary school certificate earn more than women with the same type of credentials. Focussing on the population-weighted estimates we find that the private RORE are convex in all sectors of employment, irrespective of using school attendance or graduation as an explanatory variable of earnings. As expected, private RORE are higher at all comparable levels of education

---

[4]We also add to the few francophone and lusophone sub-Saharan Africa countries for which there exist RORE estimates. Two exceptions are Psacharoupolos (1994) for Senegal, Kazianga (2003) for Burkina Faso and Schultz (2004)

for graduates than for those who fail to graduate. This difference indicates that there is a value from having successfully completed an education cycle and may arise because the labour market interprets school graduates as being of higher productivity than those who do not graduate. The results are particularly enlightening for primary school: while primary school graduates working in the private sector earn significant positive returns, those who have not successfully completed primary school earn no returns. Hence, assuming that the quality of schooling does not change, one policy implication of our result is to strive to at least make students graduate from primary school.

There are a number of other interesting results which are worth highlighting. The returns to education are much higher for university graduates, or even for those who have attended university but did not graduate, than for any other education level. For example, everything staying constant, a university graduate earns 4.6 times more than a primary school graduate. Given the large size of the informal sector, it is of interest to note that workers in that sector earn higher returns to vocational education than to general education. We also find that those who live in rural areas earn less than those in urban areas, and females who work in the private and informal sectors earn less than their male counterparts. Interestingly, once we control for other characteristics, there is no male-female earnings gap in the public sector.

Our estimation strategy is related to Lassibille and Tan (2005) for Rwanda who find convex RORE in all sectors of employment. Apart from using data for Cameroon, we differ from these two authors by estimating a sample-weighted model which provides a consistent estimate of the population regression function under the null hypothesis that the model is correctly specified (Deaton, 1997, p.71). Although our estimates are consistent with those of Lassibille and Tan (2005), there is an important difference. While they find no returns for primary school graduates, we do find that these workers earn positive returns in the informal and private formal sectors, but not in the public sector. Lassibille and Tan (2005) also find no statistically significant male-female wage gap in the public or private formal sectors, but such a gap exists in the informal sector. Our estimates are also in line with Schultz (2004) and are confirmed by our robustness checks.

The fact that there are positive private returns to having graduated from primary school, but not from having attended primary school, has important policy implications. This threshold, combined with the low share of the population who complete primary school, suggest that many households are in a poverty trap. Although the expected benefits from completing primary school are high, many parents may be too poor to afford to see their children through primary school. These parents may not be able to afford the material to enable their children to perform at school. Given the budget constraint they face, parents may decide not to educate their children who in turn make the same choice when they become parents. To avoid this intergenerational poverty trap, policies which target budget-constrained households, such as cash transfers, would allow these children to complete primary school. Moreover, given the high RORE for university graduates, a scaling-up of the education budget at all levels is required to increase the number of students who reach and complete secondary and tertiary education. Such policies may also help to solve any coordination failure problem where firms are reluctant to adopt skill-biased technologies because of the low aggregate human capital (Galor and Moav, 2000) and thus increase economic growth in Africa.

The remainder of the paper is organized as follows. Section 2 sets up a very simple framework to understand the fundamentals of an economy which can give rise to convex or concave returns to education. Section 3 gives a brief overview of the educational system and of the labour market in Cameroon, and describes the main characteristics of the 2001 Cameroon CHS. Section 4 outlines our estimation strategy, while the estimates of the earnings and participation equations are in Section 5. Section 6 concludes. The proof and all tables are in the Appendix at the end of the paper.

2. A Simple Model of Convex Returns to Education

We construct a simple model to highlight the fundamentals of an economy which can give rise to either concave or convex returns to education. Consider an economy populated by a large number of individuals, each endowed with some human capital (or education). For the sake of simplicity, we assume three education levels, which in turn imply some skills level: a person is

either uneducated (unskilled), has only primary education (semi-skilled), or at least secondary education (skilled). There are U uneducated persons, P who have attended primary school and S have at least secondary education.

On the production side, assume a two-sectors economy composed of a formal and an informal sectors. The informal sector is characterized by a technology which can be used by labour with no education. Those who work in that sector are paid their reservation wage $\underline{w}$. Concerning the formal sector, we assume firms operate in a perfectly competitive environment and use a technology which has semi-skilled and skilled workers as inputs. As in Acemoglu (2002), we assume formal-sector firms produce a homogenous good using a constant elasticity of substitution production function.

Let a representative formal-sector firm hire p individuals with primary education and s persons with at least secondary school to produce y units of the marketable good:

$$y = [(a_p p)^\varphi + (a_s s)^\varphi]^{\frac{1}{\varphi}}, \tag{2.1}$$

where a_p and a_s are factor-augmenting technology terms and the parameter $\varphi \leq 1$.

As firms operate in a perfectly competitive environment, workers are paid at their marginal product. Clearly, we assume that firms seek to maximize profits from producing y subject to input prices w and we solve for profit maximization as a non-constrained optimization problem. Thus, using (2.1), and letting $\lambda = s/p$, we obtain that skilled and semi-skilled workers earn

$$w_s = a_p \left(\frac{a_s}{a_p}\right)^\varphi \left[\lambda^{-\varphi} + \left(\frac{a_s}{a_p}\right)^\varphi\right]^{\frac{1-\varphi}{\varphi}}, \tag{2.2}$$

$$w_p = a_p \left[1 + \left(\frac{a_s}{a_p}\right)^\varphi \lambda^\varphi\right]^{\frac{1-\varphi}{\varphi}}, \tag{2.3}$$

respectively.

Generally, there are two ways to model labour-augmenting technical progress (a_k, $k = p, s$): as the introduction of new production methods that directly increase the productivity of labour, or as the introduction of new goods and tasks that use labour (Acemoglu, 2002). But for simplicity, let suppose here that labour-augmenting progress takes the first form. Hence, the ratio a_s/a_p captures

skill bias of production technology in our environment. It is therefore useful to briefly outline the intuition for why returns to education can be convex. The following proposition gives conditions under which the wage premium for skilled workers, relative to semi-skilled ones, is greater than the wage premium earned by semi-skilled workers relative to those who are unskilled.

Proposition 1. (Concavity or convexity of returns to education) *The returns to education are strictly convex if:*

$$\frac{\lambda^{-\varphi} + (a_s/a_p)^\varphi}{[1 + (a_s/a_p)^\varphi \lambda^\varphi]^2} > \left[\frac{a_p}{(a_s/a_p)^\varphi \, \underline{\omega}}\right]^{\frac{\varphi}{1-\varphi}} \tag{2.4}$$

Otherwise, returns to education are concave.

Proposition 1 means that the relative scarcity of skilled workers, which is captured by λ, and the nature of the technology as measured by a_s/a_p combine to generate convex returns to education. Proposition 1 holds trivially if λ is relatively small. Now, suppose for instance that $a_s/a_p = 1$, that is, labour-augmenting progress is identical for all categories of skilled workers. Thus, comparing (2.2) and (2.3), it follows that those who have completed secondary school never earn less than those with only primary education. In fact, there is a positive premium to education as long as there are fewer skilled workers than unskilled ones, i.e. $\lambda < 1$. If an economy is characterized by the opposite ($\lambda > 1$), skilled and semi-skilled wages would be equal in equilibrium because skilled workers can hold unskilled positions.[5] It is interesting however to note that for a more general case of labour-augmenting progress (i.e., $a_s/a_p \neq 1$), the scarcity of skilled workers per se is not sufficient to generate convex returns to education in an economy. Indeed, a corollary of Proposition 1 is that the returns to education are concave if skilled and semi-skilled workers are complements, that is, when φ approaches 0: (2.4) never holds in this case. Consequently, observing convex returns to education allows us to make inferences about both the share of skilled individuals in the country and the technology being used. In many developing countries there are far less people with secondary education than those who have only primary education. As a result, when the ratio s/p is relatively small, the returns to education can be convex provided that φ is not too high. Note

---

[5]Note that by assumption, workers in the informal sector earn less than those with only primary education and who work in the formal sector.

that the proposition excludes the case where skilled and unskilled workers are perfect substitutes ($\varphi = 1$) in which case all workers earn the same wage.

Although our model is extremely simple, the main implications would still hold in more complex environments. For example, consider the impact of an administrative sector on Proposition 1. Assume, as is the case in Cameroon, that employment conditions in the administrative sector are as good as, if not better than, in the private formal sector. Moreover assume there are few openings in the administrative sector. The number of vacant positions, and wages, is determined by the government. It is also the case that those in the administrative sector enjoy having lifetime employment. Consequently, a rational individual would prefer to work for the government instead of the private sector, thus creating an excess demand for these positions. Introducing such an administrative sector in our model would reduce the share of skilled workers available for the private sector and make the returns to education more convex. A more realistic model should allow parents to choose their investment in the education of their children. In this case, the number of individuals, at each level of education, will depend on their parents' income, the opportunity cost of attending school and of the expected returns of doing so. In such an environment, although the rates of returns to education are very high, parents may rationally choose not to educate their children if the cost of doing so is too high (Dessy and Vencatachelum, 2003). This may be the case if parents have no access to credit markets to complement the income fall when their children attend school. Consequently, high convex returns to education point to significant barriers which parents face in educating their children.

In what follows, we discuss the institutional aspects of the educational sector and labour market in Cameroon. This allows us to highlight the constraints which parents face in educating their children, the supply of skilled and unskilled labour and the technology which firms use in Cameroon.

3.   Institutions and the Cameroon Household Survey

We briefly review in section A the institutional and economic environments which may matter for the returns to education in Cameroon. We then discuss the main characteristics of the 2001

Cameroon household survey and carry a non-parametric analysis in section B.

3.1 Institutional and economic environment

Cameroon has two parallel educationnal systems along the same lines as the British and French ones. Primary education, which consists of six grades in French-speaking Cameroon, and of seven grades in English-speaking areas, is compulsory from age five. There is approximately the same number of government and private combined to religious-run primary schools. While government-run schools charge no tuition fee, private and religious-run ones usually do. Primary schools graduates can choose between secondary (grammar) schools, technical (vocational) schools, and training institutes. After secondary school, those who wish to pursue further studies in Cameroon can choose among six state-owned and two private universities, and about a dozen professional schools.

Compared to the rest of sub-Saharan Africa, the Cameroon educational system has performed relatively well. The adult (those aged 15 and above) literacy rate is estimated at 72 per cent while the corresponding number for sub-Saharan Africa is 62 per cent (United Nations Development Program, 2003). There exists however important regional and gender disparities in educational attainment in Cameroon. In 2001, the net school enrolment rate for those aged 6 to 14 years was 79 per cent countrywide, 90 per cent in cities and 70 per cent in rural areas. Moreover, while 80 per cent of males are literate, this is true for only 60 per cent of females.

These educational attainments have been threatened by the economic downturn which hit Cameroon in the 80s and 90s. The government's revenue fell because of lower world commodity prices while at the same time its expenditure increased. For instance, the public-sector wage bill reached 63 per cent of the government's revenue in the fiscal year 1985-86. In the meantime, international prices of raw materials widely produced in Cameroon, fell by 11.3 per cent for cocoa, 12.5 per cent for coffee robusta, and 5.2 per cent for cotton (Le Cameroun en chiffres, 2000; DSCN/MINEFI, 2001). As a result, the government could not pay its employees. Some civil servants earned more through second jobs and /or bribes than from their official jobs. Many were

not paid on time or had to pay bribes in order to be paid (World Bank, 2001). All this gave additional impetus to the informal sector. The government reacted by cutting the wages of civil servants and administration contract workers (but not military personnel) first by 15 per cent and then by an additional 45 per cent. The government also reduced its other expenditures, including that on education. Public expenditure on education fell therefore from 309 million US$ to 223 million US$ from 1995 to 1999, i.e., a level which is only marginally higher than in 1980 (WDI, 2004). Similarly, the student/teacher ratio in primary schools increased from 51 to 65 between 1997 and 2000.[6] These cuts reduced the size of the public service by nearly 15 per cent between 1990 and 1998 (Ministry of Finance, Economic and Financial report 1999/2000, p45). Bearing those institutional and macroeconomic facts in mind, we now present the relevant data from the 2001 CHS which is used to estimate the rates of returns to education.

3.2 Data and Descriptive Statistics

The 2001 CHS is a representative sample of the population which contains informations at both the household and individual level.[7] Each of the ten province was split in an urban and a rural cluster and the two largest towns, Douala and Yaounde, were treated separately. A two-stage stratified cluster design was used in Douala, Yaounde, small and large towns in urban areas. The first stage draws randomly from the population of *Zones de denombrement* (ZD) and then in a second stage households were drawn. A three-stage stratified cluster design was used in rural areas: first *arrondissements* were drawn, then ZD and third households.[8] In summary, 1,200 households were surveyed in each of Douala and Yaounde, while an average of 915 households were sampled in each other province. The final sample consists of 10,992 households and 56,443 individuals.

labour force: Table 1 provides some summary statistics of the main variables of interest. The

[6] The latest available figure for 2000, indicates that public expenditure in education has increased by 43 per cent from 1999. School-days and workdays were also modified to allow children to attend school and participate in the labor market (Eloundou-Enyengue and Davanzo, 2003).

[7] The 2001 CHS used the same methodology and questionnaires as the well-known living standard measurement surveys (Direction de la Statistique et de la Comptabilité Nationale 2001).

[8] Further information on the design of the survey is available in Direction de la Statistique et de la Comptabilité Nationale (2001).

average respondent is 22 years old and 50 per cent of respondents are between 16 and 60 years old. As in Michaud and Vencatachelum (2001), we start by restricting the sample to those who are older than 16 (29,456 individuals). We then exclude those who report being inactive on the labour market (6,281) or who are unemployed but have stopped looking for a job for at least a month (2,724). Excluding these individuals is in line with the usual definition of the labour force which counts as unemployed only those who have actively looked for employment. We also remove unpaid trainees (480), who can be assimilated to students, and those who report attending school full time (680). After accounting for the above restrictions, we obtain 19,291 labour market participants, among whom 10,265 are males and 9,026 are females. The unemployment rate computed by using the International labour Organization definition reveals the following informations. First, slightly more than 8 per cent of labour market participants are unemployed. Second, more males (i.e. 8.7 per cent) than females (8.1 per cent) are unemployed.

Earnings: The explanatory variable of interest is the individual's hourly earnings from his or her main occupation. We use hourly earnings to account for the number of hours worked which is a choice variable in many instances. These earnings include any premium that the person may have received in addition to his or her regular wages. For instance, in the public sector, earnings comprise earned wage, technical premium and other premiums due to the status each civil servant has in the State structure. To the extent that these other earnings are correlated with an individual's characteristics, excluding them would underestimate the returns to education and could lead to biased estimates.[9] The average monthly earnings equals 55,701 CFA Francs (Communauté Financière d'Afrique), but males earn (69,331 CFA) more than females (37734 CFA). In addition, hourly wages are significantly higher for males (415 CFA) compared to females (291 CFA).[10] By contrast however, we were unable to reject the null hypothesis of wage equality across gender within

---

[9] We derive hourly wage, Y_i, from hours worked per week, weeks worked per year and annual salary as follow: $Y_i = R_i/([Weeks/years] * [hours/weeks])$, where R_i, represents the sum of principal and secondary incomes declared by an individual i.

[10] The 2001 exchange rate was 100 CFA for 1 French Franc. The hypothesis that males and females earn equal wages is strongly rejected with t-tests of equal and unequal variances of 5.34 and 5.10 for the informal sector; 4.56 and 4.30 for the formal private sector.

para-statal companies.

Formal/Informal sector: Given the importance of the informal sector across Africa, we cannot exclude those who work in that sector from our sample.[11] We define those whose employers, or themselves if they are self-employed, are not registered for tax purposes as being in the informal sector. The remainder of wage earners are in the formal sector. Given the small number of respondents in para-statal companies, we include them in the public sector. Using that definition, we find that 65 per cent of those with positive earnings are in the informal sector, 24 per cent in the formal private sector and the remainder 11 per cent are in the public sector. Those in the formal private sector report working on average 8.7 hours daily, which is higher than the corresponding number for those in the public sector (8.1 hours) or the informal sector (7.2 hours). Similarly, male's average number of hours worked per month is statistically greater (204 hours) compared to women (171 hours). As expected, informal sector workers earn the least (32,894 CFA), while those in the public sector earn the most (133,182 CFA).

Region of residence: While fewer respondents live in urban areas (45 per cent), those who have a job earn a wage premium of 35 per cent in comparison with their counterparts (30,878 CFA compared to 73,861 CFA). This difference reflects the nature of activities in rural and urban areas. Agricultural activities and farming constitute the main activity (43 per cent) for those with positive earnings and is concentrated in rural areas. Small commercial activities account for 20 per cent of all workers. Finally, only 6.4 per cent of those with positive earnings report working in the manufacturing sector. Given this low figure, studies of RORE which focus on those who work in the manufacturing sector (for example Arne Bigsten et Al, 2000), are unlikely to be informative of the RORE for the population at large.

Education: Although the median labour market participant has completed primary school, close to a quarter of them have never attended school, and close to thirty percent is illiterate. Females are much less likely than males to have completed any education cycle, and more females than males are illiterate (39 per cent compared to 25 per cent). Informal sector workers are more

---

[11]In Sub-Saharan Africa, is not unusual for informality to exceed 50% of the Gross Domestic Product (Palmade, 2005).

likely to never have attended school (36 per cent) than those who work in the formal private sector (21 per cent) or in the public sector (2 per cent) ones. Interestingly, close to 30 per cent of those who have attended primary school, and are currently in the labour market have failed to graduate from primary school. More over, 26 per cent of those who passed primary school never attended secondary school.

As expected, we find that earning are positively correlated with education. However, there is no statistically significant difference between the monthly earnings of those who have never attended school and those with primary education. It is only for those with at least the first level of secondary or technical secondary education that additional schooling yields much higher earnings. The premium for those with the second-level of secondary school education relative to those with only primary education is 130 per cent. The corresponding premium is considerably higher for females (191 per cent) than for males (98 per cent).

University educated workers earn the highest wages. In fact, they earn twice as much as their counterparts with only secondary education. It is also interesting to note that university graduates in para-statal bodies earn the highest salaries (308,830 CFA monthly). Hence, this simple non-parametric analysis implies that there are relatively few educated people who can secure relatively well-paid positions in the public sector, in para-statal bodies or in the private sector. There is also a large pool of unskilled workers who work either in the private or informal sector. Consequently, this suggests that Cameroon meets the conditions of our model to generate convex returns to education.[12] We now need to test whether such convex returns are in fact present. The next section outlines the estimation strategy to identify how labour market participants are selected into the formal and informal sectors. We then use this procedure to correct for potential sample selection problems when estimating the earnings equation.

---

[12] Although this is a simple non-parametric analysis, it provides a first indication that returns to education are convex and that there are no returns to having simply attended primary education in Cameroon.

4. Estimation strategy

Assume the data generating process of earnings is given by a Mincerian equation (Mincer, 1974). As standard in the empirical earnings literature, the dependent variable is the logarithm of hourly earnings of individual i working in sector k (y_{ik}); and the vector of explanatory variables (X_{ik}) includes potential experience and potential experience squared, five educational dummies for completed education cycle (primary, secondary one, secondary two, vocational one, vocational two and university), industry of employment, gender and regional characteristics. As earnings are observed only for those who are employed, ordinary least squares (OLS) estimates of the earnings equation may be biased because of sample selection (Heckman, 1979). Moreover, individuals are not randomly assigned to their sector of employment. If such a choice, or constraint, is not accounted for, further biases of the parameter estimates of the earnings equation may arise.[13]

4.1 Labour market Participation

As in Lassibille and Tan (2005), assume the underlying selection process of employment sector follows a polychotomous normal model with four mutually exclusive labour-market outcomes: unemployed $k = 0$ (the reference group); employed in the informal sector $(k = 1)$; in the private formal sector $(k = 2)$; and in the public (including para-statal companies) sector $(k = 3)$. As a rational individual i in this environment selects the employment sector alternative k which yields the highest present value of net benefits, let y_{ik}^* denote the unobserved utility for a labour market participant i who chooses the employment sector k. Thus,

---

[13] However, besides sample selection, a likely much bigger inference challenge is the endogeneity of the education levels leading to omitted variable bias. Indeed, education levels are likely correlated with a host of variables that are not observed but important such as political or socio-economic patronage with certain well-connected individuals being able to access both higher education levels and take one of the coveted jobs, and households' credit constraints, which affect both the education levels of children and their future earnings potential independent of their education levels. To overcome this problem, there would have to be either instrumental variables or randomized evaluation data, neither which are available. Thus, due to omitted variable bias generated by the endogeneity of education levels, the results provided in this chapter should not be taken as clear causal inference of the effect of education on earnings but instead as analyses of how educational attainment is correlated with labour market outcomes that include earnings and employment.

$$y_{ik}^* = \beta_k' Z_{ik} + \eta_{ik}, \text{ for } k = 1, 2, 3. \tag{4.1}$$

For a typical sector k, β_k is a vector of parameters; Z_{ik} represents the maximum set of explanatory variables affecting the employment decision for all individuals i; and η_{ik} is a not parametrically specified random error term. Assume (η_{ik})'s are independent and identically Gumbel distributed. Clearly, the *Irrelevant Independent Alternative* (IIA) hypothesis is satisfied. Then, as shown in the literature on polychotomous choices (see McFadden, 1973), the probability that an individual i has outcome k is given by a conditional logit:

$$p_{ik} = \frac{\exp\left(\beta_k' Z_{ik}\right)}{\sum_{k=1}^{3} \exp\left(\beta_k' Z_{ik}\right)}, \tag{4.2}$$

Equation (4.2) estimates the effects of controlled factors on the probability that an individual, i, chooses a sector of employment k among three alternatives: (1) informal sector (alternative 1); (2) formal private sector (alternative 2); or formal public and parastatal sector (alternative 3).

4.2 Earnings Estimates with selectivity

Self-selection can occur in observed wages $(Y_{ik,})$ if individuals are not randomly assigned to their sector of employment and are faced with more than two choices (McFadden, 1973). Under the null hypothesis that labour market participants are endogenously selected in one of three employment sectors aforementioned, we rely on a two-stage method proposed by Trost and Lee (1984) to correct for potential sample selection when estimating the earnings equation.

Using their notation and relying on the logit maximum likelihood method, we estimate in the first stage a polychotomous model of the choice of employment sector (4.2), and use the estimates $\widehat{\beta}_k$ to form:[14]

---

[14]In the presence of multinomial choices and when selection is over a large number of alternatives not totally independents, the selection bias problem is fundamentally a matter of residuals correlation. From Monte-Carlo experiments, Bourguignon, Fournier and Gurgand (2004) suggest that selection bias correction based on the multinomial logit model can provide fairly good correction for the outcome equation, even when the IIA hypothesis is violated.

$$\widehat{\theta}_{ik} = \frac{\phi\left[J\left(\widehat{\beta}'_k Z_{ik}\right)\right]}{F\left(\widehat{\beta}'_k Z_{ik}\right)}, \tag{4.3}$$

where ϕ is the standard normal density function; Φ is a standard normal distribution and F a logistic marginal distribution. $J \equiv \Phi^{-1}F$, is a strictly increasing transformation and J is implicitly determined by $\widehat{\beta}'_k Z_{ik}$, for all $k = 1, 2, 3$ and all i.

In a second stage, conditional on the alternative k being chosen, we then consistently estimate by OLS the earnings function:

$$\ln y_{ik} = \delta'_k X_{ik} + \gamma_k \widehat{\theta}_{ik} + \varepsilon_{ik}, \tag{4.4}$$

for $k = 1, 2, 3$, where ε_{ik} is a mean-zero random error term; δ_k is a parameters vector and γ_k is a parameter.

Trost and Lee's two-steps procedure requires one or more identifying variable(s), i.e. Z must contain at least one variable which is not an element of X. Otherwise, the sample selection procedure may give worse results than simple ordinary least squares. We draw from the existing literature to find identifying variables. As in Jovanovic and Lokshin (2004) and for the same reasons, we use the following three variables to identify sectorial choice: employment situation or industry of employment in 1996, marital status and household size. The first variable accounts for possible inertia in changing the sector of employment or of the barriers to find employment in the formal sector if unemployed. We expect those who already worked in the formal sector in 1996 to remain in that sector. Marital status, as well as household size, is a measure of the need for job security. Hence, we expect married individuals to prefer employment in the formal than in the informal sector, or they will work in the informal sector rather than being unemployed. The same rationale can hold for household size. The other explanatory variables of the sector of employment include educational attainment, gender, area and province of residence.[15]

---

[15]Bourguignon, Fournier and Gurgand (2004) criticize Trost and Lee's procedure. They argue that the correction of the selection bias should use all the correlations between the disturbance term of the earnings equation (i.e., η_{ik}) and the disturbance terms of all categorical latent expressions (i.e., ε_{ik}). Bourguignon, Fournier and Gurgand prove

5. Results Analysis

All our specifications have the same explanatory variables except that education is either measured by the highest education cycle attended or graduation from an education cycle. The estimates of the determinants of a worker's sector of employment are in Table 3, with school attendance as explanatory variable, and Table 4, with graduation as explanatory variable. The estimates of the Mincerian hourly earnings equations are in Table 5 and Table 6 with respectively school attendance and graduation as explanatory variables. We distinguish between seven levels of school attendance: (i) never attended, (ii) primary school, (iii) secondary school level 1, (iv) secondary school level 2, (v) vocational school level 1, (vi) vocational school level 2, and (vii) university. We also consider the corresponding graduation cycles which are listed as explanatory in Tables 3 and 6.

5.1 Sector choice

We start by contrasting the results across the two measures of labour market participant's human capital (Tables 3 and 4). We find interesting differences between the impact of education when measured by having attended a particular education cycle or having graduated from that cycle. First, we note that having attended only primary school does not increase the likelihood that a labour market participant will find employment compared to someone who has never attended school. However, primary school graduates are more likely to find employment in the formal (public and private) sector and are less likely to be in the informal sector. Second, the marginal probability of being in the formal sector is much higher for a labour market participant who has graduated from any education cycle than for someone who has only attended that education level. Interestingly, the coefficients of the impact of human capital on labour market outcome are estimated with greater precision when we use graduation from, as opposed to attendance of, an education cycle. This

this is not the case in Trost and Lee's method which we use to verify whether our results are robust. We have also verified if our results are robust to that critique. In addition, we performed Dahl (2002)' semiparametric method since it also corrects selection bias where there are a large number of exclusive choices. Results reported in tables 7 to 8, indicate that: (i) the qualitative conclusions are preserved for all sector of employment estimates; (ii) Trost and Lee (1984)'s method does not suffer from Bourguignon and Al.'s critique.

result fits the intuition that a formal degree is better measure of an individual's human capital and is used as a screening device by both firms in the private sector and the government in their hiring decisions.

There are similarities between the estimates when using the two measures of human capital. Primary school graduates who pursued further studies are less likely to work in the informal sector. Thus, relative to uneducated labour market participants, or with primary schooling only, secondary school graduates are less likely to be in the informal sector, and are more likely to work in the formal sectors, than to be unemployed. Moreover, better education increases the predicted probability that an individual works in the formal sector compared to the informal one. Furthermore, our results suggest that an increase in the level of educational attainment raises the predicted probability that an individual works in the private formal sector, compared to the public and para-statal sector. For instance, workers with university profile have a predicted probability of working in the private formal sector that exceeds about 28 percent when have graduated and 16 percent when attended that level their probability of working in the public sector. It seems therefore that Cameroon high-skilled labour market participants prefer the private formal sector to the public sector.[16] One can however claim that this last result is a trivial and obviously expected result. This is generally true for all developed countries and for some developing countries as well (see Psacharopoulos, 1994; Psacharopoulos and Patrinos, 2002). But, Bennell (1996) claims that salaries in developing countries are driven by salaries of the public sector which are determined out of the market clearing system as observed in private sector. Thus, returns to educations are to be taken very carefully. Suppose for instance that the Paul Benell 's statement always holds. Then, in the case of Cameroon, one could expects the predicted probability of employment for an individual with a substantial year or level of schooling to raise more in the public sector than it is the case in the private formal sector.[17]

---

[16] An intuitive explanation of this result is that because the private sector is very dynamic and faces foreign competitiveness, private firms are most able to hire workers with high qualifications than public administration do, since within public services, qualifications are standardized within legal procedures and public status doesn't necessary requires for workers to exhibit an university profile for example.

[17] In the case of Rwanda, Lassibille and Tan (2005) found that workers with higher education have a predicted probability of working in the public sector that exceeds by about 70% the probability of working in the formal private

Since we obtain the contrary of what Benell stated, we therefore provide evidences of an existing labour market clearing in Cameroon, who rank sectors as follows: the private formal sector first, the public sector in second position and the informal sector in the last position. Urban area residents are more likely to work in the formal private sector than to be unemployed, and are less likely to work in the informal sector. The area of residence is not a significant explanatory variable in being employed in the public sector. Finally, we controlled provinces of residence of labour market participant so as to account for all other omitted variables within our study. We found for instance that, *ceteris paribus*, a South West province's job seeker is more likely to work in both informal and public sectors, compared to a potential worker living in either Douala or in Yaoundé. However, we uncovered empirical evidence suggesting that a typical Yaoundé's labour market participant is more likely to work in the informal sector and in the public sector as well, compared to a typical Douala's labour market participant. This last feature could be possibly related to the importance of public service in Yaoundé and the public employment freeze of the latest 1990s.

Most of the identifying variables (household size, marital status and employment status in 1996) are statistically significant in explaining the employment sector. First, our results show that an individual's occupation in 1996 is almost always statistically significant. As expected, those who in 1996, were in the formal private sector, or in the public sector, are less likely to be in the informal sector in 2001. Such individuals are more likely to be in the private and public sectors respectively. It is of interest to note that inertia is highest in the public sector because the highest marginal probability of being employed in the public sector is if one was already in that sector in 1996. This empirical pattern remains consistent with the late 1990s "restructuring" of public and semi-publics firms that leads to a bankruptcy of many public sector companies, an to the end of the recruitment in the public sector (Eloundou Enyegue et al, 2004). Despite the employment freeze, and wage cuts, in the public sector following the economic downturn of the 80s and 90s, this sector remains the most attractive sector of employment in 2001, for unemployed and looking for, and for those who were not in the labour force in 1996. This striking employment behavior

sector.

can be intuitively justified by the life-long employment guarantee generally offered in the public service, compared to the private sector where workers must always remain competitive to secure their jobs positions. Second, our results undercover gender discrimination in work opportunities offered to men and women in the Cameroon labour market. Women are more likely to work in the informal sector than men. Conversely, men are more likely than women to work in the private formal sector, or in the public and para-statal sector.[18] Although this last evidence can be strongly supportive of feminists argumentations that there still be a lot to do in helping to solve for an under-representation of Cameroonian women in all important economic spheres, gender does not however appear to play a role for hiring in the public and para-statal sector. Third, those labour market participants who are not married are the most likely to be unemployed whether human capital is measured by graduation from, or attendance of, an education cycle. In other words, in Cameroon labour market, being single is a wrong signal that a potential worker sends to potential employers. Large family size has a deleterious effect on employment in the informal sector, while there is no statistically significant effect in formal sectors.

5.2   Earnings equation

We now turn to the estimates of the earnings equation by employment sector which are reported in Tables 5 and 6 with respectively school attendance and graduation from education cycle as explanatory variables. We report two series of estimates: (i) Trost and Lee (1984)'s non-weighted estimates, and (ii) Trost and Lee (1984)'s weighted estimates. Using population-weighted estimates allow for inferences at the population level. Interestingly, there are two important differences (primary education and residing in an urban area) between the population-weighted and non-weighted estimates obtained by Trost and Lee's method.

The standard Mincerian specification estimated by weighted Trost and Lee's method fits the data well with an adjusted R-square of 0.5 for those in the formal sector but only 0.075 for those in the informal sector. The sample selection correction term is negative and statistically significant

---

[18]Estimates not shown here to save space indicate that men probability to work in the private formal sector and in the public and para-statal sector is quiet higher than women's probability to be employed in those sectors.

for those who work in the public sector but not for those in the informal or private formal sectors. The negative selection correction term means that the unobserved characteristics of those who work in the public sector are positively correlated with the unobserved components which affect their reservation earnings. However, such a correlation does not exist for those who work in the informal sector or in the formal private sector. Intuitively, this absence of correlation may arise because the alternative occupation for those who are in the informal or in the formal private sectors may be subsistence farming. In these activities, the unobserved characteristics are orthogonal to what is rewarded by the market in the informal or the private sectors.

The returns to education are convex in all three sectors of employment and there are no returns for those who have only attended primary school but not graduated, regardless of the sector. The profile of the convexity of the RORE to education is similar, and close in magnitude, to what has been estimated for Ghana, Côte d'Ivoire, Kenya and Black South Africans (Schultz, 2004, Tables 2 to 6). However, in our case, the threshold level after which returns to having attended school are positive is the second level of secondary or vocational school in the formal (public and private) sector, and the first level of secondary school in the informal sector. This difference may be a consequence of the different technologies which are used in each of those sectors. However, RORE are positive for primary school graduates who work in the informal sector or in the private sector.

Interestingly, having attended vocational school generate higher returns than general education for those who work in the informal sector. Intuitively, many occupations in the informal sector require technical skills and, as a result, those with such training earn higher returns than those with general scholarly training. Conversely, returns to formal general education is higher in the formal sector than in the informal one. In particular, returns to the second level of secondary education are highest for those in the public sector. The exceptionally high profitability of higher education is robust across all methods. This is consistent with findings in other countries where the modern sector is usually small and wages tend to be sticky (Lassibille and Peng Tan, 2005).

There are similarities and difference between our estimates and those from the other two studies of RORE in Cameroon. Bingsten and Al. (2001, Table5) find positive and statistically significant

returns at both the primary and secondary levels in their sample of workers in the manufacturing sector. In our case, there are no returns to having graduated from primary school for those who work in the public and para-statal sectors. Having attended school generates positive returns in the public and private sectors as from the second level of secondary school onwards. Note that Bingsten and Al. (2001) do not distinguish between the two levels of secondary education. Lanot and Muller (1997), who distinguish only between primary and higher education, find no returns to primary education but their estimate of returns to higher education is greater than ours. Recall however that neither of those two studies can inform us about the RORE in the informal sector, or for vocational education, and that their samples are not representative of the population.

The other explanatory variables of earnings in Cameroon confirm our non-parametric analysis, have the expected signs and match most findings for other countries in sub-Saharan Africa. The number of years of potential experience displays the characteristic concave pattern in all specifications. Women in the informal or the private sector earn significantly less than their male counterparts. However, the gender earnings gap does not exist in the public sector. The opposite holds for urban workers: urban workers in the public sector earn more than those in rural areas.

6. Conclusion and Policy Prescriptions

We contribute to the economics of education literature by using the 2001 Cameroon Household Survey to estimate the private rates of return to education in Cameroon. We allow private RORE to differ by education level and by sector -formal (public or private) or informal -of employment and correct for a labour market participant's employment into one of those sectors. We compared RORE between those who attended an education cycle with those who graduated from that cycle.

Our results highlight the importance of using representative population samples to estimate private RORE which are valid for the population at large. We find strong convex RORE in all sectors of employment. Those who only attended primary school, but failed to graduate, earn no return in any sector of employment. However, the returns for primary school graduates are positive and statistically significant. Private RORE are also very high for those who attended, or

graduated from university. The convex and high rates of returns to education is consistent with recent findings in many other countries in sub-Saharan Africa. The other determinants of earnings are in line with the empirical literature. For instance, the number of years of potential experience displays the characteristic concave pattern in all specifications. Women in the informal or the private sector earn significantly less that their male counterparts. Those who live in rural areas consistently receive lower earnings than those in urban ones.

There are a number of policy prescriptions which derive from our results. The fact that those who do not graduate from primary school earn no returns indicates that many individuals are in a poverty trap. Assuming that the quality of schooling does not change, one policy implication of our result is to strive to at least make students graduate from primary school and continue to further studies. In that regard, a scaling-up of the education budget at all levels is required for the number and quality of secondary and university graduates to increase and thus take advantage of high RORE. There is room to allocate more resources to all levels of education so as to be more inclusive of those who cannot afford to send their children to school. For instance transfers could be targeted to families which cannot educate their children through secondary school.

Given our results, cuts to the Cameroon education budget in the 1980s and 1990s are likely to have had adverse effects both on these individuals welfare and on human capital accumulation. Aggregate human capital generates positive external effects, including on children's and women's health (Schultz, 2002), and is an explanatory factor of economic growth (Barro, 2002). This implication is also valid for the rest of sub-Saharan Africa where the share of gross domestic product allocated to public education had reached an all-time high of 4.5 per cent in 1994, had unfortunately fallen to 3.4 per cent in 1999, the latest available figure (World Development Indicators, 2004). It is therefore time for a renewed emphasis on quality investment in education to generate sustained economic development.

References

[1] Acemoglu, Daron (2002) "Technical Change, Inequality and the labour Market", *Journal of Economic Literature*, 40(1), pp. 7-72.

[2] Barro, Robert (2002) "Inequality and growth in a panel of countries". *Journal of Economic Growth,* 5(1), pp. 5-32.

[3] Bennell, Paul (1996) "Rates of return to education: Does the conventional pattern prevail in sub-Saharan Africa?" *World Development,* 24(1), pp. 83-199.

[4] Bigsten, Arne, Anders Isaksson, Mans Soderbom, Paul Collier, Albert Zeufack, Stefan Dercon, Marcel Fafchamps, Jan Willem Cunning, Francis Teal, Bernard Gauthier, Abena Oduro, Reuxo Oostemdorp, and Cathy Patillo (2000) "Rates of return on physical and human capital in Africa's manufacturing sector". *Economic Development and Cultural Change,* 48, pp. 801-827.

[5] Bourguignon, Francois, Martin Fournier, and Marc Gurgand (2004) "Selection bias corrections based on the multinomial logit model: Monte-carlo comparisons". Working Paper, National Center for Scientific Research (CNRS), National Institute of Statistics and Economic Studies (INSEE), Center for Research in Economics and Statistics (CREST) and French Centre for Research on Contemporary China (CEFC).

[6] Dahl, Gordon B. (2002) "Mobility and the Return to Education: Testing a Roy Model with Multiple Markets", *Econometrica, 70(6),* pp. 2367-2420.

[7] Deaton, Angus (1997) *The Analysis of Household Surveys. A Microeconometric Approach to Development Policy*, 3rd ed. (The Johns Hopkins University Press)

[8] Dessy Eloi Sylvain and Vencatachellum Désiré (2003) "Explaining Cross-Country Differences in Policy Response to Child Labour", *Canadian Journal of Economics,* 36(1), pp. 1-20.

[9] Direction de la Statistique et de la Comptabilité Nationale (2001) "Deuxième enquête Camerounaise auprès des ménages. Méthodologie générale". Ministère de l'Économie et des Finances,

Yaounde-Cameroun. (2002) "Conditions de vie des populations et profil de pauvreté au Cameroun en 2001: Rapport Principal de l'ECAM II", Ministère de l'Économie et des Finances, Yaounde-Cameroun.

[10] DSCN/MINEFI (2001) "Le Cameroun en chiffres 2000", Direction de la Statistique et de la Comptabilité Nationale et Ministère de l'Économie et des Finances, Yaounde-Cameroun.

[11] Dubin, Jeffrey. A. and McFadden Daniel L. (1984) "An Econometric Analysis of Residential Electric Appliance Holdings and Consumption" *Econometrica, 52(2)*, pp. 345-362.

[12] Eloundou-Enyengue, Parfait M., Onguene, V.P, Bahoken S, Tamukong J, Mbangwana M, Evina E. J, Djongoue M.C (2004): " Access to Schooling and Employment in Cameroon: New Inequalities and opportunities", SAGA Working Paper, Cornell University.

[13] Eloundou-Enyengue, Parfait M., and Julie Davanzo (2003) "Economic downturn and schooling inequality, Cameroon 1987-95". *Population Studies* ,57(2), pp. 183-97.

[14] Galor, Oded, and Omer Moav (2000) "Ability biased technological transition, wage inequality and economic growth". *Quarterly Journal of Economics,* 115(2),pp. 469-498.

[15] Heckman, James (1979) "Sample selection bias as a specification error". *Econometrica* 47, pp. 153-161

[16] Jovanovic, Branko, and Michael M. Lokshin (2004) "Wage differentials between the state and private sectors in Moscow". *Review of Income and Wealth* 50(1), pp. 107-123.

[17] ILO (2002) "Women and Men in the Informal Economy: A Statistical Picture", the 90th Session of the International Labour Conference.

[18] Kazianga Harounan (2004) "Schooling Returns for Wages Earners in Burkina Faso : Evidences from the 1994 and 1998 National Surveys ", Center Discussion paper no. 892, Economic Growth Center, Yale University.

[19] Lanot Gauthier, and Muller Christophe (1997) "Dualistic sector choice and female labour supply: evidence from formal and informal sectors in Cameroon". Center for the Study of African Economies WPS 97-9.

[20] Lassibille, Gérard, and Jee-Peng Tan (2005) "The returns to education in Rwanda". *Journal of African Economies* 14(1), pp. 92-116.

[21] Lee, Lung-Fei (1983) " Generalized Econometric Models with Selectivity" *Econometrica* 5, 507-512.

[22] McFadden Daniel L. (1973):" Conditional Logit Analysis of Qualitative Choice Behavior", in P. Zarembka (ed.), *Frontiers in Econometrics,* Academic Press.

[23] Michaud, Pierre-Carl and Vencatachellum, Désiré (2001) "The Union Wage Premium For Blacks in South Africa" Working Paper, University of Cape Town and HEC, Montreal.

[24] Mincer, Jacob (1974) *Schooling, Experience, and Earnings* (New York and London: National Bureau of Economic Research and Columbia University Press).

[25] MINEFI (2000) *Rapport Économique et Financier 1999/2000.* Yaoundé-Cameroun..

[26] Mwabu Germano and Schultz T Paul (1996) "Education Returns across Quintiles of the Wage Function: Alternative Explanations for Returns to Education in South Africa", *American Economic Review,* 86(2), pp. 335-339.

[27] Mwabu Germano and Schultz T Paul (2000) "Wage Premiums for Education and Location of South African Workers by Gender and Race", *Economic Development and Cultural Change,* 48(2), pp. 307-334.

[28] Palmade Vincent (2005): "Why Worry About Rising Informality? The Biggest and Least Well Understood. Impediment to Economic Development". Working Paper, Foreign Investment Advisory Service (FIAS), Washington, D.C.

[29] Psacharopoulos Georges and Patrinos Harry Anthony (2002) "Returns to Investment in Education: A Further Update", World Bank Policy Research Working Paper No 2881, Washington D.C.

[30] Psacharopoulos, Georges. (1994) "Returns to Investment in Education: A Global Update", World Development, 22(9), 1325-43.

[31] Schultz, T. Paul (2002) "Why governments should invest more to educate girls". *World Development* 30(2), 207-225

[32] Schultz, T. Paul (2004) "Evidence of returns to schooling in Africa from household surveys: Monitoring and restructuring the market for education". *Journal of African Economies, 13, AERC Supplement 2*, pp. ii95-ii148.

[33] Siphambe Kufigwa Happy (1999) "Rates of Return to Education in Botswana", *Economics of Education Review,* 19(3), pp. 291-300.

[34] Trost, Robert P., and Lung-Fei Lee (1984) "Technical Training and Earnings: A polychotomous choice model with selectivity". *The Review of Economics and Statistics* 66(1), pp. 151-156.

[35] United Nations Development Programme (2003) 'Human development report 2003. Oxford University Press 198 Madison Avenue, New York, New York, 10016.

[36] World Bank (2001). *World Development Report 2000/2001.* New York: Oxford University Press.

[37] World Development Indicators (2004), The World Bank Group.

7. Appendix

Proof of the proposition

The wage premium earned by a worker with secondary education relative to someone with primary education is given by:

$$\frac{\omega_s}{\omega_p} - 1. \tag{7.1}$$

Similarly, the wage premium of a worker with primary education relative to someone who works in the informal sector equals:

$$\frac{\omega_p}{\underline{\omega}} - 1. \tag{7.2}$$

The returns to education are strictly convex if (7.1) is greater than (7.2), i.e. after simplifying and taking the logarithm of wages:

$$\ln\left(\omega_s\right) > 2\ln\left(\omega_p\right) - \ln\left(\underline{\omega}\right) \tag{7.3}$$

Otherwise the returns to education are concave.

Substituting the logarithm of (2.2) and (2.3) in the left hand sides of (7.3), we obtain that:

$$\left(\frac{1-\varphi}{\varphi}\right)\ln\left[\lambda^{-\varphi} + \left(\frac{a_s}{a_p}\right)^{\varphi}\right] > \left(\frac{1-\varphi}{\varphi}\right)\ln\left[1 + \lambda^{\varphi}\left(\frac{a_s}{a_p}\right)^{\varphi}\right]^2 + \ln\left(a_p\right) - \varphi\ln\left(\frac{a_s}{a_p}\right) - \ln\left(\underline{\omega}\right). \tag{7.4}$$

Simplifying the left hand side of (7.4) give

$$\frac{\lambda^{-\varphi} + (a_s/a_p)^{\varphi}}{\left[1 + (a_s/a_p)^{\varphi}\lambda^{\varphi}\right]^2} > \left[\frac{a_p}{(a_s/a_p)^{\varphi}\underline{\omega}}\right]^{\frac{\varphi}{1-\varphi}}. \tag{7.5}$$

This completes the proof.

Table 1: Summary Statistics, Cameroon, 2001 Cameroon Household Survey[1]

	All	Males	Females	T-test Unequal	T-test Equal
Number of respondents	56 443	27 727	28 716		
Labor force					
Number of labor market participants	19 291	10 265	9 026		
urban sector	8240	4780	3460		
rural sector	11051	5485	5566		
Unemployment, in percentage					
ILO definition	8.41	8.68	8.11		
Labor market participants with zero earnings	21	17	25		
Distribution of wage earners					
Number of wage-earners	14 058	7 907	6 151		
Formal private sector	3 377	2 522	855		
public sector	1 293	889	404		
para-statal companies	259	209	50		
Informal sector	9 129	4 287	4 842		
Average monthly earnings (in CFA Francs)					
by sector of activity					
All Sectors	55701	69331	37734		
Informal sector	32 894	40 078	26 534	5.34	5.10
Private formal sector	83 866	90 403	64 586	4.56	4.30
Public sector	133 182	144 266	108 790	5.10	3.93
Para-statal companies	130 531	135 346	110 405	1.09	0.93
by region					
Urban areas	75 719	89 398	54 820		
Rural areas	40 265	52 046	26 379		
by education level					
No schooling	37 958	50 494	27 857		
Primary school	37 886	46 604	26 419		
First level of general secondary school	53 557	63 990	37 512		
Second level of general secondary school	87 720	92 377	76 820		
First level of technical secondary school	52 965	62 313	38 187		
Second level of technical secondary school	89 830	98 570	69 303		
University	189 930	190 755	187 059		
Hours worked and earning					
Average number of hours worked per month	190	204	171	29.1	29
Average hourly earnings in CFA francs					
Country wide	361	415	291	22.9	22.7
Urban areas	442	482	381		
Rural areas	299	357	230		

[1] **Note to Table 1**: The survey is the "Enquête Camerounaise auprès des Menages" (ECAM II). The T-ratio is for the equality of wages between men women. unequal indicates that the two samples are tested with unequal variances.   The CFA franc is pegged to the french franc at 100 CFA for 1 french franc.

Table 2: Education and employment by gender of labor market participant [2]

	All		Males		Females	
	Labor force	Wage earners	Labor force	Wage earners	Labor force	Wage earners
Number of respondents	20 451	15 039	10 977	8 430	9 474	6 609
Respondents with missing earnings data	n.a.	728		285		443
% of which is literate and numerate	70		78	75	61	59
Num. missing education data	51	32	18	10	33	22
Sample with data on education	20 400		10 959		9 441	
% with						
No schooling	27	28	20	22	34	36
Primary school	35	34	35	33	35	33
Secondary school						
General 1st level	17	16	18	17	16	15
General 2nd level	8	8	10	10	5	6
Technical 1st level	6	5	6	6	5	5
Technical 2nd level	2	3	3	3	2	2
University education	5	6	8	8	3	3

[2] **Note to Table 2**: Wage earners are those who report having a remunerated employment. Wage earners include those with missing data on their wages (465 individuals: 143 males and 322 females). Labor force is as defined in the paper. Unemployed is those who do not have a paid employment, i.e., labour force minus wage earners.

Table 3: Sector of employment, marginal effect, School attendance [3]

| | Informal | | Formal | | | |
| | | | Private | | Public | |
	(1)	(2)	(1)	(2)	(1)	(2)
Education-Highest level attended						
Primary school	-0.004	-0.004	0.024*	0.024*	0.011*	0.011*
	(0.27)	(0.27)	(1.91)	(1.91)	(1.65)	(1.65)
Secondary school, first level	-0.069***	-0.069***	0.089***	0.089***	0.031**	0.031**
	(3.06)	(3.07)	(4.79)	(4.78)	(2.07)	(2.07)
Secondary school, second level	-0.220***	-0.220***	0.144***	0.144***	0.126**	0.126**
	(6.49)	(6.50)	(4.89)	(4.89)	(2.53)	(2.53)
Vocational training, level one	-0.113***	-0.113***	0.092***	0.092***	0.066**	0.066**
	(3.57)	(3.57)	(3.61)	(3.61)	(2.10)	(2.10)
Vocational training, level two	-0.269***	-0.269***	0.255***	0.255***	0.076*	0.076*
	(7.00)	(7.01)	(6.29)	(6.30)	(1.85)	(1.85)
University	-0.419***	-0.419***	0.270***	0.270***	0.231***	0.231***
	(13.00)	(13.05)	(5.21)	(5.21)	(2.95)	(2.95)
Age, gender and location						
Age	0.001	0.001	-0.001***	-0.001***	0.000	0.000
	(1.18)	(1.18)	(2.97)	(-2.97)	(1.58)	(1.58)
Female	0.031***	0.031***	-0.113***	-0.113***	-0.003*	-0.003*
	(2.61)	(2.61)	(13.52)	(13.55)	(1.66)	(1.66)
Urban	-0.066***	-0.066***	0.126***	0.126***	0.000	0.000
	(4.57)	(4.54)	(10.69)	(10.84)	(0.16)	(0.16)
Identifying variables						
Household size	-0.007***	-0.007***	-0.001	-0.001	-0.000	-0.000
	(4.88)	(4.89)	(0.97)	(0.97)	(0.93)	(0.93)
Single	-0.101***	-0.101***	-0.019**	-0.019**	-0.006***	-0.006***
	(6.83)	(6.83)	(2.15)	(2.15)	(3.92)	(3.91)
Labour market status in 1996						
Work in the private sector	-0.242***	-0.242***	0.162***	0.162***	0.060***	0.060***
	(11.54)	(11.57)	(9.17)	(9.17)	(3.79)	(3.79)
Work in the public sector	-0.508***	-0.508***	-0.094***	-0.094***	0.766***	0.766***
	(20.80)	(20.75)	(7.99)	(8.00)	(19.35)	(19.37)
Unpaid family workers	-0.175***	-0.175***	-0.089***	-0.089***	-0.005	-0.005
	(9.26)	(9.27)	(9.17)	(9.21)	(1.63)	(1.63)
Assistant workers	-0.190***	-0.190***	0.105***	0.105***	0.014	0.014
	(5.21)	(5.21)	(3.33)	(3.32)	(1.24)	(1.24)
Unemployed and looking for work	-0.328***	-0.328***	-0.019	-0.019	0.034***	0.034***
	(14.20)	(14.23)	(1.41)	(1.41)	(2.97)	(2.97)
Not in the labor force	-0.230***	-0.230***	-0.049***	-0.049***	0.027***	0.027***
	(12.62)	(12.63)	(5.42)	(5.43)	(3.39)	(3.39)

Table 3 continues on next page

Table 3 (concluded): Sector of employment, marginal effect, School attendance

Province						
Douala		-0.047**		0.008		-0.007***
		(2.29)		(0.64)		(5.43)
Yaounde	0.039**		-0.010		0.014***	
	(2.06)		(0.87)		(3.18)	
Adamaoua	0.040	0.005	0.039*	0.054**	0.014*	-0.000
	(1.36)	(0.17)	(1.64)	(2.10)	(1.84)	(0.00)
Centre	0.051*	0.003	-0.064***	-0.059***	-0.002	-0.010***
	(2.10)	(0.1)	(5.95)	(5.05)	(0.58)	(4.86)
East	-0.022	-0.068**	-0.021	-0.014	0.010*	-0.002
	(0.73)	(2.18	(1.18)	(0.76)	(1.91)	(1.04)
Extreme North	-0.178***	-0.211***	0.346***	0.371***	0.018**	0.003
	(6.66)	(7.91)	(13.00)	(13.44)	(2.55)	(0.80)
Littoral	0.044**	-0.002	-0.038***	-0.032**	0.003	-0.006***
	(1.94)	(0.07)	(3.27)	(2.47)	(0.84)	(2.95)
North	0.269***	0.258***	-0.064***	-0.053***	0.015*	0.002
	(15.12)	(14.63)	(4.97)	(3.73)	(1.81)	(0.36)
North-West	-0.084***	-0.136***	-0.053***	-0.049***	0.002	-0.006***
	(3.33)	(5.26)	(4.06)	(3.62)	(0.50)	(2.72)
West	0.171***	0.134***	-0.073***	-0.066***	-0.002	-0.008***
	(9.22)	(6.75)	(7.31)	(6.02)	(0.72)	(4.75)
South	-0.042	-0.091***	0.028	0.0353	-0.004	-0.010***
	(1.37)	(2.89)	(1.19)	(1.42)	(1.38)	(5.31)
South-West	0.073***	0.066***	-0.013	0.004	0.075***	0.032***
	(2.84)	(2.63)	(0.78)	(0.23)	(4.56)	(3.81)
Number of observations	11018		2609		220	

[3] **Note to Table 3:** Workers of parastatal companies are included in the public sector. The reference category for school attendance is those who have never attended school. The reference category for labour market status in 1996 is those who where self-employed. The reference for the province category are respectively Douala for model (1) and Yaoundé for model (2). The robust t-ratios are reported under parenthesis under each parameter estimate. *, **, and, *** denote the parameter is statiscally different from zero at 10%, 5% and 1% level respectively.

Table 4: Sector of employment, marginal effect, Highest diploma [4]

| | Informal | | Formal | | | |
| | | | Private | | Public | |
	(1)	(2)	(1)	(2)	(1)	(2)
Education-Labor market participant holds a:						
Primary school certificate	-0.085***	-0.085***	0.079***	0.079***	0.013**	0.013**
	(6.01)	(6.01)	(6.62)	(6.62)	(2.42)	(2.42)
First level secondary school diploma	-0.218***	-0.218***	0.174***	0.174***	0.054***	0.054***
	(8.96)	(8.97)	(7.81)	(7.81)	(3.09)	(3.09)
Probatoire diploma	-0.327***	-0.327***	0.242***	0.242***	0.087**	0.087**
	(8.53)	(8.53)	(6.07)	(6.07)	(2.56)	(2.56)
High school certificate	-0.430***	-0.429***	0.296***	0.300***	0.120***	0.120***
	(13.66)	(13.66)	(8.30)	(8.30)	(3.04)	(3.04)
Technical degree (BTS or DUT)	-0.597***	-0.597***	0.468***	0.468***	0.153**	0.153**
	(15.63)	(15.63)	(6.19)	(6.19)	(2.26)	(2.26)
University degree (BA, BSc. And above)	-0.503***	-0.503***	0.298***	0.298***	0.232***	0.232***
	(13.62)	(13.62)	(5.93)	(5.94)	(3.99)	(3.99)
Age, gender and location						
Age	0.001**	0.001**	-0.001***	-0.001***	0.000	0.000
	(2.38)	(2.38)	(3.48)	(3.48)	(0.73)	(0.73)
Female	0.079***	0.079***	-0.116***	-0.117***	-0.002	-0.002
	(6.94)	(6.94)	(13.20)	(13.20)	(1.43)	(1.43)
Urban	-0.130***	-0.130***	0.118***	0.118***	-0.001	-0.001
	(9.29)	(9.30)	(9.83)	(9.83)	(0.41)	(0.41)
Identifying variables						
Household size	-0.008***	-0.008***	-0.000	-0.000	-0.000	-0.000
	(6.18)	(6.18)	(0.17)	(0.17)	(0.55)	(0.55)
Single	-0.081***	-0.081***	-0.006	-0.006	-0.010***	-0.006***
	(5.75)	(5.75)	(0.59)	(0.59)	(3.21)	(3.21)
Labour market status in 1996						
Work in the private sector	-0.327***	-0.327***	0.152***	0.152***	0.061***	0.061***
	(15.16)	(15.16)	(8.48)	(8.48)	(3.76)	(3.76)
Work in the public sector	-0.605***	-0.605***	-0.112***	-0.112***	0.766***	0.766***
	(26.33)	(26.30)	(10.40)	(10.40)	(19.73)	(19.73)
Unpaid family workers	-0.267***	-0.267***	-0.103***	-0.103***	-0.007**	-0.007**
	(12.84)	(12.77)	(10.77)	(10.77)	(2.30)	(2.30)
Assistant workers	-0.283***	-0.283***	0.078***	0.078***	0.022	0.022
	(7.84)	(7.84)	(2.66)	(2.66)	(1.59)	(1.59)
Unemployed and looking for work	-0.415***	-0.415***	-0.032**	-0.032**	0.037***	0.037***
	(17.35)	(17.31)	(2.38)	(2.38)	(3.06)	(3.06)
Not in the labor force	-0.294***	-0.294***	-0.060***	-0.060***	0.027***	0.027***
	(14.56)	(14.53)	(6.39)	(6.39)	(3.37)	(3.37)

Table 4 (concluded): Sector of employment, marginal effect, Highest diploma

Province

Douala		-0.035*		0.015		-0.007***
		(1.82)		(1.10)		(4.83)
Yaounde	0.0269		-0.016		0.013***	
	(1.56)		(1.31)		(2.91)	
Adamaoua	0.002	-0.022	0.073***	0.100***	0.012	-0.001
	(0.07)	(0.69)	(2.66)	(3.27)	(1.63)	(0.16)
Centre	0.130***	0.107***	-0.067***	-0.055***	-0.003	-0.009***
	(7.72)	(5.68)	(5.45)	(4.00)	(1.09)	(4.87)
East	0.055**	0.030	-0.030*	-0.015	0.009*	-0.002
	(2.31)	(1.13)	(1.68)	(0.76)	(1.76)	(0.84)
Extreme North	-0.283***	-0.314***	0.357***	0.388***	0.014**	0.001
	(10.69)	(11.65)	(13.56)	(14.27)	(2.10)	(0.30)
Littoral	0.097***	0.072***	-0.055***	-0.042***	0.002	-0.006***
	(5.80)	(3.86)	(4.64)	(3.16)	(0.46)	(3.05)
North	0.189***	0.181***	-0.078***	-0.066***	0.012	-0.0001
	(11.53)	(10.86)	(6.04)	(4.48)	(1.49)	(0.01)
North-West	0.040*	0.005	-0.070***	-0.059***	-0.002	-0.010***
	(1.91)	(0.20)	(5.39)	(4.20)	(0.67)	(4.18)
West	0.118***	0.091***	-0.083***	-0.072***	-0.003	-0.010***
	(7.23)	(5.00)	(7.79)	(6.12)	(1.18)	(4.85)
South	-0.001	-0.038	0.008	0.024	-0.005	-0.010***
	(0.03)	(1.23)	(0.37)	(0.95)	(1.48)	(5.00)
South-West	0.039*	0.034	-0.044***	-0.027	0.058***	0.025***
	(1.64)	(1.43)	(2.89)	(1.53)	(4.21)	(3.36)
Number of observations	12643		2851		238	

[4] **Note to Table 4:** Workers of parastatal companies are included in the public sector. The reference category for school attendance is those who have never attended school. The reference category for labour market status in 1996 is those who where self-employed. The reference for the province category are respectively Douala for model (1) and Yaoundé for model (2). The first level of secondary school diploma corresponds to the BEPC, CAP or the GCE-O Level. High school certificate is either the Baccalaureat (French speaking) or the CGE A level (English speaking). The robust t-ratios are reported under parenthesis under each parameter estimate. *, **, and, *** denote the parameter is statiscally different from zero at 10%, 5% and 1% level respectively.

Table 5 : Mincerian hourly earnings equation, by sector, Highest education level attended [5]

	Trost and Lee (1984)											
	Unweighted Estimates						Population-Weighted Estimates					
	Informal		Formal				Informal		Formal			
			Private		Public				Private		Public	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Education												
Primary school	0.065**	0.065**	-0.037	-0.037	0.095	0.095	0.051	0.051	-0.078	-0.078	-0.059	-0.059
	(2.363)	(2.363)	(0.566)	(0.566)	(0.588)	(0.588)	(1.524)	(1.524)	(0.768)	(0.768)	(0.271)	(0.271)
Secondary school level 1	0.139***	0.139***	0.178**	0.178**	0.397**	0.397**	0.135***	0.135***	0.126	0.126	0.270	0.270
	(3.639)	(3.639)	(2.376)	(2.376)	(2.458)	(2.458)	(2.898)	(2.898)	(1.133)	(1.133)	(1.224)	(1.224)
Secondary school level 2	0.446***	0.446***	0.421***	0.421***	0.676***	0.676***	0.424***	0.424***	0.349***	0.349***	0.581***	0.581***
	(6.987)	(6.987)	(5.227)	(5.227)	(4.150)	(4.150)	(5.505)	(5.505)	(3.060)	(3.060)	(2.614)	(2.614)
University	0.767***	0.767***	1.122***	1.122***	1.120***	1.120***	0.833***	0.833***	1.034***	1.034***	1.031***	1.031***
	(6.182)	(6.182)	(12.398)	(12.398)	(6.856)	(6.856)	(5.806)	(5.806)	(8.377)	(8.377)	(4.613)	(4.613)
Vocational school level 1	0.226***	0.226***	0.107	0.107	0.280	0.280	0.231***	0.231***	0.074	0.074	0.144	0.144
	(4.135)	(4.135)	(1.256)	(1.256)	(1.638)	(1.638)	(3.715)	(3.715)	(0.618)	(0.618)	(0.628)	(0.628)
Vocational school level 2	0.556***	0.556***	0.437***	0.437***	0.603***	0.603***	0.511***	0.511***	0.374***	0.374***	0.472*	0.472*
	(5.341)	(5.341)	(4.265)	(4.265)	(3.480)	(3.480)	(4.324)	(4.324)	(2.784)	(2.784)	(1.933)	(1.933)
Potential experience												
Experience	0.017***	0.017***	0.051***	0.051***	0.051***	0.051***	0.012***	0.012***	0.040***	0.040***	0.065***	0.065***
	(7.407)	(7.407)	(11.468)	(11.468)	(3.704)	(3.704)	(4.395)	(4.395)	(6.473)	(6.473)	(3.336)	(3.336)
Experience squared	-0.021***	-0.021***	-0.059***	-0.059***	-0.059**	-0.059**	-0.012***	-0.012***	-0.046***	-0.046***	-0.093**	-0.093**
	(5.120)	(5.120)	(6.780)	(6.780)	(2.121)	(2.121)	(2.752)	(2.752)	(3.818)	(3.818)	(2.335)	(2.335)
Gender and location												
Female	-0.198***	-0.198***	-0.172***	-0.172***	-0.051	-0.051	-0.205***	-0.205***	-0.274***	-0.274***	-0.041	-0.041
	(8.420)	(8.420)	(3.573)	(3.573)	(1.375)	(1.375)	(7.000)	(7.000)	(4.545)	(4.545)	(0.832)	(0.832)
Urban	0.082***	0.082***	-0.024	-0.024	0.091**	0.091**	0.035	0.035	-0.015	-0.015	0.172***	0.172***
	(2.618)	(2.618)	(0.483)	(0.483)	(2.190)	(2.190)	(0.871)	(0.871)	(0.229)	(0.229)	(2.870)	(2.870)
Sector												
Commerce	-0.078**	-0.078**	-0.119*	-0.119*	0.186	0.186	-0.063	-0.063	-0.257***	-0.257***	0.521*	0.521*
	(2.556)	(2.556)	(1.841)	(1.841)	(0.600)	(0.600)	(1.386)	(1.386)	(3.186)	(3.186)	(1.938)	(1.938)
Construction and transport	-0.107**	-0.107**	-0.008	-0.008	0.818***	0.818***	-0.038	-0.038	-0.182**	-0.182**	0.776***	0.776***
	(2.317)	(2.317)	(0.117)	(0.117)	(5.420)	(5.420)	(0.658)	(0.658)	(2.036)	(2.036)	(3.931)	(3.931)

Table 5 (continued) : Mincerian hourly earnings equation, by sector, Highest education level attended

Manufacturing	0.017	0.017	0.011	0.011	0.392**	0.392**	0.024	0.024	-0.168*	-0.168*	0.260	0.260
	(0.344)	(0.344)	(0.161)	(0.161)	(2.260)	(2.260)	(0.339)	(0.339)	(1.923)	(1.923)	(1.240)	(1.240)
Service	-0.172***	-0.172***	-0.131*	-0.131*	0.572***	0.572***	-0.131**	-0.131**	-0.310***	-0.310***	0.566***	0.566***
	(4.414)	(4.414)	(1.946)	(1.946)	(5.218)	(5.218)	(2.425)	(2.425)	(3.590)	(3.590)	(4.061)	(4.061)
Province												
Douala		-0.003		0.047		-0.045		-0.004		0.099*		-0.037
		(0.049)		(0.840)		(0.617)		(0.073)		(1.721)		(0.475)
Yaounde	0.003		-0.047		0.045		0.004		-0.099*		0.037	
	(0.049)		(0.840)		(0.617)		(0.073)		(1.721)		(0.475)	
Adamaoua	0.170***	0.168***	-0.235***	-0.189**	-0.104	-0.149*	0.162**	0.158**	-0.252**	-0.153	0.011	-0.026
	(3.059)	(2.834)	(2.922)	(2.242)	(1.023)	(1.731)	(2.511)	(2.394)	(2.176)	(1.289)	(0.103)	(0.288)
Centre	-0.008	-0.011	-0.130*	-0.083	-0.087	-0.132*	-0.153**	-0.157**	-0.130	-0.030	-0.053	-0.090
	(0.161)	(0.197)	(1.658)	(1.022)	(0.960)	(1.795)	(2.412)	(2.447)	(1.356)	(0.309)	(0.475)	(0.922)
East	0.014	0.012	0.015	0.061	-0.047	-0.092	0.032	0.028	0.173	0.272**	0.010	-0.027
	(0.239)	(0.187)	(0.179)	(0.710)	(0.549)	(1.403)	(0.426)	(0.368)	(1.551)	(2.396)	(0.105)	(0.339)
Extreme North	0.002	-0.001	-0.192**	-0.146*	-0.005	-0.050	-0.050	-0.054	-0.302***	-0.202*	-0.223	-0.261*
	(0.028)	(0.017)	(2.408)	(1.674)	(0.043)	(0.546)	(0.783)	(0.815)	(2.771)	(1.753)	(1.365)	(1.695)
Littoral	0.062	0.060	-0.313***	-0.267***	-0.137	-0.182**	0.030	0.027	-0.368***	-0.269***	-0.092	-0.129
	(1.107)	(1.006)	(4.155)	(3.347)	(1.367)	(2.143)	(0.504)	(0.433)	(4.464)	(3.092)	(0.860)	(1.402)
North	-0.137***	-0.140**	-0.027	0.020	-0.043	-0.088	-0.208***	-0.212***	-0.035	0.065	-0.086	-0.123
	(2.697)	(2.575)	(0.290)	(0.208)	(0.367)	(0.864)	(3.452)	(3.466)	(0.280)	(0.522)	(0.555)	(0.877)
North West	-0.210***	-0.213***	-0.680***	-0.633***	0.105	0.060	-0.264***	-0.268***	-0.573***	-0.473***	0.114	0.076
	(4.102)	(3.900)	(7.824)	(7.065)	(1.054)	(0.707)	(4.551)	(4.557)	(5.560)	(4.503)	(0.981)	(0.757)
West	0.031	0.029	-0.485***	-0.438***	-0.098	-0.143**	-0.037	-0.041	-0.500***	-0.401***	-0.018	-0.055
	(0.646)	(0.556)	(6.246)	(5.501)	(1.129)	(2.075)	(0.673)	(0.739)	(5.846)	(4.644)	(0.184)	(0.691)
South	0.115**	0.113*	-0.179***	-0.132*	-0.074	-0.119*	0.104	0.100	-0.286***	-0.187*	-0.085	-0.122
	(1.961)	(1.822)	(2.607)	(1.776)	(0.924)	(1.903)	(1.164)	(1.113)	(2.738)	(1.707)	(0.875)	(1.487)
South West	0.227***	0.225***	-0.370***	-0.323***	-0.207**	-0.253***	0.213***	0.209***	-0.311***	-0.212**	-0.201	-0.238**
	(4.154)	(3.865)	(4.457)	(3.786)	(2.119)	(3.168)	(3.238)	(3.140)	(2.970)	(1.979)	(1.611)	(2.242)

Table 5 continued on next page

Table 5 (concluded) : Mincerian hourly earnings equation, by sector, Highest education level attended

Selection term	0.090*	0.090*	-0.052	-0.052	-0.234***	-0.234***	0.053	0.053	-0.118	-0.118	-0.213***	-0.213***
	(1.652)	(1.652)	(0.773)	(0.773)	(6.409)	(6.409)	(0.718)	(0.718)	(1.538)	(1.538)	(4.779)	(4.779)
Constant	4.679***	4.681***	4.864***	4.817***	4.448***	4.494***	4.792***	4.795***	5.293***	5.194***	4.323***	4.361***
	(74.758)	(72.234)	(35.437)	(33.399)	(17.525)	(18.587)	(63.643)	(63.392)	(29.430)	(27.777)	(11.812)	(12.352)
Observations	9042		3351		1544		9042		3351		1544	
R-Squared	0.070		0.233		0.446		0.075		0.194		0.513	

[5]**Note to Table 5:** Workers of parastatal companies are included in the public sector. The reference group for education is those who have never attended school. The reference for the province category are respectively Douala for model (1) and Yaoundé model (2). The robust t-ratios are reported under parenthesis under each parameter estimate. *, **, and, *** denote the parameter is statiscally different from zero at 10%, 5% and 1% respectively.

Table 6 : Mincerian hourly earnings equation, by sector, School graduate [6]

	Trost and Lee (1984)											
	Unweighted Estimates						Population-Weighted Estimates					
	Informal		Formal				Informal		Formal			
			Private		Public				Private		Public	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Labor market participant holds												
Primary school certificate	0.106***	0.106***	0.121**	0.121**	0.332***	0.332***	0.107***	0.107***	0.130*	0.130*	0.177	0.177
	(4.034)	(4.034)	(2.376)	(2.376)	(3.297)	(3.297)	(3.400)	(3.400)	(1.652)	(1.652)	(1.284)	(1.284)
First level sec. school Diploma	0.347***	0.347***	0.432***	0.432***	0.677***	0.677***	0.300***	0.300***	0.438***	0.438***	0.507***	0.507***
	(6.348)	(6.348)	(6.735)	(6.735)	(6.642)	(6.642)	(4.435)	(4.435)	(4.802)	(4.802)	(3.396)	(3.396)
Probatoire Diploma	0.608***	0.608***	0.554***	0.554***	0.788***	0.788***	0.637***	0.637***	0.525***	0.525***	0.596***	0.596***
	(5.579)	(5.579)	(6.414)	(6.414)	(6.943)	(6.943)	(4.841)	(4.841)	(4.617)	(4.617)	(3.748)	(3.748)
High school certificate	0.665***	0.665***	0.738***	0.738***	0.914***	0.914***	0.585***	0.585***	0.672***	0.672***	0.796***	0.796***
	(6.403)	(6.403)	(9.673)	(9.673)	(8.704)	(8.704)	(4.878)	(4.878)	(6.895)	(6.895)	(5.320)	(5.320)
Technical degree (BTS or DUT)	0.277*	0.277*	1.172***	1.172***	1.070***	1.070***	0.205	0.205	1.211***	1.211***	0.895***	0.895***
	(1.811)	(1.811)	(10.299)	(10.299)	(8.684)	(8.684)	(1.038)	(1.038)	(9.027)	(9.027)	(4.851)	(4.851)
Univ. degree (B.A. M.A and above)	1.303***	1.303***	1.490***	1.490***	1.344***	1.344***	1.321***	1.321***	1.453***	1.453***	1.247***	1.247***
	(7.054)	(7.054)	(16.028)	(16.028)	(12.442)	(12.442)	(6.304)	(6.304)	(12.135)	(12.135)	(8.363)	(8.363)
Potential experience												
Experience	0.016***	0.016***	0.049***	0.049***	0.048***	0.048***	0.011***	0.011***	0.040***	0.040***	0.058***	0.058***
	(7.400)	(7.400)	(11.431)	(11.431)	(3.778)	(3.778)	(4.228)	(4.228)	(6.726)	(6.726)	(2.832)	(2.832)
Experience squared	-0.023***	-0.023***	-0.058***	-0.058***	-0.059**	-0.059**	-0.013***	-0.013***	-0.046***	-0.046***	-0.086*	-0.086*
	(5.683)	(5.683)	(6.678)	(6.678)	(2.175)	(2.175)	(2.964)	(2.964)	(3.892)	(3.892)	(1.958)	(1.958)
Gender and location												
Female	-0.226***	-0.226***	-0.156***	-0.156***	-0.048	-0.048	-0.227***	-0.227***	-0.276***	-0.276***	-0.008	-0.008
	(9.671)	(9.671)	(3.283)	(3.283)	(1.361)	(1.361)	(7.746)	(7.746)	(4.502)	(4.502)	(0.156)	(0.156)
Urban	0.153***	0.153***	-0.023	-0.023	0.069*	0.069*	0.070*	0.070*	0.013	0.013	0.169***	0.169***
	(4.814)	(4.814)	(0.483)	(0.483)	(1.659)	(1.659)	(1.704)	(1.704)	(0.204)	(0.204)	(2.718)	(2.718)
Sector												
Commerce	-0.026	-0.026	-0.062	-0.062	0.295	0.295	-0.012	-0.012	-0.192**	-0.192**	0.643**	0.643**
	(0.825)	(0.825)	(0.955)	(0.955)	(0.869)	(0.869)	(0.264)	(0.264)	(2.348)	(2.348)	(2.174)	(2.174)
Construction and transport	0.024	0.024	0.037	0.037	0.908***	0.908***	0.086	0.086	-0.075	-0.075	0.908***	0.908***
	(0.487)	(0.487)	(0.515)	(0.515)	(4.711)	(4.711)	(1.459)	(1.459)	(0.805)	(0.805)	(4.551)	(4.551)

Table 6 (continued) : Mincerian hourly earnings equation, by sector, School graduate

Manufacturing	0.052	0.052	0.051	0.051	0.567***	0.567***	0.088	0.088	-0.118	-0.118	0.449***	0.449***
	(1.110)	(1.110)	(0.754)	(0.754)	(4.115)	(4.115)	(1.271)	(1.271)	(1.305)	(1.305)	(2.946)	(2.946)
Service	-0.101**	-0.101**	-0.103	-0.103	0.525***	0.525***	-0.059	-0.059	-0.248***	-0.248***	0.471***	0.471***
	(2.561)	(2.561)	(1.526)	(1.526)	(4.948)	(4.948)	(1.088)	(1.088)	(2.781)	(2.781)	(3.240)	(3.240)
Province												
Douala	0.018		-0.045		0.047		0.028		-0.088		0.038	
	(0.341)		(0.821)		(0.675)		(0.509)		(1.526)		(0.517)	
Yaounde		-0.018		0.045		-0.047		-0.028		0.088		-0.038
		(0.341)		(0.821)		(0.675)		(0.509)		(1.526)		(0.517)
Adamaoua	0.143**	0.125**	-0.220***	-0.175**	-0.057	-0.104	0.129*	0.101	-0.340***	-0.252**	0.030	-0.008
	(2.546)	(2.126)	(2.725)	(2.067)	(0.590)	(1.260)	(1.958)	(1.521)	(2.760)	(2.005)	(0.266)	(0.085)
Centre	-0.131**	-0.149***	-0.168**	-0.124	-0.050	-0.097	-0.335***	-0.363***	-0.408***	-0.320**	0.015	-0.023
	(2.472)	(2.679)	(2.116)	(1.510)	(0.579)	(1.371)	(5.298)	(5.749)	(3.076)	(2.413)	(0.137)	(0.239)
East	-0.145**	-0.163***	0.073	0.117	0.026	-0.022	-0.167**	-0.195***	0.260**	0.348***	0.129	0.091
	(2.496)	(2.686)	(0.868)	(1.356)	(0.307)	(0.330)	(2.256)	(2.621)	(2.358)	(3.111)	(1.333)	(1.157)
Extreme North	0.092*	0.074	-0.124	-0.079	0.050	0.002	0.045	0.017	-0.132	-0.044	-0.115	-0.153
	(1.677)	(1.281)	(1.589)	(0.926)	(0.484)	(0.027)	(0.708)	(0.266)	(1.239)	(0.391)	(0.721)	(1.012)
Littoral	-0.028	-0.045	-0.253***	-0.209***	-0.076	-0.123	-0.089	-0.117*	-0.299***	-0.212**	-0.003	-0.041
	(0.496)	(0.776)	(3.382)	(2.668)	(0.786)	(1.475)	(1.450)	(1.908)	(3.670)	(2.506)	(0.032)	(0.461)
North	-0.039	-0.056	0.057	0.101	-0.032	-0.080	-0.112*	-0.140**	0.064	0.152	-0.082	-0.120
	(0.769)	(1.061)	(0.612)	(1.082)	(0.279)	(0.765)	(1.881)	(2.348)	(0.523)	(1.235)	(0.547)	(0.874)
North West	-0.394***	-0.411***	-0.779***	-0.734***	0.049	0.001	-0.490***	-0.518***	-0.714***	-0.627***	0.055	0.017
	(7.645)	(7.603)	(8.852)	(8.182)	(0.482)	(0.014)	(8.304)	(8.801)	(6.586)	(5.731)	(0.462)	(0.155)
West	0.087*	0.070	-0.495***	-0.450***	0.089	-0.136**	0.032	0.004	-0.519***	-0.431***	0.005	-0.032
	(1.778)	(1.348)	(6.410)	(5.709)	(1.067)	(2.041)	(0.569)	(0.075)	(6.094)	(5.060)	(0.057)	(0.410)
South	0.009	-0.009	-0.113*	-0.069	-0.030	-0.077	-0.037	-0.065	-0.190*	-0.102	-0.019	-0.056
	(0.144)	(0.148)	(1.666)	(0.942)	(0.396)	(1.303)	(0.441)	(0.768)	(1.823)	(0.939)	(0.194)	(0.674)
South West	0.298***	0.280***	-0.411***	-0.366***	-0.283***	-0.331***	0.275***	0.247***	-0.349***	-0.261**	-0.301**	-0.338***
	(5.401)	(4.851)	(4.899)	(4.290)	(2.937)	(4.048)	(4.126)	(3.710)	(3.379)	(2.506)	(2.265)	(2.824)

Table 6 (concluded) : Mincerian hourly earnings equation, by sector,School graduate

Selection term	0.054	0.054	-0.095	-0.095	-0.233***	-0.233***	0.057	0.057	-0.118	-0.118	-0.241***	-0.241***
	(0.991)	(0.991)	(1.429)	(1.429)	(6.631)	(6.631)	(0.772)	(0.772)	(1.493)	(1.493)	(5.100)	(5.100)
Constant	4.605***	4.622***	4.817***	4.772***	4.465***	4.512***	4.712***	4.739***	5.085***	4.998***	4.470***	4.507***
	(80.309)	(77.982)	(37.930)	(35.330)	(20.070)	(21.425)	(67.762)	(68.639)	(30.581)	(28.648)	(12.985)	(13.645)
Number of observation	10133		3430		1552		10133		3430		1552	
R-Squared	0.085	0.085	0.254	0.254	0.471	0.471	0.104	0.104	0.216	0.216	0.520	0.520

[6]**Note to Table 6:** Workers of parastatal companies are included in the public sector. The reference group for education is those who have never attended school. The reference for the province category are respectively Douala for model (1) and Yaoundé model (2). The first level of secondary school diploma corresponds to the BEPC, CAP or the GCE-O Level. High school certificate is either the Baccalaureat (French speaking) or the CGE A level (English speaking). The The robust t-ratios are reported under parenthesis under each parameter estimate. *, **, and, *** denote the parameter is statiscally different from zero at 10%, 5% and 1% respectively.

Table 7 : Mincerian hourly earnings equation, by sector, Highest education level attended, robustness check [7]

	Bourguignon, Fournier and Gurgan (2004)						Dahl (2002)					
	Informal		Formal				Informal		Formal			
			Private		Public				Private		Public	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Education												
Primary school	0.063**	0.063**	-0.042	-0.042	-0.290	-0.290	0.072**	0.072***	-0.032	-0.032	0.223	0.223
	(2.139)	(2.068)	(0.613)	(0.606)	(0.751)	(0.733)	(2.548)	(2.779)	(0.478)	(0.541)	(0.898)	(0.895)
Secondary school level 1	0.146***	0.146***	0.169*	0.169*	-0.160	-0.160	0.157***	0.157***	0.192**	0.192***	0.556**	0.556**
	(3.180)	(3.294)	(1.924)	(1.958)	(0.412)	(0.398)	(4.220)	(4.492)	(2.566)	(2.699)	(2.393)	(2.314)
Secondary school level 2	0.468***	0.468***	0.410***	0.410***	0.120	0.120	0.488***	0.488***	0.439***	0.439***	0.889***	0.889***
	(6.141)	(6.308)	(4.115)	(3.941)	(0.314)	(0.303)	(8.010)	(8.359)	(5.527)	(5.865)	(3.835)	(3.694)
University	0.805***	0.805***	1.083***	1.083***	0.491	0.491	0.863***	0.863***	1.145***	1.145***	1.329***	1.329***
	(5.945)	(6.207)	(8.518)	(8.209)	(1.241)	(1.197)	(7.845)	(7.337)	(13.488)	(13.883)	(5.657)	(5.506)
Vocational school level 1	0.225***	0.225***	0.083	0.083	-0.183	-0.183	0.244***	0.244***	0.119	0.119	0.456*	0.456*
	(3.726)	(3.746)	(0.930)	(0.877)	(0.487)	(0.469)	(4.518)	(4.965)	(1.344)	(1.498)	(1.892)	(1.829)
Vocational school level 2	0.582***	0.582***	0.433***	0.433***	0.032	0.032	0.605***	0.605***	0.467***	0.467***	0.792***	0.792***
	(4.980)	(5.202)	(3.492)	(3.485)	(0.081)	(0.078)	(5.865)	(6.032)	(4.705)	(5.026)	(3.323)	(3.153)
Potential experience												
Experience	0.013***	0.013***	0.039***	0.039***	0.059***	0.059***	0.017***	0.017***	0.051***	0.051***	0.089***	0.089***
	(4.931)	(5.261)	(7.642)	(7.449)	(3.470)	(3.374)	(7.632)	(7.800)	(11.206)	(11.928)	(5.946)	(5.872)
Experience squared	-0.016***	-0.016***	-0.043***	-0.043***	-0.067**	-0.067*	-0.022***	-0.022***	-0.060***	-0.060***	-0.119***	-0.119***
	(3.700)	(4.057)	(4.728)	(4.571)	(1.969)	(1.921)	(5.300)	(5.366)	(6.503)	(7.194)	(3.664)	(3.648)
Gender and location												
Female	-0.181***	-0.181***	-0.091	-0.091*	-0.109*	-0.109*	-0.217***	-0.217***	-0.195***	-0.195***	-0.034	-0.034
	(6.127)	(5.892)	(1.552)	(1.663)	(1.917)	(1.942)	(11.025)	(10.734)	(5.023)	(4.638)	(0.828)	(0.873)
Urban	0.078**	0.078**	-0.063	-0.063	0.093*	0.093*	0.101***	0.101***	-0.005	-0.005	0.060	0.060
	(2.335)	(2.362)	(1.302)	(1.366)	(1.927)	(1.780)	(3.498)	(3.718)	(0.131)	(0.133)	(1.312)	(1.361)
Sector [a]												
Commerce	-0.072**	-0.072**	-0.119*	-0.119*	0.000	0.000	-0.080***	-0.080***	-0.122**	-0.122*	0.000	0.000
	(2.157)	(2.309)	(1.677)	(1.721)	(.)	(.)	(2.666)	(2.751)	(1.987)	(1.824)	(.)	(.)
Construction and transport	-0.092*	-0.092*	-0.010	-0.010	0.000	0.000	-0.094*	-0.094**	-0.007	-0.007	0.000	0.000
	(1.941)	(1.898)	(0.126)	(0.130)	(.)	(.)	(1.901)	(2.185)	(0.106)	(0.101)	(.)	(.)

Table 7 (continued) : Mincerian hourly earnings equation, by sector, Highest education level attended, robustness check

Manufacturing	0.020	0.020	0.013	0.013	0.000	0.000	0.014	0.014	0.013	0.013	0.000	0.000
	(0.409)	(0.398)	(0.167)	(0.173)	(.)	(.)	(0.280)	(0.273)	(0.193)	(0.189)	(.)	(.)
Service	-0.150***	-0.150***	-0.116	-0.116*	0.000	0.000	-0.164***	-0.164***	-0.128**	-0.128*	0.000	0.000
	(3.608)	(3.689)	(1.572)	(1.666)	(.)	(.)	(4.375)	(4.314)	(1.962)	(1.956)	(.)	(.)
Province												
Douala		0.025		0.082		-0.053		0.005		0.054		-0.137
		(0.477)		(1.402)		(0.562)		(0.102)		(0.964)		(1.569)
Yaounde	-0.025		-0.082		0.053		-0.005		-0.054		0.137	
	(0.510)		(1.433)		(0.548)		(0.107)		(0.979)		(1.620)	
Adamaoua	0.099	0.124*	-0.351***	-0.268***	-0.222	-0.276**	0.168***	0.173***	-0.237***	-0.183**	-0.014	-0.151*
	(1.349)	(1.816)	(3.725)	(2.958)	(1.414)	(2.106)	(3.062)	(2.917)	(3.048)	(2.219)	(0.125)	(1.752)
Centre	-0.043	-0.018	-0.181**	-0.099	-0.139	-0.192**	-0.025	-0.020	-0.145*	-0.091	-0.076	-0.213***
	(0.806)	(0.302)	(2.230)	(1.157)	(1.196)	(2.117)	(0.496)	(0.373)	(1.882)	(1.131)	(0.730)	(2.685)
East	-0.001	0.024	0.018	0.100	-0.152	-0.206**	0.004	0.009	0.011	0.065	0.043	-0.094
	(0.020)	(0.372)	(0.209)	(1.136)	(1.243)	(2.491)	(0.062)	(0.149)	(0.132)	(0.739)	(0.432)	(1.375)
Extreme North	-0.051	-0.026	-0.361***	-0.278***	-0.132	-0.186	0.040	0.046	-0.163**	-0.110	0.056	-0.081
	(0.882)	(0.425)	(4.175)	(3.148)	(0.937)	(1.602)	(0.783)	(0.859)	(2.316)	(1.498)	(0.457)	(0.822)
Littoral	0.038	0.063	-0.335***	-0.253***	-0.214	-0.267**	0.049	0.054	-0.318***	-0.264***	-0.107	-0.244***
	(0.652)	(1.054)	(4.210)	(3.136)	(1.614)	(2.439)	(0.859)	(0.900)	(4.170)	(3.173)	(0.915)	(2.682)
North	-0.286***	-0.261***	-0.240**	-0.158	0.091	0.038	-0.156***	-0.150***	-0.051	0.003	0.005	-0.132
	(4.672)	(4.027)	(2.202)	(1.406)	(0.571)	(0.296)	(3.007)	(2.766)	(0.583)	(0.032)	(0.037)	(1.163)
North West	-0.205***	-0.180***	-0.640***	-0.558***	0.060	0.007	-0.221***	-0.216***	-0.688***	-0.634***	0.203*	0.066
	(4.030)	(3.313)	(6.955)	(6.090)	(0.459)	(0.068)	(4.358)	(4.014)	(8.064)	(6.990)	(1.784)	(0.728)
West	-0.058	-0.032	-0.599***	-0.517***	-0.106	-0.160	0.011	0.016	-0.506***	-0.452***	-0.002	-0.139*
	(1.170)	(0.587)	(6.675)	(6.278)	(0.839)	(1.619)	(0.219)	(0.298)	(6.760)	(5.876)	(0.023)	(1.776)
South	0.111*	0.136**	-0.181***	-0.099	-0.184*	-0.237***	0.111*	0.117**	-0.171**	-0.117	-0.069	-0.206***
	(1.889)	(2.199)	(2.681)	(1.369)	(1.709)	(2.941)	(1.909)	(1.961)	(2.389)	(1.552)	(0.763)	(3.066)
South West	0.122**	0.148**	-0.549***	-0.467***	0.283	0.229	0.222***	0.227***	-0.380***	-0.326***	-0.018	-0.154
	(1.964)	(2.198)	(4.378)	(3.801)	(1.315)	(1.070)	(3.901)	(3.906)	(4.713)	(3.661)	(0.157)	(1.633)

Table 7 (concluded) : Mincerian hourly earnings equation, by sector, Highest education level attended, robustness check

Selection term												
Selection term 0	0.455**	0.455**	0.877***	0.877***	-0.591**	-0.591*						
	(2.230)	(2.233)	(3.896)	(3.910)	(2.077)	(1.902)						
Selection term 1	-0.043	-0.043	-0.090	-0.090	0.582	0.582						
	(0.357)	(0.359)	(0.295)	(0.291)	(1.587)	(1.495)						
Selection term 2	-0.019	-0.019	-0.039	-0.039	-0.266	-0.266						
	(0.068)	(0.075)	(0.348)	(0.372)	(0.848)	(0.877)						
Selection term 3	-0.203	-0.203	-0.050	-0.050	-0.318***	-0.318***						
	(0.544)	(0.544)	(0.149)	(0.153)	(2.863)	(2.618)						
Constant	4.953***	4.928***	5.259***	5.177***	5.587***	5.640***	4.711***	4.706***	4.794***	4.740***	4.098***	4.235***
	(44.535)	(43.732)	(22.746)	(21.459)	(11.650)	(11.156)	(77.976)	(76.594)	(48.219)	(45.830)	(15.188)	(15.967)

[7] **Note to Table 7:** Workers of parastatal companies are included in the public sector. The reference group for education is those who have never attended school. The reference for the province category are Douala for model (1) and Yaoundé for model (2). The robust t-ratios are reported under parenthesis under each parameter estimate. *, **, and, *** denote the parameter is statiscally different from zero at 10%, 5% and 1% level respectively. (a) indicates these variables were dropped to solve for multicolinearity problem coming with this method.

Table 8 : Mincerian hourly earnings equation, by sector, School graduate, robustness check [8]

	Bourguignon, Fournier and Gurgan (2004)						Dahl (2002)					
	Informal		Formal				Informal		Formal			
			Private		Public				Private		Public	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Education			-									
Primary school certificate	0.110***	0.110***	0.098*	0.098*	0.256**	0.256**	0.112***	0.112***	0.142***	0.142***	0.432***	0.432***
	(3.926)	(3.906)	(1.778)	(1.742)	(2.297)	(2.340)	(4.312)	(4.359)	(2.978)	(3.030)	(4.060)	(4.297)
First level sec. school diploma	0.353***	0.353***	0.386***	0.386***	0.586***	0.586***	0.364***	0.364***	0.467***	0.467***	0.855***	0.855***
	(5.621)	(6.046)	(5.002)	(5.132)	(4.966)	(5.062)	(7.142)	(7.488)	(7.718)	(7.881)	(8.153)	(8.549)
Probatoire diploma	0.619***	0.619***	0.518***	0.518***	0.706***	0.706***	0.638***	0.638***	0.601***	0.601***	0.984***	0.984***
	(5.507)	(5.602)	(5.422)	(5.416)	(5.399)	(5.535)	(6.359)	(6.444)	(7.794)	(7.764)	(8.538)	(8.922)
High school certificate	0.680***	0.680***	0.668***	0.668***	0.810***	0.810***	0.707***	0.707***	0.792***	0.792***	1.093***	1.093***
	(6.349)	(6.309)	(7.226)	(7.233)	(6.359)	(6.575)	(7.151)	(6.958)	(12.071)	(12.833)	(10.021)	(10.667)
Technical degree (BTS or DUT)	0.299*	0.299*	1.090***	1.090***	0.936***	0.936***	0.354**	0.354***	1.239***	1.239***	1.263***	1.263***
	(1.810)	(1.896)	(7.657)	(7.656)	(6.290)	(6.184)	(2.492)	(2.659)	(11.718)	(11.493)	(9.734)	(10.439)
University (BA, BSc. and above)	1.340***	1.340***	1.385***	1.385***	1.226***	1.226***	1.362***	1.362***	1.524***	1.524***	1.547***	1.547***
	(6.819)	(6.910)	(11.578)	(11.149)	(9.352)	(9.637)	(7.469)	(7.286)	(17.460)	(17.371)	(13.938)	(14.600)
Potential experience												
Experience	0.013***	0.013***	0.037***	0.037***	0.047***	0.047***	0.016***	0.016***	0.049***	0.049***	0.080***	0.080***
	(5.234)	(5.263)	(7.605)	(7.742)	(3.624)	(3.387)	(7.266)	(7.305)	(11.045)	(11.686)	(7.443)	(7.198)
Experience squared	-0.019***	-0.019***	-0.042***	-0.042***	-0.055**	-0.055*	-0.023***	-0.023***	-0.059***	-0.059***	-0.108***	-0.108***
	(4.432)	(4.525)	(4.536)	(4.579)	(2.059)	(1.881)	(5.646)	(5.618)	(6.579)	(6.980)	(4.451)	(4.365)
Gender and location												
Female	-0.213***	-0.213***	-0.082	-0.082	-0.015	-0.015	-0.237***	-0.237***	-0.197***	-0.197***	-0.073**	-0.073**
	(7.174)	(6.934)	(1.472)	(1.452)	(0.330)	(0.350)	(11.736)	(11.848)	(4.832)	(5.031)	(2.087)	(2.044)
Urban	0.169***	0.169***	-0.013	-0.013	0.029	0.029	0.164***	0.164***	0.010	0.010	0.042	0.042
	(5.166)	(4.982)	(0.276)	(0.282)	(0.668)	(0.633)	(5.203)	(5.782)	(0.232)	(0.238)	(0.970)	(0.979)
Sector [a]												
Commerce	-0.022	-0.022	-0.073	-0.073	0.222	0.222	-0.028	-0.028	-0.065	-0.065	0.046	0.046
	(0.689)	(0.729)	(1.135)	(1.119)	(0.545)	(0.576)	(0.895)	(0.885)	(1.054)	(1.013)	(0.107)	(0.113)
Construction and transport	0.031	0.031	0.023	0.023	0.861***	0.861***	0.032	0.032	0.043	0.043	0.815***	0.815***
	(0.617)	(0.636)	(0.312)	(0.324)	(4.379)	(4.403)	(0.695)	(0.688)	(0.623)	(0.608)	(4.452)	(4.313)

Table 8 (continued) : Mincerian hourly earnings equation, by sector, School graduate, robustness check

Manufacturing	0.053	0.053	0.037	0.037	0.540***	0.540***	0.049	0.049	0.056	0.056	0.526***	0.526***
	(1.163)	(1.130)	(0.510)	(0.541)	(3.889)	(3.969)	(1.103)	(1.073)	(0.809)	(0.839)	(4.001)	(3.754)
Service	-0.086**	-0.086**	-0.102	-0.102	0.493***	0.493***	-0.096**	-0.096**	-0.097	-0.097	0.601***	0.601***
	(2.092)	(2.257)	(1.412)	(1.543)	(4.641)	(4.769)	(2.404)	(2.540)	(1.425)	(1.375)	(5.766)	(5.522)
Province												
Douala	0.001		-0.082		0.062		0.011		-0.059		0.106	
	(0.016)		(1.511)		(0.831)		(0.212)		(1.065)		(1.502)	
Yaounde		-0.001		0.082		-0.062		-0.011		0.059		-0.106
		(0.016)		(1.462)		(0.888)		(0.237)		(1.172)		(1.442)
Adamaoua	0.090	0.089	-0.344***	-0.261***	-0.070	-0.131	0.140***	0.129**	-0.215**	-0.157**	-0.027	-0.134
	(1.511)	(1.457)	(3.905)	(3.062)	(0.654)	(1.550)	(2.586)	(2.176)	(2.496)	(1.967)	(0.275)	(1.626)
Centre	-0.171***	-0.172***	-0.262***	-0.179**	-0.041	-0.103	-0.144***	-0.155***	-0.199***	-0.141*	-0.069	-0.175**
	(3.180)	(3.262)	(3.205)	(2.094)	(0.421)	(1.417)	(2.742)	(2.841)	(2.644)	(1.748)	(0.749)	(2.488)
East	-0.178***	-0.178***	0.007	0.089	0.015	-0.047	-0.155***	-0.166***	0.059	0.117	0.079	-0.027
	(3.061)	(2.856)	(0.081)	(1.004)	(0.164)	(0.711)	(2.599)	(2.609)	(0.665)	(1.415)	(0.992)	(0.400)
Extreme North	0.069	0.068	-0.249***	-0.167**	-0.025	-0.086	0.114**	0.102**	-0.069	-0.010	0.071	-0.036
	(1.221)	(1.156)	(2.973)	(2.028)	(0.221)	(0.890)	(2.250)	(2.021)	(0.990)	(0.136)	(0.683)	(0.407)
Littoral	-0.060	-0.061	-0.311***	-0.229***	-0.053	-0.114	-0.039	-0.051	-0.269***	-0.210***	-0.050	-0.156*
	(1.007)	(1.077)	(3.826)	(2.921)	(0.499)	(1.261)	(0.694)	(0.865)	(3.463)	(2.746)	(0.506)	(1.747)
North	-0.106*	-0.107*	-0.082	0.001	0.006	-0.056	-0.054	-0.065	0.014	0.072	0.017	-0.089
	(1.926)	(1.920)	(0.821)	(0.006)	(0.045)	(0.576)	(1.075)	(1.251)	(0.155)	(0.796)	(0.155)	(0.834)
North West	-0.418***	-0.419***	-0.789***	-0.707***	0.064	0.002	-0.405***	-0.417***	-0.805***	-0.746***	0.065	-0.041
	(7.901)	(7.570)	(8.419)	(7.697)	(0.610)	(0.025)	(7.861)	(7.636)	(9.045)	(8.364)	(0.601)	(0.451)
West	0.046	0.045	-0.566***	-0.483***	-0.080	-0.142**	0.073	0.061	-0.531***	-0.473***	-0.077	-0.183**
	(0.898)	(0.876)	(6.874)	(5.971)	(0.864)	(2.103)	(1.483)	(1.211)	(6.891)	(6.211)	(0.928)	(2.406)
South	-0.007	-0.008	-0.145**	-0.063	-0.084	-0.146**	0.001	-0.011	-0.109	-0.050	-0.049	-0.156**
	(0.126)	(0.137)	(1.975)	(0.900)	(1.015)	(2.437)	(0.009)	(0.179)	(1.589)	(0.711)	(0.654)	(2.558)
South West	0.251***	0.250***	-0.542***	-0.460***	-0.240**	-0.302***	0.291***	0.280***	-0.436***	-0.377***	-0.199**	-0.305***
	(4.350)	(4.309)	(5.503)	(5.294)	(2.328)	(3.825)	(5.169)	(4.753)	(5.284)	(4.496)	(2.049)	(3.736)

Table 8 (concluded) : Mincerian hourly earnings equation, by sector, School graduate, robustness check

Selection term												
Selection term 0	0.334**	0.334***	0.622***	0.622***	0.172	0.172						
	(2.554)	(2.576)	(3.202)	(3.511)	(0.657)	(0.611)						
Selection term 1	-0.006	-0.006	-0.090	-0.090	0.695**	0.695**						
	(0.064)	(0.068)	(0.333)	(0.335)	(2.077)	(2.162)						
Selection term 2	-0.051	-0.051	-0.158*	-0.158*	0.055	0.055						
	(0.262)	(0.261)	(1.850)	(1.855)	(0.275)	(0.274)						
Selection term 3	-0.174	-0.174	-0.362	-0.362	-0.069	-0.069						
	(0.737)	(0.784)	(1.149)	(1.182)	(0.701)	(0.747)						
Selection term 4												
Constant	4.740***	4.741***	5.139***	5.057***	4.642***	4.704***	4.630***	4.641***	4.689***	4.630***	3.644***	3.750***
	(55.521)	(57.205)	(25.457)	(25.128)	(19.170)	(19.537)	(82.123)	(81.392)	(52.714)	(51.403)	(21.374)	(21.444)

[8] **Note to Table 8:** Workers of parastatal companies are included in the public sector. The reference group for education is those who have never attended school. The reference for the province category are Douala for model (1) and Yaoundé for model (2). The robust t-ratios are reported under parenthesis under each parameter estimate. *, **, and, *** denote the parameter is statiscally different from zero at 10%, 5% and 1% level respectively. (a). indicates these variables were automatically dropped to solve for multicolinearity problem coming with this method. The first level of secondary diploma corresponds to the BEPC, CAP or the GCE-O Level. High school certificate is either the Baccalaureat (French speaking) or the GCE Advanced level (English speaking).

Conclusion générale

Un des postulats fondamentaux du cadre néo-classique est que l'homo oeconomicus, i.e., l'agent doté d'une rationalité illimitée ou substantielle optimise ses choix en s'orientant en tout temps vers l'utilité espérée la plus élevée. Deux essais de cette thèse ont cependant démontré que la présence de normes sociales dans la plupart des environnements sous développés peut faire en sorte qu'y être néoclassique ne soit pas nécessairement rationnel. Dans un troisième essai, nous avons montré que la rémunération du capital humain dans bon nombre de pays en développement est significativement différente de celle qui est très souvent observée dans beaucoup de pays riches.

Le premier chapitre avait deux objectifs importants. Le premier était d'explorer les implications pour le choix par les femmes de l'activité économique et de la demande de capital, de l'interaction entre les facteurs économiques et sociaux. L'accès au crédit à des conditions avantageuses et l'absence de légalité étaient les principaux facteurs économiques sous-tendant la décision des femmes d'entreprendre des activités économiques dans notre modèle, alors que la prédominance dans l'économie informelle de formes patriarcales de régulation des affaires caractérisait le contexte social régissant cette décision. Le second objectif consistait à dégager les conditions nécessaires et suffisantes pour que les services de microfinance généralement offerts aux femmes contribuent à la consolidation de leur émancipation socioéconomique. Nous nous sommes inspiré de la littérature existante pour supposer que les revenus gagnés par les entrepreneures représentaient le facteur le plus décisif pour leur émancipation. Pour atteindre nos objectifs, nous avons construit un modèle comportant un jeu super modulaire de choix d'activités économiques entre des entrepreneures homogènes ex ante. Nous avons démontré que ce jeu admet deux équilibres de Nash tous symétriques en stratégies pures et ordonnées au sens de Pareto. Nous avons aussi montré que l'équilibre où toutes les femmes choisissent d'opérer des activités économiques à haute productivité dans le secteur informel avait plus d'impact sur leur émancipation, et était par conséquent préféré à celui où les femmes choisissaient toutes de rester confinées dans des activités moins lucratives (ou à faible productivité). En raison de cette multiplicité d'équilibres, nous avons conclu que l'accès au crédit bien qu'étant nécessaire, ne constituait pas une condition suffisante pour faire de l'émancipation des

femmes une réalité de tous les jours. Nous avons montré que les échecs de coordination dans les choix d'activités par les femmes pouvaient empêcher ces dernières de créer des réseaux d'affaires assez grands pour atténuer les formes patriarcales de régulation d'affaires qui les désavantagent comparativement aux hommes, lorsque vient le temps d'opérer des activités plus lucratives. Nous avons démontré qu'une condition suffisante à la consolidation de l'émancipation des femmes via les services de microfinance serait que les institutions de microfinance assujettissent l'accès des femmes au crédit à leur adoption d'activités économiques informelles plus productives. A notre sens, une telle conditionnalité pourrait aider les organisations de microfinance à organiser ces femmes dans des réseaux d'affaires (les coopératives sont un exemple) assez grands pour atténuer les pratiques patriarcales qui accroissent considérablement les coût d'opération d' activités à haute productivité dans l'économie informelle lorsqu'on est une femme. Finalement, le premier chapitre a démontré l'importance de la prise en compte du contexte socioculturel dans l'implémentation des projets de développement ciblant spécifiquement les femmes vivant dans les environnements sous développés.

Le deuxième chapitre visait lui aussi deux objectifs principaux. Le premier était de démontrer comment les normes sociales pouvaient influencer les décisions de modernisation des exploitations agricoles (ou fermes) en Afrique Subsaharienne. Le contexte socioculturel que nous avons considéré met l'accent sur la prédominance dans les communautés rurales africaines des traditions de solidarité et de générosité qui obligent les individus à partager leurs avoirs avec les autres membres de leur communauté. Comme conséquence, les personnes ayant l'esprit d'entreprise et le souci d' innovation dans leurs activités font inévitablement face à des problèmes de contrôle total de leurs actifs financiers et non financiers. Le deuxième but était de proposer des conditions nécessaires et suffisantes pour que les fermiers modernisent leurs pratiques agricoles dans un tel contexte. Dans ce chapitre, nous avons également pris en compte le fait que l'environnement africain, excepté les pays déchirés par la guerre, procure des opportunités économiques potentiellement profitables aux propriétaires de petites exploitations agricoles, qui, selon les théoriciens néo-Boserupiens jouent un rôle de premier plan dans la décision d'introduire des innovations technologiques dans l'agriculture. Pour atteindre ces deux buts, nous avons utilisé un cadre de théorie de jeux comprenant un jeu

non coopératif de décision de modernisation des activités agricoles entre des fermiers propriétaires et homogènes en début de période. Nous avons démontré que ce jeu admet deux équilibres de Nash en stratégies pures, symétriques et ordonnés au sens de Pareto. L'équilibre où tous les fermiers choisissent de moderniser leurs techniques agricoles est préférée à celui où tous choisissent le statut quo, i.e., rejettent les innovations agricoles. En raison de la multiplicité d'équilibres, nous avons conclu que les politiques publiques peuvent jouer un rôle significatif dans la modernisation des activités agricoles en Afrique Subsaharienne, au delà de ce qui est prescrit par les théories néo-Boserupiennes d'innovation induite. En d'autres termes, la pénurie et les opportunités économiques pour les fermiers, qui ont été mises en avant par les agroéconomistes néo-Boserupiens comme les facteurs les plus déterminants de l'adoption des innovations technologiques dans l'agriculture, sont, dans le contexte de l'Afrique Subsaharienne nécessaires mais pas suffisante à la modernisation des pratiques agricoles. Nous avons démontré en effet que les échecs de coordination dans les décisions de modernisation des exploitations agricoles peuvent empêcher les fermiers de résister aux obligations traditionnelles de solidarité et de partage qui freinent leurs efforts de constitution d'épargne productive. Nous avons montré que l'obtention de conditions nécessaires et suffisantes dans le contexte de l'Afrique Subsaharienne passe par l'ajout aux pré requis néo-Boserupiens d'une technologie sécuritaire d'épargne à la Duflo (2006). A notre sens, une telle technologie d'épargne peut aider à atténuer les pressions sociales qui empêchent les propriétaires de petites exploitations en Afrique Subsaharienne de constituer une épargne nécessaire à l'achat d'engrais.

Dans le troisième chapitre de notre thèse, nous avons contribué à la littérature empirique sur les retours à l'éducation en utilisant l'enquête camerounaise auprès des ménages (effectuée en 2001) pour estimer les taux de rendement privés à l'éducation (TDRE). Nous avons permis aux TDRE de différer par niveau d'éducation et par secteur d'emploi - formel (public ou privé) ou informel- et nous avons tenu compte du biais provenant de la sélection du secteur d'activité par les différents participants au marché du travail. Nous avons comparé les TDRE de personnes qui ont fréquenté un cycle d'éducation avec ceux d'individus ayant reçu un diplôme dudit cycle. Nos estimations ont démontré l'importance d'utiliser des échantillons représentatifs de la populationdans

l'estimation des TDRE qui sont valides pour la population toute entière. Comme résultats, nous avons obtenu des TDRE hautement convexes dans tous les secteurs d'activité. Nous avons aussi montré que les individus qui sont uniquement allés à l'école primaire sans y avoir reçu de diplôme n'enregistrent aucun retour à l'éducation quelque soit le secteur d'emploi. Cependant, les retours pour les diplômés de l'école primaire sont positifs et statistiquement significatifs. Nos résultats ont révélé des TDRE très élevés pour les participants au marché du travail qui ont fréquenté l'université ainsi que pour ceux qui y ont reçu un diplôme. La convexité et le niveau élevé des taux de rendement à l'éducation que nous avons obtenu pour le Cameroun sont conformes aux résultats récents issus de beaucoup d'autres pays africains au sud du Sahara.De plus, les autres déterminants socioéconomiques des revenus que nous avons mis en lumière dans cet essai sont en droite ligne avec la littérature empirique. En nous basant sur nos résultats, nous avons prescrit un certain nombre de politique publiques. Premièrement, sous l'hypothèse que la qualité de l'enseignement ne change pas au Cameroun, nous avons recommandé que les pouvoirs publics incitent les élèves à graduer à l'école primaire et à continuer leurs études dans les autres cycles d'éducation. Deuxièmement, les autorités publiques doivent aussi allouer des transferts financiers aux familles les plus pauvres afin de leur permettre d'envoyer leurs enfants à l'école pour que ces dernier puissent profitent des retombées positives d'une telle décision.