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Economics School of Namur - ESN

The Community Inventory Credit in Rural Africa

A theoretical approach

Author : LE MARCHAND Lucas

Thesis Director : PARIENTE William

Thesis Reader : GUIRKINGER Catherine

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Abstract

Inventory credit is a financial device that combines the allocation of loan in exchange of the providing of a food crop amount, that serves the role of a collateral. Designed to target rural population, the beneficiaries smallholders accept to lock their crop in a warehouse till the end of the loan reimbursement period. Our contribution is aiming to give the start of an answer to the question : is Community Inventory Credit a reliable mean to improve rural remote households food security ?

We decided to adapt the two-period model of Gross, Guirkingner and Platteau to our research question. Thanks to their theoretical frame, we were able to construct a version of their model where nutritional status could interact with Community Credit variables as well as food crop prices. We also added in our version an investment component, made possible through the deliverance of the loan, that came as an intuition from our Beninese experience. Our results suggest a positive answer to our research question. Indeed, both price inflation and the return rate of the investment seems to enhance the households food security, by allowing a greater food crop transfer from the harvest to the lean season.

Table of Contents

Acknowledgements	2
Abstract	2
1. Introduction.....	4
2. State of the Art	6
2.1. Rural credit market imperfections	6
2.1.1. Screening	6
2.1.2. Incentives	9
2.1.3. Enforcement, collateral and state intervention	12
2.2. Inventory credit.....	15
2.2.1. Warrant Receipt System.....	17
2.2.2. The first steps in the WRS study : the contributions of Coulter & Onumah.	17
2.2.3. The literature focus on the Tanzanian WRS model.....	21
2.2.4. The lessons of WRS programs in Malawi and Indonesia.....	24
2.2.5. Theoretical approaches of WRS.....	26
2.3. Community Inventory Credit.....	27
2.3.1. Niger, the first field of study of CIC in Africa	27
2.3.2. The first evaluation of CIC in West Africa.....	29
2.3.3. The first CIC drawbacks exposed by the literature.....	30
2.3.4. The literature view on the Burkinabe experience of CIC	32
3. Context	37
4. Theoretical approach.....	40
5. Results	46
5.1. Our model and the “SLBH” phenomenon	46
5.2. Carryover effect and transformation effect.....	47
5.3. The prices ratio.....	48
5.4. The rates difference, R	50
5.5. The storing costs, β	51
5.6. The warranted crop value converter, α	52
6. Discussions	53
6.1. Price variations: expectations and context elements	53
6.2. The rates difference pertinence : insights from our Beninese experience	55
6.3. Reflections on storage costs and the warranted value converter	57
7. Conclusion	60
Bibliography.....	62

Appendix.....	65
Lagrangian developments	65
Model variables and factors	67

1. Introduction

The first time we heard about Community Inventory Credit was in a press article. Our attention had been tickled by the use of the terms of “second harvest”, to describe its outcome. At this point, we did not know anything of the practice and wonder how this mechanism could end up with such results. Inventory credit is a financial device that combines the allocation of loan in exchange of the providing of a food crop amount, that serves the role of a collateral. Designed to target rural population, the beneficiaries smallholders accept to lock their crop in a warehouse till the end of the loan reimbursement period. At this stage, the warranted crops are unlocked and either sold or consumed by the households. This unlocking process is at the origins of the “second harvest” appellation.

Appeared in Niger in the late nineties, this financial innovation was originally aiming to provide credit to rural agents traditionally excluded or rationed by formal financial markets. In the last decade, literature started to focus on specific consequences that Community Inventory Credit could induced to its beneficiaries. One of them is the betterment of households food security. Indeed, one can expect from a “second harvest” to increase smallholders income. However, in an environment where subsistence agriculture is the norm, one could also expect the crop storing and unlocking to improve households nutrition.

Our contribution is aiming to test this expectation and attempt to give the start of an answer to the question : is Community Inventory Credit a reliable mean to improve rural remote households food security ? The interest of this interrogation has been confirmed to us by an internship we effected in North Benin. There, we have been able to exchange and discuss with smallholders benefiting from Community Inventory Credit, that testified of betterment of their food consumption following the implementation of the programs. We intend in this thesis to value the qualitative elements we gathered during our intern in North-Benin, by contextualizing our results with intuitions from the field.

Data relative to Community Inventory Credit are relatively scarce and costly to obtain in our position. Therefore, we chose to treat our subject with a theoretical angle. Theoretical models are not the predominant mean for development economists to tackle Community Inventory Credit. We decided to adapt the two-period model of Gross, Guirkingner and Platteau to our research question.

Their model seemed perfectly fitted to our problem. Indeed, their contribution integrates nutritional status in the utility function. Therefore, we were able to construct a version of their model where nutritional status could interact with Community Inventory Credit variables as well as food crop prices. We also added in our version an investment component, made possible through the deliverance of the loan, that came as an intuition from our Beninese experience. Our results express a positive answer to our research question. It would seem that Community Inventory Credit could allow smallholder farmers to take advantage of the seasonal food crop prices inflation. The presence of an investing purpose to the loan also delivers positive outcomes for beneficiaries. Indeed, both price inflation and the return rate of the investment seems to enhance the households food security, by allowing a greater food crop transfer from the harvest to the lean season.

Our demonstration will follow a very classical plan. In a first part, we will focus on the state of the art: firstly, by introducing the specialized literature, we will focus on how Inventory Credit could be an answer to financial market imperfections in rural area. In a second time, we will investigate the corpus of articles and reports focusing on Inventory Credit in Africa. The stake of this second sub-part will be to differentiate through the lens of the literature the two kind of Inventory Credit we retain : Warehouse Receipt System and Community Inventory Credit. We will see along this review how the first seems to have failed to propose a reliable solution to financial and storing issues encountered by African smallholders. At the opposite we will investigate how Community Inventory Credit is seen useful or not by the existing literature, and how our reflection is constructed according to these findings. In a third part, we will present the Beninese context that gave us the will to investigate this research question, and why we consider important to confront our theoretical results to the intuition that came from it. The fourth part will be dedicated to the presentation of our version of the model, and the main equations that comes out of it. In the fifth part, we will describe our results, and how Community Inventory Credit variables are influencing the nutritional status in the lens of our approach. Those results will then be contextualized and discussed thanks to our Beninese contextual contribution and to the principal literature findings. This later part will be the sixth section. Afterward, we will conclude our thesis.

2. State of the Art

Our master thesis is lodged within broad subfields of economics sciences that are development economics and agricultural economics. We could not properly expose our contribution without first introduce the literature covering our topic. The aim set by the present state of the art is dual. First, we would like to consider the literature that is treating rural credit. As covering such a large extend could be the topic of a thesis itself, we need to be specific. More precisely, we think that the rise of inventory credit practice in remote rural area could be a consequence of the very particular structure of rural credit market : difficulty of penetration by formal institutions, strong information asymmetries, elevated cost of credit due to perpetration of usurious methods etc.

First, we will investigate the literature that have brought light on these features of rural credit. In a second place, we would then consider the state of the art on inventory credit itself.

2.1. Rural credit market imperfections

In 1990 Stiglitz and Hoff distinguished three issues encountered by financial institutions in rural credit market, that are a matter of concern and research for economists and policy makers. In first place a *screening* problem during the borrower selection. Then an *incentives* problem that may occurs during the monitoring phase. Finally, an *enforcement* problem when financial institutions need to coerce borrowers to reimburse them. Those three points are keys to understand credit market incompleteness. Therefore, the structure of the first part of our state of the art will be set according to these three points.

2.1.1. Screening

Credit market imperfections are not the prerogative of developing economies. As a critical example, the 2008 subprime crisis shed light on the massive lack of monitoring of American banks in mortgage credit allowance. However, economists have for a long time shown interest on studying those imperfections through credit allocation process in developing countries, as those countries were displaying illustrative distortions. In the upon introduction, we referred to this process through the appellation of screening. We mean by that the continuing steps of selection of borrowers by financial institution. One fundamental feature of the credit market is that the supply side, the lender, is not

getting paid right after allowing the loan but after a certain reimbursement period. This lag between the start of the exchange and its settlement implies a risk for the lenders. As a result, the latter have to carefully select his clients, through the set of information to his disposal : credit history, belonging assets, investment project etc... In low-income countries rural areas, the most of this information can be either unobservable or costly to obtain, and it can be in the interest of the borrower to maintain this state of asymmetry of information between him and the creditor. Some economists have tried to tackle this issue, let us present their work and expose how it can shed light on our subject.

In his groundbreaking article, Akerlof (1978) chose to illustrate his analysis upon asymmetric information by a bunch of examples and applications. Amongst them, one is relative to rural credit market in the Indian subcontinent. More precisely, Akerlof emphasized on the fact that traditional money lenders in rural remote areas have an advantage over banking institutions. Indeed, their knowledge of the community allow them to distinguish honest from unsolvable borrowers and so charge a subsequent interest rate. The core of the Akerlof article was a study of the the American used-car market, and how come that buyers could not differentiate decent cars from "lemon" one (argotic name for low quality second-hand vehicles). In the same vein, financial institutions cannot discriminate between these the two kinds of borrowers, the honest and the unsolvable. This example gives us an insight on one important feature of rural credit in rural area: the difficulty of screening, due to incomplete information concerning the borrower characteristics. The Akerlof example makes us understand the importance of one specific agent in the rural economy landscape, the traditional moneylender.

The traditional role of the moneylender is notably exposed by Kevane in its 1993 article. He emphasized on the rural credit market of Sudan, and its specific practice of the so called "Sheil": the moneylender, traditionally a merchant, lent money to smallholders during the growing season and pay himself back by seizing a part of the crop when harvest time comes. For classical merchants this would be similar to purchasing in advance their stocks to farmer. However, in this specific Sudanese context, the lenders impose an usurer interest rate to borrowers, so that in certain cases the latter give a share of their crop for 50% of the normal price at harvest. As a consequence, this practice has been seen in the literature as an undermining cause of the underdevelopment of rural Sudan according to Kevane. It is this literature that is criticized in the article, in the sense that Kevane considered that the majorities of the researchers' views over the Sheil practice avoid a more precise projection of what Sudanese rural credit market really is. According to some authors, if the Sheil practice is a hidden extortion, the entire informal credit market would be an exploiting system of Sudanese farmers. In opposition to that statement, Kevane describe much more complex financial relationship deeply related to social network and rural economic relations. In this set up, the role of the traditional money lender is crucial : selection between borrowers, negotiation and especially renegotiation of the terms of repayment (when

farmers encounter bad shocks for instance) etc. In this context, the traditional money lender becomes key for the understanding of informal credit relations.

The same kind of observation has been drawn by Aleem in 1990 concerning the Pakistan rural credit market. He constructed a database gathering information over many different features of the traditional moneylender activity, and particularly the screening part. Indeed, Aleem considered it as the essential part of a lending operation in rural remote areas : he noticed that that just a slight share of the allowed loans is security backed but the lender compensates the absence of collateral by a precise screening process. It is in this costly screening process that would partially reflect the high (so-called usurious) interest rate. Thus, Aleem raised the fact that every lender was either inquiring the borrower applicant profile to his fellow villagers or visiting his farm. Besides that, a majority of lenders argued that they were willing to lend only if they were the exclusive lender of the borrower and not in competition with other creditors. One could expect that big investment in the screening are motivated by a high default rate of the borrowers. However, Aleem indicates that the default rate in his sample was reasonably low, and so the reason for screening would lie in the possible delay in the final reimbursement. Indeed, the repayment schedule were often modified according to the hazard in the harvest yield. To sum up his point, the systematic screening process undertaken by traditional moneylenders results in high interest rate. In addition, traditional lenders are in every case occasional lender, and the fact that lending is not their only activity implies an opportunity cost that also results in an additional premium on the rate. The conduct of a costly screening process is also made possible because of the few borrowers per lenders and the repetition of the credit operations with the same borrowers that reduces the screening costs. Finance institutions could not find themselves profitable with such costly and long screening scheme, and so in this context traditional lenders outperform them.

This sub part was destined to give some insights of the screening process in the rural credit market. In a remote rural environment, this process is more costly than in other contexts due the absence or lack of a formal banking system. Such characteristics gives room to the expansion of informal lending operators. The latter are using complex screening process in order to discriminate solvable from unsolvable borrowers, which are way too costly for banking institutions to be undertaken. Therefore, difficulties in screening are the first reason of low penetration of formal finance markets in rural area and of persistence of traditional way of finance. Those elements on screening in rural area are also meaningful regarding our subject, community inventory credit. Indeed, we displayed in this subpart that a long and costly screening process is often mandatory when collateral is lacking. According to this feature, we can state that inventory credit allows the financial institution to get rid of a costly screening process. Indeed, the core of this practice is the providing of collateral through the deposit of a share of crop. However, we will address the point of collateral later on. The other advantage of community

inventory credit in term of screening is that the financial institution will usually deal with an organized group of smallholders. As the latter will be all together contractually tied, they will have interest to exclude scaping goat from their association, to avoid sanctions or to ensure a sustainable collaboration with the financial institution (that would not reconduct the inventory credit if it encounters too many default). This point of control amongst peers will be developed in the next part.

2.1.2. Incentives

Once the borrower's selection has been made and loans are granted, a new step starts in the lender-borrower relation. The lender wants to ensure the borrower willingness to not deviate from the announced investment project to a riskier one, which would dramatically lower lender expected returns as default chances would increase. Literature tackles this issue, usually called moral hazard, and its implication on rural financial markets. Particularly on how to avoid it through monitoring and incentives process.

In the first sub part, we emphasized on the role of the traditional money lenders and how they reflect the particularities of rural finance. Traditional lenders do not only outclass modern banking institutions by their ability in screening amongst the pool of borrower. The importance of the traditional lenders in the borrowers monitoring has been described and theorized by Conning and Udry (2007). For the two researchers, the evolution of credit technology in rural areas is a vector of change for the traditional financial relations. However, this change does not automatically imply the eviction of traditional lenders (landlords, shopkeepers, merchants...), but a requalification of their role in the lending circuit. From a creditor position, those agents would become intermediaries between formal finance institutions and rural borrowers. This become possible because of their proximity to the borrowers and so, as we previously wrote, their knowledge of rural context in a situation where risk management is difficult for formal credit institutions, mainly because of important information asymmetries. In addition to be in possession of this information, unobtainable for formal lenders, traditional creditors are also in the best position of what Conning and Udry call "active monitoring". They mean by this qualifier that the more the lender is close to its pool of borrower, the better his position for monitoring the set of projects they are undertaking but also for encouraging them in the smooth running of their enterprises. The authors consider that the monitoring process is also passing

through the credit form itself : a voucher for covering crop transportation cost, an advance in-kind (like seeds or fertilizer) etc.

By defining the nature of the loan and so its application in the investment process, the lender monitors the borrower choice and the possibility that he deviates from his productive purpose, what we usually call moral hazard. This kind of functioning is known as “interlinked transactions”, meaning the result of two agents trading on at least two different markets. Bell dedicated a full chapter to this topic in the Handbook of Development Economics (1988), and notably on its implication over moral hazard. Bell mostly focused on the Indian landlord-tenant relationship, and so the interlinkage between the credit market and the labor market. He argues that in many cases, the landlord may have had interest to allow funds borrowing to tenants during the slack season in exchange of their engagement to work in his property during the harvest season. Considering the positive relation between the granted loan and the degree of the future implication of the tenant in the landlord field, the latter can expect the harvest to be greater (as the crop result may highly depend on the effort furnish by tenant before harvest period). If the harvest is greater, the share of the crop paid to the tenant is higher, and so his ability to pay back his loan to the landlord. As a result, the interlinkage ties the smallholder liabilities, as a tenant and a borrower. This broader control allows the landlord to bundle several of his enterprises, credit and farming, and so impact both of them positively. To enable such framework, one needs to belong to the rural community and to be a key social and economic actor, what is not a new coming finance institution. Interlinkage is even sometimes a prerequisite to the credit transaction. Aleem (ibid) wrote that all sampled moneylenders in his survey were only contracting with farmers they already dealt with (as wholesaler, fertilizer trader etc...).

This ability of the rural informal moneylender to control (till a certain extend) for information asymmetries and moral hazard put him in a decent position for attracting funds from outsiders (formal credit institutions, institutional lenders). As an intermediary, his active monitoring capacity will be considered as a form of collateral from non-rural lenders, and so open the rural credit market to broader source of funding. These elements on the role and abilities of the informal money lender in rural area bring us useful considerations over our subject, inventory credit (and more precisely community inventory credit). Such credit technology does not necessary include the informal money lender in its functioning. Indeed, smallholders are able through inventory credit to borrow fund together to a formal financial institution and use their crop as collateral. The possible absence of the traditional money lender in this set up (even if nothing clearly avoids its participation, it is not the primary objective) brings up some questionings : if moral hazard and information asymmetries can be handled with the presence of an informal creditor (or intermediaries), by which means inventory credit can offer a propitious environment and so address these issues ?

To address this question, we would like once again, we would like to refer here to the classic literature in development economics. In 1990, Stiglitz wrote an article on what he called “peer monitoring” and how it is affecting credit market in developing economies. Stiglitz described an environment where a financial institution intervenes in a rural area and has to by-pass the use of traditional lenders services. More specifically, he related the enterprise of a well-known organization in the development economics landscape: the Grameen Bank. This financial institution was the first to introduce microcredit in rural Bangladesh. This microfinance institution was operating in rural area by according small loan to small group of borrowers that ended up being consignees. Meaning that they will not be able to borrow again as long as all the members of the group have not reimbursed their loans. Thus, Stiglitz depicted a set of implications and consequences of this method. One can observe that this type of contract brings additional risk to the borrower since his condition is linked with the actions of his fellow consignees. As a result, each members of the loan group will monitor the others and even sometimes involve themselves in their enterprises success. What comes out of this mechanism is the control of moral hazard and by consequence of a great share of the borrower’s defaults. Stiglitz argued that such additional risk, if we consider a broader scope than microcredit, is rewarded by larger credit amount and so at the end of the day greater economic activity and rural development. According to him, the absence of peer monitoring contracts in the past attempts from formal credit institutions to penetrate remote areas, has been one of the plausible causes of the resistance of traditional lending methods to formal ones. He meant that in many cases, the introduction of a formal creditor did absolutely not evince informal ones, because the latter were still in position to screen borrowers for information asymmetries and moral hazard. This coexistence of informal and formal market is known as the *duality in market structure*, as expressed by Aleem (ibid).

Evidence of such situation is also to note when studying the ROSCA phenomenon (for ROtative Saving and Credit Association, known in French-speaking Africa as “tontine”), that is obvious peer-monitoring mechanism: every month, each participant disburses the same amount to the collectivity and once in a year, receives the sum of all participations. The sustainability of the system is a function of the trust and the ties between the stakeholders, and so everyone has interest to be aware of the others behavior (in some cases, the members have to announce the project they will finance with their share, and stick to it). To come back to the competition with formal sector, Lelart (1989) surveyed this type of saving/lending association in Benin and related a strong reliance on them from the Beninese people, rural or urban. In fact, the participation to ROSCAs was even higher while the two major public banks were close of collapsing. Nonetheless, as underlined by Stiglitz, competition between informal and formal financial sector is not an end in itself. Indeed, introduction of peer monitoring in formal

credit contract can manage to extract costly information and so result in a potential opening of rural credit market to outsiders, public or private.

According to these elements, we can state that community inventory credit is by construction the gathering of smallholders belonging to the same rural community in a credit operation with a formal bank, using their crops as a collateral. As a community, the members will be able to monitor each other. Thus, they can appoint one or several members as responsible of the well-ongoing of each reimbursement path and investment project.

2.1.3. Enforcement, collateral and state intervention

We just had an emphasis on two point that are stressing the complexness of financial relationships in developing rural area, the borrower screening and his action monitoring. In this third part, we will treat an important matter in lending operations, the enforcement. Mainly, the lender capacity to coerce the borrower to pay back his due in the case where he did not respect his contractual engagements.

In an informal set up, such situations can occur but are often settled within the community. For instance, Udry (1990), surveyed sampled villagers in North Nigeria, analyzing their financial relations within their community. He notably documented different informal ways of enforcing delinquent borrowers: in first place, a simple call to order from the moral or religious authority of the village, that come with negotiations over a solution to repay the loan. In a second time, the borrower's default can be spread publicly amongst the community and the extreme penalty can be the exclusion from the village ceremonies. The author also described another sanction for fraudulent borrower that would be the exclusion from the solidarity and economic ties within the village. Udry stated during the period of its experiment, no repayment issues went over the first step of negotiations, evidence of a sort of efficiency in informal enforcement mechanisms.

Such efficiency has been theoretically proven by Besley and Coate in their 1995 game-theoretic contribution on group lending (Grameen Bank-type of lending). By adding a social sanction function to their "repayment game" model, they shown that repayment rate to the bank were higher than without. They introduce, in this particular context of financial relations, the notion of social collateral,

meaning the degree of social connectiveness between the group members that would be harmed in case of default (as the default of one borrower affect the all group). This can also be illustrated through the contribution of Lelart (ibid), in a context of group lending : in ROSCA, the continuity of the “rotativity” of payments is not only an economic matter but is key for social cohesion. Breaking it leads to exclusion of the social network.

Thus, the role of collateral, social or physical, is key in rural financing. In the last section, we mentioned one main feature of the inventory credit, the crop as a collateral. The absence of collateral is generally seen by development economists as one of the most important cause of credit rationing in rural areas. The strong relation between collateral expectations and credit rationing has been raised in particular by Stiglitz in one of his best-known articles, written in 1981 with Weiss. They illustrate the following mechanism: the bank set a ceiling mandatory ratio of debt over collateral (the one that maximizes its revenue) that the client needs to provide to obtain a credit. By doing this, the bank screens the pools of possible borrowers and protect itself against adverse selection : if the ratio were higher than the mandatory one, so that the collateral requirements for borrow are higher, it would attract risky borrower. By risky borrowers, we mean the one that would borrow less (in order to match the collateral ratio requirements) but for investing in low profitable projects or risky ones. By setting this ratio, the bank is clearly rationing an identifiable group of the population (the one with few assets to provide as collateral). This contribution of Stiglitz and Weiss is more reflecting the reality of a finance market in a developed economy than what we expose in this research, remote rural finance markets. Indeed, agents in these areas are not characterized by low collateral but merely its absence.

In his review of market failures in rural credit markets, Besley (1994) addressed this issue of collateral scarcity. In this text, he summarized many ideas over rural credit market on which development economist reached a consensus. He exposes the general view on collateral lack in a remote rural framework : its link with property rights. Indeed, to provide a guarantee to back a credit in an advanced economy, one can use for instance mortgaging : the borrower’s house will be the security for the credit. If he cannot match the reimbursement requirements, the lender can sell the house to not make any loose. Regarding this example, we could expect a similar process in a developing rural area with land as the security asset for the loan. However, such operation requires legal ownership rights and the property title that goes with it. In many remote rural areas in developing countries, the occidental type of property right is far from the multitude of the ongoing customs. In many cases, as related by Besley, the only use of a land by a smallholder family will be recognized by the community as Right (usufructal-type of customs rights). Obviously, it will be impossible to back a credit contract in such informal rights set up. As pointed out by Besley, those frictions between traditional way of use or owning and some more western type of lending are rising moral matters. The

introduction of a brand-new legal framework on property can easily lead to conflicts amongst rural population or between the latter and a centralized power. To link these learning to our main subject, we can advance that one main advantage of inventory credit is to allow people that were not in position to offer a collateral to furnish one.

After tackling the view of literature over enforcement and collateral management, we would like to abord one last characteristic of the rural credit market in low-income countries. Therefore, the end of this subpart will be dedicated to state intervention in rural credit market. This feature is not exactly one mark of incomplete market but of its consequence. As noticed by Gonzalez-Vega in a 1977 paper, the last quarter of the twentieth century has been the one of strong states intervention in the rural credit market, in developing countries. As we specified when treating Udry's contribution (2007), the misunderstanding and the poor assessment on the forces and informal rules of remote rural credit markets can lead to a "flooding" of credit over certain areas, meaning a mis appropriate policy that do not address proper issues. A paper specifically tackles this subject, from Claudio Gonzalez-Vega (1984). His contribution focuses on one particular aspect of government intervention in rural financial market, the interest rate ceiling, meaning the setting of a maximal credit interest rate. As we argued before, one persistent view on informal credit in rural regions is the usurer character of the lenders. Thus, policies makers attempt to limit it either by binding formal finance institutions to open branches in remote areas and imposing them a maximal interest rate. The aim was to force the opening of rural credit market to modern finance, and to oust traditional lenders by attracting their borrowers with low interest rate. As we previously saw, the formal and informal lending sector have in many cases continued to coexist but the point of Gonzalez-Vega is that compelling policies that have targeted formal financial institutions, through the obligations to lend at a ceiling rate, have had opposite consequences that the ones planed. Indeed, the first will of the policy makers was to peg bank's interest rate at a lower level than the normal market one in order to permit to smallholders to have access to a cheaper way of financing. But to counter this, formal institutions reacted by lowering the amount lend to smallholders (seen as risky borrowers) and by allowing larger credit lines to more convenient borrowers, such as landlords. This mechanism is called by Gonzalez-Verga the *Iron law of interest-rate restrictions*, the appropriation of informal credit market intervention benefit by the better-off agents (as identified as the riskless borrowers by formal banking institutions). In a 1977, Gonzalez-Vega illustrated this feature with the example of Honduras. According to him, Honduras as others Latin American countries felt back on a proactive rural credit policy by compelling banks to peg their rate under the market price. He stated that the policy ended up with a massive concentration of loans in 10% of the rural population.

This last point concerning state intervention is also interesting through the lens of our research question. We previously abord microcredit institutions when treating the peer monitoring functioning. These institutions had through their actions filled a gap between the rural demand for credit and the formal supply, by adopting new techniques to handle rural credit difficulties (with peer monitoring notably). Microcredit institutions are in majority the type of operator that providing credit in community inventory credit campaign, according to the literature, and as we will see later on. Some researchers and contributors advocate for financial state support to microcredit institutions that are involved in inventory credit, in order to secured and turn sustainable their intervention. In some sense, this comes in contradiction with the recommendations draw from the *Iron Law* of Gonzalez-Verga that are condemning central state influence over financial activities. However, we can add that what Gonzalez-Verga defend is the non-intervention of the state in a situation where it is not desired. What we described concerning microcredit institutions and inventory credit would mostly be a demand for state support.

In the introduction of this sub part, we claimed that the rise of inventory credit could be the consequence of the rural credit market incompleteness in developing countries. By that we meant that in theory, community inventory credit characteristics could be able to address issues encountered by formal banking technologies in remote rural areas, and so has been conceived as a solution to these issues. The use of a share of the smallholder harvest as collateral is the cornerstone of the mechanism that could enhance rural banking. Indeed, the presence of a collateral in an environment characterized by its scarcity is groundbreaking. This collateral will avoid an excessive cost of screening and allow an easy enforcement of the debt. In addition, the fact that the finance institution will deal and contract with a pool of borrowers instead of a single agent will permit a peer monitoring mechanism within the group. But as we just write, this would happen in theory. Therefore, we would like now to switch to the second part of our state of the art, relative to the literature studying directly inventory credit.

2.2. Inventory credit

Like the practice itself, the literature on inventory credit in Africa is quite recent, about twenty years. Over the continent, we decide to distinguish two types of inventory credit : the first one, often named *warrant receipt system* (we will use *WRS* thereafter), and *community inventory credit* (sometimes, authors use the French term "*warrantage*", we will name it *CIC*). This distinction is a simplification, Coulter (2014), one of the larger academic contributors on the subject, has chosen to

differentiate private from public inventory credit initiatives, for a more rigorous methodological perspective. If we understand this concern for precision, we did not consider it as necessary in our contribution.

What Coulter differentiate is actually two types of WRS, some are the result of public initiatives and the other from private ones. In first place, the distinction between public and private initiatives can be particularly tricky, and the literature (except Coulter) did not always follow it. Many of them are in fact cooperation between public and private initiative (Tanzania for instance). Even for the fully private ones, the state influence is often nearby (Edelman & al contribution on Malawi). On the other hand, the outcome between public and private does not seem to be very different for the smallholders. In both cases, as we will see, WRS find itself to be inadequate for the needs of farmers living in remote areas.

The difference between WRS and community inventory credit (CIC) comes on two main features. In first place, the scale, WRS designs are usually set nation-wide or region-wide while CIC is mostly occurring at the village level. This scale feature is also concerning the size of the stakeholders: if commercial banks, traders, and warehouse managers are taking their share in WRS, local Micro-finance institutions (MFI) and smallholder organization are the ones involved in CIC. The second important difference is the storing management. WRS design are always delegating the warranted crop management to a *third part*, in most cases private. In CIC systems, most of the time, this task is handled through the cooperation of the MFI and smallholders (Coulter, 2014). These differences drove us to analyze the literature treating these two categories of inventory credit separately.

As we just wrote, inventory credit as a research topic is a modern trend, so that the body of article does not belong to a precise field of economics but is mostly abord by development, agricultural and international economists. Besides that, the article corpus on inventory credit is also made by many contributions from NGOs: activity report, promotion articles etc. Such thing implies an approach of inventory credit that differs from academics. One cannot find this difference especially in terms of rigor and consistency but concerning the angle tackled, the type of data collected or the adopted methodology. Transnationals and national development agencies (World Bank, Food and Agriculture Organization, Agence Française de Développement, USAID for the main ones) are also accounting for a large share of the published works on inventory credit. This topic has also been a matter of interest for many African economists, so that many studies were issued by African research institutions or review.

Hence, this second sub-part of our state of the art will follow a simple didactic plan, we will first investigate pieces of work relative to WRS and in a second time the article dedicated to the study of CIC.

2.2.1. Warrant Receipt System

As a matter of fact, the warrant receipt system find itself to be broadly analyzed by researchers in the south and the south east of the African continent (Coulter, 2009). Within this sub region itself, some country experiments are largely documented, such as Tanzania, while others like Madagascar does not seem to be a research focus. Whereas the island is acknowledged to be one of the continent most advanced area in terms of inventory credit activities (Coulter, 2014), we could not just find any empirical research upon it. We could not find any decent explanations of this phenomenon, and so took it for granted. Hence, we decided to analyze research on WRS country by country.

2.2.2. The first steps in the WRS study : the contributions of Coulter & Onumah.

One first interesting article to start with is the contribution of Coulter & al (2000). It is important to note that the methodological reasoning of Coulter, in every of his articles and reports (alone or in collaboration), is limited to an hypothetico-deductive approach. He never does bring any evidence, econometrical we mean, of what he claims. Nonetheless, his justifications are often interesting, illustrated with precise descriptive statistics, and are a decent entry for the understanding of the WRS mechanism, and how we can differentiate it from other types of inventory credit.

In Coulter & al (2000), authors consider, in a comparative approach between warehousing capacities of several African countries, that some eastern and southern states of the continent, namely Zambia and Tanzania, had underutilization of their facilities. More precisely, they argued that the 1990 liberalization wave in the African agricultural public-hold markets resulted in a switch in terms of agricultural stocks storage habits, from state owned warehouse facilities to on-farm storage system.

As a main consequence, many public facilities find themselves unused. Author's reasoning ended up assuming this facility availability as an opportunity for governments and private sector to collaborate in public-private warehousing receipt systems enterprises: better facility-coverage of the territory and less starting costs. As a result, both countries mentioned above, Zambia and Tanzania, that are amongst the most endowed states in terms of warehouse facilities in the continent, should observe more successful WRS policies.

In 2002, Coulter & Onumah attempted to describe WRS in a very normative way, in an article that aimed to serve as a reference of how inventory credit should be implemented in Africa, regarding past experiences in the western world (particularly in the US and in Eastern Europe, documented by Höllinger & al, 2015). In their view, inventory credit and so WRS needs to benefit to the entire value chain of the agricultural markets (to “scale up”). They consider that WRS schemes in Africa have to set available warehouse for every stakeholder in the agricultural value chain, from the smallholders to the trader or the intermediary, so that they all can take advantage of their stocks as collateral for loans.

The authors discussed first the efficiency of pre-existing methods such as Collateral Management Agreement (CMA) that links three private agents, a bank, a trader, and a warehouse operator into a triangle contract relatively close to an inventory credit one. However, such agreements were only concerning export crop, and so bigger players, sometimes non-African. At the opposite, the aim of WRS is to focus on non-tradable crops and so impact domestic market, over prices and quantities.

More explicitly, they describe warrant receipt system as a network of linked, certified warehouse, at national level, that issues warrant receipt: an official document that notifies the presence of a certain standardized crop stock at a certain point in time. This document can be used by the crop depositor for backing loans but also in other transactions: the receipt is transferable. From the authors point of view, such device could facilitate trade by offering a new certified mean of exchange but also completely enhance the agricultural market efficiency: the warehouse can become a true marketplace in itself. Meaning a place of meetings between crop supply and demand. In addition, the set of requirements that is needed for making a stock deposit will require the erect of standards in weight and quality, and at the end of the day a better off information availability and quality level in the whole market.

They also denote the possible occurrence of scale economies following a WRS settlement, particularly concerning the labor needs for warehouse management (the increase by a factor x of the stock capacity of a warehouse, implies an increase of the operator’s number smaller than x , according to the authors). That would play in favor of big scale development of a WRS scheme. Besides that, such environment settlement would also be a decent ground for the rise of a future market for domestic non-tradable crop: the warehouse operator can ensure the delivery of the stock at the contract terms while in an informal set up, one side of the contract can choose to step back if the price variation does not convene it.

One major consequence of this latter feature, the rise of future market, would be a certain domestic commodity price smoothing that would ensure expected incomes of the supply chain

stakeholders. On the other hand, the domestic crop consumers could also benefit from this price smoothing, as they could more easily forecast their expenses. Therefore, it could benefit to the food security national-wide. One point that is not abord by the authors but remains important in our view is the consequence of WRS scheme on institutional environment. The process of creating a nation-wide warehouse network goes in theory with a certification process, that ensure the quality of the infrastructure and its management, and even sometimes the implementation of cost schedules or quality standards (like for Tanzania, see Tanzania Licensing Board, 2013). Such framework should be conduct by a licensing board, an institution that undertake the monitoring of the well-going the WRS functioning. This board, as we will see, can either be controlled by central power or through a cooperation between the actors. Consequences of the existence of such monitoring institutions are unclear: on one hand a proper management could allow WRS to benefit to every of its actors (well defined costs, absence of credit rationing etc.). On the other hand, some monitoring boards in Africa before the 1990-decade liberalization wave were known to raise huge rents on the value chain of agricultural product, and practiced favoritism for certain actors. To our knowledge, there is no article tackling the efficiency of monitoring boards in WRS schemes.

According to Coulter & Onumah, one main point of satisfaction of WRS would be the integration of the smallholders in formal markets circuits, notably the finance one. However, several potential caveats of WRS credit have been identified by Coulter & Onumah. A major one is the degree of dependence of such scheme to the policy coherence of the country where it is taking place. More specifically, the possible intervention of a government in the agricultural market in a way that would distort it. They gave the example of the Ghanaian public inventory scheme that has been jeopardized by the government will to massively import maize to prevent potential food scarcity. This unforeseen turmoil in the maize supply has brutally drove down Ghanaian maize price levels and so ruined price anticipations of the WRS stakeholders.

This first contribution of Coulter & Onumah on WRS displays a very macro view of the subject, in accordance with the scale they estimate necessary to set a reliable WRS scheme, nation-wide. This is quite in opposition with what we would like to study in this thesis, a more household centered approach. However, this article brings us good insights of why inventory credit can be needed at the household level. First, a lack of storage facilities (or of their use) following the 1990-decade liberalization wave, that implies a need for storage. Second, a price variability issue. Coulter & Onumah gave to state governments the responsibility of theses variations, based on their several discretional

interventions on the food market, that result in a need for household to foreseeing price variation (and in some cases, taking advantage of it).

In addition to the whole picture drawn with Coulter (ibid), Onumah (2003) brought new elements that he considers to be relevant in inventory credit policies. Through the example of Zambia (a public-private cooperation), he shows how Zambian state convinced the different agricultural and financial market stakeholders to adopt the warrant receipt system. This Zambian particularity (contrary to Tanzania or Ghana for instance) is the presence of a WRS controlling board supposedly independent from central power, and only composed of private market organization representative (banks, farmers organizations, warehouse managers). However, Onumah himself does not consider a deeper implication of smallholders in this controlling board as a priority for the success of the Zambian initiative. Instead, he advocates for a program mostly controlled by the biggest players of financial and agricultural markets in order to ensure its long-term sustainability. By claiming so, he also considers community inventory credit initiatives as low-impact projects: no scale economy opportunities, important vulnerability to commodity market distortions (domestic and worldwide) caused by exogenous interventions, limited potential benefits for involved financial institutions. According to him, sharecropper's income improvement can only occur in a context of betterment of the entire value chain, finance and trade.

In 2010, Onumah confirmed his first thought on a second article dedicated on the conduct of WRS in Southern and Eastern Africa. Still very descriptive, the author does not provide any specific evaluation framework, but mostly descriptive statistics figures. Like in his previous article, he continues to discuss and give some policy recommendations over WRS policies settlement. He advocates for the deployment of WRS activities to the public sector. In particular, the use of WRS in food purchasing for the security reserves, as the massive bulk needed can result in scale effects and a time consistent outlet for farmers organizations.

The view of Onumah on a rural development drove by the improvement of the entire agricultural market did not convinced us. At the opposite, we consider that traders and wholesalers are most of the time beneficiaries of the underdevelopment of rural areas, and more particularly of the "Selling Low, Buying High" phenomenon described by the literature (Burke, 2013). However, we agree that the price risk is real for CIC and might be hard to mitigate, in opposition to a nation-wide framework like in WRS. But we will address the price issue later on.

To sum up, the contributions of Coulter and Onumah, alone or together, are decent material to start studying inventory credit initiatives in Africa. They provide very precise elements and examples relatively to its functioning, advantages and drawbacks. However, the absence of a rigorous analysis framework is a curb to the pertinence of their contributions. They also mostly focus on a broad view of inventory credit schemes, without very precise insights of its impact on smallholder's wellbeing. On the other hand, many of their institutions and their ground experiences have been really valuable to our understanding of the topic. Therefore, we are going to move our attention to pieces of literature that favorize the study of WRS in including its influence on smallholders.

2.2.3. The literature focus on the Tanzanian WRS model

Within the South-eastern part of the continent, one of the most valuable and studied WRS scheme took place in Tanzania. Mapunda & al wrote subsequently two articles in 2018 and 2020 to document it. More precisely, they addressed two different issues, the possible influence of WRS participation over coffee yield (2018) and the determinant of WRS participation for coffee smallholders (2020) in a Tanzanian district. Few remarks have to be made upon their work and the Tanzanian environment. These papers are, to our knowledge, part of the few existing econometric analysis relative to warrant receipt system. The years of publication denote of the very recent effort put in assessing WRS with the modern tools of economic analysis. Tanzania has issued in 2005 the Warehouse Receipt Act that granted the state intervention in inventory credit, through the establishment of licensed private warehouse across the country, in order to allow the stockage of predefined crop : export crops such as coffee and cotton, but also domestic crop like maize or paddy. The issuing of warehouse receipt with the same type of objectives as the one denoted by Coulter and Onumah (ibid) was the cornerstone of this legislation: "The main objective of establishing Warehouse Receipts System [...] was to formalize the existing marketing system aiming at minimizing various constraints [...]. These constrains include post-harvest losses, poor quality, price fluctuations, lack of reliable market information, poor finance» (Tanzania Warehouse Licensing Board, p10, 2013). Thus, Tanzania targets the whole value-chain actors, for tradable and non-tradable crops.

As denoted by Magrin (2000) when relating the case of cotton culture in Chad, tradable and non-tradable crop farmers can have different needs, and often different profiles in terms of capital endowment (amongst other features). As a result, we cannot expect the findings of Mapunda & al, that are holding for coffee farmers, to be automatically generalized to food-crop smallholders. The implications for coffee are also different from a food crop concerning price fluctuations: we can expect, as pointed out by Coulter and Onumah (ibid), from a WRS scheme to hamper to a certain extend high

price variations for domestic-consumed food-crop. However, a tradable commodity price is less likely to be impacted since it is internationally set (and since the 1980/1990 liberalization wave in African agricultural markets, directly transmitted to the smallholders).

The two articles written by Mapunda & al took advantage of a sampling procedure launched by the authors in 2014 amongst members of farmers groups (FG) or cooperatives (known under AMCOS in Tanzania, for Agriculture Marketing and COoperative Societies). It is important to note that legal eligibility for smallholders to the WRS public program requires membership in such producer associations, which is mainly common for this type of export crop. The members of those organization can totally be seen as smallholders, the sampled population was in average farming less than two hectares, and either WRS beneficiaries or non-beneficiaries. Authors ran in each article a regression, in first place (2018) to address the impact of inventory credit on coffee yield using OLS method (Ordinary Least Squares). Controlling for multiple variables : household head gender and age, years of schooling, use of irrigation and cultivated area size, they found a positive impact of credit obtained through WRS on coffee yield, of about 11%. They conclude that those results are in line with the Ellis description (1993) of the neo-classical theory of agricultural production, and more precisely the *variable versus fixed inputs principle* (p 42). Meaning that the variation of a variable production resource provokes an output variation on one specific period (one year, one campaign etc...) while the variation of a fixed input will have permanent consequences on the output crop (land size variation etc...). Here, Mapunda & al states that the positive variation of credit (considered as a variable input) induced by WRS scheme, did positively impact the smallholder's coffee crops on a yearly period. These latter experienced higher crop result than smallholders that are not engage in the warehouse receipt system process.

If this first study was an interesting attempt of impact evaluation of WRS, in a productive perspective, it did not bring a new view in term of credit accessibility. Indeed, we consider like Coulter & Onumah (ibid) that WRS shall be not only an enhancer for the agricultural market (through a yield increase) but also for the credit market, bringing funding to a broader set of agents, previously non accessible by the credit market or rationed. Mapuda and his fellow researchers decided to tackle this question, and most generally what could determine participation in a WRS network for a coffee producer, in a second article published in 2020. They chose to compare inventory credit participation, the dependent variable, to market participation, and so integrate in their logit regression explanatory variables that usually appearing in a market participation analysis: gender, age, harvested area, level of education.

In addition, they proposed two others explanatory variables, the access to market information and the distance between the respondent farm and the nearest farmers coop. First, there is no satisfying explanation of what is considered as “access to information” in the article, and even if we can expect it to be price awareness, this remained unprecise. However, they displayed the results and show that both variables had a strong impact on inventory credit participation. Maybe we are not aware on our side of market information diffusion technology, that would be independent from the distance of a farmers’ association and specific to the Tanzanian context, such as phone coverage for instance (that could broadcast and share price information).

Besides, they reckoned the reliability of other variables like the smallholders age or gender. More specifically, younger peasants are more likely to join WRS campaign. In terms of gender, it seems that being a male increases probability of participation. They explain this feature by the male-dominant social system in Tanzanian rural society that limit land access for women as well as their independent participation in economic activities. This land scarcity problem can result in the allocation to women of small size or less productive lands, and so smaller crop output that would be insufficient to enroll in an inventory credit campaign. Being part of a farmer organization or coop could end up being harder for women (and in this case, the registration in such organizations is mandatory to participate to inventory credit). One last result is the strange non-significant influence of education over the probability of participation in inventory credit. Indeed, we could have expected a positive relation, mostly because the mastering of the basic reading and algebra skills is mandatory to fully understand inventory credit rules and implications. But once again one can claim that the participation in the coffee market implies for the smallholder a minimal understanding of market information, which can be enough in order to understand the functioning of inventory credit.

From the study of these two pieces of article, we learnt that WRS, in the Tanzanian context, seems to have a positive effect on coffee yields, and so that the increase of the credit availability induced by inventory credit is effective in enhancing the crop production process. However, we cannot clearly determine if this attempt of the Tanzanian government to set credit available for a majority of desiring smallholders reached its goal. Indeed, for the coffee market, the participation in the inventory credit campaign seems to rely on the proximity of market, physically (the distance from the closest farmers organization) and non-physically (the knowledge of market information), but also on gender. So that, even if in this study the education level does not impact the probability of participation, inequalities in credit access are still holding in terms of gender and market remoteness. The type of culture cropped in this experiment, coffee, is also an essential matter in our view: if we consider that coffee-growing farmers are more connected to their national market, more organized, because of the foreign orientation of their activity, WRS could end up being a more useful tool for enhancing their

well-being, as this practice is more designed for this type of set up. However, this series of article on the Tanzanian case did not provide, in our view, evidence of the well-being enhancer character of WRS for self-subsistence smallholders. We also have to put in perspective the fact that in the Tanzanian WRS scheme, the state hand is stronger than in other systems (Malawian, Zambian), so that private warehouse saw their cost scheduled by the monitoring board (Tanzania Warehouse Licensing Board, *ibid*). This feature could have supported the profitability of the practice for the coffee smallholders, that could therefore foresee their costs.

2.2.4. The lessons of WRS programs in Malawi and Indonesia.

In Malawi, another country of the region, a fully private WRS scheme has been established since 2011. It has been overseen by the Agricultural Commodity Exchange (ACE), a Malawian exchange that has been trading most of the export crop of Malawi since 2005. Thunde & Baulch described this WRS scheme in a 2019 article. As an emanation of an export crop exchange, the WRS scheme designed by ACE was mostly destined to these specific types of crop: pigeon peas, maize, soybeans etc. This export-focusing private type of WRS scheme is described by Coulter (2002 ; 2014) as very close to Collateral Management Agreement, a common way of freight management in African export port that generally involves the biggest traders and wholesalers, port facility managers and traditional finance institutions. Namely the most integrated agents in formal markets. As displayed by the authors, this private inventory credit enterprise mostly serves the interest of actors already being known as principal stakeholders of agricultural market : between its launching and the time of the study, eight years, independent farmers and cooperatives represented less than a third of the warrant receipt issuing, and around 10% of the total trade bulk. The rest of the warrant issued was in the hands of traders.

This Malawian experience seems to show that a purely private enterprise cannot carry inventory credit as a tool for reducing inequalities in access to finance, but only repeats market limitations that result in a credit rationing of rural remote agents. Expensive storage cost, elevate storage bulk requirements, could be the cause of the poor participation of smallholders (independently and grouped) in this campaign.

In 2015, another study on Malawian WRS network was made by Edelman & al. The authors were mostly focusing on the opportunity cost between on-farm storage and storage via WRS facilities, through the simulation of different price patterns, storage losses and transport costs scenarios. Authors found that in order to prefer the latter to the first (in terms of margin), smallholders need to

face high grain losses on-farm (to 5-10%), live less than 50 kilometers from the storage facility and experience a positive price trend during the hunger period. Those characteristics are realistic. Nevertheless, Edelman & al realized through interviews and village meetings that the perspective of a positive margin is not always sufficient for Malawian farmers for participation to WRS. Lack of information and absence of trust were seen as big obstacles.

However, this study was only assessing the needs for storage and not for credit, that could have increased the smallholder willingness to participate. Still, the smallholder's reluctance to join WRS campaign that would benefit them denotes of a certain tendency of this system, of not being exactly designed for their needs but for the one of bigger players, that can afford some more important risks.

We consider that the fact raised by Eldeman & al on the absence of incentive to participate in WRS for smallholders as essential. It would appear that such system, because of their nation-wide design, cannot fulfill the needs of smallholders. Indeed, many of them cannot take the risk to put trust in a system that keep away their crop (i.e their living) from them, even if it is stored and secured. This would suggest two features of what could be an inventory credit system well-designed for smallholders: local and trusted (or well understood).

As we just wrote, lack of awareness and understanding of WRS has been one important curb to the participation of smallholders. To illustrate it even more, we want to mobilize pieces of literature treating another study field than Africa. Gunawan & al (2019) attempted to evaluate farmer's perception of WRS in two Indonesian provinces. Since 2008, the country has launched a WRS program, similar to what we already exposed in Tanzania. It combines private warehouse certification from state administration as well as the settlement of public storage facilities. Both type of facilities issuing warrant receipts in order to ease credit access to Indonesian smallholders. The authors survey a sample of paddy rice producers, WRS users and non-users, in two districts of the West-Java province (where 91% of smallholders are cropping rice) through a questionnaire testing their perception of Warrant Receipt System mechanism (by scaling their perceptions from "Very Weak" to "Very Strong"). It came out that if respondents do not consider WRS as a vector of regulation complications, they express a strong perception of a lack of knowledge of its core mechanisms, associated with the perception of a lack of storage infrastructure and storage facilities. However, once fully aware of WRS functioning, smallholders mostly consider it as a reliable mean of access to credit, according to their responses. Even if very localized, this study denotes that WRS might not be fundamentally perceived as non-efficient by smallholders but mostly not well-design for their needs : in terms of facilities accessibility, storage requirements etc.

2.2.5. Theoretical approaches of WRS

The study of WRS has also been conducted on a theoretical ground. Miranda & al. (2019) constructed a two periods model where a smallholder chooses his marketing strategy for his maize crop. He may directly sell his crop surplus after harvest (at the lowest possible price) , store it in a commercial warehouse as a collateral for a loan (and face high storing and transporting cost) or store it in his own farm (and undergo a loss due to moisture). The researchers used data from the Ghanaian WRS scheme to set parameters for their model (interest rate, storing and transportation cost, price volatility...). Regarding their results, they conclude that in this Ghanaian environment, the optimal choice for producers totally excludes inventory credit solution. Meaning that smallholders will only store on-farm or sell out their crop after harvest. According to the authors, they would have two main explanation to this marketing behavior. Firstly, the costs associated to inventory credit are way too high, as already expressed by Thunde & Baulch for Malawi (ibid). Secondly, even if the seasonal price increase is an influencing factor in the smallholder decision of practicing inventory credit, this would not be sufficient. Indeed, the authors claim that warehouse-stored grain price should feature a premium comparing to on-farm grain price, which is not. Meaning that the quality of the storage and so of the grain is not properly rewarded by the market, that there is no sufficient demand for high quality maize grain.

We think that some features of this piece of work can be criticized. In a first place, the productive purpose of the loan. In the later article, income raised from inventory credit is only used to purchase “non-grain goods” that procure a certain level of utility during the lean season. From our point of view, a relevant inventory credit campaign will occur only in parallel of productive purpose for the loan, an “income-generating activity”. This activity will contribute to the repayment of the credit. In Miranda’s paper, the smallholder is entirely dependent of the crop price increase to reimburse his loan, which in our opinion is a limited view. Secondly, we are convinced that in a context of remote rural areas, a development measure has to be evaluated not only on its ability to generate income but also to ensure food security for population. No such things appear in Miranda & al.

From this oversee of literature treating WRS in Africa, some features are drawable. Warrant Receipt System find itself to be a practice that seems to mostly maintain forces of the current African agricultural markets. By that we mean an unbalance between smallholders and bigger stakeholders of the market, traders, and wholesalers. It is only in the case of export crop (here, coffee) that WRS seems

to have had reliable positive effect on the wellbeing of smallholders, but this might have been made possible because of a deeper implication of the state in its functioning (for the Tanzanian case). Besides that, the literature on WRS shed lights on different causes that could avoid bigger participation of remote areas farmers into WRS: lack of awareness and understanding of its mechanism and more generally, lack of trust in financial system and outsiders. These concerns could be addressed by the setting of more local system of inventory credit, that we already named as Community Inventory Credit. The following part will investigate the different contributions of literature on this practice.

2.3. Community Inventory Credit

In this second sub-part, we will tackle literature on community inventory credit (CIC), the practice that remains the most interesting in terms of rural development, in our view. Contrary to WRS, that were used in other locations than Africa (USA since the 1930's, Eastern Europe since the 1990's, Indonesia, see Coulter, 2014, Höllinger & al, 2015 ; Gunawan & al, 2019), CIC is in itself a relatively new financial technique, designed for the specific needs of smallholders practicing self-subsistence, and firstly introduced in Sahel. Targeting the poors by giving them a credit opportunity through the "pawning" of a collateral is not new practice. In France, the "*Monts de piété*" have served this role for centuries and municipal credit agencies are nowadays still operating with this functioning. But in developing countries, and specifically in Africa, we are not aware of such institutional initiative before the Food and Agriculture Organization (FAO) launched the "*Projet intrant*" in Niger, featuring CIC. From Niger, the CIC mostly spread in neighbor countries. The pieces of literature interested in CIC, are actually focusing on projects taking place in West Africa, but mostly in Niger and Burkina Faso. Like we did in the first part, we will consider this literature country by country.

2.3.1. Niger, the first field of study of CIC in Africa

We considered more logic to start this sub part with the corpus of articles abording Nigerien experience of CIC. As we just wrote, FAO gave the first impulse for creation of inventory credit. In the 1990 decade, the organization observed a continuous decrease of the crop yield in the southern region of Niger, where arable lands are concentrated. Thus, their main concern was to tackle this issue in order to avoid potential food crisis due to the constant pressure of population growth and land constraint. Their action was focus on a better and more generalize use of fertilizer, so that started the implementation of the so called "*Projet intrant*" (Pender & al, 2008 ; Coulter & Mahamadou, 2009). Through a farmer organization (FO), the smallholders were warehousing a share of their crop during

the lean season. Once the prices increased, the FO was selling the stored crops and use a part of the profit to purchase fertilizer in whole, at a discounted price. The FO is then reselling the discounted price fertilizer to the farmers. Thus, the first attempt of community warehousing was not including any credit, but its success motivated the introduction a credit facility in the following years of the project.

Baquadano & Sanders (2006) conceived a theoretical approach of CIC in Niger and provided precision about it. Authors attempted in their article to model smallholder income maximization, first in a context of fertilizer-purchasing driven warehousing and in a second time to a more classic inventory credit warehousing. In order to obtain applicable results, they calibrated their model according to Nigerien features, in terms of climate and crop technology. The model ends up giving an advantage to inventory credit in terms of smallholder revenue but also for the fertilizer using. Indeed, the gain from the price increase during the lean season seems more profitable when directly redistributed to farmers than collectivize for low price fertilizer purchasing, according to their model. In cause the higher incentives to warrant a bigger share of his crop for a smallholder if he is the only beneficiary of the price increase. In this study, the purpose of the loan itself is not included in the smallholder decisional process, only the consequences of different possibilities of interest rate and loan principal.

Coulter and Mahamadou (2009) raised an activity report on the same "Projet intrant", taking the form of field interviews of producers and micro finance institutions (MFI) workers. They noted the fact that because the project was the first of a kind in West Africa, the learning curve amongst the stakeholders has been quite flat in the first year of the project. As a consequence, from a community to another, the understandings of the mechanisms were different, so as the outcome (in terms of take up, stored quantities, yield increase). On the recommendations side, authors estimated that if the project were globally a success, they would suggest the intervention of public transnational institutions. For instance, the West African Central Bank, to support the finance institutions that intervene in the project in order to ensure their reliability on the long term and so the possibility for smallholders to foresee and put faith in the project. Finally, they argued that a deeper sensibilizations of beneficiaries is always needed for a better success of the project but also a stronger emphasis on new crop to warrant, dried tomatoes, garlic, onions, that are experiencing higher positive price variations during the lean season.

The FAO 's initiative in Niger gave the first opportunity to researchers to measure impact of inventory credit with econometric tools. Pender & al in their 2008 article targeted consequences of

the project (inventory credit and village input shops settlement) over yields of the whole scope of crop harvested by beneficiaries. Their econometric analysis delivered evidence of the positive relation between yield increase (for certain crops, by 30%) and the project influence (that induced a broader use of fertilizer).

Once again, these authors findings seem to show that the understanding of the mechanism is crucial for better take up of smallholders in CIC, and this comes with the insurance for the smallholder and his household to be the main beneficiaries of the CIC operation.

Overall, the literature view on the Niger experience of CIC is mostly positive. As we just wrote the econometric tool confirmed a yield betterment following the project action. To our knowledge, no studies on Niger seek for specific household-related features, like nutrition, savings etc. As we will see, researchers on the Burkinabe experience will fill this gap.

2.3.2. The first evaluation of CIC in West Africa

Some drawbacks of community inventory credit schemes have been illustrated in the 2014 article of Casaburi & al. It reports the impact study of a pilot campaign of community inventory credit in Sierra Leone, that occurred in 2010-2011. Thanks to a Randomized Controlled Trial (RCT), authors were able to reckon the possible impact of community inventory credit on a large set of features. One core characteristic of a pilot campaign is its short time coverage, in order to just test some very targeted specificities of community inventory credit. If this is totally understandable in terms of policy planning, the consequences of this temporal constraint were strong on the evaluation outcomes, as suggested by the authors themselves. Indeed, the potential beneficiaries of the pilot directly had the awareness of the short-termness of the project.

However, it has had the merits of illustrating some issues of community inventory credit and more generally of rural finance. First, the authors observed a general mistrust feeling for banking institutions amongst smallholders. In addition of the anticipation of the end of the pilot in the following years, it seemed difficult to attract farmers in the project. During feedback meetings, many beneficiaries argued that the promise of a longer financial relationship with banking institutions could have helped to build trust. During preliminaries approaches authors find out that in the targeted population, only a few percent already contracted with formal financier to purchase a loan, and around 12% had financial relations with an unformal lender. Those informal lenders happened to be in most cases crop traders or big tenants, and the informal loans linked with harvest trade (sale in advance)

or with labor market (promise of work). This type of linkage, that we defined earlier as interlinked transactions, are key to understand the rural economy in Sub Saharan countries.

The introduction of a community inventory credit scheme came stress those links and apparently, it seemed that many informal traders saw in it a threat to their position in the community. The authors reported that numerous traders came into village communities to warn the smallholders about this pilot project, invoking possible spoilation of their crops by banks and central governments. This experience denotes of the impossibility to implement reliable formal financial relations in rural remote areas without first a long-term view and on the other hand addressing the role and influence of traditional lenders.

More relatively to community inventory credit itself, this article raised few more interesting facts. Authors concludes after their assessment that among the share of participant, two opposite types of farmers took advantage of inventory community credit opportunities. First, the biggest farmers, often the community leaders, strongly participates in the project. Indeed, even if aware of the one-year stand of the project, they could bear the risk of a low profitability. Because of their role in their communities, they were also in a decent power position against informal traders and their influence (if they were not one of them). However, and it is way more surprising, authors observed a positive relation between remoteness, mainly the distance from the market, and participation in the project. The chances of participation were also bigger if the household head was a woman. Those two last features raise an interesting element. If in this case, the benefits of this pilot experiment were concentrated among the better off share of farmers (i.e community leaders), it has also allowed a substantial empowerment of the worst-off class of smallholders, women and most remote ones. We can argue that the later are also rationed by informal lenders, and that inventory credit happened to be a decent solution to this issue, either in terms in access to finance but also in terms of crop marketing, as they are traditionally and geographically excluded from markets.

2.3.3. The first CIC drawbacks exposed by the literature

If Casaburi & al have exposed a drawback of CIC in term of possible traditional social links harming, the risk of seeing traditional moneylenders and traders defending their dominant position, they did not specifically criticize the practice in itself. Addoh & al (2010), saw in community inventory credit an ambivalent practice for the Sahelian smallholders (Niger, Mali, Burkina). Indeed, their considered after having surveyed market prices (but not farm-gate prices) of a bunch of stapple crop during 9 agricultural campaigns (2001-2009), that price seasonality were mostly uncertain. Meaning

that the occurrence of multiple political and agricultural crisis during the studied decade avoided the appearance of a anticipable price seasonality, upward. They considered that for many crops, the event of a clear price increase during lean season happened in average a year over two. According to this finding, they stated that such price environment would lead community inventory credit to be a highly speculative activity, which from their opinions should not be a characteristic of a decent rural development policy.

Finally, they estimated that the income generated by the smallholder through inventory credit is not sufficient to be an incentive. If the remarks brought by this article are interesting and have to be included in a critical study of inventory credit, their justification are quite poor: no econometric proof, reasoning based on non-relevant price... In addition, their results are contradicted by the rich Sub-Saharan Africa cereal price variations study of Cedrez & al (2020). This latter article depicted at continent level cereal price (in marketplace) variations for 18 years. They estimated that within-countries variations were important relatively to rainfall variations and geographical remoteness (two of their main explanative variables of price variation model). In addition, they considered that the betterment of storage facilities access could help to damper large price variations in remote areas.

Relatively to the work we are trying to achieve in this thesis, these two articles remind us that price variation should play a major role in our theoretical approach. Without being necessarily at the center of our analysis, its influence on the smallholders' anticipations and so the decision to participate in the CIC campaign remains key. From our own ground experience in Benin, we remembered smallholders' testimonies on their experience of CIC, claiming that in the years experiencing large positive price variation, and so large benefit from CIC, the participation in the following campaign were increasing, in cause the hope of similar revenues.

The analysis of Garrido & Sanchez (2015), in their report for OXFAM, came to confirm previously cited analysis of positive outcomes of community inventory credit (Pender & al, 2008 ; Coulter & Mahamadou, 2009) as well as its drawbacks (Addoh & al, 2010). They particularly defend the point we just highlighted in the article of Cedrez & al, the importance of storing in rural development. As a consequence, they consider that CIC should be mainly to its storing facility component, and not an over-speculative activity that would imply high price risk and uncertainty. However, they do not considered CIC as a bad financial device, but that smaller loan should be granted, in order to reduce the risk of loss for the smallholder in case of a decreasing price trend during the lean season.

Concerning this last remark from Garrido & Sanchez, we never observed, in other article or during our own experience, the allowance of credit lines superior to 80% of the crop value at current price (at harvest time). In addition, most of the literature relates of very small default rate of inventory credit participants. An interview conducted during our Benin experience with an NGO officer responsible of the CIC component confirmed this literature statement.

2.3.4. The literature view on the Burkinabe experience of CIC

We would like to conclude this state of the art by the review of CIC activity in Burkina-Faso, the African country that literature has pointed as the most successful for inventory credit. This might also be the country where the most in-depth studies have been conducted by researchers, as observable in the relevant articles of Delavallade & Godlonton (2020) and of Le Cotty & al (2019).

But before reviewing those academic papers, we would like to shed light on articles and documents issued by FAO on the Burkinabe CIC experience. Those reports are constructed as are many NGO's reports, with smallholders' testimonies, descriptive statistics and activity review, that can hardly be taken as scientific evidence. However, they can stand for being a source of inspiration for our reasoning. These papers (Sidi & Hassane, 2012 ; Simphal, 2012) relates few interesting characteristics of Burkinabe's inventory credit that could account for its success : CIC mostly takes place in the south west of the country, a region that is over-producing many crops. This excess at harvest gives an incentive for storage.

Moreover, the FAO's authors relate that community inventory credit took advantage of the past failure of cereal-banks in the region. Indeed, those banks, that were in charge of storing and lending crop (in form of deposit or loan) collapsed at the beginning of the 20th century, mostly because of mismanagement. The consequence of this collapsing has been, in first place the presence in the region of storing infrastructures, and secondly of "middle managers" that, after the failure of the cereal banking system, were willing to provide more reliable financial solutions to local farmers. The combination of all these characteristics were, according to FAO, key to understand the success of community inventory credit in the region.

In addition to these papers, other NGOs sources (like Ghione, 2013) raised the concept of "second harvest", in order to describe the moment of the crop stock release, at the end of the loan

repayment period. They considered the fact that in those regions, in some cases, the amount of crop warranted through inventory credit process were sufficient to reimburse the loan (taking advantage of the price increase) and for households to take back a part of the stored crop for their food requirements. This ideal situation is hard to generalize because it has been the result of a very specific and favorable environment. However, it helps to draw a theoretical perfect framework of community inventory credit : decent crop surplus, seasonal positive price trend, low cost of warehouse storing in parallel of high on-farm storage losses.

In recent times, Delavallade & Godlonton (2020) brought interesting elements on community inventory credit in Burkina-Faso. As we wrote above, this landlocked Saharan country is one of the most diligent in terms of community inventory credit implementation in the last decade. A durable relation between NGOs and central power resulted in a country-wise spreading of this practice, legally defined since 2005. One key consequence of that is a larger awareness of inventory credit functioning among Burkinabe smallholders than in other African countries.

In their article, Delavallade & Godlonton ran a RCT experiment in different Burkinabe village communities. Through lotteries, they selected at the household level a treatment group, that received access to community inventory credit, and a control group that had not (every households were willing to engage in warrantage). However, at the village level, they split all the villages of the experiment in two randomly assigned groups, one with a high exposure to program (67% of the interested households were given access to warrantage) and one with low exposure village (33% of interested household selected). Such design was willing to highlight potential snowball effect into take-up rate in the program and in bulk of crop stored, but also to check for the presence of spillover effects (on control group and non-participating households). An important difference with the previously cited Casaburi & al (2014) is the type of crop stored, here it is a staple crop that is used as collateral, which can have consequences in terms of “willing-to-store” behavior : bigger social pressure for sharing, bigger loss risk of on-farm storage ; these consequences are incentives to participate in community inventory credit. This is showed by the very important take-up rate for the treatment group, at least for the storing component of inventory credit, while around 30% of the treatment group signed up for a credit.

At the opposite of many article on the subject, Delavallade & Godlonton surveyed the change in consumption and investment that occurred for the debtor households. Quite clearly, they observed two important trends: an increase in human capital investment (school tuitions) and an increase in

livestock purchasing . The latter is seen by the authors as a saving operation but could also be understood as a productive investment. Finally, they noted a jump in the seed purchase for the overall treatment group, sign of a willing to increase production in the next campaign. At the village level, the difference in exposure resulted in a higher take up in high exposure village (but a similar volume of credit contracted). On the other hand, the authors did not relate any specific spillover effect in control and non-participant groups. An interesting point is that they did not observe a notable decrease of social solidarity (that could have been feared, because of the decrease of crop available during the storing period). However, like in Casaburi & al, the opportunity of warehouse storing has not ended up in a larger overall amount of crop stored, but mostly in a substitution of traditional way of storing to warehousing. Without being a drawback, this displays the limit of this practice as storing incentive device, at least in the first year of implementation. In addition, the sensibilization process anterior to the implementation seems to have had a positive impact on the take up, this comes to confirm our previous thoughts on inventory credit understanding as a key factor to its diffusion to remote areas.

The last series contribution we will analyze is the one wrote by Le Coty & Maitre d'Hotel .Their first paper on the subject was a short article wrote in 2013, on a specific feature observed during several CIC campaigns in Burkina Faso. Warehouse managers (often a designed member of the smallholder depositors or of the FO) noticed at every campaign the case of smallholders that are in need of storage facility but do not subscribe to any credit line yet offered by the project. Indeed, the desire of participation in community inventory credit does not seem to only lie in craving for cash flow, but also in the necessity for a storage outside the farm.

More precisely, authors described a way for smallholders to secure their crop from unwanted solicitations, meaning solidarity transfer asked by relatives. Storing his crop in a warehouse destined for inventory credit implies for the smallholder a commitment, in the sense that he cannot have access to its deposit till the term of the campaign. Then he can be sure that he will not be tempted to take from his crop for unnecessary reasons. If one can argue that such practice can harm traditional solidarity links, we can think more of a tool to handle it in a more durable ways all along the hunger season. This role of inventory credit as commitment device, as named by Le Cotty and Maître d'Hôtel, is at the center of their research development on this practice.

In the following years after their first article, Le Cotty & al released a series of two articles (2019 & 2020) on the Burkinabe context, taking advantage of the starting in 2014 of a community inventory

credit system between different village communities and local IMFs. In these papers, they tackled community inventory credit under different aspects, through the setting of a theoretical framework and a set of econometrical analysis. In first place, they tested its convenience as a commitment device for the producers. Indeed, ten months before the beginning of the warrantage sensibilization, they investigated amongst the village inhabitants their risk aversion as well as their time discounting preferences. Hereafter, once the program was launched, they analyzed amongst the villagers participating in community inventory credit, their results in the first experiment. It came out that smallholders interested in warrantage expressed strong present-biased preferences. This characteristic implies that those smallholders might have participated into inventory credit in order to preserve a share of their harvest against their selves urges (or the ones of their social circle).

In addition, they noticed that a majority of farmers were only using warrantage system for its storing facilities (like in their first article in 2013 as well as in Delavallade & Godlonton, 2020), as the share of borrower amongst the participant never exceeded a third in the three first years of the program. If one could interpret this figure as a failure of inventory credit as a financial easier tool, it provides evidence of its interest as a way of overcoming the “Selling Low, Buying High” phenomenon. Indeed, because warrantage commits participants to lock their crop for a given period of time, it allows smallholders to avoid temptation of selling their crop (at a low price) right after harvest or to give away a part of their reserves through kinship gift and find themselves in a food insecurity situation afterward (in the case of a price increase). In this perspective, inventory credit comes to fill the lack of commitment device in these rural remote areas. Once they investigated this feature in their first article (and proved its reliability through a bunch of solidness tests), they studied its consequences in a second paper.

More precisely, they shown that inventory credit, by releasing the commitment (or storage) constraint as well as credit constraint in some case, had influence on a whole bunch of smallholders’ wellbeing features. In terms of food security, their second study displayed that warrantage participants experienced in average a food self-subsistence period longer of seventeen days (contrary to non-beneficiaries) as well as a betterment of the household nutritional diversity (more proteins and calciums). These consequences can be the result of either the commitment feature, that enable the farmers to dispatch their surplus more evenly along the season (longer self-subsistence) or of the credit access that can allow the access to a larger scope of food (or to investments that return higher revenues, that provokes an increase of the food budget).

Their results also come to confirm the finding of Delavallade & Godlonton, in the sense of a clear positive variations of the participating household’s savings, through livestock purchasing. Still in

line with the previous findings of the literature treating the Burkinabe experience of community inventory credit, Le Cotty & al stated that the participation in the warrantage campaign has influence on productive factors. If Delavallade & Godlonton were advocating for the presence of larger fertilizer purchasing amongst participants, Le Cotty & al paper claimed also for an increase of investment in land (one half hectare of maize in average). The similarities between the two studies results comes also with the lack of evidence concerning spillover effect of community inventory credit to non-beneficiaries household. They conclude their article claiming that, without providing any evidence but just intuitions, that those results, inherent to the project take up by the population, were conditional to the trust express by smallholders for the other stakeholders of the project (IMFs and NGOs). Such intuitions would be in line with the results of Casaburi & al in the Sierra Leone context, where the lack of trust to financial and storing institutions curbed the participations to the project.

This state of the art on inventory credit shed lights on different features that will help the design of our model. Inventory credit is a practice that have to be implemented on a village level to impact smallholders. Nation-wide initiative, or the ones described by the literature, did not display sufficient proof of their validity as a rural development mechanism : storage facility far from farm, high cost of storing (except in case of a deep public intervention), grabbing of credit resources by other stakeholders, lack of trust toward formal institutions, bad understanding following the absence of sensibilization are the more invoked causes of failure to reach this goal. At the opposite, authors writing on community inventory credit have shown that in a specific environment, featuring harvest surplus, staple crop farming, seasonal price increase, lack of commitment device, long term relation between financiers and beneficiaries, this practice was able to deliver a positive output in terms of smallholder's well-being betterment.

From the study of the existing literature, we exposed that inventory credit in Africa is a practice with a broad scope of applications. Its purpose, its stakeholders, its management and so its outcome are highly variable from a place to another. We chose to differentiate warrant receipt system from community inventory credit system. Firstly, on the size criterion : the first are often settled national-wide while the later are village or region-base. We also made a difference in term of the type of stakeholders that benefit from it. WRS are supposed to include the entire agricultural value chain, from the smallholders to the exporter, while CIC is completely dedicated to the financial empowerment of the smallholders communities. At the end of the day, our purpose was to understand through the

literature lent how both systems could impact remote households. On this concern, the literature view is pretty clear. WRS scheme did not offer the insurance of a reliable rural finance tool. Indeed, it is by its size itself, that it has been displayed unfitted to the smallholders needs : storage facilities far from farm, high cost of storing (except in case of a deep public intervention) were reluctant for the smallholders' participation. This has had as consequence the grabbing of credit resources by other stakeholders and so resulted in a lack of trust from smallholders toward these institutions. The poor mechanisms understanding following the absence of sensibilization over WRS was the more invoked causes of WRS failure to reach smallholders. On the other hand, literature treating CIC has shown more reliable proofs of its validity as rural financial instrument. Indeed, it seems that CIC experiments are enhancing smallholders wellbeing when it features the right environment : a seasonal positive price trend, harvest staple crop surplus and trust between beneficiaries and other actors (NGO and microfinance). Last but not least, literature has also highlighted the interest of CIC as a commitment device. Indeed, the simple providing of a tool that allows rural household to escape urges of gifting or low-price selling has shown results in households nutrition betterments all over the season. From our point, this state of the art justified our will to drive our contribution focus on CIC. In addition, from our knowledge, there is a lack of mere theoretical approach of CIC impact on smallholders. Therefore, we will now present our theoretical view of CIC.

3. Context

Our interest in Community Inventory Practice arises from our experience in a West African country, Benin. For 3 months, we took place as an intern in a Belgian NGO that is operating in the northern region of Atacora, near the border with Togo and Burkina Faso. This area experiences a climate closed from the semi-arid environment of the south of Burkina Faso. However, the hilly character of the Atacora toponymy permits to take advantage of the monsoon depressions. As a consequence, the culture of many vegetables is possible in addition of the more traditional food crop and cereal harvested in West Africa, like maize, sorghum or millet.

The drawback of this mountain environment is the difficult access of smallholders to basic infrastructures (roads, school, water tanks etc.) and so their remoteness from markets. As a result, after the harvest seasons they are targeted by wholesalers and crop traders, who are traveling through the countryside, that want to buy their crop surplus at the lowest price. For the smallholders, three main reasons give them an incentive to cease their crop to a particularly low price, the absence of

other marketing opportunities (caused by their remoteness), the important need for cash flow (to meet their need for purchasing intrants for instance) and their poor storage facilities.

Thus, they end being stuck in what the literature calls the “Selling Low, Buying High” phenomenon that we defined earlier, when their food stocks do not meet their food needs during the lean season. They are sometimes forced to buy back some food crops, at a different (often higher) price, moving them to a hard food insecurity situation. Based in Natitingou, the region capital city, “Iles de Paix”, the Belgian NGO that hired us, aims at providing solutions to smallholders of the region. In first place, by supporting them in the betterment of their yield through the implementation of more sustainable growing techniques (less intrans-intensive crops, vegetable gardening in the lean season etc.) and the construction of village wells. In a second time, they specifically tackle the three issues we enunciated as responsible of the “Selling Low, Buying High” phenomenon: on the storing side, they support producer in the improvement of their on-farm storing device. For the liquidity constraint issue, they implement Community Inventory Credit scheme amongst village communities and support the smallholders in the launching of side activities during the lean season. Finally, seeking for other outlets for smallholder crops than the usual marketing chain, that benefits to wholesalers.

Our intervention was part of this last operational component. Indeed, our mission was to survey a sample of the population of the main city of the area, Natitingou. This survey aimed to understand the food tastes of the Natitinguan population, their vision of alimentation and of food purchasing. The results of the survey were aiming to state if urban population was a decent outlet for the smallholders production. Thus, if we did not specifically work on inventory credit, our action was in line with a full set of interlinked process that was aiming to enhance smallholders wellbeing.

However, our interest in inventory credit was already existing at this stage, so that we decided to take advantage of this opportunity to gather some qualitative ground feedback from the beneficiaries themselves. Therefore, we had the occasion to take part to some village meetings and ask specific question over the community credit activity. The feedbacks of producer on Community Inventory Credit were for the most of it in line with many findings of the literature.

First of all, the experience of CIC in north Benin seems to be a low risky project from the perspective of the finance institutions. Indeed, the reimbursement rate was for every campaign we have been informed of, higher than 95% and generally close to 100%. On the smallholders side, most of the encountered farmers were satisfied of their participation in CIC. On one hand, the credits were spent either in the creation of a side business, often ran by the household women (small scale food transformations, like soya cheese or millet beer) or in the constitution of a buffer savings, through the purchase of small size cattle (mostly chicken and hens). This latter fact comes to confirm the findings

of Le Coty & al and of Delavallade & Godlonton concerning the positive influence of CIC on smallholders savings and buffer stocks. On the other hand, the seasonal price increase was captured through the storing of the crop and its sale at the reimbursement time. On this specific part, smallholders were totally conscient of the higher risk induced by this speculative move. However, many were arguing that the better off food availability resulting of the CIC, at the end of the storing period, was enough to counterbalance the price risk.

We also had the occasion of meeting a NGO officer from the Swiss cooperation organization Helvetas, in charge of a whole CIC campaign in the region (our NGO, Iles de Paix, was mostly dealing with the storing issues and grain quality, but not the financial part). He confirmed us that the CIC went durable in communities with the strongest “institutional set up” amongst the villagers, particularly in places where smallholders were tied in a village-wise FO. Helvetas was in charge of the technical support of smallholders and were providing secured fund to the micro finance institutions, in order to permit MFI to participate in CIC for the longest possible period. In some cases, the village community and the MFI were continuing to contract through CIC without the support of Helvetas. However, the NGO considered that the lack of solvability and the short-term view of many MFI were a big obstacle to the development of CIC in the region, and that a Benin state guarantee would enhance the durability of these projects.

These last elements are in line with many findings of the literature we just studied above: Sidi, F. D., & Hassane, S. (2012) (presence of former institutional links to favorize CIC development) or Coulter, J., & Onumah, G. (2002) (a deeper central State intervention to support the long-term development of the CIC practice). We consider these connections, between our field experience and the academic view over CIC, give meanings to the observations and of the testimonies we gathered during our internship.

Amongst all of these elements one particularly motivated our economic interest, the possibility of using CIC as a decent tool to overcome the “Selling Low, Buying High” phenomenon. Indeed, it offers to remote stallholders an alternative solution to the whole sale of their crops to one unique trader that will take advantage of the low crop prices that follows the harvest season. By following this strategy, smallholders put themselves in the position of potentially rebuying food crops later in the lean season, but this time facing a higher price and so a situation of food insecurity. As we wrote in this thesis, some academics and NGO workers has also claimed in their articles and reports how the unlocking of the crops at the end of the CIC process was often seen by producers as a “second harvest” (see Sidi & Hassane, 2012 ; Ghione & al, 2013 ; Le Cotty & al, 2019). Meaning that once the credit reimbursement settled, the resting surplus could be sold or consumed, regarding the needs of the household at this

time of the season. Obviously, such features can only occur in context of positive price seasonality, but we will discuss this point later on.

We think this potential capacity of CIC to overcome the “Selling Low, Buying High” phenomenon is worthy enough to be studied on theoretical ground. Indeed, such food security issues are keys to allow a decent development path in rural remote areas, as we personally observe in Benin. Thus, the upcoming parts of this master thesis will be dedicated to the theoretical study of the CIC as a vector of betterment of their food security.

4. Theoretical approach

This thesis aims to provide a theoretical view over Community Inventory Credit. In the latter part, we displayed some elements over CIC that we personally observed during an internship in rural Benin. These observations find themselves to be in majority converging with the existing literature covering this topic.

One of them had particularly gained our focus: the possibility for smallholder households using CIC, to overcome the “Selling Low, Buying High” phenomenon, and so to experience a more secured nutritional state all over the season. We would like from now on to analyze this feature in a theoretical framework in order to understand the smallholders behavior, and if thanks to it, CIC can provide to rural remote households a way to overcome this kind of phenomenon.

Amongst the immense bulk of academic papers covering agricultural households modeling, one particularly seems to fit to our problem, including nutritional status. In 2020, three development economists : Gross, Gurkinger and Plateau defined in a paper named “Buy As You Need : Nutrition and Food Storage Imperfections” a model of intertemporal utility maximization for rural household in developing countries. First, this model depicts a three-equation system that we decide to keep in our version :

$$U(N_1, O_1) + \gamma U(N_2, O_2) \tag{1}$$

$$N_1 = f(N_0) + n(C_1) - a(L_1) \tag{2}$$

$$N_2 = f(N_1) + n(C_2) - a(L_2) \tag{3}$$

As one can observe in the equation **(1)**, the household head will have to maximize its utility in two periods. In our view, the two periods are splitting the agricultural campaign in two key moments. The first period corresponds to the harvest season, a period of food abundance, while the second version represents the lean season, the moment of the year where food crop is the scarcest. In the model, utility depends on the nutrition status N_t and the consumption of a numeraire good O_t . The value γ accounts for the discount of the second period. The key aspect in this model is the nutrition status of the household, on which depends utility level. As described in **(2)** and **(3)**, this variable in t is set according to N_{t-1} (the function f captures the past nutrition depreciation with $0 < f' < 1$), positively related to a consumption variable C_t ($n' > 0$ and $n'' < 0$) and negatively to what Gross & al call a “labour effort” (page 5) L_t , that are given for the sake of simplicity (everything is described in Gross & al, 2020). To sum up, in our model smallholders utility mostly depends on nutrition status which is the result of the sum of past nutrition status and current consumption level diminished by the effort put in their activities.

Once we get to this stage, we would like now to take distance from the original model of Gross & al. In their article, they constructed a model where smallholders food consumption C_t relies either on their harvest (partly consumed in $t=1$ while the rest can be stored and so consumed in $t=2$) or on food purchase on the market (in both period).

We aim to have a general framework that can include different situations we encountered in the North-Benin environment. To differ from Gross & al, we would like to set a situation where smallholders are more self-subsistent rather than depending on the market for their food consumption C_t , and particularly in the first period. Also, we would like to allow smallholders to rely on the market for their revenues, by being able to sell their crop in the two periods (the model of Gross & al is treating income as an external component).

Those features would permit to illustrate more easily the “Selling Low, Buying High” phenomenon, that we observed as a major curb to rural development in Benin. In addition, we would like to introduce variables related to CIC. Specifically, a loan variable that would positively impact the budget constraint of smallholders in the first period but would require to be reimbursed in the second. Let us illustrate what would correspond to our version of the C_t function in the two periods.

$$C_1 = y - q_1 - s \tag{4}$$

$$C_2 = \beta s - q_2 + m \tag{5}$$

In comparison to Gross & al, we added the variable q_t that accounts for a part of the total harvested crop y that will be sold on the market. In our model, the variable s is also representing the stored share of the total harvest. However, in order to introduce CIC in our model, we consider that s will be warranted in order to be granted of a credit. We set that there is no access to a storing facility other than through CIC. This hypothesis is big but not so unrealistic according to what we observe in North Benin, meaning the poor availability of storing devices and the important losses that comes with it.

In the second period, equation **(5)**, the smallholder food consumption relies on one hand on βs , the amount previously stored diminished by β ($0 \leq \beta < 1$) that accounts for storage losses, to which the smallholder choose or not to cease q_2 . On the other hand, he can choose to purchase the amount m of food crop on the market. Before any further developments, we should precise the following constraints:

$$0 \leq q_1 + s < y \quad \text{(6)}$$

$$C_2 \leq \beta s \quad \text{(7)}$$

$$0 \leq m \quad \text{(8)}$$

We just set that the amounts ceased in $t=1$ to be stored, s , and the one destined to be sold, q_1 , cannot be negative, meaning being borrowed to another farmer for instance. It must be deducted from the total available harvest y and is strictly inferior to it, see **(6)**. In the same vein, the amount q_2 is only existing if s has been stored through CIC in the first period (since there is no other storing possibilities) and so is strictly inferior to it **(7)**. The constraint **(8)** implies that m cannot be negative. In **(6)**, **(7)** and **(8)** we stated that the variable s , q_t and m can be equal to 0.

We permitted it to allow different extreme possibilities. For instance, one where smallholder can choose to not participate in CIC at all and only relies on the market for their food consumption in second period i.e where $s = 0$ and $q_2 = 0$. At the opposite, a smallholder can decide to just use CIC to

manage its food consumption, i.e with $q_1 = 0$ and $m = 0$. From our view, the study of these particular cases could be useful to illustrate the difference between a smallholder that is willing to fully relies on CIC (s positive and $q_1 = 0$) and another one that would remain to a more traditional way of marketing his crop ($s = 0$ and q_1 positive) but so would be exposed to the “Selling Low Buying High” phenomenon. This stated, let us now dig into the budget constraint for both periods of our model.

$$P_1q_1 + B \geq O_1 + b \quad (9)$$

$$\text{with } B = \alpha sP_1 \text{ and } 0 < \alpha < 1 \quad (10)$$

$$r_i b + P_2q_2 \geq O_2 + P_2m + r_{CIC} B \quad (11)$$

We displayed in equation (9) on the income side, a revenue based on the sale of the share of the crop q_1 at the price P_1 and the allowance of a loan B backed on the warrant of the amount of crop s as set in equation (10). On the expenses side, we find the purchase of the numeraire O_1 and b , a part of the total income that is kept aside. In Gross & al, authors consider b as saving that yields interest in the second period. From our view, we estimate that the banking system is incomplete and that no such saving technology is available.

In this context, we would like to illustrate one key aspect of CIC that we observe in Benin. Smallholders that were choosing to participate in CIC were often support in starting and conducting a side business after the harvest season, such as gardening or catling. Therefore, we consider that this cash amount b will be invest in some profitable activities that will return r_i in the second period. This is displayed in equation (11) where the returns of the side business $r_i b$ and the sale of the crop amount q_2 (that comes from crop unlocking at the end of the storing period of CIC) at the price P_2 come to finance the purchase of the numeraire O_2 , the purchase of food crop from the market m and the reimbursement of the loan B contracted in $t = 1$. Once again, the possibility selling the amount q_2 is conditional to the participation in CIC (and so the storing of the crop share s in a warehouse).

It can seem odd that on one hand the agent can sell q_2 and on the other hand buy m . As we set before in the conditions (6) – (8), those variables are possibly equal to 0. Indeed, as previously stated, we want this model to include extreme possibilities: a smallholder mostly relying on the market for its food consumption or another one that would count on the crop unlocking in $t = 2$ following its

participation in CIC. We also set r_{CIC} , the interest rate of the loan allowed through CIC. We consider this rate is being set on an exogen basis, but considerations about this rate and its difference with r_i will come later. According to what we just present, let us now display the consumption function as well as the budget constraint in their combined form:

$$\beta C_1 + C_2 = \beta y + m - \beta q_1 - q_2 \quad (12)$$

$$r_i P_1 q_1 + (r_i - r_{CIC})B + P_2 q_2 \geq r_i O_1 + O_2 + P_2 m \quad (13)$$

Like one can observe in **(13)**, the component $(r_i - r_{CIC})$ is decisive in the final budget constraint. To ease the readiness of our equations, let us define $R = (r_i - r_{CIC})$, the difference between the productive investment return and the CIC interest rate.

In a first place, we would like to put our focus on the extreme case of a smallholder that would only rely on CIC for its food consumption in the second period. Therefore, we set $q_1 = 0$ because the household is only willing to use its harvest surplus to obtain a credit through CIC. In addition, m is set to 0 in $t = 2$ because the household will only rely on βs to meet its food requirements. **(12)** and **(13)** become :

$$\beta C_1 + C_2 = \beta y - q_2 \quad (14)$$

$$(r_i - r_{CIC})B + P_2 q_2 \geq r_i O_1 + O_2 \quad (15)$$

Therefore, we obtain the following Lagrangian.

$$\begin{aligned}
 L = & U(N_1, O_1) + \gamma U(N_2, O_2) - \lambda_1 (N_1 - f(N_0) - n(C_1) + a(L_1)) - \lambda_2 (N_2 - f(N_1) - n(C_2) + \\
 & a(L_2)) \\
 & - \lambda_3 (r_1 O_1 + O_2 - R \alpha(s P_1) + P_2 q_2) - \lambda_4 (\beta C_1 + C_2 - \beta y + q_2) - \lambda_5 (C_2 - \beta s) + \varphi s
 \end{aligned} \tag{16}$$

One will notice that we decide to express B in function of s as set in **(10)**. Also, we include the constraint **(7)** in interaction with the lagrangian multiplier λ_5 and we add a non-negativity constraint to s , in order to fit with the **(6)** requirements. The first order conditions and the developments are available in the appendix.

Following the path of Gross & al, we wanted to express the ratio of intertemporal marginal utilities of nutrition. Indeed, such a ratio is meaningful to inform us on the intertemporal allocation of food in a situation where CIC is the only mean of transferring harvested food from the harvest season to the lean season. Our version of the model delivered this expression:

$$\frac{U_N(N_1, O_1)}{\gamma U_N(N_2, O_2)} = \frac{\frac{\beta}{n'(C_1)}}{\left(1 + \frac{1}{\beta n'(C_2)} \frac{R \alpha P_1}{P_2}\right)} - f'(N_1) \tag{17}$$

5. Results

This section will be dedicated to the exposure of the different interest variables composing the right side of the equation **(17)** that defined the marginal utilities of nutrition ratio. Or in other words, the relative intertemporal repartition of nutrition between the harvest and the lean season. We will proceed factor by factor, according to the help we think they might bring to the understanding of the supposed influence of CIC over the nutrition repartition over time.

5.1. Our model and the “SLBH” phenomenon

Before analyzing the ratio exposed in the equation **(17)**, it is necessary to provide precisions over what we called the “selling low buying high” phenomenon. If a household find itself in the situation where, after selling an important part (if not the majority) of its crop to meet its liquidity urges after harvest, it is in need to “buy back” food crop in the lean season to fulfill its nutritional requirements, it is possible that the household ends up in this “selling low buying high” cycle.

Actually, this will happen if the household environment faced a food crop price increase between the harvest and the lean season : the income generated by the crop sell at the harvest season is not sufficient to purchase food items at the new, higher, price. The main result will be a strict rationing of the food share allocated to every household members and so disastrous consequence in terms of food insecurity.

We tried in our version of the Gross & al model to include two “extreme cases”. One featuring with a household counting exclusively on the CIC mechanism to meet its nutritional needs ; this version was represented by the couple of equation **(14)** and **(15)** and ended with the ratio exposed in the equation **(17)**. The second one was supposed to reflect a “selling low buying high” situation as we just described in the first lines of this paragraph. Its modeled equivalent would have delivered the following couple of equation :

$$C_1 + C_2 = y + m - q_1 \quad (18)$$

$$r_1 P_1 q_1 \geq r_1 O_1 + O_2 + P_2 m \quad (19)$$

As one can observe, the terms relative to CIC, namely s , q_2 , r_{CIC} and β , have disappeared from both equations. The budget constraint, **(19)**, is clearly displaying the potential unbalance between income and expenses encountered by the household. In case of a P_2 largely higher than P_1 , the only way for the inequation to hold is to cut off either in the numeraire good consumption or in m , the food consumption. This last option being the worse, but not the least probable : if the income is already thin and the non-food goods consumption almost inexistant, the household will have to reduce m .

During our intern in Benin, we have been told of some agricultural campaigns where the maize 100 kg bag price, one of the local reference unit, was almost doubling between the harvest time and the lean season. Such inflation trend, even if occasional, may strongly harmed food security of fragile rural population. In our framework, one can see that r_i may impact positively the household income. We will discuss this point hereafter. Sadly, our analysis of this “extreme case” of the model did not yield an interesting and interpretable output as we get for the other extreme case, featuring CIC and exposed in the previous section.

Therefore, we do not propose a decent comparison of the marginal utilities ratio exposed in **(17)**. We will come back on this caveat later on. However, it seems quite plausible that the nutritional status of a household, allowed with the features displayed in **(18)** and **(19)** facing a sharp price increase, could be harmed. At the opposite, on deflating price trend could put the household in a decent nutritional security position.

This precision made; we want to come back to the analysis of the result displayed in equation **(17)**. Let us give it a look once again :

$$\frac{U_N(N_1, O_1)}{\gamma U_N(N_2, O_2)} = \frac{\frac{\beta}{n'(C_1)}}{\left(1 + \frac{1}{\beta n'(C_2)} \frac{R \alpha P_1}{P_2}\right)} - f'(N_1)$$

5.2. Carryover effect and transformation effect

In a first place, we need to define $f'(N_1)$ and $n'(C_1)$ that are both negatively impacting our marginal utilities ratio. This first term is defined by Gross & al as the marginal “carryover effect” (page 6) of nutritional status from period 1 to period 2 . Meaning the additional gain of nutrition in period 2 carried from period 1. The later term is the marginal transformation effect of consumption in period 1

over the nutritional status in period 1, meaning the additional gain in the nutritional status in period 1 from an additional present food unit consumption.

Their negative roles on the marginal utilities ratio are intuitive. Indeed, the higher they are, higher is the incentive to consume in period 1 : the transformation of food unit in nutritional unit is better and a better nutritional status in period 1 is the guarantee of a better nutritional status in period 2 (the transfer of nutritional unit between the two period being more efficient). The incentive of consuming more in the first period could result in an increasing of the nutritional status of the first period relatively to the second period. This latter fact would automatically imply a lower $\frac{U_N(N_1, O_1)}{\gamma U_N(N_2, O_2)}$ (the bigger N_1 , the lower $U_N(N_1, O_1)$).

On the other hand, the term $n' (C_2)$ is having a counter effect of its equivalent in the first period. Like one can see, it will positively impact the ratio. It is understandable because the more efficient the transition from consumption to nutrition in second period, the more interest the household has to postpone its food consumption to the lean season. It will observe a gain in utility. However, these marginal terms are not the object of our focus, for the following observations, we take them as given and granted. This said, every of the following reasonings will be made *ceteris paribus*.

5.3. The prices ratio

We would like now to emphasis on the price ratio $\frac{P_1}{P_2}$, present on the denominator of the right-side ratio of the equation. Let us first study a situation of deflation, where P_1 is higher than P_2 . In this situation, the price ratio would positively impact the denominator value, and so at the end of the day, pushing downward the entire ratio. As we previously exposed in the previous paragraph, a lower marginal utilities ratio implies a higher nutritional status in the harvest season, the first period, relatively to the lean season, the second period. This consequence of a deflating trend over the intemporal allocation of nutrition in this extreme CIC case is quite logical.

Indeed, we expressed in the equation (10) the granted CIC loan B as defined by the warranted crop share s valuated at the crop price at harvest P_1 (we will come back on the term α soon after). However, the budget constraint in the second period implies that the household will reimburse its loan by selling a share q_2 at the price P_2 of the unlocked warranted crop βs . This operation can become unbearable if the food prices shrink along the agricultural campaign (even if the α comes to mitigate, as we will see). In this case, it results that practicing CIC will be surely not profitable for the household. Thus, as no other storing device than CIC is available in our model, the household interest is to increase

its food consumption in the first period to compensate a presumably poor nutritional status in the second one.

At the opposite, if the household faces an increasing price trend, i.e P_1 lower than P_2 , the intuition given by the model might be different. Indeed, an inflation trend will result in a lower denominator in the right side of the equation (17) and automatically a higher ratio. Its interpretation might be the following : the insurance of an inflating crop price trend ensures for the smallholder household a profitable CIC operation, and so is an incentive to transfer an important share of its harvest in the second period through CIC. As a result, the share of β_s dedicated to q_2 , the amount of crop sell on the market, could be greater.

We can also argue that the price increase between the two period allow the household to devote a smaller q_2 amount to the financing of its expenses in second period, O_2 the numeraire and $r_t B$ the loan reimbursement. This second option would permit the consumption of a larger share of β_s to C_2 . Indeed, the household utility depends on both nutritional status, impacted by the food consumption, and the numeraire good consumption. Then, the goal of a better off utility level by the smallholder can be achieved either by an increase in O_t or N_t (and so C_t). We did not include in the model a functional form for the utility function, that would feature weights for the numeraire and the nutritional status. This could have given us insights on how the household deal with the arbitrage between the two component of its utility function.

It is actually complicated to draw a clear statement over this arbitrage. We learnt by the literature study and our development economics classes that in low-income countries, the non-food consumption, here materialized by O_t , might play a major role in the household life even in a food insecurity situation. We think in particular in expenses for festivals or for religious matters. In addition, one can think that the non-food goods consumption could expand with the revenue at the opposite of the food goods.

However, the model yields us the intuition of a higher nutritional status in the second period relatively to the one in the first period, when the household facing an inflationist environment. Such feature would be a big argument in favor of the capacity of CIC to help smallholders household to overcome the "Selling Low Buying High" phenomenon. In the discussion section, we will put the emphasis on this important point.

5.4. The rates difference, R

One can easily notice that one of the most important element, if not the most, of the equation is the term R . It accounts for the difference between the return-on-investment r_i and the CIC loan interest rate r_{cic} . Let us bring our focus on this point. Earlier, we set in our model presentation that a share of the loan B, b , would be kept away in order to be invested in a productive activity, cattle raising, gardening, food crop transformation etc. We made the hypothesis that this productive investment would deliver a return that is positive and also directly observable in the second period. This is a big assumption but not totally undefendable, we will discuss it later on.

We can count three possible states for R , positive, negative or null. The positive option would relate a situation where the return on investment would be higher than the credit interest rate. When R is positive, it would likely be valued between 0 and 1 (as both r_i and r_{cic} are in the form $1 + \rho$, with ρ between 0 and 1). In such state of nature, there is two possible influences resulting from the factor R . It would either accentuate the upward ratio push of the price inflation we just described or at the opposite, mitigate the downward push provoked by the deflating price trend. We found a possible explanation to this phenomenon. When the price increase between the harvest and the lean season, we already explained that the model was describing a nutritional status relatively better off in the second than in the first period. This is linked with the incentive of taking advantage of the price inflation, that is made possible by the transfer of crop through CIC.

The fact that R would be positive, and so that the return on investment outperform the CIC interest rate, implies that there is an additional incentive for households to participate in CIC. Indeed, the bigger harvested crop amount s they decide to warrant, the bigger the loan they will obtain. As a result, they would invest a broader share of this loan in their side business, that would yield a greater income in the second period. The increase in s may also result in the increasing of the food consumption in the lean season, as we already demonstrated previously. This is what is suggested by the model.

One drawback of the model is the intuition given by a possible negative level of R . In this situation, the denominator would presumably become lower than 1, and so drive up the ratio level. This would occur whatever the direction of the crop price trend. Meaning that we could end up with a decreasing price trend, that we already exposed as non-favorable for the practice of CIC, but with a higher marginal utilities ratio. This would be translated into a relatively higher nutritional status in the lean season. Like the only available way for household to save food crop from the harvest to the lean season is to use CIC, this is quite counter intuitive. However, we can provide some possible solutions

to this issue. First, we can state that a situation where on one hand, food prices are decreasing and the other hand, interest rates remain elevated is odd. If this would eventually happen, it would be a very local and conjunctural dynamic.

This said, we could argue that in a situation where the smallholder is aware of the negative level of R , he would just refuse to participate in CIC, anticipating his possible default. We could also link the issue raised this negative R to a point we previously aborded in the state-of-the-art review, the use of CIC as “commitment device”. The intuition would be the following : even we did not include that in our model, we can imagine smallholders, observing a high CIC interest rate, using only the storing feature of CIC and not subscribing to any loan. As a result, they would just bear the lost induced by β and transfer food from the first to the second period. If those explanations are not entirely satisfying, they allow us to offer perspectives of understanding the bizarre intuition offered by a negative level of R .

The last possible state for R is to be zero if both rate are equal. In this situation, the marginal utility ration would be the following :

$$\frac{U_N(N_1, O_1)}{\gamma U_N(N_2, O_2)} = \frac{\beta}{n'(c_1)} - f'(N_1) \quad (20)$$

In this situation, β plays an important role, let us dig into this element.

5.5. The storing costs, β

β can be understood in two different ways. The first one, as expressed by Gross & al in their article, is a loss due to the storing conditions. We did not select this first option. The reason is that in the corpus of literature we studied treating CIC, from academics or NGOs, the inventory credit is seen as one of the most reliable solution to store food crop without suffering of any losses. Often, the warehouse is resistant enough to keep the stocks away from climate influence. The warranted crop bags quality is also checked at the beginning of the campaign and monitored until its unlocking, in order to ensure the proper dryness and the non-propagation of pest. Thus, if seen as storing loss, the difference between β and 1 could be negligible.

However, we can consider it in a second perspective : as a cost of storing. In the discussion part we will tackle the validity of this view. But for the sake of clarity, we will stick to this vision of β as

a storage cost, at the moment. If we only pay attention to the equation (17), it is difficult to disentangle the precise influence of β over the entire ratio. As one can observe, its presence in the numerator (playing a positive role) as well as in the denominator (playing a negative role) turns hard its interpretation. However, when the R term is null, meaning when the return on investment is equal to the CIC interest rate, we need to put more focus on β .

In the equation (20) displayed previously, its influence on the marginal utilities ratio has a decent interpretation. As one can check, a β that tends to 0, meaning an increasing storage cost, will deliver a nutritional status relatively higher in the first period than in the second, for given values of $f'(N_1)$ and $n'(C_1)$. Indeed, an elevated cost of storage is a curb to the smallholder participation. This feature has been widely advanced by the literature as we exposed it in the state of the art. As a result, the household will prefer to consume more of its food crop at harvest than in the lean season. Automatically, a low storage coast (β close to 1) will favorize the participation of smallholders, as they will be able to transfer more food to the second period. Thus, in a situation where R is null, β might be one of the decisive decisional factor of the household to participate or not in CIC.

5.6. The warranted crop value converter, α

The last term we did not investigate is the α . If we will discussions on how it is set in the following section, we want first to understand its function in the definition of the marginal utilities ratio. This term has not a very precise name, it acts like a converter from the warranted crop value (in terms of P_1) to the granted loan value. It will always be positive and inferior or equal to 1. As one can see, we find it at the denominator as a factor of the crop prices ratio and the rates difference. If it is lower than 1, it will reduce the impact of these elements, $\frac{R P_1}{P_2}$, over the denominator.

The logic of this reasoning is quite trivial. Indeed, the lower is α , the lower is the loan. The loan size will impact the investment size and logically the reimbursement size. The two later are largely influencing the utility in the second period, because they are key features of the budget constraint. If the loan principal is lower, they will have a lower influence on the utility during the lean season. On the other hand, if α is equal to 1, it will entirely transfer the influence of R and $\frac{P_1}{P_2}$, as all the value of the warranted crop is transferred into a loan.

We conducted in this sub-part an analysis factor by factor of the equation (17). This linear way of proceeding highlights some possible relations between the marginal nutrition utilities ratio and variables mostly connected to the CIC functioning. Doing so we wanted to understand how, in an extreme case as we constructed in our model, a smallholder household intertemporal nutrition could be impacted by the practice of inventory credit. On one hand, we estimated that many relations illustrated in this section were for the most of it, intuitive and in accordance with different findings of the literature. The importance of an increasing price trend between the two periods or low storing costs have confirmed through the model lent, their importance in favorizing the success of CIC. However, we think that these features we shed light on, have to be discussed and contextualized. This is necessary in order to understand if CIC can be the tool that allows smallholders households to handle more easily their nutrition over time. The next section is dedicated to the discussion of these questions.

6. Discussions

While we exposed in the previous paragraphs the main intuitions raised by the observation of our model result. We intended to let some questions unanswered in order to offered them to a proper discussion in the following lines. Thus, the next part is dedicated to question some of the assumptions we made till now and confront some of our result to some important fact of the literature and to our own field experience of CIC in Benin.

6.1. Price variations: expectations and context elements

In the previous section, we described the intuition delivered by our model concerning price variations. On this point, our result was in line with the literature opinion : an increasing price trend is one of the most important feature for the success of a CIC operation. In the current sub-part, we would like now to question and discuss it. If we try to contextualize this result in the West African context, we have been close with, does such price trend occur ? Is it sufficient to raise interest in CIC?

In north Benin, we have been told during CIC beneficiaries meeting that the perspective of a large price increase was often what was driving the interest of newcomers. For instance, we remember the intervention of an NGO worker that was claiming that two campaigns ago, one of the Farmer

Organization he was working with achieved to sell its warranted crop at price almost doubled in comparison with the price at harvest. Thus, he observed that the very next season, the FO was forced to refuse the new members for the CIC participation. If such situation is rare, we have noted during different meetings we have attempted, some sort of heterogeneity in the CIC outcome from a community to another, and more especially a heterogeneity in terms of price. According to some testimonies, from NGO worker or beneficiaries, the prices to which the unlocked crops were sold in the lean season (i.e P_2 in our model), were sometimes quite different from a community to another.

One explanation that has been given to us was that some FO took advantage of the foreign demand. Indeed, the region we were based in, Atacora, is at the cross between the Burkina Faso and Togolese border. As a result, some Beninese communities were having traditional links with abroad commercial partners (they were often from the same ethnic group). We remember the example of village with many Togolese ties, that sold all its warranted crop to a merchant from the neighbor country to a price more interesting than the local market price. However, if we agree that we can observe a differential between the different price the communities are selling their crop, can we simply expect P_2 higher than P_1 , not only occasionally but on a seasonal basis.

From our experience in Benin, many actors of the agricultural market confirmed us that crop food prices were experiencing a seasonal inflation that was reaching a peak just before harvest. According to them, it was the mere market logic : The main component of the household in rural area is cereal, maize, sorghum and millet. Like the majority of the food consumed by Atacora inhabitants was produced locally, it is expected that the prices remain low after harvest, at abundance time and by opposition high when scarce, just before harvest. From a year to another, it was only the extent of this positive price trend that potentially variable but the food crop prices inflation was considered as certain for the locals.

If we take a short step back to the literature, we would like to recall one main result of the study of Cedrez & al (2020). In their modeling of cereal price variation at the African continent level, they estimate that the “within-year” variation in the semi-arid climate (like in Atacora) was widely explained by the cereals cropping seasonality: prices are low at harvest, high before harvest. Therefore, it comes to confirm the intuition that came from our Beninese experience. In this context, if we look back at the result rose from our model, it seems that the practice of CIC could suit to the Beninese environment as a tool for overcoming the “Selling Low, Buying High” phenomenon. Indeed, if we take for granted the model results, when a household practicing CIC experiences a positive price trend between the harvest and the lean season, its nutritional status is relatively better off in the second period. At the opposite, when stuck in the “Selling Low, Buying High” cycle, smallholder farmers

face a brutal decrease of their nutrition between the two periods. Therefore, we can estimate that a smoother intertemporal nutritional status, as permitted by CIC credit, is more desirable for smallholders than a huge intertemporal imbalance, as in the “SLBH” cycle. Particularly when prices are increasing on a seasonal basis.

We need to specify that Cedrez & al have indicated in their paper that the “within-year” variations were amplified by the market incompleteness, lack of infrastructures, financial market and storing devices. One can imagine that if CIC would come to be generalize in north Benin, the seasonal price variation would be dampened because it would fulfil the storing and financing needs. In this context, would it be still interesting for smallholders to practice CIC ? A quick look at the equation **(17)** shows that if we consider $\Delta P = 0$, the difference between the return on investment and the CIC interest rate, R , becomes an essential factor of the equation. Thus, let us discuss the pertinence of this term.

6.2. The rates difference pertinence : insights from our Beninese experience

The term R may seem odd in different ways. First, we consider in our model an environment where the household can on one hand obtain a credit but on the other hand not benefiting from a bank account or any other financial product, that would yield interests. It means that their loan would be delivered in cash. This assumption is disputable, in the sense that it exists NGO activity reports assuming that in some areas, the subscription to a bank account is a prerequisite to the participation in CIC. We heard such things also in Benin, but that seems far to be generalized. The argument in favor of a mandatory bank account is that in addition to be solution to credit rationing, CIC would also be an enhancer for the financialization of the entire society.

On the other hand, it would also definitely be a curb to the spreading of the practice. Indeed, some academic contributions (Casaburi & al for instance) have insisted on the importance of trust between the smallholders community and the MFI to reinforce participation. Other articles (like Eldeman & al) have shown that keep away the producer resources from themselves was one explanation of the non-participation in inventory credit. An obligatory bank account could give to smallholder a feeling of spoilation, of their crop or of their loan. Thus, we think that mandatory access to a bank account and financial should not be the first priority of a CIC program.

However, in order to defend the validity of R we need to justify r_i , the return on investment. One of the main critic that can be made on the corpus of article assessing inventory credit is the poor focus on the use of the loan. The statement to make relative to this is the following : either the CIC programs studied by the researchers does not feature any follow up of the loan use or they are just not interested in its study. Casaburi & al (ibid) or Le Cotty & al (2019) abord the fact that an increase in household savings (through cattle purchasing) or in human capital (through the expenses in school fees) is observed in their studied case, but never a directly productive investment (that might be just non existing).

This denotes largely with our experience in Benin. Indeed, a striking fact that could not be ignore when we observed the conducting of CIC by the NGO network we were into, was the emphasis put on the importance of a productive investment of the loan. For many NGO workers we were working with, one of the motivation of their action was the will of helping smallholders to emancipate themselves from a unique income source. Thus, an important part of the NGOs action was aiming to motivate and support beneficiaries smallholders in the conduct of a side activity. Therefore, we could not attempt to model the situation of these smallholders without letting room for such variable. And beyond our sole experience, we estimate that this is through this investment that CIC can also get a social interest. Indeed, like the core of the agricultural work is often done by men in the Atacoran household culture (when the household head is a male), the loan has notably permitted the rise or the intensification of a more female-centered economic activities through gardening or food transformation. We had noted in particular the very successful operation of a group of women, belonging to a village community that was practicing CIC. They were using a part of the loan their household were granted of to invest together in small scale soya cheese transformation enterprise. This find itself to be quite profitable, for their household revenue but also for their empowerment in the community as well as in their families. One could also argue that the rise of such small-scale business could be an incentive for the youngsters amongst communities to stay, and not sell their labor force as agricultural worker or to migrate to cities.

In the result section, we pointed out the odd result yield by the model when R is negative, meaning that r_i is lower than r_{cic} . We just discuss the fact that during our Beninese experience, we assisted to a real effort from NGOs and smallholders to create an environment where r_i would be positive, and so not so low. We need now to discuss of the r_{cic} level. We already abord the fact that the literature sees inventory credit as a mostly safe practice. From our ground experience in Benin, we only have been informed of reimbursement rates close to 100%. On this point, the peer monitoring process we described in the first part of the state of the art, is certainly working. From this perspective,

it seems plausible that r_{cic} remains low. The other major point in favor of a bearable CIC interest rate is the presence of a collateral, the warranted crop, which is obviously a huge guarantee for the MFI.

Two possible reasons of a high r_{cic} would be the weak competition in the IMF sector as well as their management. During the different village meetings we attempted, it has been said several times that the biggest obstacle of durable CIC program was the difficulty to find a reliable IMF. Indeed, the Atacora region was poorly endowed with this type of institutions. As a result, it was happening that occasionally, an IMF decides to briskly increase its rates from a year to another because they were aware that the FO would struggle to find another bank. On this point, we only had the opinion of the smallholders, so that we might not be totally aware of the possible negotiations and conflicts between the actors. We have been also told that some IMFs were sometimes brutally collapsing, often because of management mistakes or even in some case, embezzlement. Even if the last point is not really on the side of CIC as a stable financial tool, we are thinking that those issues coming from IMF can be solve, we will discuss this possibility further. However, we estimate that outside the banking institution reliability problem, it seems plausible that the R term in equation (17) remains positive. Another possibility is to limit the influence of R , by defining smaller loans. We will investigate this option in the following paragraph, tackling α and β .

6.3. Reflections on storage costs and the warranted value converter

Both terms are strongly linked with s , the warranted amount of food crop. As we previously stated, α can be seen as a converter from the warranted crop value to the loan value. We can also treat it as the factor that defines the amount of crop that will serve the role of collateral. Again, the literature and our own experience are in line, we have seen in multiple cases, α being set at 80%. There are no precise explanations to this pegging.

When we conducted an interview in Benin with the NGO officer in charge of inventory credit at Helvetas, we questioned him on the definition of α . He answered that when the NGO started its CIC program in Benin in the early 2010 decade, there was a consensus with the partner IMF to set α below 80%. The reason was the unknown outcome of CIC at this point, and so a chosen prudence in the size of the granted loan. However, once the first campaigns were conducted without any large defaults, the smallholders insisted to receive greater loans. At the end of the bargaining process, α was set to 80%. Since then, it remained steady and served as a reference for the other programs occurring in the region.

Nevertheless, we could think of a more flexible settings of α . Indeed, we have asserted the fact in the state of the art, that CIC was seen by researchers (in particular Le Cotty & al) as a commitment device. Meaning a tool that helps smallholders to secure a part of their crops against their own urges or the one of their relatives. If CIC was only a mere commitment device and not a financial one, α could be 0. Thus, producers would only bear the β cost, and get back their warranted crop at the lean season. This was not so feasible in our model version because CIC was the only source of income, but such thing could totally be possible in a realistic set up. It could also be an individualize term, regarding the need of each household. However, an individualized policy could also put more work to the IMF, with bigger monitoring requirements and potentially, smaller benefits and maybe much less interest to be engage in CIC (if the granted loans bulk ends up being smaller). The definition of α could come as an arbitrage between an emphasis on the food security (with a low α , more crops can be transferred without bearing the weight of a heavy reimbursement) or the dynamism of the activity (with a high α , the loans are greater, so could be the productive investments).

If α might potentially be defined individually, β has to hold for an entire set of beneficiaries. As we previously wrote, this term can be understood as a storing cost. We claimed several times in this thesis how large storing costs could avoid the smallholders interest in CIC. Some authors, like Miranda & al, even pointed it as one of the main cause of the slow spreading of inventory credit on the African continent.

Our perception of β was different when we were in Benin. Indeed, we never obtained very precise answers on how the storing cost would be defined in CIC. In some cases, we understand that the warehouse management was handled by the FO members, alternately and voluntarily. As a result, the majority of the storing cost was internalized by the community members. Sometimes, one member of the FO was occupying a precise function in the management of the CIC program, as the representative of the FO to the IMF, or the associate accountable for instance. Once again, we have not been told of a remuneration in this case, but this might just have been ellipted during my presence. We are aware that, as mentioned in their article by Casaburi & al, CIC can sometimes be more favorable to certain members of the community, already occupying a leading role outside the program. However, we were not aware of such power relations maintained through the distribution of positions or retributions, that might have impacted at the end of the day, the storing costs.

Driving the discussion to the costs force us to briefly abord the role of the external actors in CIC. Indeed, CIC programs may represent huge investments for the NGOs implicated in their conducting : preliminary survey, the setup of a frame, the following up process etc. Sometimes the building of the warehouse is required if not available. Such investments were taking an important

budget line in NGOs like “Iles de Paix” or Helvetas. While our internship was taking place, the Helvetas officer in charge of CIC related us the project of negotiations with the Beninese central state in order to unlock financial support, for the involved NGOs and IMF, with the aim to turn the program sustainable over time. This also comes in line with our previous discussions on the level of r_{CIC} . Indeed, one could imagine a state subsidized line of credit dedicated to the CIC for IMF. Such state financial support was already invoked in the literature, notably by Coulter & Onumah (2002), as a primordial determinant of the success and possible spreading of inventory credit over the African continent.

In this section, we attempted to provide some reflexive content to our thesis. The aim was to discuss some chosen findings and assumptions of our theoretical model and confront them to the most striking facts of the literature as well as some observations and qualitative elements gathered during our internship in the North-Benin.

We consider that this exercise has shown some positive outcome in favor of our theoretical attempt. Indeed, we can claim after this part that the seasonal price variation is likely to favorize the success of CIC in regions similar to North-Benin and in accordance with our model, potentially enhance the food security of smallholders household. This might be reinforced by the possibility of using CIC not just like a financial tool but like a commitment device and so save more easily food crop than with a classical on-farm storage.

On the income side, the possibility for smallholders to invest in small scale activity during the lean season could create a new dynamic in the rural economy of these regions, still largely dependent of food crop sale. We estimate that our model illustrated the interest of this later feature. Concerning the storage cost, we did not find during our field experience in Atacora any clear evidence of the way they were handled in CIC program. On the other hand, the result of the model seems to go in the direction of the literature on this specific point. More focus could be put on this question in further work on CIC.

7. Conclusion

Introduced in Africa during the last decade of the 20th century, inventory credit still remains a marginal practice nowadays. Reasons are several : mistrust between the different actors, lack of political will, absence of sufficient financing are plausible causes of its slow spreading on the continent. However, one can observe since the mid 2010, an increasing interest of few development economists in CIC. Until this period, the view proposed by economist over CIC was often flawed and incomplete. The application of new analysis tools, econometrics for the most, brought a new perception of the practice. In addition, the follow up of different CIC programs from their elaboration to their set up by development economists offers the possibility to extend the practice understanding and more especially its consequence on the beneficiaries smallholders lives. The inflation of knowledge concerning inventory credit is important. It provides elements to help NGOs and policy makers to drive their decisions of including or not CIC programs in their actions.

At our level, we try to lodge our thesis within this new corpus abording CIC. More precisely, we attempted to contribute on a more theoretical ground. Thus, the originality of our work comes by the few contributions evoking CIC through the lent of theoretical model. From our field observations in Benin, we had the intuition that CIC might be a decent tool to help smallholders household to overcome their nutrition issues encountered during the lean season, by relaxing their cash and storing constraints. To tackle this question, we needed a household-centered model including nutritional questions, in link with storage and food crop management. We adapted the two-period model of Gross & al and added a CIC component. We focused on an extreme situation where inventory credit was the only mean for smallholder to generate an income and transfer food crop to the lean season. By doing so, we wanted to highlight how CIC could influence the intertemporal nutrition distribution, in interaction with prices, storing costs, interest and return rates.

The different outcomes of our model were mostly in line with findings of the literature as well as with some intuitions and qualitative data collected during our stay in North-Benin. According to our results, CIC could permit to rural household to benefit from the seasonal price increase, thanks to its storing component combined with the locking of the crop as collateral, that commits smallholders. Indeed, the model informed us that when food crop prices inflation occurs along the year, household nutrition status gets relatively better off in the lean season, period traditionally marked by food scarcity. From our experience in Benin, we found relevant to include in the model a productive purpose to the granted loan. From our theoretical perspective, this productive investment also found itself to be a source of nutrition betterment in the lean season, like the investment return could be dedicated

to the loan reimbursement while the warranted food crop could be consumed and not sell. Those theoretical insights delivered by the model seems to be in favor of CIC as useful tool that would offer another alternative to the “Selling Low, Buying High” phenomenon to African households living in rural semi-arid environment like we met in Benin.

However, our model occasionally yielded odd results concerning the difference between the investment return rates and the loan interest rate. Therefore, our approach did not succeed in providing decent intuitions regarding the setting of the CIC interest rate and its influence on household nutrition. Further research could put the emphasis on this point, as well as investigating the situations of IMF institutions that are key actors for the success of CIC. Some more in-depth approach of the profiles of CIC beneficiaries and their relations in the village community could inform us of the potential harming that CIC could cause to traditional solidarity links. Furthermore, on how CIC can maintain or discuss economic and financial power distribution. From our opinion, it is primordial that the future findings on CIC may have an operational extent, to serve the decision making of the deciders and development actors.

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Appendix

Lagrangian developments

As exposed in the main part of our contribution, our version of the Gross & al model delivered the following Lagrangian :

$$L = U(N_1, O_1) + \gamma U(N_2, O_2) - \lambda_1 (N_1 - f(N_0) - n(C_1) + a(L_1)) - \lambda_2 (N_2 - f(N_1) - n(C_2) + a(L_2)) \\ - \lambda_3 (r_i O_1 + O_2 - R \alpha(sP_1) + P_2 q_2) - \lambda_4 (\beta C_1 + C_2 - \beta y + q_2) - \lambda_5 (C_2 - \beta s) + \varphi s$$

And so, it comes its first order conditions :

$$\frac{dL}{dO_1} = U_O(N_1, O_1) - r_i \lambda_3 = 0$$

$$\frac{dL}{dO_2} = U_O(N_2, O_2) - \lambda_3 = 0$$

$$\frac{dL}{dN_1} = U_N(N_1, O_1) - \lambda_1 + \lambda_2 f'(N_1) = 0$$

$$\frac{dL}{dN_2} = \gamma U_N(N_2, O_2) - \lambda_2 = 0$$

$$\frac{dL}{dC_1} = \lambda_1 n'(C_1) - \lambda_4 \beta = 0$$

$$\frac{dL}{dC_2} = \lambda_2 n'(C_2) - \lambda_4 - \lambda_5 = 0$$

$$\frac{dL}{dq_2} = -\lambda_3 P_2 - \lambda_4 = 0$$

$$\frac{dL}{ds} = \lambda_3 R \alpha P_1 - \beta \lambda_5 + \varphi = 0$$

In this extreme case, the household participation in CIC is mandatory and so s requires to be positive. Therefore, φ will be equal to 0. Equalizing the two last first order conditions we obtain :

$$-\lambda_3 P_2 - \lambda_4 = \lambda_3 R \alpha P_1 - \beta \lambda_5$$

And so, an expression of λ_5 in function of λ_4 :

$$\lambda_5 = \frac{1}{\beta} \left(\lambda_4 \frac{R \alpha P_1}{P_2} \right)$$

Then, we can express λ_1 and λ_2 in function of λ_4 :

$$\lambda_1 = \frac{\beta}{n'(C_1)} \lambda_4$$

$$\lambda_2 = \left(1 + \frac{1}{\beta} \frac{R \alpha P_1}{P_2} \right) \lambda_4$$

According to the third and the fourth first order conditions, we can write the marginal utilities ratio as:

$$\frac{U_N(N_1, O_1)}{\gamma U_N(N_2, O_2)} = \frac{\lambda_1 - \lambda_2 f'(N_1)}{\lambda_2}$$

And so if we inject the new expression of λ_1 and λ_2 we obtain :

$$\frac{U_N(N_1, O_1)}{\gamma U_N(N_2, O_2)} = \frac{\frac{\beta}{n'(C_1)}}{\left(1 + \frac{1}{\beta} \frac{R \alpha P_1}{P_2} \right)} - f'(N_1)$$

Model variables and factors

U_t : Total utility of the household at time t

N_t : Nutritional status of the household at time t

O_t : Numeraire good consumption at time t

C_t : Consumption level of the household at time t

y : Total Harvest produced by the household

q_t : Amount of the harvest sold on the market at time t

s : Amount of the harvest warranted through CIC

m : Amount of food crop bought on the market

B : Loan granted during the CIC process

b : Amount of the budget kept aside for the second period

r_i : Return on investment

r_{cic} : Interest rate of the loan

P_t : Price of the harvested crop

γ : A discount factor

β : A storing costs factor

α : the converter factor