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Failing synergies among public programs: the economy-wide effects of one rural credit and two social protection programs simultaneously implemented in Southern Brazil

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Declaration

According to the § 17 of the Doctoral Examinations Regulations of the Faculty 09,
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I declare that the dissertation here submitted is entirely my own work, written without any illegitimate help by any third party and solely with materials as indicated in the dissertation. I have indicated in the text where I have used texts from already published sources, either word for word or in substance, and where I have made statements based on oral information given to me. At all times during the investigations carried out by me and described in the dissertation, I have followed the principles of good scientific practice as defined in the "Statutes of the Justus Liebig University Gießen for the Safeguarding of Good Scientific Practice".

Gießen, June 6th 2021

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1 Introduction

1.1 Agricultural development and social protection programs

Rural underdevelopment remains one of the biggest problems in most of the developing countries (De Janvry et al., 2002). More than half of the world poor live in rural areas, with estimations from 2010 pointing that 78% of the poor lived in rural areas (FAO, 2015). In Brazil, even though a reduction in poverty and extreme poverty could be identified for rural areas in Brazil, they still have the highest share in terms of population in both categories (S. Soares et al., 2016).

There have been many initiatives around the globe to support farming as a way to improve living conditions of poor farmers, especially in developing countries. Different modalities of intervention have been deployed, such as financial support to productive and non-productive rural activities, special credit lines and crop insurance schemes, and access to markets (van der Ploeg et al., 2012), as well as cash-based programs, especially targeting poor rural households (Sumberg & Sabates-Wheeler, 2011).

The programs that contributed to reducing poverty, implemented in rural areas can be divided into two groups: agricultural development, and social protection programs. The former programs focus on improving productivity in crops and improving access to markets, influencing the composition and scale of crops, investment in risky but profitable infrastructures, among others (Conning & Udry, 2007). Agricultural development programs sensibly increase both the adoption and the extent of use of agricultural technology (Abate et al., 2016), increased the technical efficiency at the farm level in China (Zhao & Barry, 2014), has led to an increase in consumption and led to housing improvements in Ethiopia (Berhane & Gardebroek, 2011), and reduced overall poverty in the Philippines (Agbola et al., 2017).

Social protection programs aim to reduce socio-economic risks, vulnerability, extreme poverty and deprivation (Croppenstedt et al., 2018). Social protection can be understood as a combination of social assistance programs (protection against poverty) such as cash transfer

(Devereux, 2016), and food programs, such as school feeding programs. They are especially important for poverty reduction in rural areas of developing countries (Sumberg & Sabates-Wheeler, 2011), and generally focus on the socially and economically vulnerable people (Fiszbein et al., 2014). Furthermore, social protection stimulate investment in agricultural inputs in Mexico (Gertler et al., 2012) as well as in in Zambia (Handa et al., 2016). Investments in productive assets in agriculture, such as working tools and machinery were found for beneficiaries of cash transfers in Malawi (Boone et al., 2013) and in Kenya (Asfaw et al., 2014). Conditional cash transfer in rural Paraguay increased investment in agriculture and savings (F. V Soares et al., 2010), and led to an increase of agricultural income of around 10% after 18 months of program participation in Mexico (Gertler et al., 2012). Cash transfer programs increase education outcomes of children of program participants (Fiszbein et al., 2009) and increase quantity and quality of food available to participants and reduces the prevalence of food insecurity in sub-Saharan Africa (Tiwari et al., 2016).

In Brazil, agricultural development and social protection programs have been implemented side by side in rural areas. As an example of the former, PRONAF, a rural credit program for smallholder farmers, is the most important representative in terms of program budget and number of beneficiaries. PRONAF loans are positively correlated with an increase in per capita agricultural and total municipal GDP (Castro et al., 2014), and with an increase in productivity among participants (Feijo, 2003) across all Brazilian States (Araujo & Vieira Filho, 2018). PRONAF loans are given primarily to cash crop producers, as three quarters of PRONAF loans given to soybean and maize producers (Gazolla & Schneider, 2013), which reduces farm production diversity, as one third of all participants produced only one crop in 2014 (Sambuichi et al., 2016). Even though total and per capita value of production of poor PRONAF loan takers is higher as compared to poor PRONAF non-loan takers (Magalhães & Filizzola, 2005), most of the loans are given to wealthy family farmers (Grisa et al., 2014; Schneider et al., 2004).

For the latter, *Bolsa Família* and the rural pension programs have received great public attention in Brazil, especially due to its coverage and targeting of rural poor and vulnerable households. While the effects of *Bolsa Família* on smallholder farmers' land productivity and on

income are inconclusive (Costa et al., 2018; Garcia et al., 2016), pension transfers are used to support agricultural production, especially for subsistence (Delgado & Cardoso Jr., 2000). Furthermore, *Bolsa Família* improves food consumption, and therefore dietary diversity (Lopez-Arana et al., 2016), and increases food expenditure and total energy available for participating households (das Neves et al., 2017). *Bolsa Família* also increases long-term potential for economic growth and transformation of poor regions (Rougier et al., 2018). Similar results are found for the rural pension program, which increases the demand for consumption goods and agricultural goods (Schwarzer & Querino, 2002), affecting local commerce, increasing businesses and job creation (Augusto & Ribeiro, 2006).

However, little attention has been given to the effects produced by public programs simultaneously implemented in rural areas. Even though it seems plausible social protection and agricultural development programs may potentially produce synergies that would strengthen the livelihoods of poor smallholders (Tirivayi et al., 2016; Veras et al., 2016), few empirical studies have addressed aimed to fill this knowledge gap. In theory, increased cash availability through social protection may increase demand for local products, such as staples, which in turn affect local prices. Increased prices incentivize agricultural households to increase agricultural production, if part of the available cash is invested. Additional investments in agriculture can be promoted by agricultural development programs, such as credit, promoting further production increases (Veras et al., 2016). As agricultural interventions do not always reach nor are not always adopted by the poorest agricultural households who face market failures and are risk averse, social protection interventions can alleviate credit, liquidity and savings constraints and provide the greater certainty that poorer households require for investing in agriculture and riskier income-generating activities. In the same vein, agricultural interventions can be delivered to non-beneficiaries of social protection in the same locales as cash transfers are occurring to take advantage of the increase in local demand, loosen their capital and liquidity constraints and increase their supply response in order to maximize the income multiplier (Tirivayi et al., 2016).

Empirically, some studies have focused on the effects produced by participation in more than one program at the household level, such as in Brazil, where simultaneous participation in PRONAF and *Bolsa Família* produce positive significant results in land productivity and household income at the municipality level in Brazil (Garcia et al., 2016). Similar results were found in Malawi, as complementarity and incremental effects on households participating in an agricultural development and a social protection program, with the results for each of the standalone programs being smaller than the combination of them (Pace et al., 2018). To our knowledge, only one study addressed the effects of simultaneous implementation of public programs and their transmission throughout the rural economy, showing that they extend beyond direct beneficiary households, as a result of consumption and other local linkages in rural Malawi (Kagin et al., 2018).

Production and consumption linkages among agricultural households are instrumental in shaping the impact of policy, market and environmental changes on production and farmers' welfare (J E Taylor & Adelman, 1996). As such, they capture not only for the direct, but also for the indirect effects produced on households by public programs (Breisinger, Diao, et al., 2009; Tadele, 2008). In concrete terms, it means that a village-wide analysis allows to identify the net impact, which in the case of price changes, is not only the result of changes in staple output and consumption on a representative producing farm (as depicted by a household model), but rather as a result of production and consumption effects, as a result of the existing inter-household income linkages (J E Taylor & Adelman, 1996). Unfortunately, microeconomic household-farm models, the cornerstone of microeconomic policy analysis over a long period of time, do not take these linkages into account (J E Taylor & Adelman, 1996). Therefore, the analysis of interactions among sectors or households within an economy, and the transmission of policy effects throughout a given economy, requires economy-wide frameworks (Sadoulet & De Janvry, 1995).

Village-wide economic analysis can be conducted with the aid of a Social Accounting Matrix (SAM), which are designed to capture the complex interlinkages among village production activities, village institutions and the outside world (J E Taylor & Adelman, 1996). The analysis

can be further enhanced with the use of Computable General Equilibrium (CGE) models, which allow for integrating non-linear elasticities, behavioral responses in production and consumption decisions, and constraints in factor supply. These features makes the CGE models among the most comprehensive tools for assessing the linkages of economy and household welfare (Breisinger, Diao, et al., 2009; Diao & Thurlow, 2012).

1.2 Study aim and research questions

As seen above, most of the impact assessments of PRONAF, *Bolsa Família* and rural pension programs aimed at assessing the programs' impacts at household levels only. However, all these studies focused on beneficiaries while spillover effects as well as impact on economic linkages remain understudied. Furthermore, it is still unclear which effects the concomitant implementation of public programs produce in rural economies.

The reviewed literature on the public programs clearly shows that PRONAF produces positive impacts on farm productivity and production, and on farm income of participating farms. Furthermore, *Bolsa Família* and rural pension programs undoubtedly positively affect household income and food security, especially of poor and vulnerable participating households. However, it remains unclear how non-participating households are affected by the implementation of the public programs in rural economies. The interlinkages among economic activities and households in rural areas are responsible for the transmission of changes in consumption and production patterns, first triggered by participating households, and finally transmitted to other households. From a local economy-wide perspective, as they spend their income, the beneficiary households unleash general equilibrium effects that transmit program impacts to non-beneficiaries in the economy.

Furthermore, the concomitant implementation of PRONAF, *Bolsa Família* and the rural pension programs may affect the outcomes of the individual programs. For example, a higher cash availability for *Bolsa Família* and rural pension beneficiaries may increase the demand for local goods, leading to an increase in local prices, which stimulate the production of local goods by agricultural producers with access to the credit market. Additionally, an increase in production

investment by PRONAF loan takers is going to affect the demand for labor, increasing local wages, which will be further increased in case of cash transfers to beneficiary labor supplying households. As such, labor costs will influence production decisions by farmers, which in turn will have effects on the local commodity markets.

Against this background, this thesis aims at answering the research question: Which are the economy-wide impacts of public programs implemented concomitantly in the economy of a Brazilian rural village? Specifically, we aim at dealing with the questions: (i) Which impacts of individual public programs implemented in rural Brazil have been assessed so far? (ii) What are the representative types of households in a rural community in Brazil? (iii) How is the structure and how are the interlinkages among economic sectors in a rural village in Brazil? (iv) What are the general equilibrium effects of changes in public spending on programs in the economy of a rural community in Brazil?

It is hypothesized that (i) the current assessments of the impact, generated by Brazilian agricultural development and social protection programs in rural areas, comes short of investigating the indirect program effects, and the effects of concomitant program implementation; (ii) households vary in terms of their livelihood strategy in Brazilian rural areas, which affects the way they are impacted by policy changes; (iii) the relatively few intra-village interlinkages among economic activities limit the transmission of policy changes in a rural economy; and (iv) the outcomes of public programs depend on the transmission of commodity and labor price changes throughout the economy.

In order to address these questions, we organized this work as follows. First, we conducted a comprehensive literature review on the impacts assessed so far generated by PRONAF, *Bolsa Família* and rural pension programs. In section 3 we outline the data collection tools and the study area, and present descriptively present data on the village rural economy. Next, we determine representative households according to their role in the village economy in order to better assess the economy-wide program impacts by applying the livelihood strategy framework, based on household income-generating activities. In section 5 we built a village SAM, highlighting the linkages and flows among the different village economy sectors, and

conduct a SAM multiplier analysis to assess the transmission of exogenous shocks throughout the economy by scenario analysis on program implementation in the village. Finally, section 6 discusses the implementation of a CGE model and the particularities of the adopted STAGE model, as well as presents the results of CGE simulation on concomitant program implementation.

2 Literature review

2.1 Introduction

There have been many initiatives around the globe to support farming as a way to improve the living conditions of poor farmers, especially in developing countries. Different modalities of intervention have been deployed, which are normally divided into agricultural development and social protection programs. The former focus on improving access to markets for agricultural products and for production inputs, while social protection programs aim to reduce socio-economic risks, vulnerability, extreme poverty and deprivation of beneficiary households. While both areas of policy are important elements of poverty reduction in rural areas, coordination between these two types of interventions is generally limited (Slater et al., 2016) and limited attention has been paid regarding the interaction between them (Tirivayi et al., 2016).

Conceptually, there is a two-way relationship between social protection and agriculture. On the one hand, poor rural households that mostly rely on agriculture for their livelihood are often affected by limited access to resources, low agricultural productivity, poorly functioning markets and repeated exposure to risks (Croppenstedt et al., 2018; Dorward et al., 2006; Fiszbein et al., 2014). Social protection can reduce the vulnerability of rural households by alleviating liquidity constraints by providing cash and in-kind support (Devereux, 2016), especially in rural areas of the developing world (Sumberg & Sabates-Wheeler, 2011). On the other hand, agricultural policies and interventions can help smallholder households to manage risks by stimulating productivity in crops and improving access to markets, influencing the composition and scale of crops, investment in risky but profitable infrastructures (Conning & Udry, 2007), and affecting overall household welfare (Barry & Robison, 2001).

It is plausible to assume that concomitant implementation of social protection and agricultural development programs may influence the outcomes of produced by the individual programs, potentially producing synergies that would strengthen the livelihoods of poor smallholders (Tirivayi et al., 2016; Veras et al., 2016). However, synergetic outcomes depend highly on

coordination between agricultural and social protection policies (Veras et al., 2016), which is not always pursued at policy and local levels, even when they have similar aims and stakeholders (Slater et al., 2016). Furthermore, linkages among different economic sectors and among rural households transmit the effects produced by public programs on participating households to other households in a given economy (Breisinger & Ecker, 2014; J E Taylor & Adelman, 1996). Regardless of the need to adopt economy-wide analysis frameworks to assess the transmission of policy effects in a given economy (Sadoulet & De Janvry, 1995), studies using such methods are so far rare.

Moreover, there are relatively few empirical studies investigating the interactions between the two types of interventions. Some studies have focused on the effects produced by participation in more than one program at the household level, such as in Brazil, where simultaneous participation in PRONAF and *Bolsa Família* produce positive significant results in land productivity and household income at the municipality level in Brazil (Garcia et al., 2016). Similar results were found in Malawi, as complementarity and incremental effects on households participating in an agricultural development and a social protection program, with the results for each of the standalone programs being smaller than the combination of them (Pace et al., 2018). To our knowledge, only one study addressed the effects of simultaneous implementation of public programs and their transmission throughout the rural economy, showing that they extend beyond direct beneficiary households, as a result of consumption and other local linkages in rural Malawi (Kagin et al., 2018).

Unfortunately, other parts of the world with a long tradition of implementing agricultural and social protection programs concomitantly, especially Latin America, have not been yet subject of scrutiny. Brazil is one notorious example of simultaneously implementing both types of programs in rural areas, especially targeting smallholder farmers. Several empirical studies on the Brazilian programs assess the effects produced by the individual on beneficiary households, the effects of concomitant program implementation and the assessment of potential complementarities among programs remain understudied (Abramovay & Veiga, 1999; Wittman & Blesh, 2017).

Therefore, this study aims at exploring the potential outcomes of concomitant implementation of public programs in a rural village economy by assessing a literature review on the individual Brazilian social protection and agricultural development programs. As such, we propose a theory of change that identifies the pathways through which social protection and agricultural development programs affect rural households and rural economies.

2.2 Impact pathways

Generally speaking, effects of policy changes in rural areas are transmitted throughout the economy through the linkages of households with local markets, such as local commodity and labor markets (J E Taylor & Adelman, 1996). Taking into consideration the basic flows within an economy, there are three plausible pathways through which the effects of social protection and agricultural development programs are transmitted throughout the economy (Breisinger, Thomas, et al., 2009). Namely, they are: (i) the direct effects on program participants; (ii) the effects on local commodity markets; and (iii) the effects on factor markets; and (iv) the indirect effects on village households. The basic economic flows in rural economies in shown in Figure 2.1.

2.2.1 Direct effects on program participants

Public programs implemented in rural areas benefit, in the first place, the households directly participating in the programs. Participants of social protection programs have a strong positive effect on household income resulting from the direct cash transfers, leading to an increase in the quantity and quality of food consumption for the participating households, and as such increasing food security (Tiwari et al., 2016). Social protection programs lead to an increase in agricultural investment, leading to an increase in the demand of crop inputs (Gertler et al., 2012; Handa et al., 2016; Todd et al., 2010), and in productive assets, such as working tools and machinery (Asfaw et al., 2014; Boone et al., 2013; F. V Soares et al., 2010). As a result, program participants increase the consumption of food types from own (subsistence) production, such as in Malawi (Boone et al., 2013), and increase the value and variety of food consumed from own production in Mexico (Todd et al., 2010).

Access to agricultural development programs strongly promotes productive investment (Abate et al., 2016), which lead to a strong positive effect on agricultural production (Barry & Robison, 2001), and consequently produce higher farm income from agriculture (Diagne et al., 2000). The effects of household income on consumption are not as strong as for participants of social protection programs, as most of the agricultural development programs are targeted towards better-off farmers (Luan, 2015; Mersland & Øystein Strom, 2013), which do not face as strong consumption constraints as social protection participants.

2.2.2 Effects on local commodity production

The effects of public programs on local commodity markets are relatively clear. Social protection programs lead to an increase in agricultural investment, leading to an increase in the demand of crop inputs (Gertler et al., 2012; Handa et al., 2016), and in productive assets, such as working tools and machinery (Asfaw et al., 2014; Boone et al., 2013; F. V Soares et al., 2010), all of which are mostly imported into rural villages. However, these effects are bigger for households with relatively higher asset endowments and not for the asset poor (Barca et al., 2015). Moreover, a big share of the household transfers by social protection programs will be used to smooth consumption, leading to an increase in the quantity and quality of food consumption for most of the participating households in Sub-Saharan African (Tiwari et al., 2016) and in Mexico (Barrientos & Sabates-Wheeler, 2006). Additionally, given the importance of subsistence production for poor beneficiaries of social protection (IEG, 2011a), increased household income will increase household production of staples itself, putting a downward pressure on prices. As a result, the effects of social protection on local production of staples will highly depend on the extent of changes in local food demand and the resulting supply by local farmers.

Agricultural development programs definitely have an effect on agricultural production (Barry & Robison, 2001), and consequently on farm income (Diagne et al., 2000; IEG, 2011b). As a consequence, they may increase consumption, meal quality and food security, such as in the case of microcredit in several sub-Saharan African countries (Stewart et al., 2010). However, these effects are limited, as these programs are targeted towards better-off farmers (Luan,

2015; Mersland & Øystein Strom, 2013), which do not face as strong consumption constraints as social protection participants. An increase in the production of cash crops, creating a perceived scarcity of staples in the household, as higher income from cash crops increases the demand for normal goods, including staples. The shadow price of staples, therefore, increases. The upward pressure on the staple price will intensify if increasing cash crop production requires shifting fixed household resources (e.g. land or scarce human capital) out of staple production (J Edward Taylor & Adelman, 2003). The higher shadow price of staples induces the household to invest additional resources in staple production, possibly reducing its cash crop supply. As a result, similarly to the effects described for the social protection programs, staple production will depend on the effect on demand and perceived scarcity of staples in the local market.

2.2.3 Effects on local factor markets

In rural villages, policy effects are transmitted from participating households to the rest of the economy through local markets, especially labor and commodity markets. The effects of social protection programs on labor supply are diverse. An increase in the income of poor households, the main group of participants of social protection programs, may reduce the local supply of labor due to an increase in the household shadow wage, increasing the household flexibility in labor allocation (Asfaw et al., 2014). Indeed, even though most studies in Latin America do not show reduction in adult labor supply (Foguel & Barros, 2010; IEG, 2011a), cash transfers reduced the labor supply of women , informal and unpaid workers in Brazil (IEG, 2011a) and in Ecuador (Edmonds & Schady, 2012). Furthermore, studies find that cash transfer induce a shift from on-farm to non-farm work in Latin America (Gertler et al., 2012; Maluccio, 2010). However, when accompanied by investments in agriculture, participant households increase time devoted to farming activities (Boone et al., 2013). Thus, local wages may go up, as on-farm labor demand may increase due to increased agricultural activity, therefore reducing the supply of off-farm labor.

Agricultural development programs may increase the demand for labor in general, especially of readily available family labor, but also of hired off-farm work. Indeed, evidence show that

irrigation increased labor intensity in Ethiopia, and increased employment opportunities for poor and smallholder farmers at large farms in Peru (IEG, 2011b). In Nepal, a vegetable and cash-crop program increased adult labor allocated to cash crops production (Paolisso et al., 2002). On the supply side, participants of agricultural development programs will aim to cover their labor demand by allocating more family labor to on-farm activities (IEG, 2011b), reducing the availability of labor to off-farm activities. As such, the combination of an increase in labor demand and a reduction in off-farm labor supply lead to an increase in the local wages, benefitting off-farm workers, and increasing production costs for farming households.

2.2.4 Indirect effects on village households

Households which do not participate in public program are indirectly affected by policy changes through economic linkages among economic sectors and households (J E Taylor & Adelman, 1996). As rural areas are characterized by households pursuing differing livelihood strategies (Brown et al., 2006; Nielsen et al., 2013), indirect program effects are expected to affect households differently. As such, households characterized as net producers/consumers of staples, or as off-farm workers, will be affected differently by the changes engendered by public programs on the local commodity and labor markets.

The increase in local staple demand due to social protection programs may increase local staple prices, affecting the welfare of net consumer households. An increase in the production of staples through farming households participating in agricultural development programs may pressure staple prices down. Thus, the resulting local staple prices will determine the indirect effects the programs have on household welfare, for both participant and non-participant households.

Furthermore, the effects of policy changes on the labor market will influence the income of off-farming households, which commonly belong to the poorest households in rural areas. As the effects of both social protection and agricultural development programs lead to an increase in local wages, off-farm workers are expected to increase their income, and farming households are expected to increase their labor costs. As such, the indirect effects will depend on the

economic activities in which the households are engaged, with income increasing for off-farm laborers, on the one hand, and production costs increasing for farming households, on the other hand, irrespective of whether they participate in any of the public programs or not.

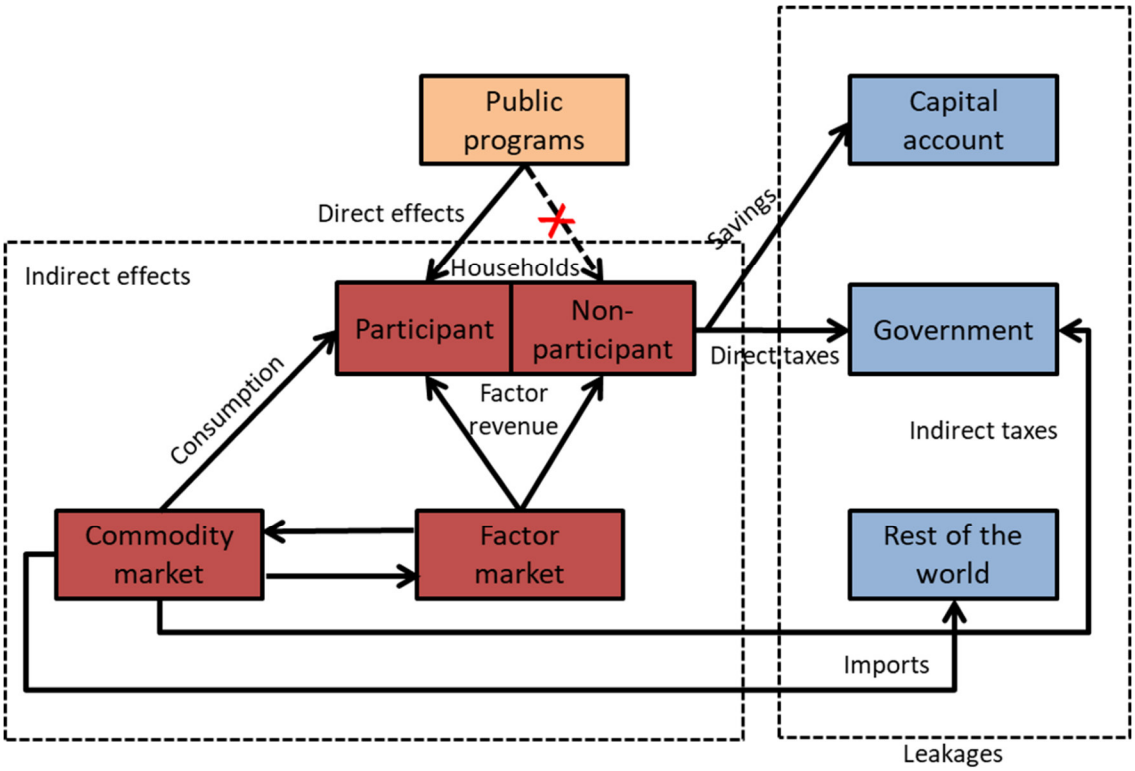

Figure 2.1: Basic economic flows in village economies
Source: adapted from Breisinger et al. (2009)

The impact pathways summarized in this section are not static, but rather dynamic, as the economic flows continuously transmit the effects of policy changes to other economic sectors. For example, an increase in the demand for local labor will increase local wages, leading to an increase in income for local off-farm workers, potentially increasing their household income and consequently increasing their demand for local goods. In the same vein, concomitant implementation of both types of programs may simultaneously produce an increase in the demand for local goods due to higher household income, increasing local prices, which will incentivize agricultural households to invest in local production. As both types of programs are commonly implemented in the same locales, participants of agricultural development programs will benefit from an increase in the demand for local goods, which in turn will benefit participants of social protection programs by lowering local prices of consumed goods.

The rationale just described will guide the review on the effects produced by Brazilian social protection and agricultural development programs in Brazilian rural village economies. For that scope, we next explain the methodology used in our review, followed by a brief description on selected Brazilian programs. The review of studies on selected programs comes next, followed by the discussion on the potential joint effects produced by concomitant program implementation in Brazilian rural areas.

2.3 Methodology

2.3.1 Search strategy and study selection

Regardless of the originality of this review on the Brazilian social protection and agricultural development programs, it was not intended to be exhaustive, but rather to highlight the relevant literature on assessing the effects of the individual programs. We searched for peer-reviewed and grey literature using the Web of Science (for publications in English) and Scielo portals (for publications in Portuguese), as well as the websites of the World Bank, FAO, IFPRI, WFP, the Brazilian Economic Research Institute (IPEA), and from the Brazilian government. We prioritized our search on publications in English whenever possible, but also reviewed several papers published in Portuguese to make findings of the Brazilian programs available to the broader academic community (non-Portuguese reading audience). Furthermore, our review primarily looked at quantitative studies and evidence presented in systematic reviews. We supplemented the empirical review with several qualitative studies

Direct search was used as a starting point for the literature review, followed by a snowball approach to access further references. By doing so, the literature review identified four systematic reviews which provided the ground for further literature search: (i) IEG (2011a) and IEG (2011b) for the international literature on the impacts produced by social protection and agricultural development programs around the world, respectively; (ii) Tirivayi et al. (2016) for the potential of creating synergetic outcomes through the joint implementation of programs in rural areas; and (iii) Grisa et al. (2014) for the studies on relevant agricultural development policies in Brazil. Overall, we inspected around 150 impact evaluations conducted in developing

regions, out of which around 60 studies assessed the selected Brazilian social protection and agricultural development programs, most of them published in Portuguese.

2.3.2 Outcomes

In this literature review, we focused on outcomes produced by Brazilian programs in rural areas along the impact pathways summarized in Figure 2.1, namely direct and indirect effects on rural households, and on local markets in rural economies. The outcomes on households related to the implications for agriculture e.g. crop production and productivity, agricultural investment, and labor allocation. The effects on the local economy concentrated on the measured and potential spillover effects produced by the programs on non-participating households (e.g. consumption and labor supply), income multipliers, and changes in local markets.

As the number of Brazilian social protection and agricultural development program is relatively high, we narrowed our focus to the four most prominent programs implemented in rural areas, presented in detail below.

2.4 Brazilian agricultural development and social protection

Brazil has a robust set of agricultural development and social protection programs in place (Silveira et al., 2016). In the table below (Table 2.1), the most important agricultural development for smallholder farmers and social protection programs implemented in Brazil are presented. Four agricultural development programs for smallholder farmers are in place in Brazil. PRONAF (National Program to Strengthen Family Farming) is a subsidized credit program created in 1995, and which is implemented under two modalities: crop loans, given to farmers every year, and investment loans for the purchase of machinery or building infrastructure. The food procurement programs PAA (Food Acquisition Program) and the PNAE (National School Feeding Program) purchase food from smallholder farmers for later consumption by social institutions offering meals to socially vulnerable people and by school pupils, respectively (WWP, 2017a). The “Harvest Guarantee” program is a crop insurance program for smallholder farmers in the drought-prone Brazilian Northeast.

Table 2.1: Number of benefits or contracts and the budget allocated to each program

	Number of contracts or grants (thousand)	Amount (million BRL)
AGRICULTURAL DEVELOPMENT		
PRONAF$^{\Psi}$	1,839	24,748
- Crop loan	615	10,152
- Investment loan	1,224	14,596
Food Purchase Program (PAA)†	96	467
School Feeding Program (PNAE)†	n.a.	2,474
Harvest Guarantee$^{\Psi}$	909	773
SOCIAL PROTECTION		
Rural Pension*	8,482	60,945
Continuous Cash Benefit Program (BPC)$^{\Psi}$	4,130	35,141
Bolsa Família$^{\Psi}$		
- Total	13,717	27,186
- Rural	3,744	8,422

*2012, †2013, $^{\Psi}$2014. The program budgets are reported as nominal values of the respective years.
Source: adapted from Silveira et al. (2016)

Three main social protection programs are targeting rural households in Brazil. Two programs are social assistance, i.e. benefit in cash provided based on an income test (*Bolsa Família* and "*Continuous Cash Benefits Program*" (BPC)), and one as social insurance, i.e. benefit is paid after the compulsory contribution has previously been made (rural pension system). *Bolsa Família* program is a conditional cash transfer program established in 2002, which transfers cash according to per capita household income. As can be seen in Table 2.1, around 30% of the program's total budget is transferred to rural households. The "*Continuous Cash Benefits Program*", targeted towards urban and rural households whose members are poor elderly or handicapped, pays one minimum salary to people who have never contributed to the regular pension system. The Rural Pension is a non-contributory rural pension system that targets rural women and men who have worked in agriculture until 55 and 60 years of age, respectively, paying one minimum wage monthly per beneficiary.

Among all programs, PRONAF, Rural Pension, BPC and *Bolsa Família* have the highest overall budgets. There is, unfortunately, no information about the budget of the BPC transferred to

rural households, but if we assume, as for *Bolsa Família*, that around one-third of it goes to the rural areas, we could expect that around 14 billion BRL were transferred to rural households in 2014.

2.5 Program characteristics

Table 2.2: Summary of Brazilian programs' characteristics

Programs	General program characteristics
PRONAF	PRONAF is a rural credit program, attributed on an annual basis to support the production of commercial crops, in a modality called PRONAF *Custeio.* Around 60% of total credit volume given to smallholders and around 50% of the contracts were given under this modality in 2017. Additionally, there are also credit lines for investment, which run for longer periods, to be used on the purchase of machinery or to build barns or improve farms' infrastructure. The loan projects contain information on the crop and inputs to be produced or purchased and are delivered to the local bank branch which decides about project viability and finally about credit approval.
Bolsa Família	The *Bolsa Família* Program is a conditional cash transfer program aimed at self-declared low-income families, with about half of the 13 million beneficiary families living in rural areas. Families with a monthly per capita income of around USD 40 (around twice the national poverty line) can apply to receive the *Bolsa Família* benefit, which household women are entitled to receive in a dedicated free-of-charge bank account in the Caixa Economica Federal, one of the Brazilian public banks. Cash transfer is conditioned by vaccination of household children between 0 and 6 years of age, in addition to the pre and postnatal agenda for pregnant and nursing mothers, as well as 75% school attendance for school-age children and adolescents. Failure to comply with any of the conditionalities may lead to benefit cancellation.
Rural Pension and BPC	The Rural Pension is a non-contributory pension scheme implemented in Brazil first in 1971, during the military dictatorship, and fully redesigned with the 1988 Constitution, which pays monthly a minimum salary to beneficiaries. There is no limitation on the number of member beneficiaries per household and is paid to household members above 60 for men and 55 years of age for women. The BPC is a non-contributory social assistance scheme, implemented in 1996, and pays one minimum salary to elderly above 65 years of age and disabled people for households with an average per capita income of one-quarter of the minimum salary.

Source: author's compilation

2.5.1 The National Program to Strengthen Family Farming – PRONAF

PRONAF was launched in 1995 as the first program for smallholder farmers in Brazil and is by far the most important program by the number of financial resources invested in family farming. PRONAF's budget increased from BRL 5.6 billion[1], borrowed by smallholder farmers through 791 thousand loans, in 1999, to BRL 24.8 billion through 1.8 million loans in 2014 (Bank, 2017). In general, the budget for investment and crop loans is divided by half for each.

[1] BRL/USD: 3.5 (approx.)

The resources allocated to PRONAF are likely to continue to grow, as agriculture is a key export sector.

PRONAF is targeted towards households engaged in agricultural production, with land title, which can be provided as collaterals to the banks when taking the credit. This group of households makes productive investments in buying machinery and building infrastructure, as well as hire labor to conduct cropping activities. They are responsible for the surplus production of agricultural goods, which can potentially be consumed in the local market or sold to outside markets.

The loan project is developed with the support of an officer from the public office extension service (called EMATER, in Portuguese). The loan projects contain information on the crop and inputs to be produced or purchased and are delivered to the local bank branch which decides about project viability and, in the end, about credit approval. The program has high rates of payback, as farmers try to avoid losing collaterals to the bank in case of default.

2.5.2 The Bolsa Família Program

Bolsa Família is the flagship program of the Brazilian social protection system. In the broader strategy of ending hunger and poverty in the country, *Bolsa Família* was implemented to increase families' income through monthly cash installments to poor households. *Bolsa Família's* financial resources have increased since its inception, though at a lower rate since 2014.

Bolsa Família benefits urban as well as rural households. About one-quarter of *Bolsa Família* beneficiaries live in rural areas (Silveira et al., 2016). The *Bolsa Família* transfers are complemented by the programs under the "Rural Productive Inclusion" initiative of the "Brazil Without Extreme Poverty" Plan, such as access to extension services ("ATER"), to investment and conservation grants ("*Fomento*" and "*Bolsa Verde*"), to rain-water harvesting ("P1CM") and access to electricity ("Light for all") (WWP, 2016).

Bolsa Família beneficiaries in rural areas are households with proven low income. As a cash transfer for households to complement their consumption needs, *Bolsa Família* targets households that lack access to land, and therefore, face strong constraints in accessing the market for agricultural inputs and credit. Therefore, it is expected that this group of households engage in agricultural wage labor.

The management of the *Bolsa Família* transfers, payment procedures and operations are coordinated by the Ministry of Social Development. The registration of families is conducted by the municipalities, which enter families' self-declared data in the Unified Registry System for Social Programs and provide guidance to families to resolve situations that may have led to their benefits being blocked, suspended or canceled (WWP, 2017b). The *Bolsa Família* transfers are granted to families according to per capita income, the number of family members, and whether there are children or adolescents aged 0 to 17 years or pregnant/lactating women in the household (WWP, 2017b).

2.5.3 The rural pension system and the BPC

The Brazilian Rural Pension, created in 1971, was substantially expanded after democratization in 1988 and is a program that specifically targets the rural elderly (Schwarzer & Querino, 2002). The program beneficiaries are men and women above the age of 60 and 55, respectively, with proven agricultural activity for most of their lives. The rural pension system paid in 2012 an amount of nearly 60 billion BRL to around 8.5 million beneficiaries all over the country, being by far the program with the highest budget implemented in rural Brazil (Silveira et al., 2016).

Part of the program funds come from a tax of 2.5% (called FUNRURAL), which is levied on every direct sale of agricultural products by farmers, and paid by the product buyer. Therefore, the system is described as non-contributory as the beneficiaries are not obliged to have contributed to the pension system, but may indirectly contribute by the sales of agricultural products and consequently by the payment of the FUNRURAL tax. The benefits are paid by the National Social Insurance Institute (INSS). Once the benefit is granted, there is no further compliance demanded from beneficiaries to any specific criteria.

The "Continuous Cash Benefits Program" is another non-contributory social assistance scheme, which benefits people above the age of 65 as well as disabled people, given the household per capita income does not surpass one-quarter of the minimum wage. The control over income is done by municipal authorities (normally the Office for Social Assistance), and once granted, the benefit is paid by the INSS. Benefits may be canceled if any eligibility criteria are not met by the household, such as income increases. Regular household visits by local authorities serve to control fraud.

In terms of economic activities, the relatively high cash transfers made by the programs cover household expenses. Some of the cash could be used to loosen credit constraints, but are not necessary to guarantee the household's surviving. Moreover, investments in agriculture would mean an additional burden for household members already engaged in the care of elderly and disabled family members.

2.6 Effects of PRONAF in rural areas

Most of the available evidence on the direct and indirect impacts produced on rural households by the PRONAF is strongly focused on outcomes on agricultural outcomes, such as production and productivity, farm revenue, and crop diversification. There is also some evidence on the impacts of program implementation on the regional and the national economies, while the assessment of program impacts on non-beneficiaries is largely scant. A summary of the reviewed studies is presented in Table 2.3.

2.6.1 Direct effects on rural households

Most of the studies show that PRONAF participants registered higher crop productivity as compared to non-participants in 2000 and 2001 for the whole of Brazil (Feijo, 2003). Additionally, increase in the value of production, planted area and land productivity is directly related with the amount of credit accessed by farmers in all Brazilian states (Araujo & Vieira Filho, 2018). This effect is also registered for poor rural households, for whom PRONAF participation significantly increases total and per capita value of agricultural production, as compared to poor PRONAF non-participants (Magalhães & Filizzola, 2005; Telles et al., 2017).

However, the productivity of PRONAF participants and non-participants may not differ significantly, largely due to underlying differences between participant and non-participant households (Garcia et al., 2016). The same can be concluded from a study in the State of Pernambuco, where crop productivity was significantly lower among participant households, and agricultural revenue did not differ significantly among the two groups of households (Magalhães et al., 2006).

PRONAF loans are strongly skewed towards cash crops, with three quarters of PRONAF loans given to soybean and maize producers (Gazolla & Schneider, 2013). As such, it is no surprise that mostly wealthy cash-crop producing smallholder farmers from the richer States of Southern Brazil receive most of the PRONAF loans (Grisa et al., 2014; Schneider et al., 2004). This is contributing to widen the gap between the poorer and richer smallholder farmers in rural communities (Aquino & Schneider, 2012), as disparities among family farmers increased between 1996 and 2006, according to analysis of data from the Agricultural Census (Guanziroli et al., 2012). These disparities are even noticeable across States and regions in Brazil, as cash crop production by wealthier smallholder farmers is concentrated in already better-off Brazilian regions (Castro et al., 2014), further accentuating regional disparities among smallholder farmers (Aquino et al., 2003; Guanziroli et al., 2012). The loose coordination among stakeholders, such as extension services, farmers' associations and the banking sector contribute to skew the access to PRONAF loans towards the wealthier families (Aquino & Teixeira, 2005).

PRONAF support of cash crop production has a deleterious effect on crop production diversity and subsistence food crop production by smallholder farmers. One third of all smallholder farmers accessing PRONAF produced only one crop in 2014 (Sambuichi et al., 2016), reducing the "invisible" subsistence food production, and therefore reducing food security of rural households (Grisa et al., 2010). PRONAF participants do not use more sustainable agricultural practices than their non-participant peers (Damasceno et al., 2011). As such, it seems undeniable that PRONAF is playing an important role in "commodifying" the Brazilian rural

areas and reducing food production, with potential negative effects on the availability of locally produced food, such as staples.

2.6.2 On the rural economy

The effects produced by PRONAF on agricultural production and productivity, and the consequent increase in farm income of participant households, have clear positive effects on the economy. There is a strong correlation between the volume of PRONAF loans with absolute agricultural GDP and agricultural production at the municipal level for the period between 1995 and 2004 (Mattei, 2005), as well as strongly correlated with per capita agricultural and total municipal GDP (Castro et al., 2014). The effects of PRONAF are not only due to direct effects on participant households, but also due to indirect effects resulting from multiplier effects in the local economy. Teixeira & Castro (2004) found that subsidizing the interest rates of rural credit (called "equalization" of interest rates) returns BRL 1.75 for rural credit given to smallholder farming and BRL 3.57 for commercial agriculture in terms of municipal GDP for every BRL 1 subsidized. The difference in the multiplier effects for the two groups of farmers lies on the amount of equalization costs, which are lower for commercial farmers as compared with family farmers (Teixeira & Castro, 2004). Spending public resources in the subsidization of rural credit brings greater returns than reallocating and investing in other economic sectors under three scenarios of factor mobility (total, partial and without mobility) (Pinto & Teixeira, 2015). These results highly depend on the Brazilian region under consideration, as varying economic structures lead to different results under different scenarios of factor mobility (Pinto & Teixeira, 2015).

2.6.3 Indirect effects on rural households

Even though this literature review did not find any study on the indirect effects produced by PRONAF on non-participant households, the increase in agricultural production and productivity, and the consequently positive effects on the wider economy, show that the program may positively affect non-participant households. However, the strong support of cash

Table 2.3: Summary of selected literature on effects produced by PRONAF

#	Reference	Research objective	Findings	Assessment method
1	Feijo (2003)	Analysis of productivity of crops supported by PRONAF in comparison with crops with little or no support using information from Brazil's National Statistics Bureau and the Central Bank	Productivity for crops receiving PRONAF loans is slightly higher in comparison with crops with no support in 2000 and 2001	Ex-post. Tornqvist-Theil productivity analysis
2	Sambuichi et al. (2016)	Analysis of crop diversification for PRONAF loan takers using family farmers' database for calculating Simpson Index of Diversity (SID)	Diversity was high for 57% of family farmers, even though specialization is increasing over time and significantly influenced by regions, farm size, farmers' age and education, agricultural production and public technical assistance	Ex-post. Simpson index of Diversity
3	Garcia et al. (2016)	Assessment of effects of rural credit (PRONAF) and *Bolsa Família* at the village level on income, average land productivity and child labor using data from the Agricultural Census of 1996 and 2006	PRONAF has no significant effect on land productivity and on income, and significant positive effect on child labor. The combination of *Bolsa Família* and PRONAF produce significant positive effects on land productivity and income and no significant effect on child labor.	Ex-post. Linear regression (OLS)
4	Magalhães & Filizzola (2005)	Analysis of PRONAF in terms of the value of production in global terms, per capita and per hectare, controlling for farmers' characteristics in Parana State using primary data	Total and per capita value of production are significantly higher for poorer loan takers in comparison to poor PRONAF non-beneficiaries. Value of production per hectare is significantly higher for better-off family farmers.	Ex-post. Propensity Score matching followed by regression analysis (OLS)
5	Araujo & Vieira Filho (2018)	Analysis of Pronaf impacts on planted area, gross value of agricultural and livestock production and land productivity in all Brazilian states in the period between 2007 and 2016.	Planted area, production value and the productivity of land responded positively when controlling for the amount of credit. However, when controlling for credit contracts, the program has negative effects on the variables of interest	Ex-post. Panel auto regressive method
6	Damasceno et al. (2011)	Analysis of the contribution of PRONAF B to smallholder farming's sustainability, employment and farm income by surveying 15 beneficiaries and 15 non-beneficiaries in 3 different municipalities in Ceara State.	Sustainability of beneficiaries and non-beneficiaries did not differ significantly. Beneficiaries had a significantly higher farm income and were not significantly affected on rural employment.	Ex-post. Descriptive statistics, t-test and Mann-Whitney U test
7	Magalhães et al. (2006)	Analysis on PRONAF'S impacts on agricultural revenue, as well as revenue per hectare and per capita in the State of Pernambuco with survey data from 4,500 questionnaires	Agricultural revenue and revenue per capita are not significantly different among PRONAF beneficiaries and non-beneficiaries. Revenue per hectare was negative and significantly different for beneficiaries, pointing to loss of productivity	Ex-post. Propensity Score matching followed by regression analysis (OLS)
8	Gazolla & Schneider (2013)	Analysis and discussion on agricultural production supported by PRONAF and its impacts for the family farming sector and their organizations in Southern Brazil	Cash crops are preferentially granted support by PRONAF, especially soybeans and maize. Food crops receive little support as compared to cash crops, even though farmers keep on producing them for subsistence.	Targeting assessment

9	Teixeira & Castro (2004)	Analysis of the governmental cost for equalizing interest rates for rural credit programs using Input Product Matrix	Returns as high as 1.75 and 3.57 BRL are found for every 1 BRL invested in equalization of interest rates for family and commercial farming, respectively	Ex-ante. Input-Output Matrix
10	Pinto & Teixeira (2015)	Analysis of the impacts of equalization of interest rates and rural credit under three scenarios: 1) complete removal of equalization and credit and relocation to other economic sectors; 2) complete removal of equalization costs and rural credit, and 3) partial removal of equalization and rural credit to other economic sectors. All scenarios are tested against total, partial and absence of factor mobility.	High positive return to investment in terms of growth generation and welfare for all Brazilian regions, regardless of the scenario of factor mobility considered.	Ex-ante. General equilibrium modeling
11	Mattei (2005)	Regress GDP, agricultural GDP, agricultural production, employment and tax revenue from 100 municipalities with the highest loan amount on PRONAF loans using municipality indicators and PRONAF figures	The total GDP and agricultural GDP grew in 25 and 69 municipalities, respectively; the area under annual crop production grew in 72 municipalities, and the total agricultural production grew in 86 cases; the total employment grew in 81 municipalities, and the agricultural employment grew in 54 municipalities, and tax revenue increased in 89 cases.	Ex-post. Linear regression analysis (OLS)
12	Castro et al. (2014)	Impacts of PRONAF in terms of *per capita* increase in GDP and agricultural GDP for Brazilian municipalities, states, and regions	PRONAF resources allocation at the municipal, regional and state level significantly affect the increase of total and agricultural GDP	Ex-post. Linear regression analysis (OLS)
13	Aquino & Schneider (2012)	Analysis of PRONAF's development and adjustments since its inception, allocation of resources by regions and types of farmers and its implications	PRONAF contributes to skew income towards better-off family farmers. Poorer families are not being able to join the program. Support of cash crops and lack of geographical targeting may be contributing in not getting poorer farmers on board of the program.	Targeting assessment
14	Grisa et al. (2014)	Analysis of geographical distribution of PRONAF loans and type of crops and farmers receiving support by using data from the Central Bank and from Ministry for Agrarian Development	Big increase in number of PRONAF loans and amount of resources over the years. Better-off commodity-producing family farmers, from Southern Brazil, are better endowed to meet PRONAF's access requirements.	Targeting assessment
15	Aquino & Teixeira (2005)	Analysis of PRONAF and criteria used to select beneficiaries, as well as analysis of stakeholders' role in allowing broad farmers' participation, using primary data collected in Northeastern Brazil	The use of homogeneous criteria for selecting loan takers is detrimental to the poorest farmers in the poorest region of Brazil. Loosely coordinated stakeholders, such as farmers' union, credit agencies and workers of the rural technical service contribute to low number of loans and consequently low impact of PRONAF in the region.	Implementation assessment

Source: author's compilation

crop production by PRONAF loans (Gazolla & Schneider, 2013), and the consequent negative effects on the local food and subsistence production (Grisa et al., 2010) show that PRONAF loans have limited effects on the local staple markets. As such, an increase in staple production as a response to higher local staple prices should not be expected from PRONAF loan takers, reducing the welfare of non-participant staple consuming households.

Furthermore, an increase in agricultural investment due to rural credit seems to have limited effects on the off-farm labor market, as off-farm income of PRONAF non-participant households did not differ significantly from participant ones among poor households in Ceará State (Damasceno et al., 2011). As family labor is the most important production factor used by smallholder farmers, the effects on off-farm labor remains small, and therefore, the indirect effects, especially on non-participant households, remains limited.

2.7 Effects of Bolsa Família in rural areas

Several studies were conducted in Brazil on *Bolsa Família*, but only few focusing on its impacts on rural households. After screening around 20 studies according to the review criteria, we finally selected nine studies. The research objectives, the findings and the assessment methods used in each of the studies are presented in Table 2.4.

2.7.1 Direct effects of on rural households

On the production side, the effects of *Bolsa Família* on smallholder farmers' land productivity and on income are inconclusive. While most of the international literature show that cash-based transfers to rural households have positive effects on investment in agriculture, and consequently on agricultural production, *Bolsa Família* has null effect on land productivity and on income of rural households (Costa et al., 2018), when controlling for participation bias through propensity score matching. Another study, using linear regression, shows that *Bolsa Família* even has negative significant effects on the same variables (Garcia et al., 2016). In line with most studies in Latin America, *Bolsa Família* does not affect adult labor supply (Foguel & Barros, 2010). Even though *Bolsa Família* also increases investment in human capital by

Table 2.4: Summary of selected literature on the effects of *Bolsa Família*

#	Reference	Research objective	Findings	Assessment method
1	Garcia et al. (2016)	Assessment of effects of rural credit (PRONAF) and *Bolsa Família* at the village level on income, average land productivity and child labor using data from the Agricultural Census of 1996 and 2006	*Bolsa Família* has a significant negative effect on land productivity and on income, but significant positive effects on child labor. The combination of *Bolsa Família* and PRONAF produce significant positive effects on land productivity and income and no significant effect on child labor.	Ex-post. Linear regression (OLS)
2	Costa et al. (2018)	Assessment of an agricultural development project[2] and *Bolsa Família* in 13 contiguous municipalities in the Brazilian Northeast between 1997 and 2005 on land productivity, agricultural income and child labor.	Neither the project nor the program – whether in isolation or their interaction - significantly affected the average growth of land productivity, income per adult or the share of establishments using child labor. Access to credit was significantly affected by the incidence of social programs, and the interaction between the program and project had a significant effect on the share of farms with access to electricity	Ex-post. Difference in Difference using Propensity Score Matching
3	Melo & Duarte (2010)	Assessment of school attendance for children from rural households in Northeastern Brazil	Children from *Bolsa Família* households have a higher school attendance of about 5.4 to 5.9 percent in comparison to non-beneficiary households. However, all the difference is due to increased girls' school attendance, as no difference has been registered for boys' attendance	Ex-post. Propensity Score Matching followed by Logit model
4	Coelho & Melo (2017)	Assessment of *Bolsa Família* impacts on household food consumption in rural areas of Southern and Northeastern Brazil	Using a Diet Quality Index, program beneficiaries had, in average, a higher index as compared to non-beneficiary households. The program was especially effective in reducing fat and sodium consumption, as well as increasing food consumption diversity	Ex-post. Propensity Score Matching followed by Logit model
5	Sperandio et al. (2017)	Assessment of *Bolsa Família* impact on food consumption in Northeast and Southeast of Brazil	In both regions, program participants had 60% of household energy coming from unprocessed food, and had lower consumption of processed and ultra-processed foods as compared to non-participants	Ex-post. T-tests and probit model after Propensity Score Matching.
6	Foguel & Barros (2010)	Assessment of *Bolsa Família* effects on labor supply using the Brazilian National Household Survey (PNAD) between 2001 and 2005.	*Bolsa Família* does not significantly affect the labor supply of male and female workers, also for beneficiaries classified as poor. These results are based on the analysis of the participation rate in the labor market, as well as the average number of hours worked	Time series analysis
7	Neri et al. (2013)	Analysis of multiplier effects of *Bolsa Família* and social protection benefits in terms of global GDP, total and household consumption, total and household income	*Bolsa Família* has the highest multiplier among the considered social protection programs, as high as 1.78 for GDP and 2.4 for household consumption. Cash transfer to poor households have a positive and important macroeconomic effect in Brazil, above other employment and pension-related benefits	Ex-ante. Multiplier analysis on Social Accounting Matrix
8	Rasella et al. (2013)	Assessment of under-five-mortality in Brazilian municipalities with data on death and live birth statistics and on *Bolsa Família* resource allocation	Overall under-five-mortality decreased significantly in all municipalities, as well as poverty-related deaths due to diarrhea and malnutrition reduction	Ex-post. Binomial regression models using panel data
9	Rougier et al. (2018)	Assessment of *Bolsa Família* in local economic growth through local demand multiplier and local productive structures for 184 municipalities of Ceara State in Brazil	Municipalities' economic structure is essential to determine the direction of the impacts produced by *Bolsa Família* in local economies, as cash transfers promoted light manufacturing activities in the poorest municipalities and prompted informal activities in weakly productive services in all municipalities	Ex-post. Linear regression (OLS and 2SLS)

Source: author's compilation

[2] Project funded by the International Fund for Agricultural Development (IFAD).

increasing school enrollment (Rasella et al., 2013), especially for girls in rural areas (Melo & Duarte, 2010), the effects of *Bolsa Família* on farming households still remains understudied.

On the consumption side, the program effects are much more clear. Among (urban and rural) participant households, *Bolsa Família* improves food consumption, and therefore dietary diversity (Coelho & Melo, 2017; Lopez-Arana et al., 2016). Beneficiaries of *Bolsa Família* have higher food expenditure and higher total energy availability as compared to non-beneficiary households (das Neves et al., 2017). Participants also have higher diet quality, as their consumption of unprocessed or minimally processed food (das Neves et al., 2017; Sperandio et al., 2017), as well as their fat and sodium consumption (Coelho & Melo, 2017) is significantly lower as compared to non-participants.

2.7.2 On the rural economy

The effects of *Bolsa Família* on rural economies have not been assessed yet. However, *Bolsa Família* creates a multiplier effect of 1.78 in terms of the national Brazilian GDP and an average of 2.4 for household consumption, an effect bigger than for other social protection programs in Brazil (Neri et al., 2013). These multiplier effects are a result in the promotion of light manufacturing activities and of informal activities in weakly productive services, such as registered in the poorest municipalities of Northeastern Brazil (Rougier et al., 2018). As such, we expect that *Bolsa Família* may also increase the demand for locally produced staples, producing multipliers in rural economies.

Regarding the labor market, *Bolsa Família* does not have an effect on adult labor supply (Foguel & Barros, 2010), indicating that local wages may remain unaffected, and therefore not affecting the production costs of local agricultural commodities.

2.7.3 Indirect effects on rural households

The indirect effects of *Bolsa Família* on rural households have not been assessed yet. However, on the one hand, the combination of an increase in food consumption, among which local staples, and no investment in agricultural production by participant households necessarily will

lead to an increase in local staple prices, leaving non-participant staple consuming households worse-off. On the other hand, the absence of effects of *Bolsa Família* on labor supply (Foguel & Barros, 2010) indicates that local wages may remain unaffected, leaving off-farm working households unaffected.

2.8 Effects of rural pension and BPC on rural areas

Several studies were conducted in Brazil on the rural pension system, with a special focus on the effects on poverty reduction and on investment in agricultural production in rural Brazil. After screening around 25 studies according to the review criteria, we finally selected six studies, which are going to be further scrutinized. The research objectives, the findings and the assessment methods used in each of the studies are presented in Table 2.5.

2.8.1 Direct effects on rural households

Rural pension and BPC have a significant effect on the income of participant households, especially among poor ones (Delgado & Cardoso Jr., 2000; Tavares et al., 2011), serving as a safety net for rural households when harvests fail (Augusto & Ribeiro, 2006). For about 90% of the beneficiary households, the transfers from the rural pension system made more than 50% of the total household income (Schwarzer, 2000). BPC is responsible for 7% of the fall of the national Gini coefficient between 1995 and 2004 (F. V Soares et al., 2006).

Resources transferred through the rural pension system are partially used to support productive investments. Around half of the surveyed households in the State of Rio Grande do Sul record that part of the pension transfers are used to support agricultural production, especially for subsistence (Delgado & Cardoso Jr., 2000). Furthermore, the purchase of durable goods (e.g. refrigerators) and investments in beneficiaries' houses is higher for participants than for non-participants (Delgado & Cardoso Jr., 2000). The BPC and the rural pension programs have a very important role in sustaining productive investments especially among rural households, as they otherwise lack access to other sources of rural credit to support investment in agriculture (Schwarzer & Querino, 2002).

However, rural pension also has negative effects on labor supply. The access to old-age benefits is a strong determinant of retirement of rural workers in Brazil: receiving old-age benefits increases the probability of not working by about thirty-eight percentage points and reduces total hours per week by 22½ h (de Carvalho Filho, 2008). Even though no studies on the effects of BPC on agriculture were found, similar effects should be expected as the ones found for the rural pension transfers.

2.8.2 On the rural economy

The benefits received from rural pension promotes the development of the rural economy. In many municipalities, rural pension transfers make the highest share of income, even bigger than the transfers from the federal government to finance the activities of the municipal public administration (Schwarzer, 2000). Therefore, it is expected that the rural pension transfers stimulate the local economy through increased demand for consumption goods and agricultural goods (Schwarzer & Querino, 2002). Indeed, rural pension benefits increase the demand for goods and services in the local commerce, increasing businesses and job creation (Augusto & Ribeiro, 2006). However, these transfers affect supply of labor of beneficiary households, affecting local wages (de Carvalho Filho, 2008).

2.8.3 Indirect effects on rural households

As with the other programs, there are no studies on the indirect effects of the BPC and rural pension programs on rural households. However, as both programs increase the overall household consumption, and therefore potentially of local staples, as well as increase the investment in agricultural production, it prices of local commodities may potentially remain unchanged. As such, non-participant households may not be affected by price increases of locally produced goods.

However, the program effects on the labor market are slightly different. While BPC and rural pension transfers, on the one hand, reduce off-farm labor supply, they also increase investment in agriculture, which may lead to an increase in labor demand, either covered by family or by off-farm labor. As a result, increase in wages can be expected, which clearly affect

Table 2.5: Summary of selected literature on the effects of rural pension and BPC

#	Reference	Research objective	Findings	Assessment method
1	Delgado & Cardoso Jr. (2000)	Analysis of the effects of the Previdencia Rural on the rural households in terms of income using data from the National Household Survey on households in the Rio Grande do Sul State	*Previdencia Rural* contributes greatly to reduce the poverty among rural households. The transfers contribute to smooth household consumption, and functions as a source of liquidity to allow productive investment in agriculture for around 50% of the beneficiary households	Ex-post. Descriptive analysis
2	de Carvalho Filho (2008)	Assessment of effects on the labor supply by beneficiaries in Brazilian rural areas using data of the National Household Survey	The access to old-age benefits is a strong determinant of retirement of rural workers in Brazil: receiving old-age benefits increases the probability of not working by about thirty-eight percentage points and reduces total hours per week by 22½ h	Ex-post. Difference-in-difference
3	Tavares et al. (2011)	Assessment of allocation of income of beneficiaries of the rural pension system within the family, and identify the reasons for family dependence on their economic resources, using primary data from 65 rural households from Vicosa, in Minas Gerais State.	Around 80% of the rural pension benefits responded for at least half the household income. The families depended on that resource due to some problems, such as unemployment, low income, unplanned pregnancy, divorce and other events	Ex-post. Descriptive analysis
4	Augusto & Ribeiro (2006)	Assessment of the effects of rural pensions in rural households and in the local services sector in the municipality of Medina, in Minas Gerais State	Rural pensions are important for the beneficiary rural households as a steady source of income and safety net in case of poor harvests and lack of other sources of income. In the local economy, the pension benefits increase the demand for goods and services, increasing local businesses and creating new jobs.	Ex-post. Descriptive analysis
5	Soares et al. (2006)	Evaluation of cash transfer programs in reducing inequality in Brazil between 1995 and 2004 as well as its impact on poverty using the 2004 Brazilian National Household Survey (PNAD)	Most of BPC and Bolsa-Família budgets are targeted towards households below the poverty line: 74% of BPC reported income and 80% of Bolsa-Família reported income. Both programs were jointly responsible for 28% of the fall in the Gini inequality between 1995 and 2004 in Brazil	Ex-post. Descriptive analysis

Source: author's compilation

non-participant households, either by increasing off-farm work income or by increasing the costs of agricultural production.

2.9 Discussion on findings of reviewed studies

The empirical literature on the outcomes of Brazilian programs on rural households and communities is neither extensive nor well established. While the focus of studies on PRONAF is basically on agricultural outcomes, the focus of studies on *Bolsa Família* is on household consumption and on food security, and of rural pension/BPC is on targeting and the potential of fostering investment in agriculture. So, besides farm/household income, none of the remaining variables were assessed for all the programs. Table 2.6 summarizes the evidences on the effects of PRONAF, *Bolsa Família* and the rural pension/BPC programs.

The effects of the individual programs on participant households, on the rural economy, and finally on non-participant households enables us to draw some conclusions about the effects of programs implemented simultaneously in rural villages. The next section discusses the possible outcomes resulting from the combination of effects produced by PRONAF, *Bolsa Família* and the rural pension/BPC programs, looking at the direct effects on participants, on the effects on local commodity and labor markets, and finally the indirect program effects on rural households. The summary of the impact pathways of joint PRONAF, *Bolsa Família* and rural pension/BPC program implementation in rural areas is shown in Figure 2.2.

2.9.1 Direct effects on program participants

Overall, the findings of this review show that the three programs produce positive effects in household income, either through an increase in available cash (*Bolsa Família* and BPC/rural pension) or due to higher revenue of agricultural production activities (PRONAF and BPC/rural pension).

The effects on agricultural production vary across the individual programs. PRONAF has a strong effect on stimulating investment in agricultural production, and consequently, in increasing

Table 2.6: Summary of results reviewed for the selected Brazilian programs (+: positive effects; -: negative effects; 0: zero effect; NA: not assessed)

Variables	PRONAF		*Bolsa Família*		Rural Pension/BPC	
Direct effects on participant rural households						
Farm/household income	0 +	Null effects for farmers in Northeast Brazil* Positive effects for the poorest loan takers	- 0	Negative significant impact No significant impact*	+	Household income is greatly increase as a result of direct transfers. No assessment about return to productive investments
Agricultural productivity	+ -	Productivity is higher for farmers accessing credit Productivity was lower for farmers in Pernambuco State*	- 0	Significant negative impact No significant impact*	NA	
Investment in agriculture	+	Overall increase in investment in agricultural production	NA		+	Increase in investment in agricultural production
Household consumption	NA		+	Increase in overall household consumption, especially in the quantity and quality of food	+	Increase in overall household consumption, especially of non-food goods
Off-farm income	NA		NA		-	Transfers from the pension system increase household labor shadow price
Effects on the economy						
Tax revenue	+	Growth registered in 83% of Brazilian municipalities	NA		NA	
Agricultural GDP	+	Agricultural GDP growth in 69% of Brazilian municipalities	NA		NA	
Multiplier effects	+	Multiplier of 1.75 for each 1 BRL invested in family farming*	+	Multiplier of 1.78 in terms of GDP growth and 2.4 for household consumption*	NA	

*Effects assessed using research designs with counterfactuals or ex-ante simulations

Source: author's compilation

farm agricultural revenue. However, as shown by the reviewed studies, this increase is though stronger for the production of cash crop production, as most of the PRONAF credit contracts are destined to the production of maize and soybeans, in detriment of subsistence staple crop production for home consumption and for the local market.

The Brazilian social protection programs implemented in rural areas may also have an effect on agricultural production. The absence of effects produced by *Bolsa Família* on agricultural production and farm income show diametrically different results as revealed by other studies on similar programs, such as in Zambia (Handa et al., 2016) and in Mexico (Gertler et al., 2012). However, this result is probably due to the underlying data used in the analysis, which is aggregated at the municipality level and does not account for non-commercial agricultural production. As such, *Bolsa Família* participants, who are mostly poor, may indeed not invest part of their cash transfers into commercial (cash crop) production, but may well invest on food crop (subsistence) production. Slightly different effects we can expect for the effects of rural pension/BPC programs on agricultural production, as participant households show a wider income range, from the very poor to the wealthier ones. As such, the rural pension/BPC may stimulate rather food crop production for the former group of households, while wealthier households may be rather engaged into the cash crop production.

The effects on household consumption also vary across the programs. On the one hand, even though no information has been found on the effects of PRONAF on food and non-food consumption, it should be expected that an increase in income of participant households is not going to substantially affect household consumption, as most of the agricultural development programs are targeted towards better-off farmers (Luan, 2015; Mersland & Øystein Strom, 2013), which do not face as strong consumption constraints as social protection participants. As such, the effect on household demand of goods, such as staples, may remain low. On the other hand, the effect of social protection programs on participant household consumption is very high, especially among *Bolsa Família* beneficiaries, which strongly increase their consumption demand, especially of food.

2.9.2 Effects on the rural economy

There is little doubt that programs implemented in rural areas have an influence on the local rural economy, beyond the effects on participant households. It is relatively evident that the implementation of the programs in a given economy increases the GDP. Indeed, the studies show that PRONAF has a clear and strong effect on agricultural GDP and tax revenue of selected municipalities. Furthermore, taking the Brazilian national economy, PRONAF and *Bolsa Família* produce multipliers of 1.75 and 1.78 in terms of GDP growth, respectively. Even though no information on the multiplier effect of rural pension/BPC is available, the results may not differ much.

In rural areas, we expect the programs to affect labor and commodity markets through the production and consumption linkages among households and economic sectors. Overall, program implementation in rural areas will increase labor demand and reduce labor supply, increasing local wages. An increase in the agricultural production induced by PRONAF loans may have a strong effect in the demand for labor, such as off-farm labor. However, this effect may be modulated by an increase in the supply of family labor, which is reallocated from other farm and/or household activities. As such, the effect on local off-farm wages may be positive, but relatively small. The rural pension/BPC program may also contribute to increase local off-farm wages as a combination of an increase in agricultural production (similar to the effect analyzed for PRONAF), and the reduction in off-farm labor supply. Even though it has been showed that the *Bolsa Família* program does not reduce labor supply, it may well reduce off-farm labor supply as a result of increased demand for family labor for subsistence production.

Furthermore, local commodities, especially for household consumption, will be less produced by PRONAF participants, and will potentially be more produced by participants of both social protection programs. On the one hand, as shown by several studies, the strong support of cash crop production by PRONAF loans will potentially lead to a reduction on the production of local staples, and so of production for household subsistence. In combination with an increase of household income of PRONAF participants, an increase in the prices of local staples should be expected. On the other hand, social protection programs may lead to an increase in the

production of local staples. This is even so for the participants of the rural pension/BPC programs, who will potentially invest part of their transfers in cash crop production. In this case, the increase in staple production may accompany the increase in household consumption, therefore dampening prices of locally produced and demanded commodities.

2.9.3 Indirect effects on households

Households which do not participate in public program are indirectly affected by policy changes through economic linkages among economic sectors and households. The effects on the local labor and commodity markets discussed in the previous section clearly have an effect on the welfare of households of a given economy, both participant and non-participant households.

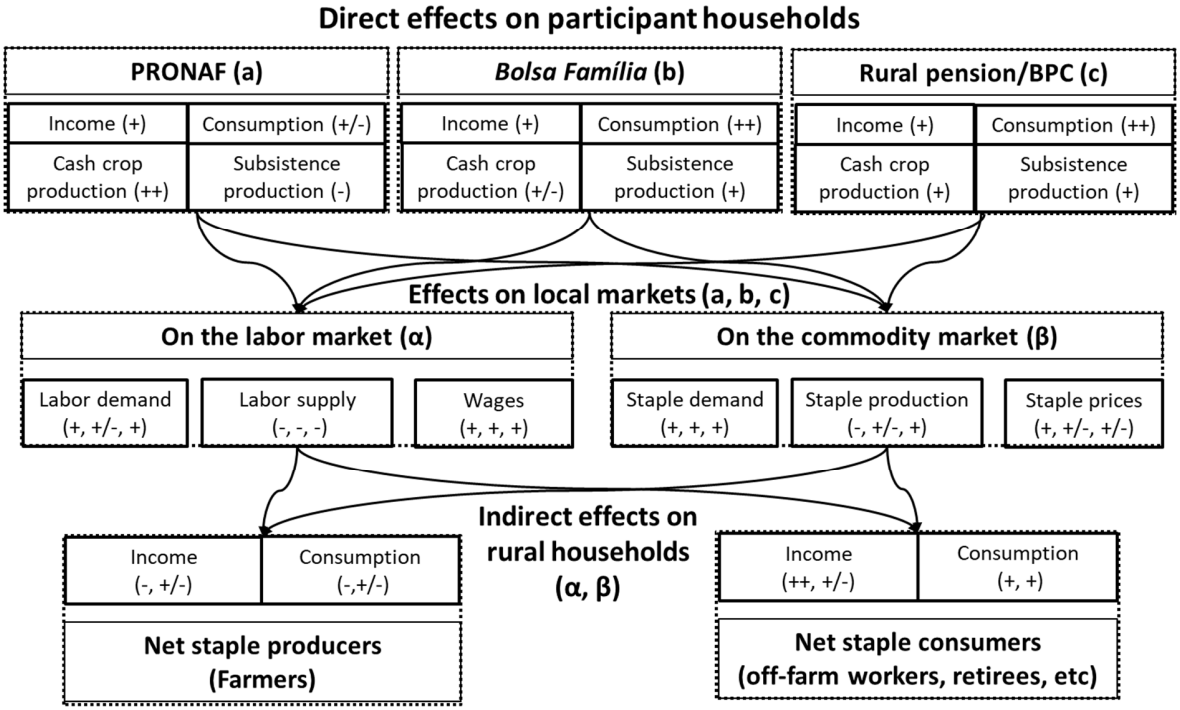

Figure 2.2: Summary of assessed and expected impacts of agricultural development and social protection programs on markets and on households (++ strong positive effect, + positive effect, +/- no clear effect, - negative effect)
Source: own elaboration

Prices of locally produced and consumed commodities, such as staples, may well go up as a result of reduction of staple production by PRONAF loan takers. As the participants of social protection programs may increase their subsistence staple production for own consumption,

the effects on the local market for staples may remain small. Thus, while lower staple prices will increase the welfare of net consumers of locally produced staples, net staple producing households will decrease their welfare as a result of reduced revenue from staple production.

As the effects of both social protection and agricultural development programs lead to an increase in local wages. Thus, on the one hand, off-farm workers, who commonly belong to the poorest households in rural areas, are expected to increase their household income. On the other hand, farming households are expected to increase their labor costs, as off-farm labor supply will decrease and on-farm labor demand will increase. Therefore, the indirect effects on households resulting from changes in the labor market will highly depend on the economic activities in which the households are engaged, irrespective of whether they participate in any of the public programs or not.

The indirect effects produced by public programs on rural households are not restricted to the status of program participation, but rather on the type of economic activity in which households are engaged, and so, on the "place" they hold in the impact pathway throughout the economy.

2.10 Summary and concluding remarks

This literature review allows us to draw three main conclusions. First of all, the evidence on the effects of Brazilian programs on rural households and rural economies is very scattered across the variables assessed in the reviewed studies. Furthermore, many studies do not use methodologies applying counterfactuals, thus failing to establish causal relationships between the public programs and the variables of interest.

Second, the total effects produced by the individual programs implemented in rural areas is not fully understood yet. Unsurprisingly, the big majority of the reviewed studies focused on the effects produced by the program on participant households. However, the obvious gap in assessing indirect effects produced by programs, especially through local commodity and labor markets, keeps us from comprehensibly understand the wider effects produced by the Brazilian public programs.

Third, the effects of concomitant program implementation in rural areas still remains understudied in Brazil and elsewhere. Regardless of the attempt to present a conceptual framework highlighting the impact pathways through which simultaneous program implementation are transmitted throughout a rural economy, the ultimate effects on rural economies and on (participant and non-participant) households is yet to be empirically assessed. The assessment of economic linkages in a given rural economy, and the consequent identification of the "economic role" of rural households in that economy is crucial to understand the transmission of program effects throughout the economy, and therefore, the ultimate beneficiaries of direct and indirect program effects.

For that scope, assessing the interlinkages among households in a given economy is crucial to understand the transmission of effects unleashed by policy changes, such as the PRONAF, *Bolsa Família* and rural pension/BPC in rural areas. A research design using an economy-wide model may be one promising option to assess the direct and indirect effects produced by the concomitant program implementation in rural Brazil.

3 Study area and data

3.1 Study area: The Rincão dos Maia village

To assess the effects of public programs implemented concomitantly in a rural economy, we selected the Rincão dos Maia village, a rural community located in the municipality of Canguçu, in Southern Brazil. The reasons for the selection of that particular community are:

I. All three public programs of interest (PRONAF, *Bolsa Família* and rural pension/BPC) are being concomitantly implemented in the village

II. Households pursue many different economic activities, such as crop production (e.g. cash crop and food crop production), livestock production (e.g. commercial production and for household subsistence), and off-farm work (e.g. unskilled rural and skilled urban work)

III. Existence of exchanges among households and prominent interlinkages among village commodity and factor markets

Rincão dos Maia is located 10 km far from Canguçu municipality's seat, and around 50 km from Pelotas, the regional major city, in the Southernmost Brazilian State of Rio Grande do Sul (Figure 3.1). The municipality is known as the Latin-American capital of smallholder farming, as around 65% of its estimated 15 thousand households living in 147 communities surrounding the municipality's seat (IBGE, 2010). Rainfall is distributed over the year, with December as the month with lowest rainfall (88 mm) and August with the highest rainfall (146 mm) over the year. The average temperature in Canguçu is 16.9 °C. The landscape is hilly, the soils mostly red, much forest (plantations) remains on hills. The municipality lies about 400 m above sea level.

In the Rincão dos Maia village, households are placed in a continuum along the dirt roads departing from Canguçu. Residents of the Rincão dos Maia were extremely poor in the past, with most of the families living in wattle and daub houses with dirt floors and covered straw or unlined roof tiles, which needed to be plastered with mud after every rain (Fialho & Moreira, 2005). Normally, houses had between two to four pieces, composed of a kitchen, a bedroom, a

living room and a storeroom to keep beans, charcoal and meat. Nowadays, the houses are mostly masonry, large and comfortable, with electricity, water and bathroom facilities (Fialho & Moreira, 2005).

The Rincão dos Maia village has around 300 households (Gerhardt et al., 2013). According to local residents, around 240 live from crop and/or livestock production, around 30 households live from rural off-farm work, and another 30 households live from off-farm skilled work, mostly in the city of Canguçu. The so-called "Maia's Edge" received its name due to the surname of the first owner of the land where the village is nowadays located (Gerhardt et al., 2013). After innumerous subdivisions due to inheritance and to land sales, the community was divided until its current organization, with an average farm size of between 7 and 10 ha. The tenure system there is private property.

Economically, the village relies on agriculture. Tobacco and peach production are the cash crops in the village. Peach production was developed in the 1980's and responded to the high demand coming from the processing industries of the neighboring city of Pelotas, but it has been slowly replaced by tobacco production since the 2000's, and this is by far the most important cash product produced in agriculture and cultivated by around half of the village households. Food crops are important crops for the great majority of the rural households, also for the ones focusing on cash crop production. Over 20 food crops were recorded from the interviewed households, with expressive beans, sweet and Irish potato, and pumpkin production for own consumption. Home garden production is found in the majority of the households, also produced for own consumption. Contrary to cash crops, food crops and home garden production use little to no off-farm inputs. Pensions and other social benefits (*Bolsa Família* program, e.g.) are important sources of income for poorer families. Day and wage labor is also another important component of the village's economy, with the day laborer earning their income from agricultural activities within the village, and the wage laborers earning their income from skilled work, especially in Canguçu.

Even though a strong development has been registered over the years in the village, it has been highly unevenly distributed. Some reasons can be mentioned: (i) access to and quality of land is

highly unevenly distributed among households, and land fertility and slope is very site specific, influencing households' return to land use; (ii) access to public services is, in general, skewed towards households with better education and better access to information, limiting households' access to services and programs; (iii) production of tobacco and peach as the most important sources of income.

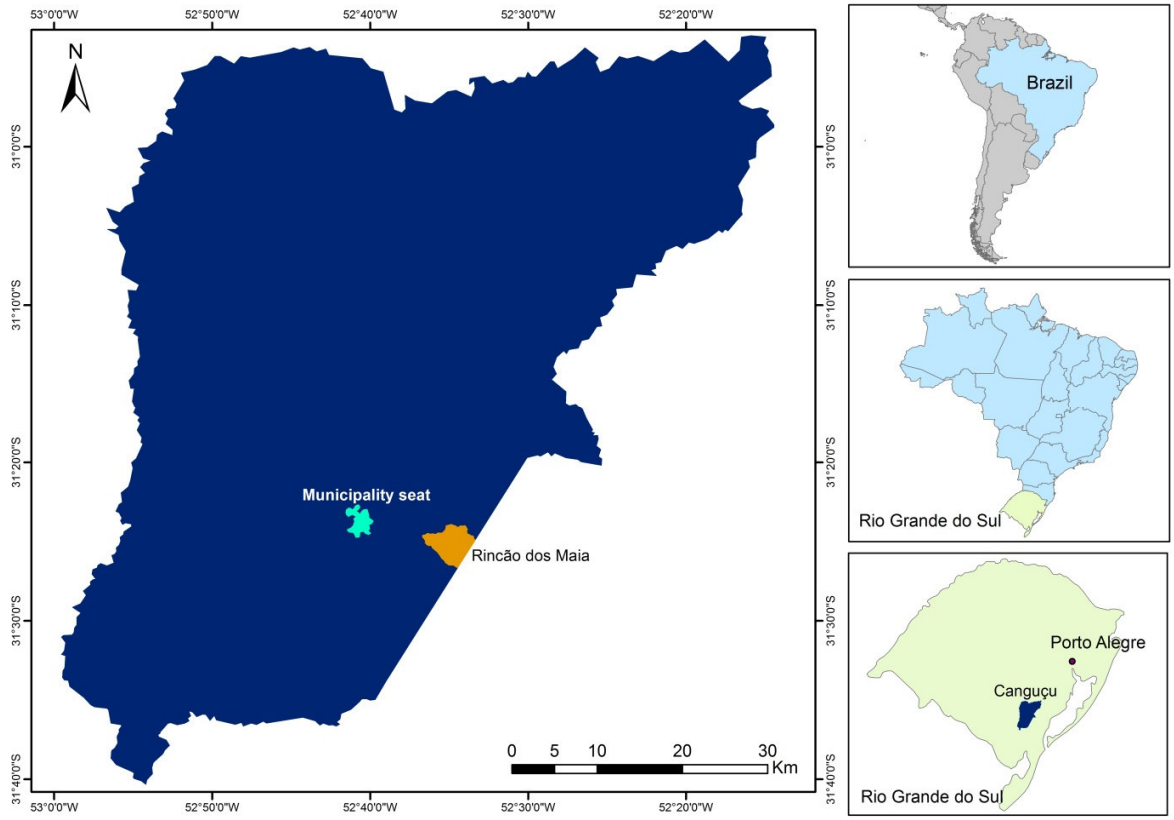

Figure 3.1: Map of Brazil and Rio Grande do Sul State (right), and of Canguçu with the Rincão dos Maia village (left)
Source: author

3.2 Data collection tools and methods

First of all, qualitative data was collected from expert and key informant interviews in the region. The main experts interviewed were from the Municipal Office of Agriculture, the Coordinator of the Extension Services, and representatives of farmers' associations. These interviews served to identify the most ideal village to conduct this study in the municipality, as well as gathering first information on economic activities carried out in the Rincão dos Maia

village. Key informant interviews were conducted mostly with knowledgeable members of the village, such as representatives of the local farmers' association and coordinators of the local churches, as well as business owners (shopkeepers). The data gathered through these interviews served to get a better understanding of the social and economic organization of the village, as well as particularities regarding the exchange of goods and services among village residents. The data gathered through the expert and key informant interviews was collected between August and November 2017.

Following the collection of qualitative information on the village economy, an appropriately structured questionnaire to allow building a SAM was prepared and applied through a household survey. Three local enumerators were selected and trained to carry out the household survey. Pilot testing was undertaken so as to make sure that the household survey was appropriate. After reviewing the household survey, the household survey was administered to 101 households, around one third of the total number of households in the village. The household survey has sections on household general characteristics, information on crop and livestock production, on purchased inputs for crop and livestock, household expenditures, financial transfers, production and household assets. The information on crop activities was collected considering the period of the crop season 2016/2017 (July to June). For information on household expenditures, items were recalled in 1, 3 and 12 months' recall, depending on the frequency items are normally purchased, and transformed in annual figures. Food expenditures were also recorded for one month, and are treated in monthly figures.

The survey was adapted from the Living Standards Measurement Study (LSMS) from the World Bank (WB, 2009). The questionnaire was adapted to the local context, and translated into Portuguese. The information collected on the household survey uses the Brazilian national currency called Brazilian Real (BRL). The agricultural production sections of the questionnaire were administered to the member of the household responsible for agricultural production (often the man for male-headed households), while the sections regarding household expenditures and food purchases were administered to the member in charge (often the woman). In general, the interviews lasted, on average, three hours. In addition, focus group

discussions were conducted to gather contextual and qualitative information on economic activities and on household consumption. The household survey was conducted between November 2017 and January 2018.

3.3 Data transformation

The monetary value of household agricultural production, off-farm labor, household expenditures and asset endowment was either informed directly by the respondents or estimated based on the quantities purchased and/or sold by the household. For that scope, the quantities and the sources or purchase and/or destination of sales were recorded, and price surveys were conducted on representative markets. For the case of asset endowment, depreciation was calculated using the value as new, the depreciation rate and the equipment life.

Data collected for PRONAF crop loans considered the last five growing seasons (from 2013/2014 until 2017/2018), and about loans taken for investment since ever. In this last case, the oldest loan was taken in 1998, but more than 80% of the investment loans taken by households in 2010 or later. The loans were deflated using the IGP-DI deflation index, taking 2017 as the base year (FGV, 2019).

In three households, missing data on household expenditures and household assets was generated due to absence of person in charge for giving information at the time of interview. The missing data has been imputed using multivariate normal regression technique in Stata, based on complete information on total household income, number of household members and pension income. The coefficients of regression analyses of the original and the imputed data showed similar results, showing that the imputed data did not influence results.

3.3.1 Access to public programs in the village

In general, the first step to access PRONAF is to set up a loan project. In the study village, most of the project documents were compiled by the local farmers' association as a service provision for member farmers. For accessing *Bolsa Família*, household members need to the Municipal

Office of Social Assistance, where public servants are going to check if requirements are met and therefore whether the household is eligible for participation. Household members are entitled to receive the rural Pension/BPC in the case men and women reach the age of 60 and 55, respectively, or when they have some kind of disability.

Household participation in the three programs is very heterogeneous in the village. It is estimated that around one fourth of the village households access either PRONAF or *Bolsa Família* (according to records from the Farmers' Association and from the Office of Social Assistance of Canguçu, respectively). The participation in the rural pension/BPC is the highest among the programs, with an estimated 40% of the village households benefitting from rural pensions.

In our sample, 25 households took PRONAF crop loans over the five last cropping seasons (from 2013/2014 until 2017/2018), but only 15 households accessed PRONAF for the cropping season of 2017/2018. Additionally, PRONAF Investment was accessed by 19 households, with households recalling loans as far back as 1998. In total, 37 households accessed PRONAF in either modality. *Bolsa Família* is accessed by 27 households as for the time of the survey, and the rural pension is accessed by 41 households in our sample.

In total, 52 households accessed both PRONAF, in either of the modalities, and *Bolsa Família*. Out of these, 8 accessed PRONAF modalities and *Bolsa Família* simultaneously over the last 5 cropping seasons. When we look only at 2017, only 3 households accessed PRONAF and *Bolsa Família* simultaneously. There are 10 households which simultaneously access the rural pension/BPC and PRONAF. There is only one household in which rural pension/BPC and *Bolsa Família* benefits are paid simultaneously. Simultaneous access to the different programs is not formally forbidden, even though it is expected.

PRONAF is normally accessed by households specialized in agricultural production. Even though it is not allowed to access PRONAF for tobacco growing purposes, all of the people accessing PRONAF were also tobacco growers. PRONAF Investment loans, in many cases, are used to

build grain drying stoves, but which are ultimately being used for drying tobacco leaves (Bank, 2019).

Bolsa Família is accessed by numerous households in the village (proportion of households accessing the program is higher in the Rincão dos Maia than for the rest of Canguçu municipality). Most of the beneficiary households own little to no land, meaning that their income from agriculture is very limited, and reliance on off-farm work is relatively high.

The access to the rural pension system is restricted to households whose members are above the age of 55 and 60 years for women and men, respectively. As a rule, beneficiaries of rural pension live with the extended family, making households intergenerational in nature. As such, the pension benefits are put into the household budget, increasing household liquidity. In some few cases, the households were composed solely by pensioners.

4 Livelihood strategies and program participation in the Rincão dos Maia village

4.1 Introduction

Different public programs are implemented in rural areas of the developing world, producing direct effects on participant households, and indirect effects on both participant and non-participant households. The latter effects are transmitted to rural households through the combination of direct exchanges among households, and through the local commodity and factor markets with whom they interact (Breisinger & Ecker, 2006; J E Taylor & Adelman, 1996). Given that rural households in many countries are engaged in many different income-generating activities (Davis et al., 2010), the transmission of the indirect effects produced by public programs will highly depend on the type of activity in which each rural household is engaged in a given economy. As such, the identification of livelihood strategies is needed to understand the pathway and magnitude of effects transmitted to households due to policy changes engendered by public programs implemented simultaneously in rural economies.

There is a common notion that there exist, in some degree, distinct livelihood strategies across rural households (van den Berg, 2010). These livelihood strategies are the result of the household's engagement in specific income-generating activities, which in turn are determined by household socio-economic characteristics, such as household size and capital ownership (van den Berg, 2010). A detailed understanding of the livelihood activities in which households engage in a given economy is important to identify the effects produced by public programs implemented in rural areas of developing countries (Ameha et al., 2014). The identification of livelihood strategies offers an imperative insight the way policy interventions (Soltani et al., 2012) and environmental management interventions (Fasse & Grote, 2015; Nguyen et al., 2015) may affect rural households. Moreover, by providing an insight into the constraints and opportunities faced by rural households, the analysis of livelihood strategies is expected to increase the efficiency of the interventions targeted at the improvement of rural livelihoods (Ellis & Manda, 2012), regardless of their participation status in public programs.

Public programs are one of the strategies used to tackle or remove the constraints that limit the development of rural areas. In most cases, public programs targeted towards rural households aim at facilitating access to markets, at improving productive investments and lifting consumption constraints (Veras et al., 2016). It is usual to have different programs being implemented concomitantly in rural areas (Tirivayi et al., 2016; Veras et al., 2016). Objectives and designs vary across programs, thus it is reasonable to expect them influencing livelihood strategies differently (Veras et al., 2016). On the one hand, such influence depends on program design and objectives, which determines the target group. On the other hand, it also depends on household livelihood strategies, as households respond to program incentives according to their own characteristics (Tirivayi et al., 2016).

Agricultural development and social protection interventions coexist in rural areas of developing countries. Agricultural interventions are targeted to improve rural households' agricultural production and productivity, thus affecting rural income. Most of the interventions focus on market access to farmers, either to production inputs (e.g. fertilizers, seeds, credit, etc.) or to integrate in agricultural value chains (Kissoly et al., 2017). The households which are more likely to benefit from agricultural interventions are households which follow livelihood strategies linked to commercial agricultural production, and which are in a position to make productive investments. Social protection interventions are targeted especially to poor households. Even though the interventions are not designed to target rural households, households living in rural areas are an important target group as most of the poor live there (Devereux, 2016).

Brazil has a relatively long history in the implementation of agricultural development and social protection programs in rural areas. PRONAF is the most important agricultural development program targeting smallholder farmers in Brazil. PRONAF is responsible for increasing agricultural output and thus farm income of participant households (Feijo, 2003). However, these benefits are strongly skewed towards cash crop producers, and therefore, towards wealthier farmers, as most of the PRONAF loans are given to the productio of soybeans and

maize (Grisa et al., 2014; Schneider et al., 2004). As a consequence, food crop production and diversification of income-generating activities is undermined (Gazolla & Schneider, 2013).

Two of the most prominent social protection programs implemented in rural Brazil are the *Bolsa Família* and the rural pension/BPC programs. *Bolsa Família* is a cash transfer program targeted at poor households, one quarter of them living in rural areas, under the conditions of children vaccination and school attendance (WWP, 2017b). Even though *Bolsa Família* does not have an effect on agricultural land productivity (Costa et al., 2018), it significantly increases the quantity and quality of household food consumption (Coelho & Melo, 2017; Lopez-Arana et al., 2016) and the investment in human capital through education, especially of rural girls (Melo & Duarte, 2010). The rural pension/BPC is a non-contributory social security program benefiting households with men and women above the age of 60 and 55, respectively. Evidence suggests that rural pension affects the reduction of poverty in rural areas (Delgado & Cardoso Jr., 2000; Tavares et al., 2011), lifting liquidity constraints to cover household consumption needs (Delgado & Cardoso Jr., 2000). Furthermore, rural pension/BPC is an important source of credit for productive investment in agriculture, especially for poor farming households which lack otherwise access to rural credit (Schwarzer & Querino, 2002). While there is evidence that *Bolsa Família* does not affect adult labor supply (Foguel & Barros, 2010), the rural pension/BPC may considerably reduce the probability of working by 38% among program participants (de Carvalho Filho, 2008).

Even though the direct effects of the Brazilian programs are relatively well known, the indirect effects produced on rural economies, and therefore, on rural households, remain widely understudied. The increase in agricultural production promoted by access to rural credit through PRONAF may affect the demand for intermediary goods, such as seeds and fertilizers for crop production, or feed for livestock production, and the demand for production factors, such as labor. As some of the demanded commodities and factors may be sourced from the local economy, indirectly affecting households involved in local commodity and factor markets. Similarly, an increase in the demand for consumption goods, such as staples, promoted by households' participation in social protection programs, affect local commodity markets, and so

the production decision of local staple producers, who in turn may increase their demand for local labor, and affecting their own demand of consumption goods. As such, the assessment of the effects unleashed by public programs implemented in rural areas necessarily passes through the identification of household livelihood strategies and their exchange of commodities and factors in the local markets.

Therefore, our objective is to empirically identify household groups in the Rincão dos Maia village by assessing the combination of economic activities from which they earn most of their income. By doing so, we will be able to identify the way households are affected in the transmission of effects produced by public programs throughout the rural economy. For that scope, we apply the livelihood strategy approach by assessing the combination of income-generating activities in which households are engaged. More specifically, this section seeks to address four questions: (i) what are the household livelihood strategies? (ii) are household livelihood outcomes (i.e. income level) significantly associated with the choice/practice of livelihood strategies? (iii) how does participation in public programs relate to the livelihood strategy adopted by rural households? (iv) how are the direct and indirect effects of public programs implemented in rural areas transmitted to the different livelihood strategies? We hypothesize that: i) household participation in the different programs is strongly associated with their livelihood strategy; and (ii) the transmission of indirect effects produced by public programs is heterogeneous across the village commodity and labor markets.

4.2 Conceptual framework

4.2.1 Livelihood strategy of rural households

The livelihood strategy approach (Jansen et al., 2006; Nguyen et al., 2015; Nielsen et al., 2013) is used as the conceptual framework describing the livelihood activity choices (Nielsen et al., 2013), and the factors determining these choices (Fasse & Grote, 2015). The livelihood strategy framework is composed by assets, activities and outcomes, which are in turn influenced by the context in which households live (Figure 4.1). In the context of developing countries, the basic decision making unit regarding production and consumption decisions is the rural household

(Ellis, 2000). In many developing countries, rural households decide to access programs and earn benefit from program participation to be able to increase their total available household income. The livelihood strategy framework includes three closely related components: assets, activities and outcomes.

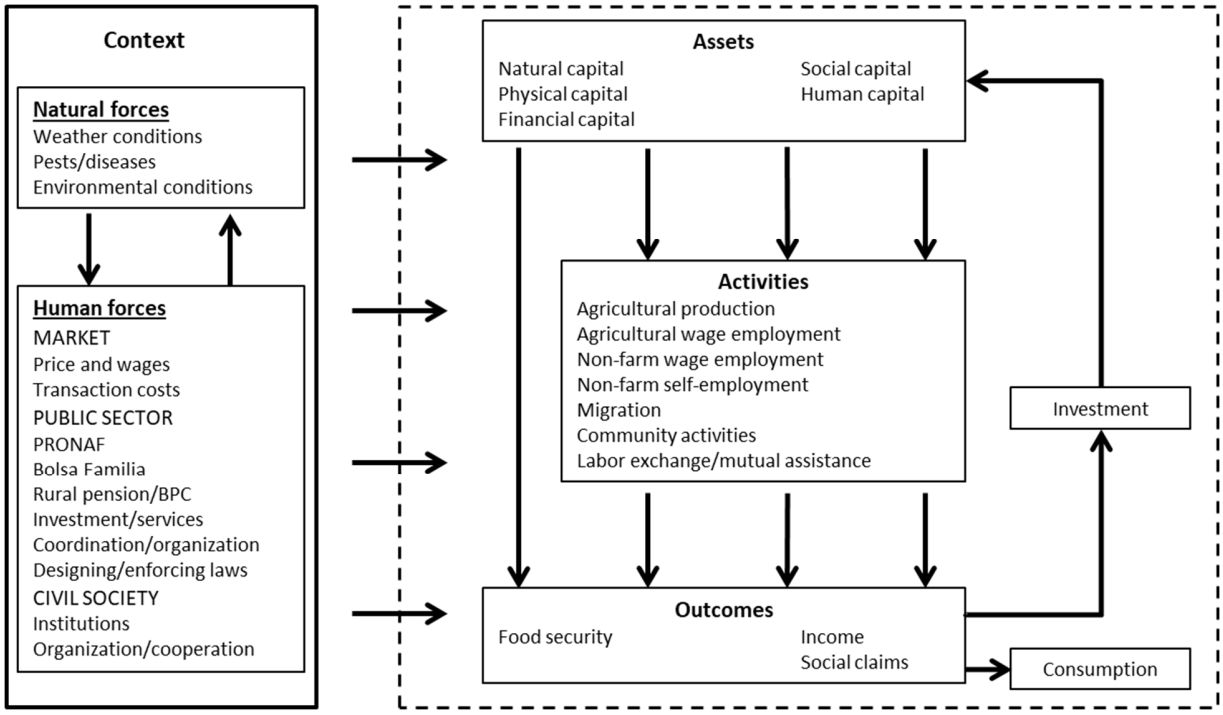

Figure 4.1: Household livelihood strategy framework
Source: adapted from Nielsen et al. (2013) and Winters et al. (2001)

The center piece of the livelihood framework is the activities and choices that households make to achieve their goals. The choices are shaped by household assets, which are divided into five types of capitals: natural capital (e.g. land owned by the household), physical capital (e.g. tractor), financial capital (e.g. access to credit), social capital (e.g. membership in institutions), and human capital (e.g. number of household members). The framework acknowledges direct links between assets and outcomes, e.g. income from remittances from relatives working away from the household. These different types of capital are the platforms for a household to choose its livelihood strategy as a combination of assets and activities (Brown et al., 2006). A household can allocate its assets to different activity choices, for example, agricultural production (cash crop and food crop production) or off-farm wage work (rural work and skilled urban work). Each livelihood strategy selected by the household leads to a set of livelihood

outcomes, highly depending on asset endowment and activities carried out by household members.

The framework acknowledges that households are immerged in the local context, which may influence household strategy choice and outcomes. This is clearly visible in the dependency of crop production on weather condition. Additionally, the participation in public programs may influence household activities, as increased access to liquidity leads to productive investments in agriculture and/or loose constraints in the search for more lucrative activities. The participation in the programs may be highly dependent on the households' livelihood strategy.

4.2.2 Program participation as part of rural livelihood strategy

The effects of public programs implemented in rural areas of developing countries strongly depend on the livelihood activities in which households engage (Ameha et al., 2014). The Brazilian public programs implemented in rural areas are characterized as interventions designed by the public sector which households can freely decide to access. In other words, households decide on accessing PRONAF, *Bolsa Família* and the rural pension/BPC programs based on their livelihood strategy.

In general, agricultural development programs improve investment in agricultural assets and induce higher income. PRONAF participants have higher agricultural productivity as compared to non-participants (Feijo, 2003). Consequently, PRONAF affects also rural economies, as PRONAF loans are positively correlated with an increase in per capita agricultural and total municipal GDP across the country (Castro et al., 2014), as well as an increase in the value of production, planted area and land productivity across all Brazilian states (Araujo & Vieira Filho, 2018). Access to PRONAF is though strongly skewed towards cash crop producers, as three quarters of PRONAF loans are given to soybeans and maize production (Gazolla & Schneider, 2013), and given especially to wealthy smallholder farmers engaged in cash crop production (Grisa et al., 2014; Schneider et al., 2004). Additionally, loose coordination among stakeholders, such as extension services, farmers' associations and the Banking sector seem to further skew its access towards the wealthier families (Aquino & Teixeira, 2005).

Social protection programs primarily lift liquidity constraints of poor households, affecting consumption and production decisions. *Bolsa Família* increases household consumption, especially of food (Coelho & Melo, 2017; Lopez-Arana et al., 2016). Even though *Bolsa Família* does not have an effect on agricultural land productivity (Costa et al., 2018), cash-based programs produced positive effects on agriculture, stimulating investments in agriculture in Mexico (Gertler et al., 2012), in Zambia (Handa et al., 2016), and in Paraguay (F. V Soares et al., 2010). The rural pension/BPC program reduces and prevents households to fall into poverty, increasing overall household consumption (Delgado & Cardoso Jr., 2000). Furthermore, rural pension/BPC transfers are used to support agricultural production, serving as a source of rural credit for household which otherwise lack access to the banking system (Schwarzer & Querino, 2002).

Therefore, farming households engaged in cash crop production may preferentially decide to participate in the PRONAF program, while off-farm working and asset-poor households may mainly rely on the participation on social protection programs. As such, the identification and characterization of household groups, according to their livelihood strategy, will enable us to assess the profile of participant households, and consequently, to assess how program indirect effects are transmitted throughout a rural economy.

4.3 Methodology

4.3.1 Clustering households with different livelihood strategies

The most common approach to characterizing livelihood strategies is to group households according to the share of income earned in different sectors of the rural economy (Barrett et al., 2005; Brown et al., 2006). However, income-based measures are not appropriate to provide insights into the strategies in which people engage to gain a living and to escape poverty, as income is stochastic and could, therefore, vary from year to year for the same household (Barrett et al., 2001). Even if income was not stochastic, household with the same income level could differ on asset endowments and, so, on what activities are conducted to earn income (Nielsen et al., 2013). One way of circumventing this problem is to group households according

to activity choices that capture the asset characteristics of each household group (Jiao et al., 2017; Nielsen et al., 2013; Walelign et al., 2017). Activity choices by households are determined by asset endowments and detached from the stochastic influence of productive outcomes (Jiao et al., 2017). As households in rural areas are characterized by diversification of income sources (Davis et al., 2010), the identification of livelihood strategies requires clustering a vector of activity variables from which households earn their income (Nielsen et al., 2013). The identification of the "right" mix of activity choices is what characterizes the livelihood strategy of rural households (Nielsen et al., 2013).

Activity variables act as the link between household assets and the *ex post* flow of income generated through those assets. Since households deploy different assets to generate a living, several activity variables should be included to capture livelihood strategies (Barrett et al., 2001). Consequently, several variables have been included in this study to identify groups of households according to their livelihood strategy. First, a combination of variables that measure the allocation of labor and input costs into the income-generating activities need to be included to account for all important aspects of livelihood strategy choice. Labor allocation is the most direct measure of strategy choice; and input costs because it measures investment in activities (on top of labor) for each activity. Additionally, money transfers, especially from public programs, such as *Bolsa Família* and the pension system, are included to account for the income from nonproductive assets.

We captured information on labor allocation in employed activities and for home garden production, but did not measure it for self-employed activities, mainly due to the difficulty in capturing such information. Therefore, following Nielsen et al. (2013), we use input costs in productive activities as an approximate measure for how households choose to invest in cash-generating activities. Additionally, to account for activities which rely little on external inputs, such as agricultural production for own consumption, we use the value of food crops produced by the household.

In total, eight activity variables are included: (i) purchased inputs in agricultural- and ii) livestock-related activities; iii) income earned from skilled off-farm and iv) from off-farm rural

wage work; v) hours per week used in home garden production and vi) value of crop and livestock production used for food; vii) transfer and viii) pension income. All variables are measured in Brazilian Reais (BRL) as for 2017, presented in figures for the whole year, and transformed into adult equivalent units (OECD, 2012) to make comparisons across households possible (Nielsen et al., 2013).

Cluster analysis of the eight selected activity variables (all continuous) was used to group households into livelihood strategies. The method is undertaken in two steps. In the first step, a principal component analysis (PCA) is used to reduce the dimensionality of the input variables and identify the principal components. In the second step, a cluster analysis on the scores of the principal components is conducted.

In the first step of the method, the eight activity variables representing household's participation in livelihood activities were used in the PCA analysis. Using the Kaiser criterion, only the components with eigenvalues higher than 1 were retained, resulting in four principal components which explain 76% of the total variance found among households. PCA enables to create a new set of variables, based on the previously selected activity variables, that represents the characteristics of the original variables in a simplified way and to reduce dimensionality of the data and the problem of high correlation between the original variables (Härdle & Simar, 2007). As such, PCA minimizes the possible difficulties and distortions in further data analysis (Backhaus et al., 2008).

In the second step, the factors determined by the PCA were used to conduct k-means clustering based on Euclidean distance. The Calinski-Harabasz criterion was used to determine the most appropriate number of livelihood clusters. This two-step approach allowed us to assign all 101 households to the four clusters identified by the analysis. The non-parametric k-sample test (Kruskal-Wallis test) and Wilkoxon rank sum test were realized in order to test the significance of differences between clusters and in livelihood outcomes.

4.4 Empirical results

4.4.1 Socio-economic characteristics of sampled village households

The households vary much across the village. Table 4.1 shows an average household size, counting all members regardless of their age, of 3.33 members, with an average age of 40.56 years. The gender of the household heads is markedly male (90%), while elderly are the household heads of 22% of sampled households.

Table 4.1: Household characteristics of sampled households in the Rincão dos Maia village

Variables	Mean	Standard deviation
General characteristics		
Household size (units)	3.33	1.54
Age of household head (years)	50.83	15.39
Age of household members (years)	40.56	17.81
Female household head (1 = yes)	0.10	0.30
Elderly household head (1 = yes)	0.22	0.42
Assets (in BRL)		
Owned land (in ha)	8.86	14.94
Tractor tools	4,040.83	9,413.1
Tractors	13,866.34	25,107.06
Crop facilities	15,841.55	19,432.65
Animal rearing facilities	5,670.75	14,530.47
Income (in BRL)		
Off-farm unskilled work	2,147.37	3,837.81
Off-farm skilled work	789.27	3,605.11
Pension benefits	4,944.59	6,327.12
Transfers	397.07	744.75
Agricultural income	21,680.47	32,808.32

Source: author

Furthermore, on average, households own 8.86 hectares of land, with big differences among households, as can be seen through the high standard deviation. Among the other agricultural assets, crop facilities have the highest average value, followed by the value of tractors. This is mainly due to the high investments in drying facilities and machinery for tobacco production, the main cash crop produced in the village. Sampled households earn, in average, most of their income from agriculture. Among the non-agriculture sources of income, pension benefits rank first, followed by off-farm unskilled and skilled work, respectively, and transfers, which are

basically the transfers received by the households through the *Bolsa Família* program. Most of this income is spent on non-food household expenditures, such as electricity and purchase of household furniture and appliances. The purchase of agricultural inputs ranks next, followed by the purchase of processed food, especially from the supermarkets of the municipality of Canguçu.

Income from agriculture, off-farm labor and pension benefits play an important role in the economy of the Rincão dos Maia village. Agriculture is the sole most important economic activity in the village, responding for an average of 49% of household income (Figure 4.2). Out of this, an average of 39% of household income is earned from crop production, especially from tobacco and peach, the most important cash crops in the village. Earning from livestock completes the share on income from agriculture, responding for an average of 10% of household income. Income from rural work responds for an average of 17% of household income, which is mostly earned in the local village crop fields. Rural laborers in general own little to no land and have numerous and young household members. Pension benefits are paid to male and female household members above 60 and 55 years of age, respectively, and respond to an average of 28% of household income. Pension income is seen as an important safety net for households, as it is a steady source of income. Incomes from transfers and from skilled urban work respond each for 3% of average household income.

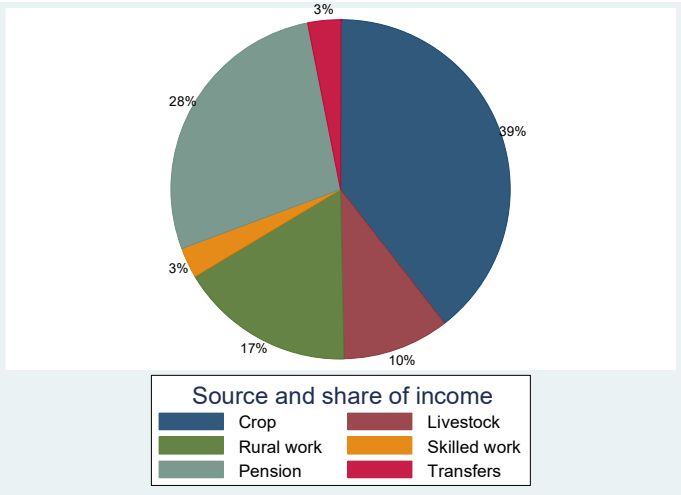

Figure 4.2: Source and average share of income of surveyed households in the Rincão dos Maia village
Source: author

4.4.2 Commodity and labor exchanges in the economy of the Rincão dos Maia village

The transmission of effects generated by policy changes throughout the local economy is strongly modulated through the exchanges of commodity and labor among households. The most important village activity is certainly agriculture, which is responsible for about half of the average village household income. While the local exchange of agricultural commodities is relatively high for livestock products, it is relatively small for crop commodities. The gross production and the destination agricultural commodities sold by local households is shown in Table 4.2.

Table 4.2: Gross production and exchange of selected agricultural commodities within the Rincão dos Maia economy and with the rest of the world

	Gross production	**Total sales**		**Rincão dos Maia**		**Canguçu**		**ROW**	
	In BRL	in BRL	%	in BRL	%	in BRL	%	in BRL	%
Gross crop production	**2,976,649**	**2,732,255**	**92%**	**23,246**	**1%**	**70,710**	**3%**	**2,637,799**	**96%**
- Tobacco	2,143,729	2,143,729	100%	0	0%	0	0%	2,143,729	100%
- Peach	396,545	395,700	100%	0	0%	6,600	2%	389,100	98%
- Maize	123,469	9,686	8%	9,686	100%	0	0%	0	0%
- Eucalyptus	37,705	5,800	15%	5,800	100%	0	0%	0	0%
- Beans	52,828	13,810	26%	3,950	29%	9,860	71%	0	0%
- Sweet potato	14,445	300	2%	300	100%	0	0%	0	0%
- Pumpkin	4,778	30	1%	30	100%	0	0%	0	0%
- Onions	3,316	2,770	84%	2,770	100%	0	0%	0	0%
Gross livestock production	**434,644**	**162,578**	**37%**	**150,176**	**92%**	**3,820**	**2%**	**8,582**	**5%**
- Cattle	161,500	139,000	86%	136,500	98%	2,500	2%	0	0%
- Milk	58,685	11,282	19%	2,700	24%	0	0%	8,582	76%
- Pork	93,909	7,700	8%	7,100	92%	600	8%	0	0%
- Chicken	105,248	1,656	2%	936	57%	720	43%	0	0%
- Sheep	13,702	1,740	13%	1,740	100%	0	0%	0	0%
- Bees	1,598	1,200	75%	1,200	100%	0	0%	0	0%

Source: author

In regard of crop production, 92% of the total household crop production is sold, with the remaining used for household subsistence. From total crop sales, only 1% is sold within the Rincão dos Maia village, although with big differences for individual crops. While all cash crops products, which respond to the bulk of village crop production, are unsurprisingly completely exported, crop products used as food and as intermediary goods are partially sold to local households. This is particularly relevant in the case of maize and Eucalyptus wood which are

completely sold in the local economy, and which are used as livestock feed and in the tobacco drying stoves, respectively. Some sales of food crops are completely done within the Rincão dos Maia village, even though in relatively small amounts.

Conversely, livestock products are majorly sold in the local economy. From the total livestock gross production, 37% is sold, with the remaining used for household subsistence. From livestock sales, a total of 92% is sold within the local economy, especially cattle, which is sold to the local slaughterhouse. Other livestock products are also mainly sold locally, and purchased for household consumption. An exception to this standard is milk, which is mainly sold to the regional processing industry.

The exchange of labor within the Rincão dos Maia village is also relatively high. Table 4.3 shows the total income received from off-farm work (workers), total cost in hiring off-farm work, and the exchange of labor among village households. It is estimated that around 30 households in the village, mostly poor, live exclusively from off-farm rural work. Around half of their off-farm labor income is paid by local farmers, especially to harvest tobacco and peach. However, as local labor supply exceeds local demand, the remaining off-farm income is earned from off-farm work in Canguçu, mainly in tobacco harvesting in neighboring villages within the Canguçu municipality, and in the neighboring municipality of Pelotas in peach harvesting.

Table 4.3: Exchange of off-farm work in the Rincão dos Maia village

Variable	Total	Rincão dos Maia		Canguçu		ROW	
	In BRL	In BRL	%	In BRL	%	In BRL	%
Off-farm labor income	**216,884.50**	98,767.50	46%	70,475	32%	47,642	22%
Off-farm labor costs	**93,610**	81,060	87%	-	-%	12,550	13%
Off-farm labor exchange	**54,438**	54,438	100%	-	-	-	-

Source: author

Most of the costs associated with hiring off-farm labor is paid to workers living in the Rincão dos Maia village. Most of the work hirers are tobacco and peach producers, who demand labor especially around crop harvest. The harvest does normally not overlap, as peach harvest takes place between September and November, and tobacco is harvested between December and

February. To reduce labor costs and to smooth labor demand throughout the harvest season, neighboring farmers also exchange labor, especially among tobacco producers.

As such, livestock products and labor are mainly exchanged within the Rincão dos Maia village economy, while crop products are mainly exported. Therefore, the effects of policy changes will be transmitted through the market for local livestock products as well as through the labor markets.

4.4.3 Description of household livelihood strategies

The results of the cluster analysis show that there are multiple income sources of rural households. Four different livelihood strategies were identified. They are: Livelihood strategy 1 (LS1) are young resource-poor off-farm workers with rural wage employment and from government transfers (*Bolsa Família*), owning little land and cultivating mostly food crops for household consumption, and respond to 22% of the surveyed households; Livelihood strategy 2 (LS2) are old resource-rich cash (peach) and food-crop producers and livestock holders, as well as receiving pension benefits, accounting for 9% of surveyed households; Livelihood strategy 3 (LS3) represent 41% of households, and are young resource-rich cash-crop producers, especially tobacco, whose income is earned primarily from agriculture, and smaller shares of income come from off-farm rural work and pension; and livelihood strategy 4 (LS4) are old pension beneficiaries conducting little farming, especially for household consumption, and account for 29% of households. The results are shown in Table 4.4.

Table 4.4: Livelihood strategies identified in a rural village in Brazil

Livelihood strategies	N. of households	Main livelihood activities
LS1	22 (21.8%)	Young resource-poor off-farm rural workers
LS2	9 (8.9%)	Peach and livestock producers with pension benefits
LS3	41 (40.6%)	Resource-rich tobacco producers
LS4	29 (28.7%)	Pension beneficiaries
Total	**101 (100%)**	

Source: author

The differences among the livelihood strategies in their characteristics, their assets and income are summarized in Table 4.5. The results of the Kruskal-Wallis and χ^2 test reveal that, except for

gender, all tested variables are significantly different at least between two livelihood strategies. In addition, the Wilcoxon rank sum test shows that, for example, LS4 is significantly different in the number of household members from all other clusters, while LS1, LS2 and LS3 are not significantly different among each other at the 95% confidence interval.

Table 4.5: Basic characteristics and assets of livelihood clusters

Variables	Whole sample	Livelihood strategies				χ^{2b}
		LS1[a] Off-farm workers	LS2[a] Peach and livestock producers	LS3[a] Resource-rich tobacco producers	LS4[a] Pension beneficiaries	
Socio-demographic characteristics						
Number of household members	3.33 (1.54)	3.86***4 (1.32)	3.56**4 (2.30)	3.83***4 (1.52)	2.14***1**2***3 (0.52)	35.939***
Average age of household members	40.56 (17.81)	24.04***2***3***4 (7.32)	49.37***1**3*4 (18.63)	33.79***1**2***4 (9.78)	59.90***1*2***3 (12.77)	58.646***
Gender of household head (1 = fem)	0.10 (0.30)	0.18*3 (0.39)	0	0.05*1 (0.22)	0.14 (0.35)	1.148
Assets						
Owned land (in ha)	8.86 (14.94)	2.78***2***3**4 (4.07)	35.40***1***3***4 (36.86)	7.76***1***2 (7.36)	6.78**1***2 (7.55)	20.702***
Tractor working tools (in BRL)	3813.33 (8544.60)	771.24**2***3 (3135.27)	6704.33**1**4 (14085.28)	6571.87***1***4 (10131.70)	603.31**2***3 (1433.39)	26.627***
Value of owned tractors (in BRL)	15665.56 (28812.54)	5250***2***3**4 (9394.58)	16464.29***1***4 (21607.04)	29060.61***1***4 (37526.56)	1256.41**1***2***3 (4482.23)	42.104***
Crop facilities (in BRL)	15841.55 (19432.65)	8236.66*2***3 (13708.98)	18500.09*1 (27876.80)	20722.36***1***4 (20451.43)	12867.28***3 (15945.45)	19.355***
Animal rearing facilities (in BRL)	5670.75 (14530.47)	1901.26***2***3 (3308.90)	24164.15***1***3***4 (40979.41)	5531.04***1***2***4 (7383.34)	2361.46***2***3 (2739.34)	34.284***
Income						
Off-farm skilled work	527.92 (2967.06)	885.00 (3525.39)	928.29*4 (3473.33)	581.82 (3421.69)	0*2	0.267
Off-farm rural work	1538.31 (3287.23)	4723.98***2***3***4 (5319.50)	247.14***1*3 (896.34)	952.68***1*2***4 (1952.54)	378.97***1***3 (1280.10)	30.910***
Exchanged work	539.00 (2208.31)	374.92 (1315.97)	274.94 (824.83)	1066.24**4 (3258.87)	0**3	6.618*
Rural pension/BPC	4796.58 (6728.71)	351.38***2***4 (1987.68)	14564.57***1***3**4 (9389.83)	851.82***2***4 (2998.07)	11613.23***1**2***3 (1857.21)	81.810***
Total non-agricultural household income	13663.55 (12894.23)	3290.63***2***4 (4552.31)	25027.71***1***3 (13751.68)	11212.18***2***4 (13437.70)	22243.69***1***3 (6452.85)	48.760***
Gross crop revenue	23883.72 (36622.38)	5666.14**2***3 (8574.70)	25766.04**1**3***4 (40875.24)	45368.89***1**2***4 (42346.88)	1796.24***2***3 (3463.82)	70.770***
Gross livestock revenue	3142.66 (10294.04)	952.76***2***3 (1488.07)	14239.57***1***4 (31779.01)	2988.92***1***4 (3051.09)	1216.19***2***3 (1345.78)	31.350***
Annual transfers	355.39 (687.40)	1508.25***2***3***4 (538.24)	0***1	81.82***1*4 (344.93)	0***1*3	68.642***
Total annual income	34244.58 (37737.90)	14087.51***2***3**4 (11125.06)	55745.61***1***4 (48782.49)	50825.94***1***4 (44048.22)	15004.63**1***2***3 (4218.13)	59.391***

*Significant at 10%, **significant at 5%, and ***significant at 1%. Standard deviations are in parenthesis. [a]Wilcoxon rank sum tests are conducted to analyze whether clusters are significantly different with each other, pairwise. [b]Nonparametric k-sample test (Kruskal-Wallis test) are conducted to test whether clusters differ significantly among each other.
Source: author

Tests were conducted on relevant socio-demographic characteristics and on assets of households for the whole sample as well as for the individual clusters. LS1 is significantly

different from other livelihood strategies regarding average age of household members, total amount of owned land and the value of owned tractors. In terms of the value of crop and animal rearing facilities, LS1 owns significantly less than households in LS2 and LS3, which are specialized in cash crop production, but very similar to LS4, which are the households of pension beneficiaries (retirees). LS2 has higher amount of owned land, as well as higher value of animal rearing facilities.

The household livelihood strategy clearly has an effect on household income across the different household groups. From a livelihood strategy perspective, it reflects the combination income-generating activities pursued by the households, which in turn are influenced by household characteristics and asset endowment. Households in LS1 have the highest income from off-farm rural work and the income from household transfers (basically cash transfers from the *Bolsa Família* program), while their total annual income is the lowest among the livelihood strategies, even though not significantly different from households in livelihood strategy LS4. Households in LS2 have an average income from pension and total livestock gross revenue higher than the other livelihood strategies, and so their total income is the highest among the village livelihood strategies, and only not significantly different from the total income from LS3. Households in LS4 have the second highest average income from pension benefits and overall non-agricultural household income (after LS2), and has the lowest crop and livestock gross revenue of all livelihood strategies. This group of households has the second lowest total annual income among the livelihood strategies identified in this analysis.

The differences regarding income across livelihoods become clear by analyzing the average share of household income (Figure 4.3). For all the livelihood strategies with the exception of LS4, income from crop production is the biggest single contributor to household income. For LS1, the relative importance of off-farm wage work follows closely the income from crop production (36 and 37%, respectively). Still, for this livelihood strategy, transfers, especially in the form of cash transfers from *Bolsa Família* respond to 9% of household income, which is the highest among the identified livelihood strategies. The importance of agricultural income is very high for LS2 and LS3, the two livelihood strategies involved in cash crop production, peach and

tobacco, respectively. While for LS2 income from crop production responds to 54% of total income, for LS3 it accounts for 85% of total household income. LS2 also has a relatively high income from livestock (30%), for which group livestock contributes the most for household income. Looking at the contribution of agriculture in general, LS3 has the highest share of income stemming from this activity (91%), with the biggest part of it coming from crop production (85%). Pension benefits respond to the biggest share of income for LS4 (76%), with relatively small contribution by crop and livestock production to their household income (13 and 8%, respectively).

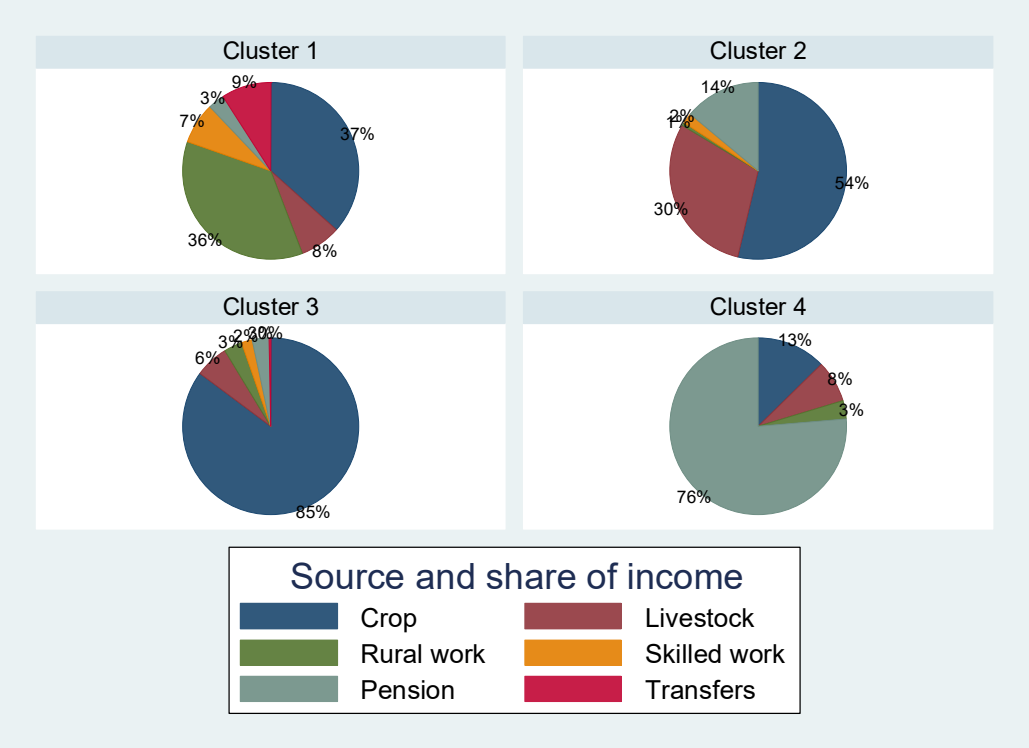

Figure 4.3: Source and share of income of households in each livelihood strategy, in %
Source author

Beyond the differences in average shares of income, the absolute difference in income among the different household groups is staggering. Figure 4.4 shows that LS2 has the highest income, in absolute terms, from agriculture (crop and livestock production), while crop production is the single highest contributor for income of households of LS3. So, LS3 shows a great reliance of income from crop production, given that all the other income sources contribute little to the

total income of households. Crop income is also an important source of income for LS1, while off-farm wage work also contributes in a similar share.

Therefore, we can see that LS2 and LS3 are strongly characterized by agricultural production in the village. LS1 is the single group of households, whose income depends relatively strongly from off-farm rural work, especially supplying labor to the cash crop producers in the village. LS4 is strongly characterized by pension income, and so is not strongly involved agriculture in the village.

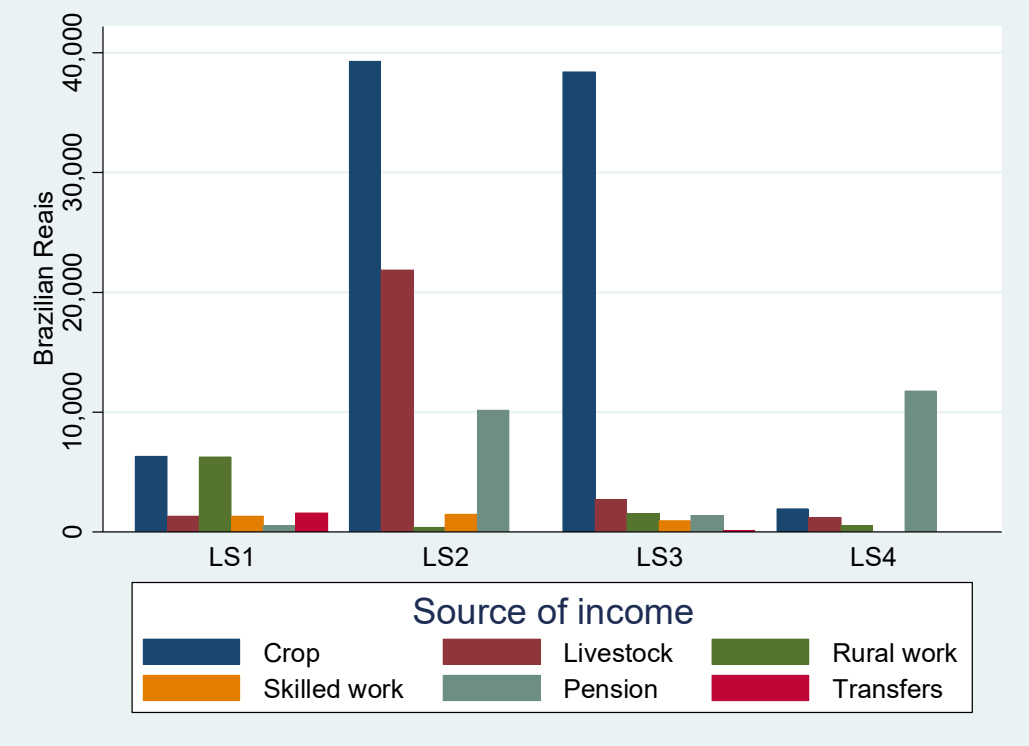

Figure 4.4: Absolute income and their sources for the different livelihood strategies, in BRL
Source author

4.4.4 Program participation according to household livelihood strategies

The participation in the PRONAF, *Bolsa Família* and rural pension/BPC is strongly determined by the household choice of livelihood strategy (Table 4.6). Access to PRONAF is significantly higher for households following LS2 and LS3 from the other two livelihood strategies, but do not differ significantly between them. Access to the program by households in LS1 and LS4 does not differ significantly, while access differs between LS1 and LS4, in the one hand, and LS2 and LS3, on the

other. This same pattern of differences can be seen if we consider the amount of credit accessed over the last 5 cropping seasons, in which we see a very significant difference among credit accessed by LS2 and LS3, which do not differ between them, and access to credit by LS1 and LS4. In the case of PRONAF crop loans only in the survey year (2017), we see that the difference between LS1 and LS2 disappears, which is because some of the farmers in LS2, which accessed PRONAF over the last 5 cropping seasons, did not do so for the survey year. The amount of credit accessed through PRONAF Investment is significantly different between credit accessed by LS1 and LS4, which are the lowest ones among the livelihood strategies, and credit accessed by LS3, the highest among them. The amount of credit accessed by LS2 is relatively high, but does not differ from the other groups.

Table 4.6: Program participation for households in the different livelihood strategies (all valued deflated - base year: 2017)

Variables	Whole sample	Livelihood strategies				χ^{2b}
		LS1[a] Off-farm workers	LS2[a] Peach and livestock producers	LS3[a] Resource-rich tobacco producers	LS4[a] Pension beneficiaries	
PRONAF						
Whether household accessed PRONAF (1 = yes)	0.37 (0.48)	0.23^{*2***3} (0.43)	0.56^{*1***4} (0.53)	0.58^{***1***4} (0.50)	0.10^{***2***3} (0.31)	14.018***
PRONAF crop loan, in 2017, in BRL	1433.07 (5387.67)	100.00^{**3} (469.04)	4777.78^{***4} (10389.63)	2427.80^{**1***4} (6698.16)	. ^{***2***3} (.)	14.131***
PRONAF Investment, in BRL	9256.50 (26016.82)	1975.45^{***3} (5480.28)	14853.33 (31608.76)	18113.91^{***1***4} (36083.08)	520.55^{***3} (1948.70)	17.239***
Bolsa Família						
Whether household receives *Bolsa Família* (1 = yes)	0.27 (0.45)	0.95^{***2***3***4} (0.21)	0^{***1}	0.15^{***1***4} (0.36)	0^{***1***3}	40.714***
Yearly rransfers from *Bolsa Família,* in BRL	397.07 (744.44)	1577.45^{***2***3***4} (635.06)	0^{***1}	131.71^{***1**4} (431.97)	0^{***1**3}	45.055***
Rural pension						
Whether household receives rural pension (1 = yes)	0.41 (0.49)	0.05^{***2***4} (0.21)	0.67^{***1***3***4} (0.50)	0.12^{***2***4} (0.33)	1.00^{***1***2***3} (0.00)	50.535***
Yearly transfers from rural pension, in BRL	4944.59 (6327.12)	511.09^{***2***4} (2397.23)	10162.67^{***1***3} (9068.50)	1371.22^{***2***4} (3725.08)	11740.55^{***1***3} (2148.40)	50.733***

*Significant at 10%, **significant at 5%, and ***significant at 1%. Standard deviations are in parenthesis. [a]Wilcoxon rank sum tests are conducted to analyze whether clusters are significantly different with each other, pairwise. [b]Nonparametric k-sample test (Kruskal-Wallis test) are conducted to test whether clusters differ significantly among each other.
Source: author

Participation in *Bolsa Família* is significantly higher for households in LS1 in regard of all other livelihood strategies, which is also obviously reflected on the net cash benefits, which are similarly significantly different from all other household groups. Households following LS3 also

report some cash transfers from *Bolsa Família*, but which are significantly lower than the transfers received by LS1 and LS4, while not significantly differing from LS2.

Participation in the rural pension/BPC programs is significantly higher for households belonging to LS2 and LS4. However, even though fewer households in LS2 participate in the rural pension program (as compared to LS4, in which all households are program participants), the average pension transfers are similar, showing that the transfers to LS2 to participant households is higher as compared to the transfers to households belonging to LS4. The rural pension/BPC transfers to LS1 and LS3 are very small, clearly showing that its contribution to household income, on average, is relatively small.

4.4.5 Exchange of commodities and factors among village households

The exchange of commodities and labor among household groups depends varies according to the type of commodity and labor (Table 4.7). As seen above, the exchange of crop products within the village economy is very small. However, local trade of crop products differs in the different household groups, with tobacco producers (LS3) selling significantly more than poor and senior households, while not significantly higher than peach producers. These differences are not due to local sales of food crop products, among which black beans is the most prominent example, but especially due to the sales of intermediary goods, especially of maize, used as feed for livestock. As a usual practice, tobacco production is followed by maize production to use the soil residual fertility, contributing to increase their maize output, which is then partially sold in the local market. However, as a widespread practice, it is no surprise that local sales of maize of mainly tobacco producers is the highest, but only different from local maize sales of senior households.

Local sales of livestock products is much more prominent as compared with local crop sales, and differs strongly across household groups. Along with the fact that LS2 earns the most from livestock production among the village households, they also trade significantly more livestock products within the village economy as compared with the other household groups. This is especially true for cattle, which is produced and sold to the local slaughterhouse. As seen

above, the sales of other livestock products is very small, and they do not differ among household groups in the village.

The differences across households in the local exchanges on the labor market are unsurprisingly highly significant. Local off-farm work income is the highest for poor households, who earn significantly more than tobacco producers and senior households. However, while overall off-farm income of poor households differs significantly from other households (Table 4.5), the absence of significance in the difference with peach producers shows the importance of off-farm income earned outside the village for poor households.

Table 4.7: Exchange of commodities and labor within the Rincão dos Maia village, in BRL

Variables	**Whole sample**	**Livelihood strategies**				χ^{2b}
		LS1[a] Off-farm workers	LS2[a] Peach and livestock producers	LS3[a] Resource-rich tobacco producers	LS4[a] Pension beneficiaries	
Crop local sales						
Total local crop sales	330.36 (1229.23)	121.82^{*3} (434.02)	232.22 (663.58)	597.07^{*1*4} (1824.91)	141.95^{*3} (440.01)	5.282
- Food crop products	78.02 (302.93)	30.91 (111.57)	10 (30)	104.88 (344.65)	96.90 (379.20)	1.171
- Crop intermediary goods	252.34 (1146.74)	90.91 (426.4)	222.22 (666.67)	492.2^{**4} (1719.69)	45.05^{**3} (242.6)	5.553
Livestock local sales						
Total local livestock sales	1486.89 (11544.92)	0^{***2*3}	14666.67^{***1**3***4} (37916.85)	413.07^{*1**2} (1629.84)	42.76^{***2} (189.41)	14.623***
- Cattle	1351.49 (11395.07)	0^{***2}	13944.44^{***1***3***4} (37613.53)	243.90^{***2} (1561.74)	34.48^{***2} (185.70)	17.301***
Local labor						
Off-farm wage work	977.9 (2360.25)	2871.93^{**3***4} (3840.71)	384.44^{*4} (1116.32)	619.63^{**1***4} (1501.96)	231.72^{***1*2***3} (1247.87)	14.049***
Hiring local labor	802.57 (3284.35)	0^{***2***3}	3515.56^{***1*3***4} (6572.38)	1124.88^{***1*2***4} (3959.12)	113.79^{***2***3} (524.90)	20.343***
Exchange labor	539.00 (2208.31)	374.92^{*4} (1315.97)	274.94^{*4} (824.83)	1066.24^{***4} (3258.87)	0^{*1*2***3}	6.618*

*Significant at 10%, **significant at 5%, and ***significant at 1%. Standard deviations are in parenthesis. [a]Wilcoxon rank sum tests are conducted to analyze whether clusters are significantly different with each other, pairwise. [b]Nonparametric k-sample test (Kruskal-Wallis test) are conducted to test whether clusters differ significantly among each other.
Source: author

The households engaged in cash crop production, namely peach and tobacco, significantly hire more off-farm workers than poor and senior households. While this is unsurprising that poor households do not engage off-farm workers, senior households do hire off-farm workers, but significantly less than cash crop producers, hinting at a small substitution effect of pension transfers on the household labor demand. The exchange of labor among village households is a widespread practice, especially among tobacco producers. As such, it is especially high for the

group of tobacco producers, but only significantly different from senior households, whose income from agriculture is the lowest among the village households. The other three household groups do not differ significantly in their labor exchange.

4.5 Discussion

4.5.1 Household livelihood strategies and public programs

The results of the cluster analysis show that households follow four different livelihood strategies in the village of Rincão dos Maia. This supports the findings on the diversity of livelihood strategies found in rural areas (Brown et al., 2006; Nielsen et al., 2013; Van den Broeck & Maertens, 2017), suggesting that rural households often engage in multiple activities and livelihood diversification, which are essential for survival and for reducing risk in a rural economy setting (Ellis, 1998). Furthermore, the identification of livelihood strategies offers an insight into the way policy interventions, such as public programs, may affect households (Fasse & Grote, 2015; Nguyen et al., 2015; Soltani et al., 2012).

Agricultural income remains the largest contributor to household total income in the Rincão dos Maia village, especially for LS3, for whom income from tobacco production is a major income source, and for LS3, for whom income from peach production and livestock make the bulk of income. These two groups of households, strongly engaged in the production of the two most important cash crops, tobacco and peach, respectively, are also the groups of households with the highest absolute income and the most agricultural assets, especially of tractors and tractor tools, and of crop facilities, such as stoves used to dry tobacco leaves. So, it comes as no surprise that these groups of households participate more strongly on PRONAF. Regardless of the fact that tobacco is the only crop that shall not receive support in the form of rural credit (Bank, 2019), all households receiving PRONAF loans are engaged in tobacco production. To circumvent this prohibition, most of the crop and investment loans are issued for the production of maize and the construction of maize-drying stoves in a tacit agreement between the stakeholders developing the credit projects (e.g. rural extension services, local farmers' union) and smallholders.

Even for households earning most of their income from peach production and livestock (LS2), tobacco production constitutes part of their livelihood strategy. In this sense, it becomes clear that PRONAF plays an important role in supporting the production of cash crops in Brazilian rural areas, producing direct effects on wealthy and asset-rich farming households. Concurrently, poor and senior households (LS1 and LS4, respectively) participate marginally on PRONAF, and therefore may earn small direct from access to credit.

Off-farm rural work is an important source of income for the household belonging to the poorest livelihood strategy, for whom off-farm work and agricultural income make each around one third of total household income. Unsurprisingly, this household group also has the highest number of household members, and therefore highest pool of potential off-farm workers, along with very small land and asset endowment. The main source of off-farm rural work in the village is on the tobacco fields and the peach orchards, generally during harvest time for both crops, but also for planting and weeding of tobacco. Even though peach harvest is conducted one to two months before tobacco harvest, rural work remains highly seasonal. As a result, this household group congregates most of the *Bolsa Família* participants, serving as an important safety net for poor households relying on off-farm work.

Rural pension/BPC benefits respond to more than one quarter of the village household income. These transfers are especially important for the group of senior village households (LS4), constituting over three quarters of household income. For households in LS2, who earn 14% of their income from pension benefits, it is likely to expect it to be a source of productive investment, especially in crop production. The group of senior households (LS4) may probably invest little of pension transfers in agricultural production, as their overall income from agriculture is low and their production for home consumption is similarly small.

4.5.2 The transmission of effects by public programs through the local commodity and labor markets

Theoretically, besides the direct effects produced by public programs on participant households, indirect effects may also be produced as a result of the interlinkages among

households and economic sectors within a rural economy. In the Rincão dos Maia village, this means that the transmission of indirect effects throughout the economy preferentially takes place through the livestock commodity and labor markets.

Overall, livestock production by village households is mainly conducted for subsistence purposes. However, the local economy is the destination of most of the sales of livestock products, especially of cattle, especially by households pursuing the livelihood strategy of peach and livestock production (LS2). As these households belong to the main groups of PRONAF and rural pension/BPC participants, we can assume that changes in these two programs will consequently induce changes in local sales of livestock.

The exchanges in the labor market may be strongly influenced by the implementation of different public programs in the Rincão dos Maia village. On the one hand, the main off-farm labor suppliers are the poorest village households, which in turn are the main group of *Bolsa Família* participants. Changes in the transfers to these households may influence household labor supply decisions, affecting the local labor market. On the other hand, changes in agricultural production, especially of cash crops, will strongly influence the labor demand. As PRONAF participants belong to the livelihood strategies engaged in cash crop production, a change in rural credit will significantly affect the demand for labor. The rural pension/BPC transfers will probably produce little effect on the labor market, as the main group of program participants demand very little village off-farm labor.

As such, even though changes in crop production will have little effect on local commodity exchange, and thus on the transmission of policy changes to other households through the commodity markets, it may have a relatively strong effect on the local labor market. As most of the crop inputs used in crop production are “imported” into the village economy, there are no major effects are expected to affect local households. However, an increase in the demand for off-farm labor may indirectly affect poor local households, the most important off-farm labor suppliers in the village.

As a result, while changes in the commodity markets may affect especially livelihood strategies strongly characterized by agricultural production, and therefore the wealthiest village households, the indirect effects, especially the ones transmitted through the labor market, have the potential to benefit poor households by increasing their off-farm labor income. However, this effect may though be dampened by an increase in the exchange of labor, which is especially common among tobacco producers.

4.6 Summary and concluding remarks

Our findings show that households pursue different livelihood strategies due to the livelihood activities conducted by each of the households. The households grouped in the four household strategies identified in this study differ significantly in their main income generating activities, which influence their income levels.

We also saw that households decide to participate in public programs in line with their livelihood strategy. As such, grouping households according to their livelihood strategy gives a relatively clear picture of the preferential group of households targeted by the program. As a result, households whose livelihood strategy encompasses high production of cash crops are more likely to access PRONAF crop loan and PRONAF Investment, especially peach and tobacco producers (LS2 and LS3, respectively), even though PRONAF participants were found in greater or lesser degree in the other livelihood strategies as well. Furthermore, poor households, which lack access to productive assets, and whose share of off-farm labor income is the highest among the sampled households, are the preferential group of households participating in *Bolsa Família*. Finally, the participation in the rural pension/BPC program covers two types of livelihood strategies: on the one hand, peach and livestock producers reflects the participant

As a result, we can expect that participation in PRONAF will have a clear effect on agricultural production, especially of tobacco and peach, the two most important cash crops in the village. The *Bolsa Família* program may also have an effect on agriculture, given that the main group of participant households also earn most of their income from agriculture. However, as they belong to the poorest livelihood strategy, the absolute changes in agricultural production may

be much lower than the ones produced by PRONAF. The rural pension/BPC program will have mixed effects, as most of the program participants belong to two different livelihood strategies: while the peach and livestock producers (LS2) may use part of the transfers to invest in agriculture, the transfers to the senior households (LS4) may be used for household consumption.

In this study, we assessed the different livelihood strategies of rural households, and how policy effects are transmitted to rural households through local commodity and labor markets. As such, we did not assess the effects produced by the programs, we only described the pathways through which policy effects are transmitted, and how different household groups are finally affected. As to further deepen our knowledge on the impacts produced by the two programs, it is still important to assess the direct and indirect impacts produced by the programs, both on program participants and non-participating, as well as to the rural economy.

5 The description of the Rincão dos Maia village economy

5.1 Introduction

While different public programs are commonly implemented simultaneously in rural areas of the developing world, their effects on rural households and on rural economies remain understudied (Tirivayi et al., 2016; Veras et al., 2016). Most of the effects produced by public programs benefit participant households, non-participants though may also be affected by policy changes, transmitted through the local commodity and labor markets in which they are engaged. Thus, a comprehensive analysis of the effects produced by public programs shall combine the direct effects produced on participants and indirect effects produced on non-participants (J E Taylor & Adelman, 1996).

For that scope, assessing linkages among rural households and economic activities in rural villages are instrumental in shaping the impact of policy, market and environmental changes on production and farmers' welfare. Intra-economy linkages are important in determining both the sign and magnitude of impacts of exogenous changes on income and production (J E Taylor & Adelman, 1996). In concrete terms, it means that an economy-wide analysis allows to identify the net impact of production and consumption effects, as a result of the existing inter-household income linkages (J E Taylor & Adelman, 1996). As such, knowing the magnitude of economic linkages between households is very important to determine the total effects of policy changes (Breisinger, Diao, et al., 2009; Tadele, 2008).

One important tool to assess economy-wide impacts of policy changes is the Social Accounting Matrix (SAM). First developed by Leon Walras in the 19th century, it captures the circular flow of income among economic actors within an economy. It was further developed by Wassily Leontief with the introduction of the input-output analysis, which shows the economic interactions between production activities that add value to the economy (Miller & Blair, 2009). Overall, the SAM accounts for interactions between production activities and the consumption of production factors, which remunerate factor owners, which in turn spend their income on the consumption of commodities, part of which are traded with the rest of the world.

Moreover, the SAM captures the expenditures and income of the different accounts simultaneously, for a given period of time, through a double accounting system (Bellu, 2012). In this sense, the income of a given actor in the economy is equaled by its expenditures, resulting in a square matrix (J E Taylor & Adelman, 1996).

The SAM is a well-established economic and analytical tools regardless of the size of the economy. Even though it has been mostly used in the context of national economies, over the last years, many researchers have worked on SAMs at a village level. Even though not as popular as their national counterparts, village SAMs are appropriate tools to summarize and illustrate the flow of inputs, outputs, and income between production activities and village households and the exchange of goods and factors with the rest of the world (J E Taylor & Adelman, 1996). Many studies have used this methodology to account for the effects on village economies in terms of welfare due to US-migration in Mexico (Adelman et al., 1988), decentralization of industrial plants to rural areas in India (Parikh & Thorbecke, 1996), technical change, output fluctuation and government policy in rural India (S. Subramanian & Sadoulet, 1990), effects of trade liberalization policies, especially in regard of maize, for Mexican farmers (J E Taylor et al., 1999), the adoption of Bt cotton in India (A. Subramanian & Qaim, 2009), and the impacts of social cash transfers of a rural village in Kenya (Thome et al., 2013), and in a rural village in Ethiopia (Gebeyehu, 2016).

Therefore, our objective in this study is to analyze the economic structure of a rural village economy by building and analyzing a SAM of the Rincão dos Maia village economy. Furthermore, the village matrix multiplier and its decompositions, derived from the village SAM, will be used in policy experiments on public program implementation to assess the effects on village production, value added and household income. More specifically, this section aims to address the following questions: (i) what is the structure of the Rincão dos Maia village economy? (ii) what are multipliers of the different economic sectors within the village economy? (iii) what are the effects on the local economy resulting from changes in public program implementation in the village? We hypothesize that: i) the village economy is strongly characterized by agricultural production, especially export-oriented crop production; (ii) the

multiplier effects are higher for the livestock commodities and village labor, which are highly exchanged within the village; and (iii) the effects resulting from policy changes are highly heterogeneous, as PRONAF produce high effects on the commodity markets, but limited effects on household income, while the social protection programs have small effects on local commodity markets, but strongly affect household income.

5.2 The description of the Rincão dos Maia village economy

5.2.1 The interlinkages among economic sectors in a village economy

The SAM is an important tool to systematize the interconnection between production activities, added value and households in rural economies. These interconnections are visually shown in the Figure 5.1. In this framework, the direction of the arrows represents the flow of money as a result of previous flow of goods and services. In the center of this framework are the households, which are endowed with factors, sold in factor markets. These factors are used in productive activities, which pay the factors, and finally remunerate the households, according to their factor endowment. Besides factor income, household can also earn income through transfers from the government (social transfers). Part of households' income can be used for the consumption of commodities, and the remaining is saved in the account "Savings/Investment". The consumption of commodities by the households generate a sales income, which is used to pay the activities for the production of commodities. These activities may also purchase commodities, used in the production process (intermediate demand). In the case production activities produce more commodities than domestically demanded (surplus production), they will be sold to the rest of the world (exports). In the opposite case, commodities are purchased from the rest of the world (imports). The government earns its income from taxes (VAT and Funrural), from foreign grants and aid, and spends its income in the form of social transfers to households. In the case the government spends more than it earns, then the government borrows money from Investment (fiscal deficit), while when it earns more than it spends, the government pays to Investment (fiscal surplus).

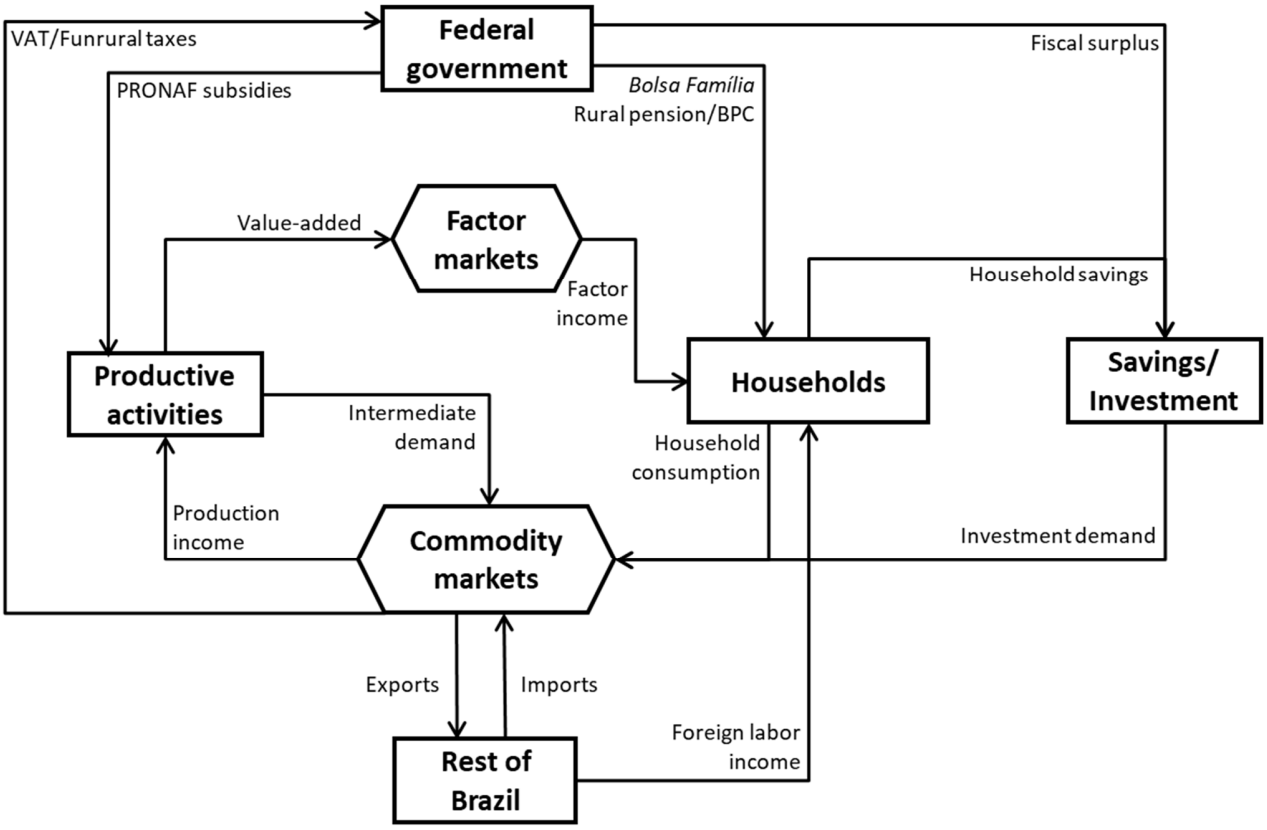

Figure 5.1: Visual representation of the circular flow of the Rincão dos Maia economy
Source: adapted from Breisinger et al. (2009)

An example of a SAM, in its tabular form, is given in the Table 5.1. The SAM contain receipts and expenditures of different village activities, village factors, village institutions, village capital accounts, and the rest of the world. The rows and columns need to be identical, so that every income registered in the row account also has a respective column account, in which the expenditures are going to be listed. The consistency of the SAM foresees that totals of rows and columns match, so the economic system becomes balanced (J E Taylor & Adelman, 1996).

Table 5.1: Outline of a village Social Accounting Matrix framework

	Expenditures							
Receipts	**1. Commodities**	**2. Activities**	**3. Factors**	**4. Institutions**		**5. Capital**	**6. Rest of the World**	**7. Row Total**
				Smallholders	**Government**			
1. Commodities		Intermediate consumption		Consumption demand	Government demand	Investment	Export	Total demand
2. Activities	Marketed production							Total output
3. Factors	Value-Added in village production						Factor transfer income	Total factor value-added
4. Institutions			Distribution of factor income	Inter-household transfers	Transfers from public programs			
Smallholders							Remittances	Total income
Government	Sales taxes	Production taxes		Income taxes			Transfer	Government income
5. Capital				Household savings	Government savings			Total savings
6. Rest of the World		Import	Factor payment	Transfers to rest of the world				Total imports
7. Column Total	Total supply	Total output	Total payments factors	Total household expenditure	Government expenditure	Total capital investment	Total exports	

Source: adapted from Taylor & Adelman (1996)

5.3 The Rincão dos Maia village SAM

The Rincão dos Maia village SAM is structured to allow the presentation of local exchanges among households and economic sectors as an important pathway through which the effects of policy changes are transmitted through the economy. Therefore, crop and livestock commodities have been explicitly grouped according to their destination, e.g. whether they have been traded in the regional (imported or exported) or in the local markets (local sales). Moreover, as households are also engaged in subsistence production, accounts aggregating the crop and livestock commodities produced by households for own consumption have also been created. Furthermore, crop and livestock activities have been aggregated at the level of household livelihood strategy. As a result, our later analysis of the multipliers will allow us to clearly identify the type of commodity impacted by policy changes according to their destination, which will give us an idea on the transmission of policy effects through the village economy. Moreover, we will be able to assess the activities conducted by each group of households impacted by the same policy changes, allowing us to make conclusions on the effects produced by policy changes on household activities.

The SAM of the Rincão dos Maia village has 20 commodities, 14 activities, 6 factors of production, divided into 3 categories of labor, 2 accounts for land and 1 account for capital, 4 different types of households, 6 accounts for the government, and one account for the Rest of the World. Table 5.2 below presents in detail the accounts of the Rincão dos Maia village SAM.

Table 5.2: The accounts of the Rincão dos Maia village SAM (2017)

Group of accounts	Labels
Commodities(20)	
Commodity Crop sales outside the village (exports)	ccrop_sale
Commodity Crop production for home consumption	ccrop_hphc
Commodity Crop sales inside the village	ccrop_locsale
Commodity Crop used for feed	ccrop_feed
Commodity Crop exchanged with other households	ccrop_exch
Commodity Crop given away as gift	ccrop_gift
Commodity Crop stored	ccrop_stored
Commodity Livestock sales outside the village (exports)	clive_sale
Commodity Livestock production for home consumption	clive_hphc
Commodity Livestock products sales inside the village	clive_locsale
Commodity Homegarden products	chomegarden
Commodity Crop inputs	ccrop_input
Commodity Livestock inputs	clive_input
Commodity Processed food	cproc_food
Commodity Construction materials	cconstruction
Commodity General household utilities and appliances	cgen_consumption
Commodity Cars and Motorbikes	cmobility
Commodity Agricultural tools	cagri_tools
Commodity Agricultural machinery	cagri_machine
Commodity Agricultural buildings	cagri_buildings
Activities (14)	
Activity Crop production Household group LS1	ahh1_crop
Activity Crop production Household group LS2	ahh2_crop
Activity Crop production Household group LS3	ahh3_crop
Activity Crop production Household group LS4	ahh4_crop
Activity Livestock production Household group LS1	ahh1_live
Activity Livestock production Household group LS2	ahh2_live
Activity Livestock production Household group LS3	ahh3_live
Activity Livestock production Household group LS4	ahh4_live
Activity Homestead gardening	ahomegarden
Activity Machinery rent	amrent
Activity Local shop	aform_market
Activity Slaughterhouse	aslaughterhouse
Activity Construction work	aconstruction
Activity Repair shops	arepairshops
Labor (3)	
Factor Family Labor	ffam_lab
Factor Off-farm Labor	fofffarm_lab
Factor Exchanged Work	fexch_lab
Land (2)	
Factor Rented Land	frentedland
Factor Owned Land	fownedland
Capital (1)	
Factor capital	fcapital
Households (4)	
Households – livelihood strategy LS1	hhcluster1
Households – livelihood strategy LS2	hhcluster2
Households – livelihood strategy LS3	hhcluster3
Households – livelihood strategy LS4	hhcluster4
Government (6)	
Government - *Bolsa Família*	govbf
Government - PRONAF loan	govpronaf
Government – Pension	govpension
Government – VAT tax	vat
Government – Export tax	exptax
Government – Sales tax	funrural_loc
Capital (2)	
Stock change	dstoc
Savings-Investment	kap
Rest of the World (1)	
Rest of the World	row

Source: author

The Rincão dos Maia village SAM was developed with information referring for the harvest year 2016/2017, which lasts from July 2016 until June 2017. The calculation of SAM data was conducted using primary data collected on the survey, supplemented by data from the literature when primary data was lacking. As a result of measurement errors or inconsistent data, SAMs are normally unbalanced at the initial stage. Therefore, we used a balancing technique called the Cross-Entropy (CE) method, which estimates coefficients that minimize the entropy distance between the prior and the new estimated coefficient matrix (Golan et al., 1994). More information can be found on the Appendix 8.1. The SAM was balanced using the cross entropy method written on GAMS, and made available by IFPRI (Robinson & El-Said, 2000). The balanced macro-SAM of the Rincão dos Maia village is presented in Table 5.3.

5.4 Description of the village SAM

5.4.1 Commodities

Commodities produced in the Rincão dos Maia village are composed by agricultural, split into crop and livestock commodities, and off-farm commodities (Table 5.4). Overall, agricultural commodities amount to 3.88 million BRL, which responds for 45% of total commodities recorded in the village economy. Out of these, 3.52 million BRL were produced by local agricultural activities, with the rest being export taxes and imports, especially of eucalyptus (used as intermediate input for drying tobacco leaves) and cattle (imported by the local slaughterhouse).

Crop commodities altogether amount to 3.13 million BRL, which accounts for 40% of total commodities recorded in the village economy. Out of these, 2.91 million BRL (36% of total commodities) are produced by cropping activities conducted by local farmers, with the remaining being accounted by export taxes (for exported commodities) and imports (eucalyptus). Most of the commodities in the village economy are produced by cropping activities, especially by cropping activities carried out by households primarily producing

Table 5.3: Balanced macro-SAM of the Rincão dos Maia village, in ten thousand BRL* (2017)

Receipts \ Payments	Commodities	Activities	Land	Labor	Capital	Households	Government	Capital account	Rest of the world	Total
Commodities		154.6				261.3		71.9	304.4	**792.1**
Activities	403.0									**403.0**
Land		48.0								**48.0**
Labor		140.4							20.3	**160.7**
Capital		60.5								**60.5**
Households			48.0	159.4	60.5		54.0			**322.0**
Government	66.4	-0.5							54.0	**119.8**
Capital account						60.7		3.6		**64.3**
Rest of the world	322.8			1.2			65.8	-11.2		**378.6**
Total	**792.1**	**403.0**	**48.0**	**160.7**	**60.5**	**322.0**	**119.8**	**64.3**	**378.6**	

*USD/BRL: 5.04 (OANDA (2020), accessed on Dec 12th 2020)

Source: author

tobacco (household group 3), with tobacco and peach production responding each for 2.14 million BRL (73%) and 0.4 million BRL (13%) of total crop sales, which are primarily exported, respectively.

Livestock commodities amount to 0.7 million BRL, which accounts for 9% of total commodities recorded in the village. Out of these, 0.6 million BRL are produced by local livestock activities, with the rest from export and sales taxes, as well as from imports of cattle. Livestock production is carried out by relatively rich households (groups 2 and 3). Throughout the different households, the livestock commodity production for home consumption responds for a high share of total livestock output.

The off-farm commodities account for the remaining commodities in the village, responding to 55% of total commodities. Out of these, 0.4 million BRL are produced or traded by local village activities, such as crop inputs (especially own seeds and livestock manure), processed food sold by the local shop, and construction and repair services. The remaining is due to VAT taxes and due to imports, which are brought into the village especially from the shops in the municipality's seat.

In Brazil, direct sales of agricultural products shall be levied with a 2.5% tax called FUNRURAL, paid by the commodity buyers. In practice, only the "official" sales are recorded through the issuance of a sales receipt, and therefore only these are considered as target of the FUNRURAL tax. In the present case, this applies for all products "exported", and the local sales destined to the local slaughterhouse (cattle and pork). For the purpose of modelling, FUNRURAL has therefore been split into an "export tax" (for exported goods) and a sales tax (for local sales). Furthermore, the VAT tax is calculated for all the processed commodities (food and non-food).

5.4.1.1 Crops

Given the importance of agricultural commodities in the village, it is worth to look at them with greater attention. Most of the crop products were sold in the formal market, which is greatly exported, with 2.6 million BRL in crop commodities exported, especially to the regional market (Table 5.5). Among these crops, tobacco and peach respond each for 73 and 13% of total

exports of crop commodities, respectively. The remaining production for sale are made up by other minor cash crops, such as tomato, soybean, peach seedlings and oranges. There are though differences in crop activities for the export market by household groups: while for cash crop producers (household groups LS2 and LS3) exports respond to around 90% of crop output, poor households (LS1) and with elderly members (LS4) export 84 and 66% of their crop outputs, respectively.

Table 5.4: Production of selected village commodities, levied taxes and imports (in ten thousand BRL)

	Crop regional market	Crop subsistence	Crop feed	Crop local sales	Livestock regional market	Livestock subsistence	Livestock local sales	Crop inputs	Livestock inputs	Processed food	General household consumption
Crop activity LS1	16.2	0.8	0.4	0.3				0.1			
Crop activity LS2	45.3	2.3	4.0	0.2				0.1			
Crop activity LS3	204.5	6.1	4.5	2.4				0.3			
Crop activity LS4	5.0	1.3	1.0	0.4				0.1			
Livestock activity LS1					0.3	4.9		0.2			
Livestock activity LS2					12.6	10.7	0.6	0.7			
Livestock activity LS3					1.1	16.9	0.7	0.5			
Livestock activity LS4					0.5	7.2	0.0	0.2			
Activity local retail								0.1		1.0	3.1
Activity slaughterhouse										29.4	
Other activities								3.4			
Tax - VAT								11.2	1.0	6.3	19.7
Tax – export	6.5				0.0						
Tax – FUNRURAL					0.6						
ROW	13.7			0.2	10.1			65.6	4.9	43.4	80.4
Total	**291.1**	**10.5**	**10.1**	**3.6**	**25.3**	**39.7**	**1.4**	**82.5**	**5.9**	**80.1**	**103.2**

Source: author

Crop commodities are also used for household subsistence and for feeding livestock. Out of the 23 crops, 20 crops were produced at least partially to supply the demand for household home consumption, even though their production value lies way below the value produced for export. In absolute terms, households specialized in cash crop production (household group 3) are again the main producers of crop commodities for home consumption. However, in relative terms, production for home consumption only responds for 3% of the activity's output of this household group, while it responds up to 15% for households with elderly members (group 4), and for around 5% for poor as well as for peach and livestock producing households (groups 1 and 2, respectively). Only maize and pumpkin were especially cultivated to be used as feed for livestock, with the other crop products given to livestock as byproducts for home consumption.

Table 5.5: Value of commodities produced by village crops in the Rincão dos Maia village, in BRL

	Exports	Subsistence	Feed	Local sales	Exchanged	Gift	Stored
Maize		447.0	90,787.1	9,686.4	170.3	851.4	22,378.4
Tobacco	2,090,135.7						
Beans	9,496.5	27,454.5		4,070.0	3,062.4	1,511.7	8,501.3
Peach	385,807.5	845.5					
Irish potato		21,600.0	190.0				
Sweet potato		8,535.0	5,557.5	300.0		375.0	52.5
Cassava		1,780.0	155.0			250.0	
Pumpkin		1,432.0	3,316.0	30.0		48.0	
Cucumber	146.3	60.0					
Tomato	10,968.8	1,350.0					
Strawberry	2,437.5	125.0					
Soybeans	36,270.0						
Peach seedlings	39,000.0			10,000.0			
Oranges	27,105.0	1,850.0	500.0				150.0
Onions		546.0		2,770.0		240.0	
Peanut		3,484.0				100.0	1,316.0
Eucalyptus		31,455.0		5,800.0		4,725.0	450.0
Fig	27,368.3	37.5		500.0			
Grapes	1,365.0	1,400.0					3,150.0
Watermelon		1,200.0					
Guava	390.0	200.0				0.0	0.0
Garlic		160.0			40.0	40.0	0.0
Total	**2,630,490.5**	**103,961.5**	**100,505.6**	**33,156.4**	**3,272.7**	**8,141.1**	**35,998.2**

Source: author

Local sales of crop commodities are relatively weak in the village. Most of the crop products sold among farmers are beans and onions (for home consumption), maize (feed), and peach seedlings and eucalyptus (as intermediate inputs for peach production and tobacco drying, respectively). It is noteworthy that only matches between local sales and local purchases were considered as local sales for this analysis, while local sales with no correspondent local purchases were considered as exports to other households in the municipality.

Corp products were also exchanged, especially for labor (beans), and given away as gifts, mostly to family members. Finally, maize, beans and eucalyptus were the most important crops stored at the farm.

5.4.1.2 Livestock

Contrary to crop production, village livestock production is mainly sold in the local market, especially cattle, sold to the local slaughterhouse, responding for 93% of total livestock sales in the village (Table 5.6). Milk is sold to the regional milk processing company, but the activity has lost importance over the last years especially due to the bankruptcy of a big local cooperative in the beginning of the 2000's. The remaining sales of livestock products are only of minor importance, with some activities registering no sales at all. The exports of livestock products only accounts for 2% of the total livestock production.

Most of livestock production is produced for home consumption for all livestock activities, with the exception of cattle (Table 5.6). Most households in the village owns some kind of livestock to supply some of the family's protein needs, and which are not intended to be sold on the market. The most remarkable examples are chicken and pork production, whose products (eggs and meat) are primarily produced for the family needs.

Table 5.6: Value of commodities produced by village livestock activities, in BRL

	Exports	**Subsistence**	**Local sales**
Cattle	2,500	22,500	136,500
Milking cows	8,582	47,403	2,700
Pig	600	86,209	7,100
Chicken - meat		92,080	
Chicken - eggs	720	11,512	936
Sheep		11,963	1,740
Bees		399	1,200
Total	**12,402**	**272,066**	**150,176**

Source: author

5.4.2 Activities

The demand of intermediate inputs by each of the village production activities gives us the village input-output table, presented in Table 5.7. In the economy of the Rincão dos Maia

village, strongly characterized by agricultural production activities, inputs for agricultural production are by far the most important commodities used as intermediate goods. Among these, the demand for imported crop inputs surpasses by far the demand for inputs sold locally and produced by the farms themselves. Tobacco and peach production activities are the ones demanded the most of crop inputs, and is reflected in the relative high demand for crop inputs by crop activities carried out by household groups 2 and 3 (mostly peach and tobacco producers, respectively). Some crop commodities produced in the village are used as intermediate goods by crop activities, such as eucalyptus (used for drying the tobacco leaves) and peach seedlings (used in peach orchards).

Livestock production, as a rule, is conducted mostly with resources and commodities produced on the farm, with relatively little inputs of purchased commodities as intermediate inputs. That explains the high value of own produced feed used in livestock production, and relatively smaller demand for purchased feed and other livestock inputs, such as veterinary assistance. Moreover, input commodities for livestock are especially demanded by livestock production carried out by cash crop producers (groups 2 and 3, respectively).

Table 5.7: Input-output table of selected village activities

	Crop activity LS1	Crop activity LS2	Crop activity LS3	Crop activity LS4	Livestock activity LS1	Livestock activity LS2	Livestock activity LS3	Livestock activity LS4	Activity local retail	Activity slaughterhouse
Crop inputs – imported	6.6	23.14	73.1	2.98					1.23	
Crop inputs - local sales		0.2	1.25		0.03	0.05	0.32	0.01		
Crop inputs - own production	0.15	0.45	2.47	0.08						
Livestock inputs - imported					0.59	2.6	1.77	0.94		
Livestock inputs - local sales										24.71
Livestock inputs - own production					0.43	4.04	4.56	1.01		
Processed food									0.72	
Total	**6.75**	**23.79**	**76.82**	**3.06**	**1.05**	**6.69**	**6.65**	**1.96**	**1.95**	**24.71**

Source: author

In the production process, factors are demanded and used. Table 5.8 presents the factor demand of selected village activities. The different labor types compose the most important production factors in the village. Among them, the most important factor is family labor, responding for 50% of total payments made for factors. This is also the only factor which is used

by all the village activities. Given that agricultural activities are the most important activities in the village economy, it pays, alone for family labor, 46% of total payment to factors. Off-farm work is only paid by cash crop producers and by households with pension beneficiaries (households 2, 3 and 4) in order to complement labor available at the household, with most of the hired labor supplied by local crop laborers. The exchange of labor is a common practice among tobacco producing households as a form to fill labor shortages at critical cropping events, especially during tobacco harvest.

Rented land is only demanded by cropping activities, especially for the production of cash crops, with livestock activities only conducted on own land. Therefore, cropping activities of cash crop producers (household groups 2 and 3) are the highest demanders for rented land. The payment for rented land among poor households (household group 1) is due to tobacco production and in-kind rent payment for own consumption in sharecropping arrangements. Owned land is also remunerated especially by cropping activities, given the big share of land destined for this activity. As land ownership is strongly skewed towards richer households, mostly producing cash crops, cropping activities by household groups 2 and 3 pay the most for owned land.

The payment for capital shows again that it was the highest by crop and livestock activities conducted by tobacco, and peach and livestock producers (household groups 3 and 2, respectively).

Table 5.8: Factor demand by village activities, in ten thousand BRL

	Crop activity LS1	Crop activity LS2	Crop activity LS3	Crop activity LS4	Livestock activity LS1	Livestock activity LS2	Livestock activity LS3	Livestock activity LS4	Activity local retail	Activity slaughterhouse
Land – rented	0.6	0.3	9.6	0.1						
Land – Owned	2.5	6.5	18.6	2.1	0.5	4.5	2.0	0.6		
Labor – family	4.7	12.5	68.8	1.7	3.1	10.8	8.4	4.3	0.8	2.4
Labor –off-farm		4.1	4.9	0.3						
Labor – exchanged	0.8	0.2	4.4							
Capital	2.6	6.8	37.1	0.9	0.8	2.7	2.1	1.1		2.4
Total	**11.2**	**30.4**	**143.4**	**5.1**	**4.4**	**18**	**12.5**	**6**	**0.8**	**4.8**

Source: author

Finally, some village activities receive PRONAF subsidies through the subsidized interest rates, as shown in Table 5.9. It was estimated through the estimation of the subsidies resulting from the access to the two credit modalities (crop and investment loans), calculated as year subsidies. From the total subsidies, the biggest share is directed towards crop production, especially to crop activities conducted by cash crop producers (household groups 2 and 3). It is remarkable that, even though no PRONAF loans can be accessed to support tobacco production, 74% of the PRONAF subsidies end up going to tobacco producers. The subsidies to livestock production are very small in comparison with subsidies to crop production.

Table 5.9: PRONAF subsidies to village agricultural activities, in BRL

	Crop activity LS1	Crop activity LS2	Crop activity LS3	Crop activity LS4	Livestock activity LS1	Livestock activity LS2	Livestock activity LS3	Livestock activity LS4	**Total**
PRONAF subsidy	-173.06	-1,103.04	-4,039.72	0	0	-124.86	-32.29	0	**-5,472.97**

Source: author

5.4.3 Factors

The factors remunerated by activities reward factor owners according to the amount of production factors owned by them. In a rural village, the factor owners are normally households, as this is the case of the Rincão dos Maia village (Table 5.10).

Table 5.10: Remuneration of households according to their factor ownership, in ten thousand BRL

	Land – rented	Land - owned	Labor - family	Labor – off-farm	Labor - exchange	Capital	**Total**
Household LS1	0.0	3.0	8.6	16.6	0.8	3.5	**32.5**
Household LS2	3.1	11.0	27.3	0.3	0.2	12.1	**54.0**
Household LS3	2.9	20.6	82.5	10.0	4.4	42.6	**163.0**
Household LS4	4.6	2.8	7.3	1.5	0.0	2.3	**18.5**
ROW				1.2			
Total	**10.6**	**37.4**	**125.6**	**29.6**	**5.4**	**60.6**	

Source: author

Most of the factor income in the village comes from labor, representing 60% of total factor income, with family labor playing a prominent role among them, representing alone 47% of total factor income. The income from labor though is not similar for among all household groups: while pension beneficiaries (household group 4) earn 48% of their income from labor,

poor and landless households (household group 1) earn 80% of their factor income from labor, and cash crop producers (household groups 2 and 3) earn 52 and 56%, respectively. For cash crop producers, around 50% of factor income is produced by family labor, while it is only 26% for poor households. For this last group, off-farm labor is the sole most important contributor to factor income, responding to 51% of total factor income. A very small amount of off-farm labor is imported into the village, attesting for the

The two land factors remunerate households in different ways. On the one hand, given that land is owned by all groups of households with the exception of poor households (group 1), their owned land income varies from 13 to 20% of total household factor income. On the other hand, rented land remunerates especially pension beneficiaries (group 4), given the fact that they own land, but do not farm all of it themselves, renting it out to neighboring farmers, especially tobacco producers.

The factor capital responds for around one quarter of total factor income for producers of cash crops (groups 2 and 3), and which are capital intensive activities.

5.4.4 Institutions: village households

Income of households is composed by factor income and transfers from the government. In the Rincão dos Maia village, government transfers through the *Bolsa Família* cash transfer program and the pension benefits contribute considerably in household income.

Household income is composed by the payment of factor revenue, paid to the households who own the factors, and the transfers from the government programs *Bolsa Família* and the pension benefits (Table 5.10). The composition of household income from factors and from government transfers varies across households: poor households (group 1), as well as cash crop producers (groups 2 and 3) earn the majority of their income from factors (88, 85 and 96%, respectively), while the group of pension beneficiaries (group 4) earns most of its income from government transfers, specifically from pension benefits (65%). As seen above, among the factors, the highest revenue comes from labor, especially from family labor.

The government transfers also vary across household groups. *Bolsa Família* is paid primarily to poor households, and to households engaged in cash crop production (groups 1 and 3). For the poor households, *Bolsa Família* transfers respond to around 9% of total household income, which is relatively low in comparison with the other sources of income show in the table below. The pension benefits are paid primarily to households with retired members and to peach producers (groups 4 and 2, respectively). Poor and tobacco producing households are relatively younger than the other households, and therefore their income from pension transfers is very low, amounting to around 3% of total income. There are no inter-household transfers in the village.

Table 5.9: Absolute and share of household income resulting from factor income and government transfers

		Factors			Government transfers		
	Total	**Land**	**Labor**	**Capital**	***Bolsa Família***	**Pension**	**Total**
	in ten thousand BRL	%					
Household LS1	**37.1**	8.1%	69.8%	9.4%	9.4%	3.0%	100%
Household LS2	**63.2**	22.3%	44.1%	19.1%	-	14.6%	100%
Household LS3	**169.2**	13.9%	57.3%	25.2%	0.3%	3.3%	100%
Household LS4	**52.6**	14.1%	16.7%	4.4%	-	64.8%	100%

Source: author

Household expenditure on commodities and household savings varies across goods and groups of households (Table 5.11). Poor households (group 1), which also lack access to land and agricultural assets, are the ones purchasing most of the crop and livestock sales by local households, both in absolute and relative terms. The most commonly sold crop product is beans, and livestock products sold and purchased locally are milk, sheep and honey.

Home production for own consumption, both crop and livestock commodities, are important sources of food across all household groups, with its relative share ranging from 12 to nearly 20% of total household expenditures. Even though the share of expenditures does not change much across households, it is remarkable that home production for own consumption is the lowest among tobacco producers (group 3). Homestead gardening also contributes to household food provision, and it responds, across all households, for 1 to 3% of total household expenditure, with the higher rates found among poor and old households (groups 1 and 4). Expenditures on food are complemented by purchases of processed food (bought on the local

and regional supermarkets), and are remarkably high for poor and older households (groups 1 and 4), hinting at a high reliance on processed food to cover the household food demand.

The biggest share of household expenditures is spent on general non-food consumption goods, such as kitchen utensils, clothes and furniture, which are especially purchased at the retailers in the municipality of Canguçu. The expenditure share is especially high for older households, for which this type of expenditures responds to nearly half of total household expenditures.

Expenditures with construction materials and bricklayer services exclusively for housing (not considering investments in crop or livestock buildings) vary strongly among household groups: while poor and peach producing households (groups 1 and 2) only spend 3 and 5% of their total expenditures on house construction, respectively, the tobacco producing and older households (groups 3 and 4) spent 13 and 20% of their expenditure in construction.

Table 5.11: Household expenditures on commodity consumption and household savings

	Household LS1		**Household LS2**		**Household LS3**		**Household LS4**	
	BRL	%	BRL	%	BRL	%	BRL	%
Crop products – local sales	1,856	1%	479	0%	687	0%	920	0%
Crop products – subsistence	6,799	2%	18,156	3%	36,664	2%	11,543	2%
Livestock products – local sales	1,704	0%	280	0%	1,470	0%	1,383	0%
Livestock products – subsistence	49,235	13%	107,331	17%	168,508	10%	71,941	14%
Homestead gardening	8,024	2%	8,580	1%	18,728	1%	15,887	3%
Processed food	99,158	27%	51,113	8%	238,163	14%	135,415	26%
General household consumption	146,070	39%	151,936	24%	452,468	27%	241,050	46%
Construction	9,525	3%	28,790	5%	211,744	12%	106,099	20%
Cars and motorbikes	27,554	7%	23,255	4%	101,685	6%	50,405	10%
Savings	18,581	5%	237,874	38%	462,309	27%	-110,348	-21%
Total	**370,607**	**100%**	**632,348**	**100%**	**1,695,783**	**100%**	**525,696**	**100%**

Source: author

5.5 SAM multiplier analysis

SAM multiplier analysis is an important step to be taken to understand the village-wide economic effects of exogenous shocks, such as development programs, on production activities, income distribution among household groups and value added. Additionally, SAM

multiplier analysis allows capturing production and consumption linkages, as well as the interactions among them.

Multi-sectoral multiplier models can be used to analyze the effects of policy changes (Adelman & Robinson, 1986), such as changes in the implementation of public programs in Rincão dos Maia village. The SAM provides the basis for a simple linear model formed by dividing each column by its total. This coefficient matrix can be expressed in a system of linear equations. Each column of the coefficient matrix sums to unity, and therefore it is singular (A. Subramanian & Qaim, 2009). Hence, this system can be solved by considering some accounts as exogenous and other as endogenous. Here, production activities, commodities, factors, and institutions accounts are treated as endogenous, and government, capital, and Rest of the World accounts are treated as exogenous. As such, assuming excess capacity in the village economy, any exogenous policy change can be satisfied through a corresponding change in the economy without having any effect on prices. The multiplier analysis further assumes unitary expenditure elasticity to maintain constant expenditure propensities, and constant production technology and resource endowment (Bellu, 2012).

The effects of policy changes on the outputs of production activities, the incomes of various factors and household groups can be estimated through the multiplier process transmitted through the SAM system. The matrix *M,* called the accounting multiplier matrix, or the Leontief matrix, contains estimated total direct and indirect effects of exogenous factors on the endogenous accounts in the village SAM (J E Taylor & Adelman, 1996). This matrix can be decomposed into separate effects as follows (equation [5.1]):

$$M = I + (M_1 - I) + (M_2 - I) * M_1 + (M_3 - I) * M_2 * M_1 \quad [5.1]$$

Where $M_1 = \left(I - \tilde{A}_n\right)^{-1}$, $M_2 = (I + A^* + A^{*2})$, and $M_1 = (I - A^{*3})^{-1}$.

The first term on the right-hand side of equation [5.1] represents the impact of the policy change (I). The second term is block diagonal and is the multiplier of the intra-block transactions. In other works, it represents the direct effects resulting from interactions within

each category of accounts, such as the inter-sectoral input-output elements or the transfers among households (Sadoulet & De Janvry, 1995). The third term represents all net effects initiated by the accounts on the other parts of the economy, and is described as the open-loop multiplier effects between any two different groups of endogenous accounts. It also shows the effects on the rest of accounts of a shock received by one particular account, for example, from production activities on factor income, from factor income on household revenues, or from household revenues on production. Finally, the fourth term captures the net effect of circular income multipliers among endogenous accounts, showing the circular effects on the accounts that are affected by change in exogenous components, which are known as the closed-loop effects of circular flow caused by exogenous shocks. Closed-loop effects show the full circular effects of an income injection traveling through the system back to its point of origin, e.g. from production activities to factors, which reward households, and then back to activities in the form of consumption demand (Sadoulet & De Janvry, 1995). Further information on SAM multipliers can be found in Appendix 8.2.

5.5.1 Results of the multipliers of village activities

The accounting multiplier effects presented in Table 5.12 are calculated as the sum of the transfer, open-loop and closed-loop effects produced by an increase in demand for activities. The transfer effects quantify the net effect of a unitary change in demand in respect to itself. Open-loop effects capture the net direct effect between (inter) accounts (has zeros in the diagonal). Closed-loop effects are indirect effects of a unitary shock of the activity account. Table 5.13 presents the breakdown the multipliers as explained above for the village activities on the commodity market. Again, the highest multiplier (total) effects are registered for the activity slaughterhouse, with a great share of its multiplier effect resulting from transfer effects, i.e., from its effect on itself. Concretely, it means that the total multiplier is highly influenced by the effects produced by the activity on the local commodity market, which is very true for the slaughterhouse due to its local purchases of cattle. The same high value is also seen for the village shop, which is owned by one village household and clearly has little linkages with other village activities and/or households.

Table 5.12: Accounting multiplier of selected village activities on commodities

	Crop activity LS1	Crop activity LS2	Crop activity LS3	Crop activity LS4	Livestock activity LS1	Livestock activity LS2	Livestock activity LS3	Livestock activity LS4	Activity homestead gardening	Activity local retail	Activity slaughterhouse
Crop regional market	0.105	0.048	0.082	0.033	0.009	0.014	0.019	0.012	0.004	0.002	0.008
Crop subsistence	0.030	0.027	0.033	0.030	0.026	0.026	0.026	0.025	0.029	0.010	0.017
Crop feed	0.024	0.021	0.024	0.023	0.107	0.191	0.264	0.154	0.031	0.019	0.101
Crop local sales	0.003	0.006	0.008	0.002	0.008	0.005	0.020	0.005	0.003	0.001	0.004
Crop others*	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.001	0.003
Homestead gardening	0.012	0.011	0.012	0.011	0.014	0.014	0.014	0.014	0.016	0.006	0.009
Livestock regional market	0.038	0.035	0.039	0.037	0.046	0.045	0.044	0.044	0.053	0.097	0.846
Livestock subsistence	0.104	0.091	0.107	0.100	0.126	0.123	0.121	0.122	0.145	0.052	0.084
Livestock local sales	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.003	0.003	0.026
Crop inputs	0.297	0.399	0.281	0.343	0.045	0.071	0.098	0.059	0.021	0.029	0.039
Livestock inputs	0.014	0.012	0.014	0.013	0.124	0.121	0.107	0.134	0.018	0.012	0.062
Processed food	0.127	0.115	0.131	0.122	0.152	0.148	0.146	0.148	0.175	0.323	0.101
Construction	0.091	0.076	0.093	0.084	0.110	0.106	0.105	0.107	0.128	0.046	0.073
General household consumption	0.259	0.226	0.261	0.236	0.297	0.291	0.286	0.289	0.342	0.496	0.198
Cars and motorbikes	0.051	0.045	0.052	0.048	0.061	0.059	0.058	0.059	0.070	0.025	0.040
Agricultural tools	0.008	0.01	0.015	0.018	0.002	0.003	0.004	0.002	0.001	0.056	0.002
Total commodities	**1.168**	**1.126**	**1.159**	**1.104**	**1.132**	**1.223**	**1.318**	**1.181**	**1.043**	**1.179**	**1.613**

*crop products exchanged, stored and received as gifts

Source: author

Table 5.12 shows the multiplier effect that a change of one unit in the activity accounts produces on the commodity demand. The total multiplier produced by a given activity is shown at the bottom of the table, which are the result of the sum of all multipliers of the village commodities. Clearly all activities produce multipliers greater than 1, which means that an increase of one unit in the demand of any given activity will produce an increase in commodity supply greater than 1. In other words, the total column sums entail the diffusion (forward) effects on the productive activities of the village generated by each activity. The effect is the highest for the activity “slaughterhouse”, with a multiplier of 1.613, especially high due to the single contribution of the commodities resulting from livestock sales. The cropping activities produce multipliers ranging from 1.104, for the cropping activities conducted by pension beneficiaries, to 1.168 for poor households. This last figure is greatly influenced by the increase

in supply of crop regional sales. An increase in demand for livestock activities produce slightly higher supply responses on the commodity markets as compared to crops, with multipliers ranging from 1.132, for poor households to 1.318, for cash crop producing households. In both cases, the supply of crop products used as feed responds for the greatest difference with the other livestock producing activities.

The understanding of the open-loop and closed-loop effects of village activities entails the linkages among different accounts in the village economy, and is therefore of great importance. The analysis of the open-loop effects, which details the impacts on accounts other than the one of origin, show that homestead gardening has the higher net direct effects in the village economy. Closed-loop effects, which entails the indirect effects produced by an increase of the demand of a given activity on other accounts, reveal that crop and livestock production activities have both the greatest indirect effects in the demand for commodities in the village.

Table 5.13: Breakdown of multiplier effects of different village activities on commodities

	Transfer effects (own effect)	Open-loop effects (net direct effect)	Closed-loop effects (indirect effect)	Accounting multipliers (total effect)
Crop activity LS1	0.416	0.448	0.304	**1.168**
Crop activity LS2	0.464	0.428	0.235	**1.126**
Crop activity LS3	0.386	0.506	0.267	**1.159**
Crop activity LS4	0.389	0.353	0.362	**1.104**
Livestock activity LS1	0.228	0.657	0.246	**1.132**
Livestock activity LS2	0.341	0.546	0.336	**1.223**
Livestock activity LS3	0.452	0.588	0.279	**1.318**
Livestock activity LS4	0.302	0.638	0.241	**1.181**
Homestead gardening	0.000	0.843	0.200	**1.043**
Activity local retail	0.803	0.302	0.074	**1.179**
Activity slaughterhouse	1.011	0.412	0.190	**1.613**

Source: author

Exogenous changes in the demand for village activities also affect factor and household income (Table 5.14). The village economy is strongly characterized by agricultural activities, which rely heavily on labor, especially family labor. Homestead gardening, machinery renting, construction and repair services produce the higher responses in factor supply in the village, with responses greater than 1.2. Livestock production activities come next, with multiplier effects slightly

greater than unity, showing that an increase in the demand for livestock producing activities would lead to an even greater response in the supply of production factors. The situation is different for crop producing activities, for which an exogenous increase in demand does not produce multipliers greater than one for production factors, especially due to the demand of labor from outside the village.

The income of households also changes as a result of exogenous changes in village economic activities. The impacts are though very similar to the ones discussed on production factors, given that households are the owners of production factors in the village.

Table 5.14: Multipliers of village activities on production factors and on household income

	Crop activity LS1	Crop activity LS2	Crop activity LS3	Crop activity LS4	Livestock activity LS1	Livestock activity LS2	Livestock activity LS3	Livestock activity LS4	Activity homestead gardening	Activity local retail	Activity slaughterhouse
Land - rented	0.041	0.008	0.048	0.014	0.004	0.006	0.009	0.005	0.002	0.001	0.003
Land - owned	0.173	0.147	0.118	0.278	0.125	0.229	0.163	0.121	0.050	0.020	0.112
Labor – family	0.397	0.340	0.446	0.322	0.718	0.601	0.626	0.690	0.920	0.383	0.403
Labor – off-farm	0.005	0.080	0.027	0.043	0.006	0.010	0.014	0.008	0.003	0.001	0.006
Labor – exchange	0.049	0.006	0.022	0.001	0.002	0.003	0.005	0.003	0.001	0.000	0.002
Capital	0.200	0.174	0.224	0.162	0.194	0.173	0.187	0.192	0.238	0.030	0.173
Household LS1	0.063	0.091	0.071	0.078	0.074	0.076	0.075	0.073	0.082	0.030	0.050
Household LS2	0.191	0.156	0.192	0.189	0.233	0.235	0.224	0.225	0.262	0.095	0.156
Household LS3	0.549	0.462	0.556	0.499	0.682	0.650	0.644	0.661	0.801	0.285	0.452
Household LS4	0.062	0.045	0.066	0.054	0.061	0.062	0.060	0.059	0.067	0.025	0.040
Total factor income	**0.865**	**0.757**	**0.886**	**0.822**	**1.049**	**1.023**	**1.004**	**1.019**	**1.213**	**0.437**	**0.699**
Total household income	**0.864**	**0.754**	**0.885**	**0.820**	**1.049**	**1.023**	**1.003**	**1.019**	**1.213**	**0.436**	**0.699**

Source: author

The breakdown of the accounting multipliers of village activities on household income helps us to identify and understand the interlinkages among household income and village economic activities. Table 5.15 presents the transfer, open-loop and closed-loop effects of changes in demand for activities and the respective multiplier effects it has on household income. Transfer effects are zero due to the absence of direct transfers between activities and households (there is no such account in the SAM). The greatest share of the total multipliers of village activities on

household income is accounted by open-loop effects, unleashed by an increased demand for production factors, which are greatly owned by village households. The open-loop effects equal to unity show the production activities whose demand for production factors are directly paid to households, without leakages to other sectors (i.e. intermediate consumption). The closed-loop effects reflect the indirect effects produced by the increase in activity demand through the change in demand for production factors, which in turn remunerate the household who own them. In this case, the higher the share of factor remuneration in terms of value produced by the activities, the higher the remuneration to the households. This is especially true for service activities (machinery renting, construction and car repair shops) and to homestead gardening. Cropping activities, with a high demand for inputs (and therefore lower remuneration of production factors in terms of total production activity), show lower indirect effects, given that the inputs are mainly imported, and therefore do not produce effects on local activities. The demand for intermediate inputs by the livestock activities is also relatively high, but partially covered by commodities produced locally, especially crop products used for feed.

Table 5.15: Breakdown of multiplier effects of different village activities on household income

	Transfer effects (own effect)	Open-loop effects (net direct effect)	Closed-loop effects (indirect effect)	Accounting multipliers (total effect)
Crop activity LS1	-	0.711	0.153	**0.864**
Crop activity LS2	-	0.619	0.135	**0.754**
Crop activity LS3	-	0.727	0.157	**0.885**
Crop activity LS4	-	0.673	0.147	**0.820**
Livestock activity LS1	-	0.864	0.185	**1.049**
Livestock activity LS2	-	0.842	0.181	**1.023**
Livestock activity LS3	-	0.826	0.177	**1.003**
Livestock activity LS4	-	0.840	0.180	**1.019**
Homestead gardening	-	1.000	0.213	**1.213**
Machinery renting	-	1.000	0.210	**1.210**
Activity local retail	-	0.360	0.077	**0.436**
Activity Slaughterhouse	-	0.576	0.123	**0.699**
Construction services	-	1.000	0.213	**1.213**
Repair shop services	-	1.000	0.212	**1.212**

Source: author

5.5.2 Multipliers of household income

Understanding the effects of changes in household income in the village is of great importance for this study, as direct cash transfers and the payment of pension benefit to households influence their demand for goods and services, which in turn may influence other households' incomes due to the interlinkages among village sectors.

Table 5.16: Multipliers of household income on commodities

	Household LS1	Household LS2	Household LS3	Household LS4
Crop regional sales	0.005	0.005	0.004	0.005
Crop subsistence	0.025	0.035	0.027	0.030
Crop feeding	0.040	0.039	0.027	0.041
Crop local sales	0.007	0.003	0.002	0.004
Crop others*	0.007	0.008	0.003	0.004
Homestead gardening	0.025	0.017	0.014	0.034
Livestock regional market	0.093	0.036	0.051	0.091
Livestock subsistence	0.165	0.200	0.122	0.172
Livestock local sales	0.008	0.002	0.003	0.006
Crop inputs	0.025	0.027	0.018	0.024
Livestock inputs	0.023	0.023	0.016	0.024
Processed food	0.309	0.118	0.170	0.303
Construction	0.054	0.072	0.145	0.233
General household consumption	0.474	0.313	0.322	0.545
Cars and motorbikes	0.090	0.051	0.071	0.113
Agricultural tools	0.001	0.001	0.001	0.002
Total commodities	**1.353**	**0.951**	**0.994**	**1.629**

*crop products exchanged, stored and received as gifts
Source: author

Table 5.16 presents the multiplier effects produced by the unitary change of household income on the village commodity market. The total multiplier effects, presented at the bottom of Table 6.8, show that poor households and household receiving pension benefits (groups 1 and 4, respectively) produce multipliers higher than unity, while the cash (peach and tobacco) producing households (groups 2 and 3, respectively) produce multipliers lower than unity. This means that an increase in household income by the two former groups of households by 1 BRL increase the demand for commodities by 1.353 and by 1.629, respectively, while the two later household groups increase the demand for commodities by only 0.951 and 0.994, respectively.

This is greatly due to the differences in the savings among households, which are relatively high among cash producing households, and low for poor households, or even negative for pension beneficiaries.

The multiplier effects are especially high for processed food and non-food consumption goods, which are mostly imported into the village. Among locally produced commodities, the highest multiplier effect resulting from increased household income is registered for livestock produced for home consumption. Among the other agricultural commodities, crop commodities produced for feed and for home consumption, as well as homestead gardening products also contribute substantially to the household income multiplier effects. Crop commodities produced for the market, both export and local markets, are little influenced by increased household demand, as there is little trade of primary goods within the village.

Table 5.17: Breakdown of multiplier effects of household income on commodities

	Transfer effects (own effect)	Open-loop effects (net direct effect)	Closed-loop effects (indirect effect)	Accounting multipliers (total effect)
Household LS1	0.000	1.119	0.233	**1.353**
Household LS2	0.000	0.735	0.216	**0.951**
Household LS3	0.000	0.831	0.163	**0.994**
Household LS4	0.000	1.376	0.254	**1.629**

Source: author

The breakdown of accounting multipliers of household income on the demand for commodities supports our analysis on the transfer, open-loop and closed-loop effects of household demand. Table 5.17 shows that most of the effects are produced through net direct effects on the demand for commodities, which means that an increase in household demand affects directly the demand for specific commodities. The indirect effects are relatively lower, which means that the effects on the demand for commodities have little influence on other sectors, such as production activities or the factor markets. The results seem plausible with the fact that most of the demanded commodities by households are imported, with little production of value added within the village through the commodity demand. The transfer effects are nil, given that commodities and households belong to different accounts, and therefore there are not transfers between accounts.

The relatively small indirect effects produced by changes in household income on the commodity markets is strongly influenced by the little interactions between the village production activities and the commodities demanded by the village households. Table 5.18 presents the accounting multipliers resulting from changes in household income on the demand for village activities, with the total multipliers presented at the bottom of the table. Across all household groups, the multipliers produced by an increase of household income in 1 BRL produce relatively small effects on village activities. However, among the households, peach and tobacco producing households (groups 2 and 3, respectively) produce the lowest activity multipliers. In comparison with poor and pension beneficiary households, the demand for local food retail and for slaughterhouse activities is remarkably low. This is an important result, as it shows that wealthy households tend to satisfy their demands with imported commodities, which in turn produce little influence on the activity demand in the village. While poor and pension beneficiary households also cover a great deal of their commodity demand with imports, their demand for local goods, which in turn are produced by local activities, is considerably higher.

Table 5.18: Accounting multipliers of household income on village activities

	Household LS1	Household LS2	Household LS3	Household LS5
Crop activity LS1	0.005	0.005	0.004	0.005
Crop activity LS2	0.027	0.029	0.019	0.026
Crop activity LS3	0.043	0.047	0.033	0.043
Crop activity LS4	0.009	0.01	0.007	0.009
Livestock activity LS1	0.022	0.025	0.016	0.023
Livestock activity LS2	0.095	0.073	0.06	0.095
Livestock activity LS3	0.077	0.088	0.056	0.08
Livestock activity LS4	0.032	0.037	0.023	0.033
Homestead gardening	0.025	0.017	0.014	0.034
Activity local retail	0.018	0.011	0.012	0.02
Activity slaughterhouse	0.114	0.044	0.063	0.112
Other village services	0.009	0.009	0.014	0.023
Total activities	**0.477**	**0.395**	**0.319**	**0.502**

Source: author

Changes in household income by 1 BRL produce across all households an outcome greater than unity (Table 5.19). Poor and pension beneficiary households have the greatest increases in

household income across all households. Tobacco producing households produce the least multiplier effect in the village. However, it is the group of household who benefits the most from increases in income of other household groups (row). These figures show that, on the one hand, tobacco producing households are in a position to better respond to increased demand for goods and services resulting from an increase in other households' income. On the other hand, an increase in household income for this same group of households does not benefit as much other village households, as most of the demanded goods do not involve local production activities, and thus have little effect on other households' income. Overall, the fact that poor and pension beneficiary households produce the highest multipliers is consistent with the results presented above, given that a change in their income influences the demand for goods, which involve local production activities, which in turn demand production factors and remunerate the households who own them.

Table 5.19: Accounting multipliers of a change of 1BRL in household income on overall income of village households

	Household LS1	**Household LS2**	**Household LS3**	**Household LS4**
Household LS1	1.020	0.019	0.014	0.022
Household LS2	0.060	1.056	0.042	0.065
Household LS3	0.174	0.161	1.122	0.190
Household LS4	0.016	0.015	0.011	1.017
Total household income	**1.270**	**1.250**	**1.189**	**1.294**

Source: author

The breakdown of multipliers generated by a change of 1 BRL in household income on other households show that, besides the transfer effects, which is 1 for all households (it stands for the change in income by 1 unit), the net direct effects (open-loop) are higher than the indirect effects. Both type of effects are particularly higher for poor and pension beneficiary households, showing that these households benefit more from increased household income through their demand of local goods (direct effects) and through their engagement in production activities demanded locally.

5.6 Scenario analysis

The objective of the scenario analysis is to assess the outcomes of combinations of government transfers using the different programs implemented concomitantly in the Rincão dos Maia village. To be able to compare the outcomes of government spending across programs, we decided to build scenarios using a fixed budget, which is then divided among the different programs, allowing for the comparison of the effects produced on the village economy across the individual programs and their combinations. Therefore, in all scenarios, an increase in public spending of BRL 10 thousand is considered, either for the programs alone, in which case the programs receive the full budget, or in combination, in which case the budget is divided equally among the programs. As such, we end up with seven different scenarios, as shown below (Table 5.20):

Table 5.20: Budget changes of the individual programs in all seven policy experiments, in BRL

Scenarios	*Bolsa Família*	Pension	PRONAF	Total
1. *Bolsa Família*	10,000	-	-	**10,000**
2. Pension	-	10,000	-	**10,000**
3. PRONAF	-	-	10,000	**10,000**
4. *Bolsa Família* + Pension	5,000	5,000	-	**10,000**
5. *Bolsa Família* + PRONAF	5,000	-	5,000	**10,000**
6. Pension + PRONAF	-	5,000	5,000	**10,000**
7. *Bolsa Família* + Pension + PRONAF	3,333	3,333	3,333	**10,000**

Source: author

The implementation of the scenarios varies across programs. *Bolsa Família* and pension benefits are paid directly to the beneficiary households, and so will the additional budget in the different scenarios. Furthermore, the payments are going to increase in the respective scenarios according to the share already (before the shock) transferred to the households. As shown above, *Bolsa Família* beneficiaries belong to the group of poor and tobacco producing households (groups 1 and 3, respectively), and pension beneficiaries are found in all household groups, but especially in household group 4. The PRONAF scenarios are implemented through the payment to activities, as per the estimated SAM they are the recipients of PRONAF transfers. Therefore, the additional PRONAF budget is paid to activities, divided across them according to their initial share of PRONAF subsidy. The group of households with older

members did not access the credit program neither for crop nor for livestock production, and poor beneficiaries did only access it for crop production, but not for livestock. Table 5.21 below shows the share of program budget transferred to households (*Bolsa Família* and pension programs) and to activities (PRONAF), and the simulated transfers to households and activities in the different scenarios.

Table 5.21: Current and simulated transfers, and their accounts of destination, in BRL

	Bolsa Família	Pension	PRONAF	1*	2*	3*	4*	5*	6*	7*
Accounts	**Current program transfers (BRL)**			**Additional transfers under each policy experiment (BRL)**						
Crop activity LS1	-	-	173.06	-	-	316	-	158	158	104
Crop activity LS2	-	-	1,103.04	-	-	2,015	-	1,008	1,008	665
Crop activity LS3	-	-	4,039.72	-	-	7,381	-	3,691	3,691	2,436
Crop activity LS4	-	-	-	-	-	-	-	-	-	-
Livestock activity LS1	-	-	-	-	-	-	-	-	-	-
Livestock activity LS2	-	-	124.86	-	-	228	-	114	114	75
Livestock activity LS3	-	-	32.29	-	-	59	-	29	29	19
Livestock activity LS4	-	-	-	-	-	-	-	-	-	-
Household LS1	34,704	11,244	-	8,654	225	-	4,439	4,327	112	2,930
Household LS2	-	91,464	-	-	1,832	-	916	-	916	605
Household LS3	5,400	56,220	-	1,346	1,126	-	1,236	673	563	816
Household LS4	-	340,476	-	-	6,817	-	3,409	-	3,409	2,350
Total	**40,104**	**499,404**	**5,472.97**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF
Source: author

All the analysis presented in this chapter are produced using the SimSIP_SAM software. The software is based on a Microsoft Excel application (macro) based on MATLAB (Parra & Wodon, 2010).

5.6.1 Results of the scenario analysis on village activities, factors and household income

Table 5.22 shows the effects that the policy scenarios have on the demand for village activities. When considering the budget allocation to individual programs, it is clear that most of the increase in activity demand is due to the increase in budget for *Bolsa Família* and pension benefits. The exception here are the crop activities and machine renting, for which an increase in the PRONAF budget has the highest effect. This is also true for crop activities conducted by

poor and elderly households, which do not benefit directly from PRONAF subsidies. The remaining activities have higher demand in the scenarios involving an increase in the budget of the *Bolsa Família* and pension programs. Surprisingly, even for the livestock production activities by peach producers, which benefits from PRONAF subsidies, has higher demand under the increase of the *Bolsa Família* and pension budgets.

The scenarios including an allocation of additional budget to the *Bolsa Família* and pension programs show the impact on production activities for home consumption and in regard of local services. The two programs stimulate higher demand across all livestock activities, whose main output are goods produced for home consumption. The same applies for homestead gardening, and is especially high when the additional budget is allocated to pension beneficiaries. The demand for retail, car repair and the slaughterhouse services is also higher with an increased budget for *Bolsa Família* and pension programs.

Table 5.22: Baseline and results of scenario analysis on activity demand

		1*	2*	3*	4*	5*	6*	7*
	Baseline (in BRL)				**%**			
Crop activity LS1	179,748	0.03	0.03	0.22	0.03	0.13	0.13	0.09
Crop activity LS1	541,268	0.05	0.05	0.43	0.05	0.24	0.24	0.17
Crop activity LS1	2,197,639	0.02	0.02	0.38	0.02	0.20	0.20	0.14
Crop activity LS1	82,477	0.11	0.11	0.12	0.11	0.12	0.11	0.11
Livestock activity LS1	54,591	0.38	0.41	0.26	0.40	0.32	0.33	0.35
Livestock activity LS1	246,792	0.36	0.35	0.30	0.36	0.33	0.32	0.34
Livestock activity LS1	192,251	0.39	0.41	0.28	0.40	0.34	0.35	0.36
Livestock activity LS1	79,267	0.39	0.41	0.26	0.40	0.32	0.33	0.35
Homestead gardening	51,224	0.46	0.56	0.23	0.51	0.35	0.40	0.42
Activity local retail	27,827	0.37	0.36	0.21	0.37	0.29	0.28	0.31
Activity slaughterhouse	294,295	0.36	0.32	0.16	0.34	0.26	0.24	0.28
Total	**4,018,588**	**0.11**	**0.11**	**0.34**	**0.11**	**0.23**	**0.23**	**0.19**

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF
Source: author

The overall increase in activity demand is the highest when PRONAF's budget is increased alone, given the relative importance of crop activities in the village economy. This result is also

seen in the scenarios in which the budget is split with other programs other than PRONAF, regardless of whether it is combined with the *Bolsa Família* or pension programs.

The analysis of the demand for production factors in the different scenarios reveals similar figures to the ones presented in the table above. Table 5.23 shows that the scenario with an increase in PRONAF'S budget has the highest effect in the demand across all factors of production. The importance of crop production in the village economy and the resulting high demand for production factors is the most plausible explanation for this outcome. All the other scenarios including an increase in PRONAF's budget also show the same trend. The highest increase in demand produced by the *Bolsa Família* and pension programs refers to family labor, especially due to an increase in demand for agricultural products used for home consumption, most of which are produced by family-owned labor.

The demand for off-farm labor is also the highest in the scenario with an increase of PRONAF's budget alone, but is relatively small with the other factors employed in village activities.

Table 5.23: Baseline and results of scenario analysis on factor demand

		1*	2*	3*	4*	5*	6*	7*
	Baseline (in BRL)	**%**						
Labor – family	1,256,486	0.13	0.14	0.34	0.13	0.23	0.24	0.20
Labor – off-farm	296,227	0.01	0.01	0.12	0.01	0.07	0.07	0.05
Labor – exchange	54,427	0.02	0.02	0.36	0.02	0.19	0.19	0.13
Land – rented	105,885	0.02	0.02	0.37	0.02	0.19	0.19	0.14
Land - owned	374,067	0.10	0.10	0.34	0.10	0.22	0.22	0.18
Capital	605,508	0.09	0.09	0.35	0.09	0.22	0.22	0.17

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF
Source: author

The different scenarios tested here also have substantial effects on household income, as shown in Table 5.24. Overall, the direct cash transfers through the *Bolsa Família* and the pension programs have the highest impact on household income, especially through the later program. In the other scenarios, the results are strongly affected by the amount allocated to both programs. An additional allocation of budget to PRONAF alone produces the lowest

income effects among the tested scenarios, showing the weak linkages among the crop activities, affected the most by PRONAF, and the final household income.

An increase in *Bolsa Família*'s budget produces the single highest increase in household income, namely to poor households (2.39%), who is the main program's beneficiary group. The same group of households experiences very little increase in its income with an increase in pension benefits, given that the original pension transfers is the smallest among households.

Regardless of the positive impacts produced on factor demand due to increased PRONAF budget, they are not translated into higher household income. This is especially due to the relative importance of factor income in total household income, which is very high for tobacco producing households (96%), but is less important for poor and peach-producing households (12 and 15%, respectively), and extremely low for households with elderly members (35%). The remaining income results from government transfers through the *Bolsa Família* and pension programs.

Table 5.24: Baseline and results of scenario analysis on household income

		1*	2*	3*	4*	5*	6*	7*
	Baseline (in BRL)				**%**			
Household LS1	370,531	2.39	0.11	0.20	1.25	1.30	0.16	0.89
Household LS2	631,913	0.09	0.39	0.29	0.24	0.19	0.34	0.25
Household LS3	1,691,795	0.18	0.17	0.32	0.17	0.25	0.24	0.22
Household LS4	525,854	0.03	1.33	0.12	0.68	0.07	0.72	0.49
Total	**3,220,093**	**0.39**	**0.40**	**0.27**	**0.39**	**0.33**	**0.33**	**0.35**

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF
Source: author

Finally, the combination of the impacts produced by the different scenarios on the commodity markets, on activities and on household income can be translated into the analysis of the impact produced on GDP, as shown in Figure 5.2. Overall, the impacts produced on GDP range from 10 to 13% among all scenarios, with the highest impact on GDP is produced by an increase in the budget of the pension program, closely followed by an increase in the budget for *Bolsa Família*, and the lowest impact produced by an increase in PRONAF's budget alone. In all

scenarios, the final impact produced on the GDP is at least as high additional injection of public funds in the programs' budgets, with the exception of the scenario with an increase in PRONAF's budget alone. In this case, there is clearly a leakage of the PRONAF budget away from the village economy, especially due to the dependency on trade with the rest of the world for produced goods (exports of crop products) and for intermediate goods (crop inputs and machinery, e.g.).

The increase in the budgets of *Bolsa Família* and pension programs strongly affect the demand for commodities and activities with strong linkages within the village economy, especially livestock production and homestead gardening. Therefore, the impacts produced on the GDP exceed the additional injection on program budgets.

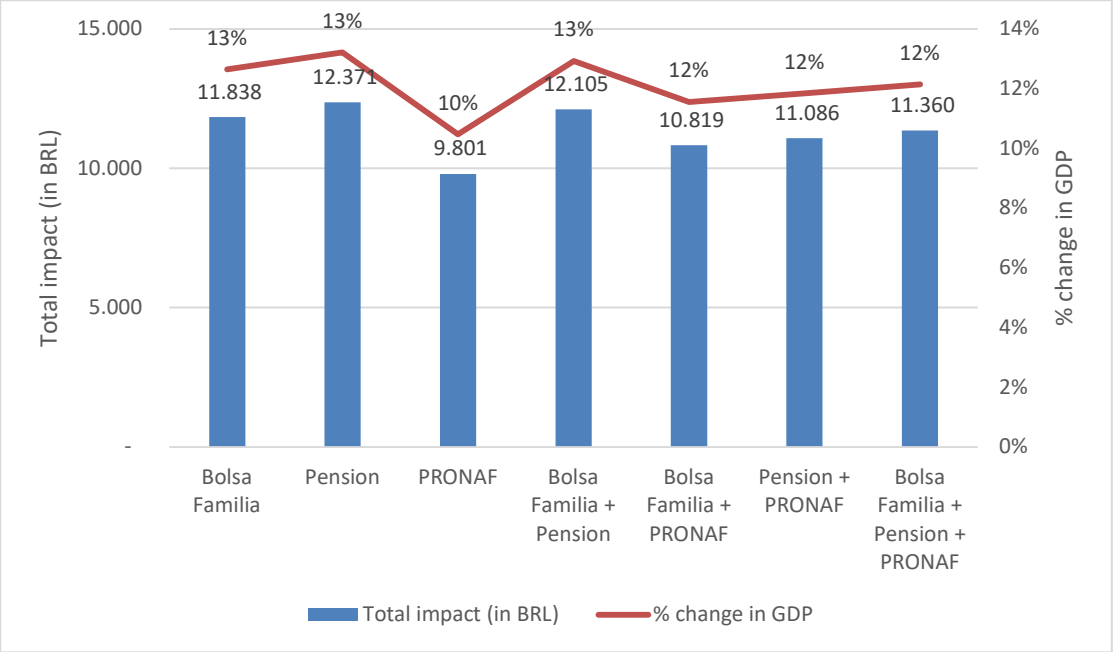

Figure 5.2: Total and percentage change in GDP resulting from scenario analysis
Source: author

5.7 Summary and concluding remarks

Our analysis indicates that the linkages among village sectors are weak, especially due to the high demand of imported intermediate inputs in the agricultural activities, with very low involvement of other village activities in its production and/or retail. Moreover, local households consume a small share of the commodities produced by local activities, and the big

majority of commodities is exported to the regional markets (especially peach and tobacco). The few commodities consumed locally are especially produced by the households for home consumption, such as crop and livestock products, as well as the produce from homestead gardening.

Village activities produce multipliers greater than one in the commodity markets, and are especially high for crop inputs and non-food consumption items purchased by households. Given that the big majority of these goods are imported, and are therefore little integrated into the village economy, they produce very small effects on other village production activities. Furthermore, the multiplier effects of village activities on household income is smaller than one in regard of crop production, retail, and the slaughterhouse, while it is greater than one for all other activities. Especially in the case of crop production, which is by far the most important economic activity in the village, this results hints at the limited potential of cropping activities to foster growth in the village economy.

Changes in household income also produce multipliers across other economy sectors. While a unity increase in the income of poor and senior households produce multipliers greater than one in the demand for commodities, an increase in the income of cash crop producing households result in an increase in demand commodity demand slightly smaller than one. Clearly, poor and senior households use income to satisfy household consumption needs, and cash-crop producing households partly use their income increase to satisfy demand for commodities, and partly allocate it to savings accounts, which is prominently high for these two groups of households.

The weak interlinkages between village activities and other economic sectors also becomes clear in the analysis of household multipliers on activities: across all household groups, an increase in income results only in an increase in the demand for village activities smaller than 0.5, and are especially low for cash-crop producing households. However, these effects get transmitted to households through an increased demand for production factors by activities, thus increasing factor income, and consequently, total final household income, especially the poorer and senior households.

The discussion on multiplier effects enables a clear understanding of the results of scenario analysis. We clearly see that household transfers produce the highest impacts on the demand for commodities, on household income, and overall GDP growth. The transfers through the pension program perform particularly well, producing the highest impact, closely followed by the *Bolsa Família* transfers. The PRONAF subsidies produce the highest impacts on the demand for village activities, especially in crop production, but which does not translate in higher GDP outcomes, given the weak linkages between the village activities and other economic sectors. Remarkably, no combination of program implementation produces a better outcome as compared with the transfer programs.

6 An Applied Village Computable General Equilibrium Model

6.1 Introduction

While the simultaneous implementation of agricultural development and social protection programs in rural areas is a common practice around the world, the effects produced on households and rural economies remain understudied (Tirivayi et al., 2016; Veras et al., 2016). Most of the effects produced by public programs benefit participant households, non-participants though may also be affected by policy changes, transmitted through the local commodity and labor markets in which they are engaged. Thus, assessing the linkages among rural households and economic activities in rural villages are instrumental in shaping the impact of policy, market and environmental changes on production and farmers' welfare (Breisinger, Thomas, et al., 2009; Tadele, 2008; J E Taylor & Adelman, 1996).

In the previous chapter, we conducted an assessment of the economy-wide effects produced by the concomitant implementation of PRONAF, *Bolsa Família* and rural pension/BPC by analyzing the SAM of the Rincão dos Maia village. This analysis is based on the key assumption that production activities are endogenous and demand-driven, with the strong assumption that there exists unlimited supply of production factors throughout the economy. This is clearly unrealistic for some sectors, agriculture in particular, at least in the short or medium run (Sadoulet & De Janvry, 1995). This framework remains fundamentally applicable in situations close to the Keynesian environment of a fix-price model, with excess production capacity in most sectors and absence of substitution. Such a framework cannot reflect accordingly the workings of a market economy in which price adjustments play an important role and where there are important substitution possibilities in both production and demand (Sadoulet & De Janvry, 1995). To capture shocks with the potential to provoke structural changes based on major relative price adjustments, economy-wide models allowing for nonlinearities and behavioral responses in production and consumption relationships in the joint determination of prices and quantities better reflect the effects produced by policy changes in a given economy.

Computable General Equilibrium (CGE) models allow for such adjustments. While the CGE retains the main strength of SAM-based village models with respect to consistency across production, household and capital accounts in a village's social, cultural and economic settings, it further allows to overcome some of the shortcomings of SAM-based models, such as: (i) the introduction of nonlinearities in the model (instead of the fixed coefficients used in the SAM models); (ii) constraints in the availability of resources can be introduced (instead of unlimited factor supply); and (iii) prices play an explicit role in the transmission of policy, market and other income shocks through the economy (J E Taylor & Adelman, 1996). Additionally, they encompass a certain number of macroeconomic components, such as investment and savings, balance of payment, and government budget (Sadoulet & De Janvry, 1995), and allow agents to make decisions about supply and demand (J E Taylor & Adelman, 1996).

CGE models are among the most comprehensive tools for assessing the linkages of economy and household welfare (Breisinger, Thomas, et al., 2009; Diao & Thurlow, 2012). CGEs are fundamentally equilibrium models, thus the proper time frame to use in the interpretation of the results is the time span it takes for all markets to reach a new equilibrium after being hit by a shock (Sadoulet & De Janvry, 1995), and, in most of the cases, they fundamentally static models, given that they solve for a single-period equilibrium. Furthermore, in static CGE models there are no asset markets, money is considered neutral, and all agents make decisions as a function of relative prices, which implies that the models are homogenous in all prices, usually an aggregate domestic price, which is chosen as numéraire (Sadoulet & De Janvry, 1995).

Several studies have used this methodology to assess the effects of policy changes on village economies. In Mexico, a village CGE was used to assess the welfare effects produced due to migration (Adelman et al., 1988), due to technical change, output fluctuation and government policy (S. Subramanian & Sadoulet, 1990), and due to liberalization policies, especially in regard of maize, for Mexican farmers (J E Taylor et al., 1999). In India, the methodology was used to analyze the effects of decentralization of industrial plants to rural areas (Parikh & Thorbecke, 1996), and the effects of the adoption of Bt cotton for rural households (A. Subramanian &

Qaim, 2009). Furthermore, it was used to assess the impacts of social cash transfers (SCT) in Kenya (Thome et al., 2013) and in Ethiopia (Gebeyehu, 2016).

The advantage of using a village CGE model for evaluating the effects of public programs lies on the assumption that households in villages are interconnected in both commodity and factors markets. Contrary to household-farm model, village-wide models allow for price changes to generate production and consumption effects on farms that produce food as well as generates income (e.g. hired-labor, value-added) and consumption effects on non-staple-producing households (J E Taylor & Adelman, 1996). However, rural areas of developing countries are characterized by missing or incomplete output and input markets (J Edward Taylor & Adelman, 2003), leading to non-separable production and consumption decisions by farming households (J E Taylor & Adelman, 1996). Therefore, the results of traditional CGE models may overestimate the welfare gains of farming households, as the non-separability of their production/consumption decisions may "insulate" them from local markets (Aragie & McDonald, 2014). Furthermore, CGE models do not incorporate technological, institutional and market policy (Dorward et al., 2004). Therefore, while CGE is undoubtedly a powerful tool to assess the effects produced by policy intervention on participant households and the transmission to other non-participant groups of households within the economy, reality lies somewhere in between household-farm and economy-wide models (Dorward et al., 2004).

The simultaneous implementation of PRONAF, *Bolsa Família* and rural pension/BPC programs in Brazilian rural villages undoubtedly demands a method which considers the economy-wide effects produced by policy changes. Furthermore, the concomitant implementation of various public programs in a rural village increase the scope for analyzing the direct and indirect effects of policy interventions, as individual programs may affect the outcomes of another one implemented simultaneously in the same economy. Thus, this section aims at analyzing the economy-wide effects produced by the simultaneous implementation of three programs in the Rincão dos Maia village by using a CGE model.

6.2 The structure of CGE models

A CGE can be described by specifying the agents and their behavior, the rules that enable all the markets to reach an equilibrium, and the macroeconomic characteristics and closures.

6.2.1 Agents and their behavior

The agents of the economy are the ones that have been identified in the SAM. However, their rules of behavior are different. Main behavioral differences concern the producers (activity accounts), the traders, and the households (commodity accounts). In a SAM-multiplier model, producers produce whatever is demanded and use factors in fixed proportions, resulting in fixed coefficients in columns. In a CGE, producers are profit maximizers and thus choose their levels of production and their purchases of inputs on the basis of prices (Sadoulet & De Janvry, 1995). On the supply side, they also decide whether to sell their produce in the domestic markets or whether to export it, and domestic products and imports are imperfect substitutes, resulting that the composition of domestic supply depends on their relative prices (Sadoulet & De Janvry, 1995). In contrast, SAM-multiplier model considers imports and domestic production in fixed shares of domestic supply. In CGE models, households maximize utility and thus choose their levels of consumption based on income and prices, while in SAM-multiplier models households' expenditure are determined in constant shares (Sadoulet & De Janvry, 1995). Other behavioral assumption of CGE models are not necessarily price responsive, such as government expenditures, tax payments, savings, and distribution of factor incomes to institutions, which are given by constant coefficients (Sadoulet & De Janvry, 1995).

6.2.2 Market equilibrium

In CGE models, all accounts are endogenous, and must therefore be in equilibrium. Producers sell their total production, factors distribute their income, institutions (e.g. households) spend their income, and investment is determined by available savings (Sadoulet & De Janvry, 1995). Equilibrium in all accounts is reached through the markets: supply and demand of commodities on the product markets, supply and demand of factors in the factor markets, and supply and demand of foreign exchange on the foreign exchange market (Sadoulet & De Janvry, 1995). The

standard rule is that equilibrium is reached based on the endogenous determination of the equilibrium prices, which are homogenous of degree zero for all accounts.

6.2.3 Macroeconomic constraints

There are four main macroeconomic components in a CGE, namely: (i) the foreign exchange market; (ii) the savings-investment equilibrium; (iii) the government budget; and (iv) the aggregate supply of primary production factors. The overall behavior of the model hinges on the rule which govern these constraints (Sadoulet & De Janvry, 1995).

In most cases, the foreign exchange market is constrained to an externally defined level of deficit, which govern the level of borrowing or the balance between imports and exports, which in turn will be affected by the exchange rate. The savings-investment balance simply implies that total investment must be equal to total savings. As there are only demand effects, no long-term consequences of present investment is captured by the model (Sadoulet & De Janvry, 1995). Government budget needs to be balanced, thus there is no reduction in one tax instrument (e.g. import or export tax through trade liberalization) without an increase in another tax instrument (e.g. sales or income tax). Finally, the supply of primary factors of production needs be modelled according to their mobility and employment across production activities. As a rule, capital is considered fixed and fully utilized in every sector, while labor, or at least some categories of labor, is mobile across sectors and may or may not fully employed. The decision about the mobility and employment of production factors has huge effects on the responses of the model to shocks and policies. While the price system serves to allocated the resources among sectors, the overall level of production is fundamentally determined by the total level of resources productively employed in the economy (Sadoulet & De Janvry, 1995).

6.2.4 Homogeneity and Numéraire

The behavioral assumptions of a CGE model are finally governed to the responses of agents to relative prices rather than to the absolute level of any price. The standard procedure is to set one price or a price index as a constant, which is called the numéraire (Sadoulet & De Janvry, 1995). Common practice is to use an aggregate producer price, an aggregate consumer price,

or, sometimes, the exchange rate. The final model results will differ according to whether the numéraire is the consumer price index, which then gives a fixed wage in terms of its purchasing power, or rather the aggregate producer price, which gives a fixed wage in terms of production costs (Sadoulet & De Janvry, 1995).

6.3 The STAGE model

6.3.1 General description

Several different CGE models have been developed over the years. For the scope of this study, the STAGE CGE model is going to be used (McDonald, 2015). The model considers that activities can produce multiple commodities, in which it assumes a fixed proportion of commodity outputs of each activity. This feature perfectly fits the Rincão dos Maia village economy, in which crop activities produce various different commodities. Furthermore, it assumes that production technologies exhibit Constant Elasticity of Substitution (CES). Finally, it assumed the Stone-Geary utility function, as it captures subsistence and non-subsistence consumption levels, which are relevant in rural settings (McDonald, 2015).

The behavioral relationships in this model are either linear or non-linear, which govern how the model's agents will respond to policy interventions. While the accounts of the SAM determine the agents that can be included within the model, and the transactions recorded in the SAM identify the transactions that indeed took place, the model defines behavioral relationships, which will influence the responses to policy changes. The details are presented in Table 6.1.

It is assumed that households choose the bundles of commodities they consume so as to maximize utility in the form of the Stone-Geary utility function, relevant for developing countries' settings where a large share of the population is poor and characterized by subsistence consumption level. Therefore, consumers choose from composite commodities available in the economy, which can be either produced in the economy or imported from the rest of the world. The composite commodities exhibit Constant Elasticity of Substitution (CES) for imported and produced commodities in the village. In this case, the function assumes imperfect substitution of imported and locally produced commodities. The optimum quantity of

Table 6.1: Behavioral relationships for the standard STAGE CGE model

	Commodities	Activities	Factors	Households	Government	Capital	RoW	Total
Commodities				Utility Functions (CD or Stone-Geary)		Fixed shares of savings	Commodity exports	Commodity demand
Activities	Domestic production							Constant Elasticity of Substitution Production Functions
Factors		Factor Demands (CES)					Factor Income from the RoW	Factor income
Households			Variable shares of factor income	Fixed shares of income	Fixed (real) transfers		Remittances	Household income
Government				Direct taxes on Household income			Transfers	Government income
Capital			Depreciation	Household savings	Government savings (residual)		Current account deficit	Total savings
RoW	Commodity imports							Total expenditure abroad
Total	Commodity supply	Activity input	Factor expenditure	Household expenditure	Government expenditure	Total investment	Total income from abroad	

Source: adapted from McDonald (2015)

imported and produced commodities in the village is mainly determined by the relative prices of these commodities. This is the so-called Armington "insight", which allows for product differentiation via the assumption of imperfect substitution. Moreover, the village is assumed to be a price taker for all imported commodities ("small country" assumption), perfectly fine given the fact that the village is too small to influence the price in the rest of the world.

Two stages of production functions are considered in the village economy. In the upper level, intermediate and value added inputs are combined using CES or Leontief production functions. If intermediate and primary inputs are aggregated using CES production function, the proportion of intermediate and value added inputs will be changed with the prices of these aggregated inputs. On the other hand, if the Leontief production function is applied, the proportion of primary factors and intermediate inputs will be combined in constant proportion. On the lower level, the intermediate inputs exclusively exhibit Leontief production function. Hence, at this stage intermediate inputs are aggregated in constant proportion relative to total intermediate input demand of each production activity. Moreover, at this stage CES production function is applied to combine value added factors. In this regard, the optimum input use is determined by the relative price of these primary inputs (McDonald, 2015).

The activities are defined as multi-product activities that produce combinations of commodity outputs. The model allows for a range of different assumptions governing the output mix produced by each activity. The first is a pure by-product assumption, which means that for any given vector of commodities demanded there is a unique vector of activity outputs that must be produced. Alternatively, activities can adjust their output mixes in the response to changes in the relative (basic) prices of domestically produced commodities using CET technologies (McDonald, 2015).

The vector of commodities demanded is determined by the domestic demand and export demand for domestically produced commodities. Using the assumption of imperfect transformation between domestic demand and export demand, in the form of a Constant

Elasticity of Transformation (CET) function, the optimal distribution of domestically produced commodities is determined by the relative prices on the alternative markets (McDonald, 2015).

The model also includes the determination of the functional distribution of income. Specifically factor supplies are defined by reference to their ownership by different institutions (households and government). In its simplest form, this formulation defines the quantities of factors supplied by each institution as fixed and equal to the quantities owned by each institution.

Further information on the transaction relationships (determination of price and quantity of commodities and activities) and the algebraic statement of the STAGE model can be found in Appendix 8.3.

6.3.2 Elasticities used in the model

Elasticity parameters are important pieces of data that substantially influence the modelling results. While shift and share parameters of production and foreign trade functions are computed during the calibration process, other elasticities need to be specified exogenously. These elasticities are: (i) the elasticities of substitution among production factors; (ii) the CES import aggregation; (iii) the CET export transformation elasticities; and (iv) the Frisch coefficients (marginal utility of income). Estimating these elasticities is beyond the scope of this research, and therefore the elasticities are taken from relevant literature. The elasticities are presented in Table 6.2.

Experience has shown that the empirical results obtained from simulations with CGEs are relatively insensitive to the specific values of elasticities, but crucially depend on their order of magnitude (Sadoulet & De Janvry, 1995). Therefore, most CGE are built with approximate values for these parameters. CES parameters for Brazil range from 0.16 to 5.3 among 24 economic sectors for the whole Brazilian economy, with the low elasticities found among heavy industrial products and the highest elasticities among light manufacturing and consumption goods (Tourinho et al., 2003). Therefore, it seems appropriate to select CES and CET commodity elasticities of 2.0, which is a widely followed procedure among CGE modelers (Sadoulet & De Janvry, 1995). Furthermore, the elasticity of substitution among production factors in CES

production functions is assumed to be 0.8, as used in other village CGE models (Gebeyehu, 2016). Sensitivity tests by varying the elasticities used in the models show low effects on study results. Sensitivity tests by varying the elasticities used in the models show low effects on study results. Indeed, increases of 50% in CES elasticities only produces a deviation of 3% from the results using the original elasticity. Therefore, any slight differences in the elasticities used in this study from alternative elasticities will only have little effects on the model final results.

Table 6.2: Elasticities used in the Rincão dos Maia STAGE CGE model

Categories	Elasticities	Values
Trade elasticities on commodities (imports and exports)	Armington CES function	2
	Armington CET function	2
	Export demand elasticity	0
	Commodity output CES aggregation	4
Production elasticities on activities (CES production functions)	CES production function for exports	2
	CES production function for value added	0.8
Income demand elasticities of households	Household LS1	0.6
	Household LS2	0.6
	Household LS3	0.6
	Household LS4	0.6
Frisch coefficients (marginal utility of income)	Household LS1	-4.6
	Household LS2	-4.3
	Household LS3	-2.8
	Household LS4	-4.1

Source: author

6.3.3 Model closure

Model closures are necessary because they define important and fundamental features that govern the working of an economic system (Pyatt, 1988; Sadoulet & De Janvry, 1995). As already describe above, there are four CGE model closures: (i) foreign exchange market; (ii) savings-investment equilibrium; (iii) government budget; and (iv) factor mobility and employment. As such, the closure rules can be perceived as operating on two levels (McDonald, 2015): (i) on a general level whereby the closure rules relate to macroeconomic considerations (e.g. investment expenditure as determined by the volume of savings); and (ii) on a specific

level where the closure rules are used to capture particular features of an economic system (e.g. the degree of inter-sectoral factor mobility).

The closure of the foreign exchange (or the rest of the world) account can be achieved by either fixing the exchange rate variable or the balance on the current account. The model is formulated with the world prices for traded commodities, PWM_c and PWE_c, declared as variables. By fixing these variables, a strong small country assumption is adopted, i.e. the economy is assumed to be a price taker on all world commodity markets. Relaxing the small country assumption can be achieved by unfixing these variables, which will imply that the country may face a downward sloping demand curve for some of its traded commodities (McDonald, 2015). For the Rincão dos Maia village economy, the exchange rate is fixed (thus the external balance is used as equilibrating variable), under the strong small country assumption that village commodities cannot influence the prices of the rest of the world.

The savings-investment closure demands that either savings or investment must be fixed. This can be achieved by fixing either the saving rates for households or the volumes of commodity investment. This involves fixing either the savings rate adjusters (only household saving rates, only enterprise savings rates, or the combination of both), or the investment volume adjusters (which is influenced by the price of investment commodities *PQD*). Fixing savings, and thus deeming the economy to be savings-driven, could be considered a neo-classical approach to the functioning of an economy. Closing the economy by fixing investment could be construed as making the model reflect the Keynesian investment-driven assumption (McDonald, 2015). In this village CGE, we assume the economy to be investment-driven, and therefore we fix the domestic final demand of investment (*INVESTSH*).

The Government account closure makes sure that the government budget balances, which is important for fiscal policy considerations. The base specification relies on the assumption that government savings are a residual, implying that if the determinants of government income and expenditure are fixed, government savings must be free to adjust (McDonald, 2015). On government revenues' side, the models presents revenue equations for each tax instrument, so the tax rates can be adjusted to achieve a given volume of revenue from each tax instrument.

Government expenditure is controlled by fixing the volumes of commodity demand (*QGD*) through the government demand adjuster (*QGDADJ*). Alternatively, either the value of government consumption expenditure can be fixed (*VGD*), or the share of government expenditure in the total value of domestic final demand (*VGDSH*). The scaling factor on the values of transfers to households adjusters (*HBFADJ* and *HPENADJ* for *Bolsa Família* and pension transfers, respectively) can be fixed. In this village model, the share of final demand by the government (*VGDSH*), the revenue of indirect tax (*ITAX*) and the adjusters of *Bolsa Família* and pension transfers to households (*HBFADJ* and *HPENADJ*) are fixed. As a result of unfixing the revenue of indirect tax (for the purpose of simulating PRONAF subsidies later on), the adjuster for the indirect tax (*TXADJ*) need to be unfixed to accommodate the changes in tax revenue. Furthermore, government savings is further used as equilibrating variable.

The factor market closure allows the modeler to make decisions about the mobility and employability of production factors in a given economy. In the case of full factor mobility and employment, total factor supply and total factor demand equate. In this case, while the total supplies of each factor are determined exogenously, the demands for factor *f* by activity *a,* along with the wage rates for factors, are determined endogenously. However, in the case of factor that factors are assumed to be activity specific, there cannot be sectoral factor mobility. For the Rincão dos Maia village model, it seems reasonable to consider off-farm unskilled and exchange labor to be activity specific, and therefore not mobile, given that these types of labor are all employed in cropping activities, and more specifically, for tobacco and peach production. The other factors (rented and owned land, family labor and capital) are assumed to be fully mobile and employed in the village.

Finally, the model allows for the choice between two price indices used for price normalization, also called numéraires. The consumer Price Index (*CPI*) is defined as a weighted sum of composite commodity prices, where the weights are the shares of each commodity in total demand. Alternatively, the domestic Producer Price Index (*PPI*) is defined by reference to the supply prices for domestically produced commodities with weights defined as shares of the value of domestic output for the domestic market (McDonald, 2015). These numéraires make

the model homogeneous of degree zero in price, and therefore only defines relative prices. CPI has finally been chosen for this model.

6.3.4 Experiment design

The objective of the scenario analysis is to assess the outcomes of combinations of government transfers using the different programs implemented concomitantly in the Rincão dos Maia village. To be able to compare the outcomes of government spending across programs, we decided to build scenarios using a fixed budget, which is then divided among the different programs, allowing for the comparison among programs. Therefore, in all scenarios, an increase in public spending of BRL 10 thousand is considered, either for the programs alone, in which case the programs receive the full budget, or in combination, in which case the budget is divided equally among the programs. As such, we end up with seven different scenarios, similarly to what has already been done in the SAM multiplier analysis, as shown in Table 6.3.

Table 6.3: Policy changes simulated in the Rincão dos Maia village economy, in BRL

Scenarios	*Bolsa Família*	Pension	PRONAF	Total
1. *Bolsa Família*	10,000	-	-	**10,000**
2. Pension	-	10,000	-	**10,000**
3. PRONAF	-	-	10,000	**10,000**
4. *Bolsa Família* + Pension	5,000	5,000	-	**10,000**
5. *Bolsa Família* + PRONAF	5,000	-	5,000	**10,000**
6. Pension + PRONAF	-	5,000	5,000	**10,000**
7. *Bolsa Família* + Pension + PRONAF	3,333	3,333	3,333	**10,000**

Source: author

The implementation of the experiments demanded some adjustment to the original code. As such, government transfers to households ($hogovconst_h$), and the correlating government transfer adjuster (*HGADJ*) was split into the two types of direct government transfers to households, namely through the *Bolsa Família* and the pension programs. Therefore, the direct transfers were split into $hobfconst_h$ and $hopenconst_h$, respectively. These changes were implemented in the two relevant model equations: the household income, and government expenditure.

The implementation of the scenarios involving PRONAF subsidies could be directly implemented using the variable *ITAX* (indirect tax revenue), to which the additional PRONAF subsidies were added and split across activities according to the original indirect tax rate presented in the village SAM.

6.4 Results and discussion on village CGE

The description of the results of the policy shocks are going to concentrate on the effects on village activities and household income, as the policy shocks primarily affect these accounts.

6.4.1 Effects on village activities

In the village STAGE CGE model, the domestic production by activity (QX_a) is calculated as the output of village activities, which is a Constant Elasticity of Substitution (CES) aggregate of the aggregate intermediate inputs ($QINT_a$) and value added (QV_a), and is used to calculate the commodity output as a fixed-proportions (or Leontief) aggregate of the output for each activity. Table 6.4 shows the percentage changes of domestic output by activity, showing heterogeneous results across all simulations. An increase in *Bolsa Família* budget, for example, produces negative effects on crop and livestock production conducted by poor households, as well as on crop production by tobacco producing households, the two household groups benefitting from *Bolsa Família* transfers. Moreover, this simulation shows a reduction in the demand for livestock production by senior households and construction services. The results also show that an increase in the budget of *Bolsa Família* produces an overall increase in the demand for homestead gardening, as well as an increase in the demand for retail services, responsible for the local retail of processed food. The demand for the slaughterhouse services are only slightly positively affected. These figures hint at the negative effects of *Bolsa Família* on agricultural activities conducted by poor households, the main group of program beneficiaries. Even though homestead gardening is increased under this scenario, the reduction in agricultural production also reveals a reduction in the production for home consumption, especially important in livestock production.

An increase in the budget of the rural pension program produce a reduction in the demand for crop activities of all households with the exception of the peach and livestock households. The livestock activities of all households register an increase in the demand, as well as all homestead gardening and service related activities, such as retail, slaughterhouse, construction and repair services, with the exception of machinery renting. These results show that the rural pension program produce a substitution effect away from crop activities towards livestock production, whose output is greatly consumed by the households. The same is also registered for homestead gardening, which registers the greatest increase among the simulated scenarios.

An increase in PRONAF subsidies produces a negative effect in the demand of all village activities, with the exception of crop production by tobacco-producing households. These results are unsurprising, as these households receive the bulk of PRONAF subsidies. Furthermore, the scenarios simulating the split of public budget with PRONAF all show a reduction in the demand for local activities, as a result of the strong negative effect produced by PRONAF alone. As such, PRONAF subsidies have a strong positive effect on the demand of tobacco-producing activity, and has an overall negative effect on local food production for home consumption, especially among livestock activities and homestead gardening.

Table 6.4: Percentage change in the domestic production by activity a (QX_a), in the different scenarios

	1*	2*	3*	4*	5*	6*	7*
Crop activity LS1	-0.010	-0.009	-0.188	-0.009	-0.099	-0.098	-0.068
Crop activity LS2	0.012	0.018	-0.376	0.015	-0.182	-0.179	-0.115
Crop activity LS3	-0.017	-0.014	0.633	-0.015	0.308	0.310	0.200
Crop activity LS4	0.049	-0.025	-1.951	0.012	-0.956	-0.994	-0.641
Livestock activity LS1	-0.008	0.003	-0.681	-0.003	-0.346	-0.340	-0.227
Livestock activity LS2	0.019	0.002	-0.408	0.011	-0.194	-0.203	-0.128
Livestock activity LS3	0.055	0.026	-0.355	0.041	-0.150	-0.165	-0.093
Livestock activity LS4	-0.005	0.004	-0.621	0.000	-0.314	-0.309	-0.206
Homestead gardening	0.200	0.266	-0.294	0.233	-0.048	-0.014	0.042
Activity local retail	0.108	0.096	-0.406	0.102	-0.149	-0.155	-0.073
Activity slaughterhouse	0.006	0.001	-0.563	0.003	-0.279	-0.282	-0.184

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF

Source: author

The effects on village activities clearly have an effect on the domestic production of village goods. Table 6.5 shows the percentage change in the domestic production across all simulated policy changes. It is important to remember here that the commodities resulting from the domestic production are either directed towards domestic consumption of commodities or to the export markets. The scenario considering an increase in *Bolsa Família's* budget alone induces an increase in the domestic production of most of village commodities, with the exception of crop products for export, for local sales, and for home consumption, as well as a reduction in the provision of construction services. An increase in the rural pension's budget alone produces similar results, with additional reduction in crop production for feed and crop inputs, as well as an increase (instead of decrease) in the provision of construction services.

The simulation on the increase of PRONAF's budget alone show a completely different picture, as the domestic production of most of the commodities show a reduction, with the notorious exceptions of crop products for export, for local sales, and for home consumption. These results are diametrically opposite to the ones produced by the simulations involving *Bolsa Família* and rural pension programs. Concretely, in the case of agricultural commodities, they hint at a strong substitution effect engendered by the PRONAF subsidies away from livestock and homestead gardening production towards crop production, especially for export, local sales and home consumption. As such, tobacco and peach production should be expected to grow rapidly, as well as maize used for feed (main crop product sold locally) and crop production for home consumption. Moreover, given the great importance of livestock production for home consumption (as compared with crop production for the same purpose), the stark reduction in domestic production by the former means that overall less domestic goods for home consumption are being produced by village households. The opposite effect is registered for the *Bolsa Família* and rural pension programs, which induce a reduction in crop production for the market (local and export) and for home consumption, but induce an increase in the production of homestead gardening goods as well as overall livestock products, especially for local sales and home consumption.

Table 6.5: Percentage change in domestic production of village commodities (QXC_c), in the different scenarios

	1*	2*	3*	4*	5*	6*	7*
Crop regional sales	-0.010	-0.008	0.367	-0.009	0.179	0.180	0.116
Crop subsistence	-0.002	-0.008	0.039	-0.005	0.018	0.015	0.010
Crop feeding	0.002	-0.002	-0.075	0.000	-0.037	-0.039	-0.025
Crop local sales	-0.006	-0.013	0.182	-0.010	0.088	0.085	0.054
Homestead gardening	0.200	0.266	-0.294	0.233	-0.048	-0.014	0.042
Livestock regional market	0.020	0.004	-0.418	0.012	-0.199	-0.207	-0.131
Livestock subsistence	0.027	0.013	-0.458	0.020	-0.216	-0.223	-0.140
Livestock local sales	0.037	0.015	-0.385	0.026	-0.174	-0.185	-0.112
Crop inputs	0.010	-0.002	-0.565	0.004	-0.279	-0.284	-0.185
Processed food	0.009	0.004	-0.558	0.007	-0.275	-0.277	-0.181
General household consumption	0.108	0.096	-0.406	0.102	-0.149	-0.155	-0.073
Agricultural tools	0.101	0.101	-0.497	0.101	-0.199	-0.198	-0.104

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF
Source: author

6.4.2 Effects on household income

In the village STAGE CGE model, household income is a result of factor ownership and government transfers (inter-household transfers and remittances were not registered). As per model closures, all production factors to be fully mobile and employed across all activities, with the exception of off-farm and exchanged labor. As a result, factors not fully employed and not mobile across activities register changes in the quantity in factors employed, while their prices remain fixed. Conversely, fully employed and fully mobile factors are employed in fixed quantities, and their quantities change over activities, as well as the prices paid for production factors.

Table 6.6 shows the percentage changes of factor income in the different simulated scenarios. The income from family labor increases consistently across all simulations. An increase in the *Bolsa Família* transfers reduce factor income of off-farm labor, while increase the factor income of family labor. This has direct impact on the income of poor households, which, on the one hand, earn a big share of their income from off-farm work, and, on the other hand, register an increase in household transfers due to greater *Bolsa Família* budget.

An increase in the transfers through the rural pension program induce an increase in family labor income, while reducing the income from exchange labor. This is strongly due to the main effects produced on domestic production activities, especially on livestock production, which rely mostly on family labor, and negative effects on most crop activities, especially the one conducted by tobacco-producing households, who rely on exchange labor in the village economy.

Higher PRONAF subsidies induce an increase in income across all factors, especially among rented land and exchanged labor, and relatively low for off-farm labor. Given the few households that earn income from renting out land, as well as engaged in exchanging labor (mostly tobacco producers), the effect on overall village household income is relatively small. Furthermore, the small increase in off-farm income indicates a low positive effect on poor households, as the main off-farm work suppliers in the village.

Table 6.6: Percentage change of income from factors (YF_f), in the different scenarios

	1*	2*	3*	4*	5*	6*	7*
Land – rented	-0.022	-0.017	0.693	-0.020	0.336	0.338	0.217
Land - owned	0.003	-0.002	0.067	0.001	0.035	0.032	0.022
Labor – family	0.006	0.014	0.193	0.010	0.100	0.104	0.070
Labor – off-farm	-0.001	0.000	0.032	-0.001	0.016	0.016	0.010
Labor – exchange	-0.017	-0.013	0.482	-0.015	0.233	0.235	0.150
Capital	-0.002	0.000	0.266	-0.001	0.132	0.133	0.087

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF
Source: author

The changes in income to households (YH_h) as a results of different policy changes is presented in Table 6.7. As a result of direct transfers to households, an increase in the budget of social protection programs have a great direct effect on household income. The increase in household income due to policy changes in regard of PRONAF subsidies are a result of the interlinkages between village activities and households.

As such, an increase of transfers by social protection programs produce an increase in household income at least as big as the original transfers across all simulations. The increase in household income beyond the original program transfers attest for the additional income

generated and transferred to households due to interlinkages among economic activities in the village (direct and indirect effects), similar to what has been already discussed on the section dedicated to the SAM multipliers.

The highest increase in overall village household income is generated by the transfers through the rural pension program. However, this scenario also induces the smallest increase in the income of poor households, which benefit little from direct transfers. An increase in the *Bolsa Família* budget clearly benefits the poor households the most, followed by the tobacco producers, among which also some program participants are found. Surprisingly, senior households under this scenario are the only households registering an income loss across all households and simulations due to an increase in village commodity prices, which are not accompanied by any additional income for this household group.

Table 6.7: Level and percentage changes in income to households (YH_h), in the different scenarios

	1*	2*	3*	4*	5*	6*	7*
	(level results, in ten thousand BRL)						
Household LS1	0.866	0.024	0.037	0.445	0.451	0.030	0.279
Household LS2	0.001	0.186	0.115	0.094	0.058	0.150	0.094
Household LS3	0.138	0.123	0.331	0.131	0.235	0.227	0.188
Household LS4	-0.001	0.682	0.055	0.341	0.027	0.368	0.222
Total	**1.005**	**1.015**	**0.537**	**1.010**	**0.771**	**0.776**	**0.783**
	(Percentage change)						
Household LS1	2.336	0.063	0.100	1.200	1.218	0.082	0.753
Household LS2	0.002	0.295	0.181	0.148	0.092	0.238	0.149
Household LS3	0.082	0.073	0.196	0.077	0.139	0.134	0.111
Household LS4	-0.001	1.297	0.104	0.648	0.051	0.700	0.423

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF
Source: author

The increase in PRONAF subsidies induce the smallest increase in household income among the tested scenarios. The increase in income of poor households is higher than the transfers by the rural pension program, especially due to an increase in prices for off-farm labor, which contributes significantly to this household group's income. Unsurprisingly, the income of tobacco-producing households, whose crop activity receive the most of PRONAF subsidies, record the highest increase in income among the households. However, even though livestock

and cropping activities by this household group receives 75% of PRONAF subsidies, they only reap 66% of total income increase among village households, especially due to increase in village factor and commodity prices used in agricultural activities.

Table 6.8 presents the results of the changes engendered by the different simulations on household consumption, explicitly showing the percentage changes in demand by the individual households, and the aggregated change in demand in commodity quantities (level results). Clearly, the *Bolsa Família* program increases the aggregated household consumption of all selected commodities, especially through a high increase in household consumption by the poorest households, the main beneficiaries of *Bolsa Família* transfers. It is important to mention that agricultural production for home consumption, and agricultural goods sold locally register the highest increase in household consumption when the budget of the *Bolsa Família* program is increased. The consumption of homestead gardening products also increases. The same is also recorded for imported consumption goods, such as processed food and general household consumption commodities. This clearly shows that the program has a strong effect on agricultural production for subsistence as well as for imported goods, as it lowers consumption constraints faced by the poorest households.

An increase in the transfers through the rural pension program produces a positive effect on the consumption of most of the already consumed commodities, especially agricultural commodities produced and sold locally, livestock production for home consumption, homestead gardening, processed food and general consumption goods. Homestead gardening registers the highest increase among the tested simulations, and the total household consumption of crop products is slightly reduced. The households benefitting the most from the pension program is the group of senior households, who increase their consumption for all selected commodities. However, households mostly engaged in cash-crop production (household groups 2 and 3) reduce their consumption of all commodities under this scenario, even though they also benefit from pension transfers.

An increase in PRONAF subsidies induces a reduction in household consumption of all selected commodities. Prices of commodities highly consumed by households, especially livestock

Table 6.8: Percentage change in household consumption of selected village commodities (QCD_c), and total absolute change in level results, in the different scenarios

		1*	2*	3*	4*	5*	6*	7*
Crop subsistence	Household LS1	2.301	0.021	0.157	1.160	1.232	0.088	0.749
	Household LS2	-0.546	-0.369	-0.833	-0.457	-0.690	-0.601	-0.550
	Household LS3	-0.228	-0.322	-0.265	-0.275	-0.247	-0.294	-0.253
	Household LS4	0.221	1.519	0.649	0.870	0.434	1.086	0.737
	Total	**0.000**	**-0.001**	**-0.016**	**0.000**	**-0.008**	**-0.009**	**-0.006**
Crop products locally sold	Household LS1	2.220	-0.009	-0.070	1.106	1.074	-0.040	0.640
	Household LS2	-0.623	-0.400	-1.065	-0.511	-0.845	-0.734	-0.659
	Household LS3	-0.349	-0.371	-0.637	-0.360	-0.494	-0.505	-0.427
	Household LS4	0.137	1.483	0.388	0.810	0.263	0.936	0.614
	Total	**0.004**	**0.001**	**-0.001**	**0.002**	**0.001**	**0.000**	**0.001**
Homestead gardening products	Household LS1	2.255	-0.001	-0.063	1.127	1.094	-0.032	0.655
	Household LS2	-0.590	-0.392	-1.058	-0.491	-0.825	-0.726	-0.645
	Household LS3	-0.297	-0.358	-0.627	-0.328	-0.463	-0.493	-0.404
	Household LS4	0.173	1.493	0.396	0.833	0.285	0.944	0.631
	Total	**0.010**	**0.014**	**-0.015**	**0.012**	**-0.002**	**-0.001**	**0.002**
Livestock subsistence	Household LS1	2.256	-0.001	-0.040	1.128	1.107	-0.021	0.663
	Household LS2	-0.589	-0.391	-1.034	-0.490	-0.812	-0.714	-0.636
	Household LS3	-0.295	-0.358	-0.588	-0.326	-0.442	-0.473	-0.391
	Household LS4	0.174	1.493	0.423	0.834	0.299	0.958	0.640
	Total	**0.011**	**0.005**	**-0.182**	**0.008**	**-0.086**	**-0.089**	**-0.055**
Livestock products locally sold	Household LS1	2.088	-0.063	-0.052	1.015	1.020	-0.058	0.592
	Household LS2	-0.748	-0.456	-1.047	-0.602	-0.898	-0.752	-0.708
	Household LS3	-0.548	-0.459	-0.608	-0.503	-0.579	-0.534	-0.504
	Household LS4	0.001	1.419	0.408	0.709	0.204	0.915	0.561
	Total	**0.003**	**0.001**	**-0.001**	**0.002**	**0.001**	**0.000**	**0.001**
Processed food	Household LS1	2.255	0.000	-0.020	1.128	1.117	-0.010	0.670
	Household LS2	-0.590	-0.390	-1.014	-0.490	-0.803	-0.703	-0.630
	Household LS3	-0.297	-0.355	-0.556	-0.326	-0.427	-0.456	-0.380
	Household LS4	0.173	1.495	0.445	0.834	0.309	0.971	0.648
	Total	**0.129**	**0.087**	**-0.111**	**0.108**	**0.009**	**-0.012**	**0.028**
General household consumption goods	Household LS1	2.256	0.001	-0.019	1.129	1.118	-0.009	0.671
	Household LS2	-0.589	-0.389	-1.013	-0.489	-0.802	-0.702	-0.629
	Household LS3	-0.295	-0.354	-0.554	-0.325	-0.425	-0.455	-0.378
	Household LS4	0.174	1.496	0.447	0.835	0.311	0.972	0.649
	Total	**0.120**	**0.115**	**-0.240**	**0.117**	**-0.060**	**-0.063**	**-0.009**

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF

Source: author

products for home consumption, as well as processed food and general consumption goods, increase more under the scenario simulating an increase in PRONAF subsidies alone. In the remaining simulations considering an increase in PRONAF subsidies, most of the results still reflect the individual effect of PRONAF, overweighing the increase in household consumption induced by the social protection programs.

The changes in the consumption of commodities by households is directly influenced by commodity prices. The effects of policy changes on prices of commodities consumed in the Rincão dos Maia village are presented in Table 6.9. The scenario with increased allocation of public funds to the individual programs produce an overall increase in prices of most of the consumed commodities. Specifically, an increase in *Bolsa Família* budget induces a reduction in prices only for crop production for home consumption, livestock products sold to the slaughterhouse, and agricultural manual tools. The price changes engendered by the rural pension program differ only in regard of crop inputs, which register a price increase. Similarly, an increase in PRONAF subsidies produce a price increase in most of the local commodities, with the exception of crop products for home consumption, for feed, as well as livestock sold to the slaughterhouse. As such, it clearly shows that domestic prices of exported and locally sold crop commodities increase, while crop products for home consumption decrease across all simulations on the individual programs. Furthermore, homestead gardening products, as well as livestock products for home consumption and locally sold register an increase in domestic prices, while livestock products to the slaughterhouse register a decrease in prices.

Among the agricultural commodities, the prices of crop products for the export markets and for local sales, homestead gardening, livestock products for home consumption and for local sale increase their prices across all simulations. This means that the increased public money invested through each of the simulations influence the demand for goods in the village economy, increasing the local prices for these goods (i.e. inflation). The same effect is also measured among intermediate goods (crop and livestock inputs), processed food, general consumption goods and agricultural tools.

A price reduction across all simulations due to the simulated policy changes is only recorded for crop production for home consumption and livestock products exported. For crop products for home consumption, it is surprising that the price reduction in the transfers through *Bolsa Família* and the pension programs produce is accompanied by a reduction in the demand of the same product. Moreover, an increase in domestic prices for processed food and general consumption goods is accompanied by an increase in the domestic demand of the same products. These results hint at substitution effects promoted by the two programs away from own production for home consumption and into purchase of processed and imported goods. Surprisingly, the same cannot be said about livestock production for home consumption and locally sold, which registers a simultaneous increase in domestic prices and quantity demand. Likewise, an increase in PRONAF subsidies lead to a simultaneous increase in domestic price and quantity demand for exported and locally sold crop products, and to a decrease in domestic prices and increase in domestic quantity demand for crop products for home consumption.

Table 6.9: Percentage change in consumer price of domestic supply of commodities (PD_c), in the different scenarios

	1*	2*	3*	4*	5*	6*	7*
Crop regional sales	0.002	0.002	0.097	0.002	0.049	0.050	0.033
Crop subsistence	-0.187	-0.089	-0.802	-0.138	-0.494	-0.445	-0.347
Crop feeding	0.036	0.030	-0.112	0.033	-0.038	-0.041	-0.017
Crop local sales	0.168	0.053	0.262	0.111	0.215	0.158	0.153
Homestead gardening	0.005	0.011	0.205	0.008	0.105	0.108	0.072
Livestock regional market	-0.017	-0.003	-0.062	-0.010	-0.039	-0.032	-0.026
Livestock subsistence	0.000	0.010	0.097	0.005	0.048	0.053	0.035
Livestock local sales	0.707	0.293	0.154	0.500	0.431	0.224	0.351
Crop inputs	-0.004	0.002	0.386	-0.001	0.191	0.194	0.127
Processed food	0.074	0.050	0.088	0.062	0.081	0.069	0.067
General household consumption	0.020	0.023	0.062	0.021	0.041	0.043	0.033
Agricultural tools	-0.057	-0.055	0.622	-0.056	0.282	0.283	0.171

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF
Source: author

6.4.3 Macroeconomic effects

The policy shocks simulated in this research clearly have an effect on the commodity and factor markets, as well as on village activities and household income, influencing the demand and supply in the village markets and the flow of income towards households. Consequently, the simulations produce various macroeconomic effects, which are presented in Table 6.10.

In the commodity market, household consumption increases only in the scenarios simulating an increase in the transfer of social protection programs alone, and is especially high in the transfers of rural pension benefits, while the simulations considering an increase in PRONAF subsidies induce a reduction in household consumption. Furthermore, the policy changes influence positively the demand for investment commodities, especially under the influence of PRONAF subsidies, given its direct effect on agricultural activities of cash crop producers. The balance of household and investment commodity consumption reveal the final domestic demand, which is positive with an increase in social protection transfers and negative with an increase in PRONAF subsidies, especially due to the effects on household consumption. The exception is the simulation with the increase in the budget of the three programs, on which the increase in investment consumption overweighs the reduction in household consumption. The effects on the village commodity demand influence village production decisions, which accompany the changes in final commodity demand, with social protection transfers increasing domestic commodity production in all scenarios, with the exception of *Bolsa Família* transfers and PRONAF subsidies increased simultaneously. Furthermore, imports increase in all scenarios due to an increase in the demand for foreign consumption goods induced by the social protection transfers, as well as an increase in intermediate and investment goods used in agricultural production. Commodity exports are reduced in the scenarios simulating an increase in social protection transfers, while is increased in scenarios considering an increase in PRONAF subsidies. In general, the balance of village foreign trade remains negative in all scenarios with an increase in social protection transfers higher than 5,000 BRL. However, regardless of PRONAF subsidies inducing an increase in the production of export-oriented commodities,

PRONAF subsidies reduce the overall domestic commodity production, especially due to negative effects on all village activities with the exception on crop production.

The effect of policy changes on the village GDP is substantial, but depends on the adopted GDP measure. On the one hand, GDP-value added, which is considered as the GDP from the income side (income from factors for households and from tax revenue for the government), registers increases only in the scenarios with an increase in social protection transfers alone. PRONAF subsidies produce a negative effect on GDP-value added, especially due to a reduction in overall tax revenue. On the other hand, GDP at market prices (GDP from the expenditure side, as it sums up the expenditure on commodities, on investment, on government consumption, together with revenue from exports minus imports) increases in all simulated policy changes, as a result on the increase in expenditure on commodities for household consumption (especially high in the social protection transfers) and intermediate goods (especially for increases in PRONAF subsidies).

Village household income increases across all simulations, but especially with an increase in direct social protection transfers to households. With an increase in PRONAF subsidies, factor income responds to a higher share of the increase in total household income, especially the income originating from labor.

Tax revenue changes due to effects on the commodity markets as well as due to model simulations. As a direct result of tobacco production increase with the increase in PRONAF subsidies, export tax revenue proportionally increases according to the increase in subsidies. Sales tax revenue increase in all simulations due to the combination of effects on the increase in the domestic final demand and of imported goods, upon which sales tax also apply. Thus, tax revenue decreases substantially in the scenarios simulating increases in PRONAF subsidies, especially due to fixing indirect tax revenue in the model closure. Even though government revenue decreases in the simulations, total government income is higher than expenditure by around 110 thousand BRL.

Table 6.10: Level changes in nominal macro totals (in ten thousand BRL), in the different scenarios

	1*	2*	3*	4*	5*	6*	7*
Household consumption	0.310	0.363	-0.804	0.336	-0.248	-0.221	-0.064
Investment consumption	0.078	0.083	0.268	0.081	0.174	0.176	0.137
Domestic final demand	0.388	0.446	-0.536	0.417	-0.075	-0.045	0.073
Domestic production	0.009	0.022	-0.011	0.015	-0.002	0.005	0.005
Import demand	0.298	0.350	0.200	0.324	0.248	0.275	0.260
Export supply	-0.034	-0.027	0.772	-0.030	0.369	0.373	0.237
GDP – Income side	0.062	0.085	-0.429	0.074	-0.184	-0.172	-0.098
GDP – Expenditure side	0.056	0.069	0.036	0.063	0.046	0.053	0.050
Household income	1.005	1.015	0.537	1.010	0.771	0.776	0.783
Factor income	0.005	0.015	0.538	0.010	0.271	0.276	0.183
Labor factor income	0.007	0.017	0.278	0.012	0.143	0.148	0.099
Household savings	0.695	0.652	1.341	0.674	1.019	0.997	0.847
Government savings	-0.943	-0.929	-0.967	-0.936	-0.955	-0.948	-0.881
Foreign savings	0.333	0.377	-0.595	0.355	-0.132	-0.110	0.016
Total savings	0.085	0.100	-0.221	0.092	-0.068	-0.061	-0.018
Export tax revenue	-0.001	-0.001	0.024	-0.001	0.011	0.012	0.007
Sales tax revenue	0.058	0.071	0.009	0.065	0.034	0.040	0.042
Indirect tax revenue	0.000	0.000	-1.000	0.000	-0.500	-0.500	-0.330
Total tax revenue	0.057	0.071	-0.967	0.064	-0.455	-0.448	-0.281

*1: *Bolsa Família*; 2: Pension; 3: PRONAF; 4: *Bolsa Família* + Pension; 5: *Bolsa Família* + PRONAF; 6: Pension + PRONAF; 7: *Bolsa Família* + Pension + PRONAF.
Source: author

6.4.4 Welfare effects

While household income is an important result to assess policy changes, it says little about the effects on consumer's welfare change, and consequently, on household utility, as it does not take changes in prices into account. However, utility is an ordinal representation of consumer's preference whose change after policy implementation is hard to measure, which prompts us to look for other proxy measures that change cardinally. One way to measure the impact of a price change in monetary terms is to assess the amount of income would have to be taken away from the consumer before the price change in order to leave him as well off as he would be after the policy shock, and thus the price change. This is called the equivalent variation, which measures the maximum amount of income that the consumer would be willing to pay to avoid the price change (Varian, 2014), and so remain at the same utility level as before the policy shock (Blonigen et al., 1997).

Figure 6.1 graphically presents the results on the equivalent variation in income of village households. We clearly see poor and senior households would be willing to pay part of its income to stay as well-off as after the price change across all simulated scenarios. In other words, it means that these two groups of households benefit from the policy changes as compared with the situation before the changes. For the group of poor households, the increase in welfare is registered when an increase in the budget of *Bolsa Família* is simulated, while in the other scenarios households remain at the same utility level as after the policy shock. The group of senior households unsurprisingly gain utility especially under the scenarios simulating an increase in the budget for rural pension, but also under the other scenarios.

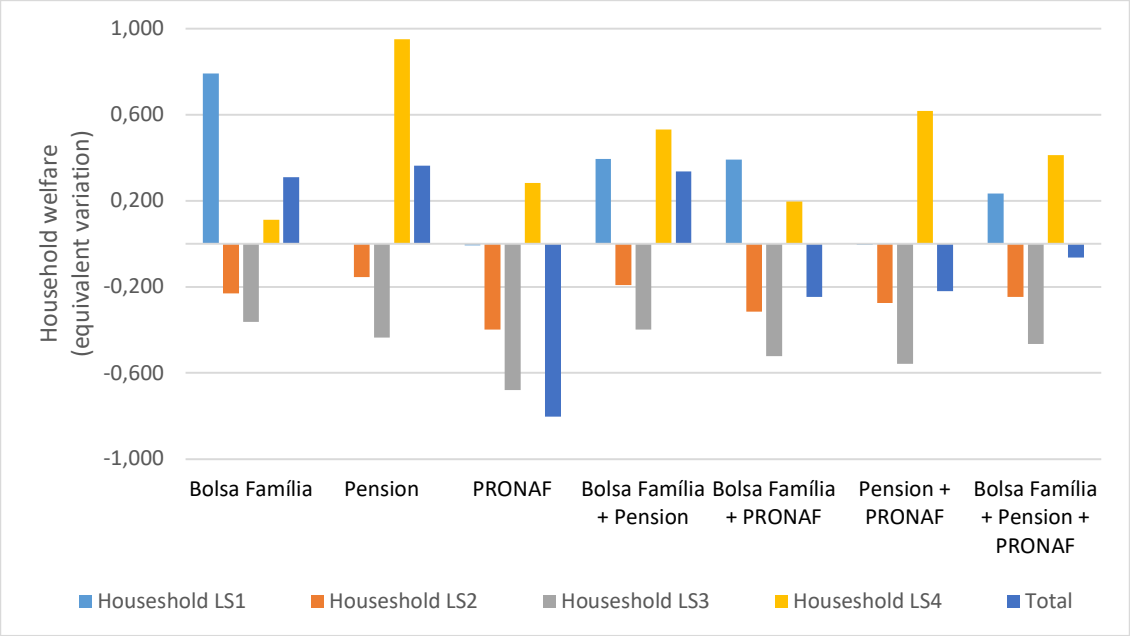

Figure 6.1: Equivalent variation by household income on consumption (in ten thousand BRL), in the different scenarios
Source: author

Conversely, cash crop producers (LS2 and LS3) need to be compensated across all simulations due to the reduction in household commodity consumption in all scenarios. This effect is especially high in the simulations considering an increase in the PRONAF subsidies, as the substitution of subsistence production (crop and livestock) for cash crops increases the prices of the former, consequently increasing the household commodity expenditures. Per definition, subsistence agricultural production is not marketed, therefore the effects of the PRONAF

subsidies on consumption (due to the changes on subsistence production) are felt only by the cash crop producers, and not by the poor and senior households.

Overall, village households would be willing to give away some of their income to retain the same utility level as before the policy shock in all scenarios simulating an increase in PRONAF subsidies. The changes in prices of commodities consumed by households, especially for subsistence, reduce the overall household welfare when PRONAF subsidies are increased. The opposite is seen in the simulations increasing the budget of social protection programs, which increase the overall household consumption, and therefore positively influence household welfare.

6.5 Sensitivity analysis

6.5.1 Effects of the Frisch coefficient on household welfare

Sensitivity analysis allows to assess how sensitive the model results are to changes in used model parameters. As measured through the equivalent variation presented before, household welfare depends greatly on commodity consumption, which in turn is influenced by commodity prices, and on marginal utility of income (Frisch coefficients). As the elasticities used in the basic model were extracted from the literature, in this section we aim at assessing the sensitivity of model results to alternative Frisch coefficients. In that regard, we multiplied the actual elasticities by 50%, 75%, 100%, 125% and 150%, respectively. The results are presented in the Figure 6.2.

As a measure of utility, the equivalent variation is expected to increase with an increase in the marginal utility of household income. Indeed, increasing the Frisch coefficient increases the overall household welfare across all simulations.

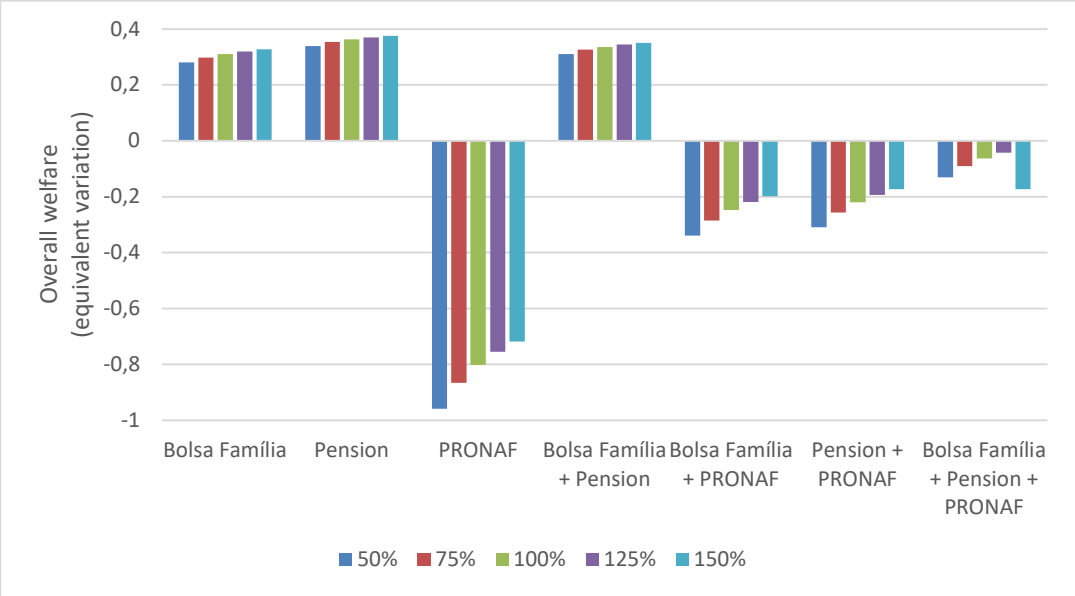

Figure 6.2: Overall household welfare under different Frisch elasticities, in the different scenarios (in ten thousand BRL)
Source: author

6.5.2 Effects of factor mobility and employment on welfare

While the results presented previously are based on the basic model, which assumes full factor mobility and employment for family labor, land (owned and rented), and capital, alternative closures in factor mobility and employment earn different results in household welfare, as shown in Figure 6.3.

The results under the basic model are the aggregated results (over all households) as discussed in the previous section. Under this closure, the aggregated welfare outcomes under the scenarios simulating an increase in the budget of the social protection programs increase household welfare, while an associated increase in PRONAF subsidies will reduce, especially due to the increase in commodity prices, reducing household consumption. These results are very similar to the results earned under the assumption of full factor mobility and employment, showing that these two model closures predict similar model outcomes.

However, the assumption of no factor mobility and no full employment, as well as full factor mobility and employment only for labor factors earn completely different results. Allowing for factor specificity to production activities and factor unemployment, maintaining wages

constant, keeps welfare gains positive across all scenarios. While the welfare gains in the scenarios increasing the budgets of *Bolsa Família* and the rural pension programs remain similar to other factor closures, the welfare gains in the scenarios simulating an increase in PRONAF subsidies strongly differs from the results of other model closures. Furthermore, the relaxation of the assumption on full employment and full mobility of family labor (the only difference to the assumptions under the basic model) produce welfare gains with an increase in the budget of social protection programs similar to the basic model, while the scenarios increasing PRONAF subsidies show strong differences. This means that allowing for "idle" factors produce positive results in terms of household welfare, especially in the case of increasing PRONAF subsidies.

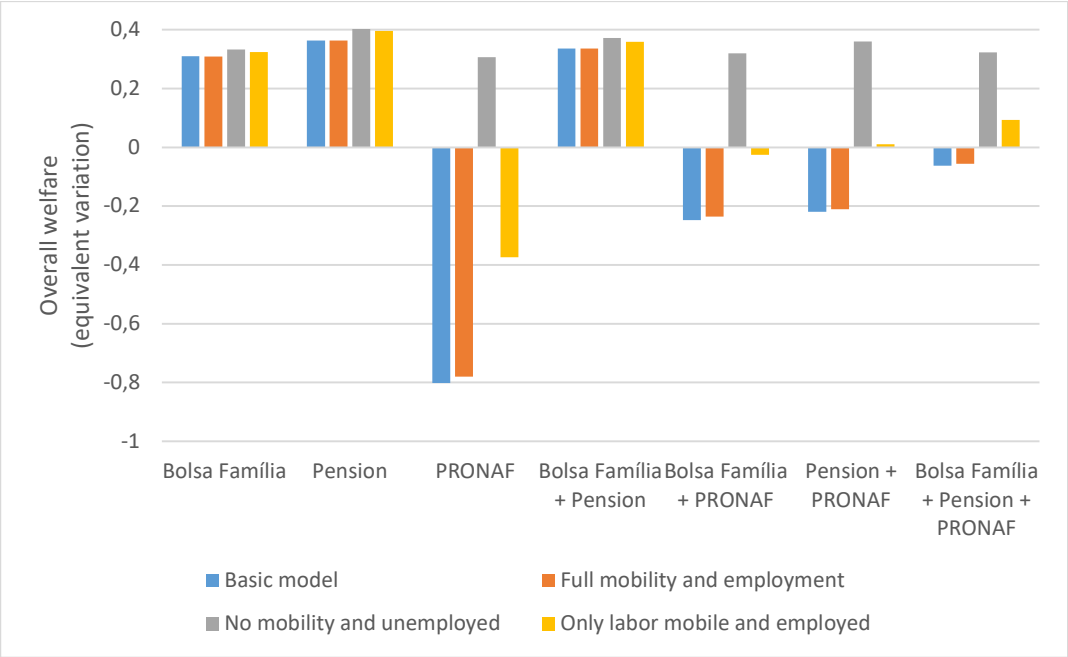

Figure 6.3: Overall household welfare under different factor mobility and employment assumptions, in all the scenarios (in ten thousand BRL)

Source: author

Overall, the choice of model closures have a relatively big effect on model results (Siddig, 2009). Greater welfare gains are expected from greater flexibility in the model assumptions, allowing for factors to remain unemployed and activity-bound, maintaining factor wages and rent constant. While such flexibility does not correspond to the reality of the Rincão dos Maia village (e.g. tractors are used for tobacco as well as for black beans production), allowing family labor

to be also unemployed and not mobile, along with the other factor closures used in the basic model, is certainly a realistic alternative to the basic model.

6.6 Discussion on findings

Beyond the results on the direct effects produced on participant household by the programs implemented in rural Brazil, this study brings further light into the economy-wide effects, transmitted through the commodity and factors markets to the village households.

The village commodity market is substantially affected by the simulated policy changes. *Bolsa Família* and the rural pension programs increase overall household consumption of commodities, including food commodities. The increase in consumption is strongly supplied by the formal retail sector, either through the local shop or through the supermarkets from the town (imports). Moreover, this increase is also supplied by own agricultural production for subsistence, especially of homestead gardening and livestock products, and very little by local crop and livestock products. While other studies showed that food consumption increases for participants of *Bolsa Família* (Coelho & Melo, 2017; Lopez-Arana et al., 2016) and of the rural pension programs (Delgado & Cardoso Jr., 2000), our study shows that these increases are not restricted to the participant households, but are registered for all village households, partly due to an increase in subsistence consumption, especially among poor households.

The simulations including changes in PRONAF subsidies show a strong increase in the production of cash crops, especially of tobacco, and of crop production for subsistence and for the local market. Conversely, overall livestock production, especially for subsistence, is strongly reduced. Other studies had already pointed out that PRONAF supports preferentially cash crop production (Gazolla & Schneider, 2013), contributing to the reduction of farm production diversity (Sambuichi et al., 2016). While the increase in cash crop production necessarily goes along with an increase in the demand for crop inputs, PRONAF reduces the domestic production of crop inputs, such as local seeds, increasing its reliance on the import of intermediate goods, especially from the town.

The local factor markets are also affected by policy changes. Under the assumptions of the basic model, the social protection programs generate a reduction in the demand for off-farm and exchanged labor, while an increase in PRONAF subsidies, either alone or in combination with an increase in the budget of the social protection programs, increase the demand for the same factors. Similarly, factor supply also change in the same direction, with reductions in off-farm and exchanged labor with an increase in the budgets of social protection programs, while PRONAF subsidies increase their supply. Furthermore, the wage of family labor (under the assumption of full employment and full mobility) increases in all simulated scenarios: while the effects of the social protection programs are very small, they are bigger with an increase of PRONAF subsidies. As such, the effects of social protection programs in reducing cash crop production reduce the demand of off-farm and exchange labor, while an increase in subsistence production increases the demand for family labor. Conversely, the increase in PRONAF subsidies increase their demand of all types of labor as a result of boosting tobacco production. In other words, the additional demand for labor due to changes in agricultural production is partially covered by family labor. These findings go in line with other studies showing a reduction in labor supply by the rural pension program (de Carvalho Filho, 2008), and show that the absence of effect of *Bolsa Família* in adult labor supply at the municipality level does not hold when closely looking at the effects of in rural areas (Foguel & Barros, 2010).

The resulting effects on household income vary strongly across the simulations. Obviously, the social protection programs have a direct effect on household income, which are bigger than the transfers themselves, showing that part of the income generates indirect effects on household income. These effects are very low, as these programs induce an increase in commodity consumption which is greatly either imported into the village (e.g. processed food) or produced on the farm for subsistence, with little effects on other village production activities. Conversely, the PRONAF subsidies produce a smaller effect on household income, but which is greatly determined by the demand for production factors demanded in cash crop production. As such, changes in household income due to indirect effects is stronger with an increase in PRONAF subsidies, especially through labor supply.

However, part of the additional income generated by the policy changes is "eaten away" by an increase in the prices of commodities consumed by households, especially due to changes in the production of village commodities, affecting their welfare. *Bolsa Família* and the rural pension programs produce an overall welfare gain among village households measured as household consumption, especially due to the combination in reduction in prices (e.g. increase in crop production for subsistence) and quantity of consumed commodities. Interestingly, while PRONAF increases the overall income of village households, especially of tobacco-producing households (LS3), which receive most of the PRONAF subsidies, most of the households loose welfare in the simulations increasing the budget of PRONAF. This welfare loss is due to increases in commodity prices, which in turn negatively affect household commodity consumption. This effect is especially strong due to the strong increase in cash crop production supported by PRONAF, reducing the production of subsistence goods, such as homestead gardening, as well as crop and livestock production for home consumption. As such, the strong support of cash crop production by PRONAF loans (Gazolla & Schneider, 2013), and the consequent negative effects on the local food and subsistence production (Grisa et al., 2010) of village households.

The hypothesis that synergies should be expected to emerge from the simultaneous implementation of agricultural development and social protection programs is not realized. While theoretically one could expect the increased consumption demand leveraged by social protection programs to be compensated by increased production of local goods (Tirivayi et al., 2016; Veras et al., 2016), the production supported by PRONAF does not support, but rather undermines the production for subsistence, further pressuring up prices of consumed goods, thus affecting household commodity consumption and consequently their welfare. Instead of synergetic outcomes from simultaneous implementation programs in rural areas, the social protection programs seem rather to compensate the price increases of consumption goods generated by the PRONAF by increasing household cash availability. As such, the combination in the implementation of social protection and agricultural development programs in rural Brazil correct the inequalities produced by PRONAF (Aquino & Schneider, 2012), without producing

the synergies that have been found elsewhere in the combination of similar programs (Pace et al., 2018).

Furthermore, the household agricultural production for subsistence and the supply of household-own production factors for most of the village production activities reduce the transmission of policy effects throughout the economy. While households are impacted by policy changes, their responses are not transmitted to other households, as they "isolate" themselves from the markets by supplying the goods and factors they need, reducing the impact of policy changes on semi-subsistence households (Aragie & McDonald, 2014).

The discussed results are embedded in the choice of elasticities and model closures, which play a crucial role in the ultimate policy effects, such as household welfare. The analysis of household welfare showed that the results are relatively insensitive to the specific values of elasticities (Sadoulet & De Janvry, 1995), but highly sensitive to model closures (Siddig, 2009). As such, while the sensitivity analysis highlighted that model formulation is consistent with the literature on CGE modelling, the results of this study shall be understood under the model assumptions, especially on the model closures on factors.

6.7 Summary and concluding remarks

In this chapter, we discussed the economy-wide effects produced by the simultaneous implementation of PRONAF, *Bolsa Família,* and rural pension/BPC programs in the Rincão dos Maia village by using the STAGE CGE model.

The simulated policy changes clearly induce changes in the village commodity and factor markets. The effects on the commodity market reveals that participants of social protection programs increase their production of agricultural goods for subsistence, as well as increase their consumption of locally sold products. Therefore, household transfers bear the potential of increasing the food security of the village as a whole, given that most of these goods are consumed by the households. The simulations also show that the effect of PRONAF leads to an increase in the production of crop export commodities (tobacco and peach), given that most of the subsidies go to farmers producing these goods. As a result, a strong increase in agricultural

production increases the demand for local production factors, increasing local factor prices and, consequently, increasing household factor income. However, these effects are relatively low for off-farm labor, which is the production factor mostly exchanged among village households. The effects registered for family labor and capital, which proportionally increase considerably, are farm-owned factors, and therefore do not contribute in transmitting the effects of policy changes throughout the economy.

The effects on the local markets consequently impact village activities. For instance, an increase in *Bolsa Família* budget produces negative effects on crop and livestock production conducted by poor households, as well as on crop production by tobacco producing households, the two household groups benefitting from *Bolsa Família* transfers. The results also show that an increase in the budget of *Bolsa Família* produces an overall increase in the demand for homestead gardening, while reduces agricultural production for subsistence, especially livestock. An increase in the budget of the rural pension program produce a reduction in the demand for crop activities of all households with the exception of the peach producing households. The livestock activities of all households register an increase in the demand, as well as all homestead gardening and service related activities, such as retail and slaughterhouse. These results show that the rural pension program produce a substitution effect away from crop activities towards livestock production, whose output is greatly consumed by the households. An increase in PRONAF subsidies produce a negative effect in the demand of all village activities, with the exception of crop production by tobacco-producing households. Furthermore, the scenarios simulating the split of public budget with PRONAF all show a reduction in the demand for local activities, as a result of the strong negative effect produced by PRONAF alone. As such, PRONAF subsidies have a strong positive effect on the demand of tobacco-producing activity, and have an overall negative effect on local food production for home consumption, especially among livestock activities and homestead gardening.

The simulated policy changes also affect household income. While the social protection affect income directly through transfers to households, the relative and absolute importance of factor income is small. The increase in household income beyond the original program transfers attest

for the additional income generated and transferred to households due to interlinkages among economic activities in the village, similar to what has been already discussed on the section dedicated to the SAM multipliers. The highest increase in overall village household income is generated by the transfers through the rural pension program. However, this scenario also induces the smallest increase in the income of poor households, which benefit little from direct transfers. An increase in the *Bolsa Família* budget clearly benefits the poor households the most. Conversely, as a result of increase in factor demand by the scenarios simulating an increase in PRONAF subsidies, factor income responds to a high share of final change in household income engendered by this policy change. This is especially important for village poor households, whose income increase is higher than the transfers by the rural pension program due to an increase in prices for off-farm labor, which contributes significantly to this household group's income.

The analysis on the welfare effects clearly show that poor and senior households maintain or increase their welfare in all simulations, and especially in the scenarios increasing the budget of social protection programs, and less when an increase in PRONAF subsidies are simulated. Peach and tobacco producers see their welfare reduced in all simulations, and especially with an increase in PRONAF subsidies. These effects on household welfare are the result of the effects on price and quantity of commodities consumed by the households: while the social protection programs lead to an overall increase in household consumption due to higher household income, PRONAF subsidies increase the prices of produced and locally sold commodities, therefore leading to a reduction in household consumption.

Against our initial hypothesis, there are no synergies whatsoever in any combination of program implementation in Brazilian rural areas. The effects produced by the individual programs on the labor and commodity markets, as highlighted in this economy-wide analysis, clearly show that the production and consumption linkages influenced by the public programs are relatively weak. Furthermore, while the simulated policy changes affect the household commodity and labor demand and supply, they do not necessarily enter the local market, such as in the case of subsistence production and family labor. As such, the combination of weak

linkages of household production for and consumption from the local market, and the strong subsistence production and reliance on family labor, limit the potential of creating synergetic outcomes from the simultaneous implementation of PRONAF, *Bolsa Família* and rural pension/BPC.

Given the symbolic status of PRONAF as public policy for smallholders in Brazil, it cannot be expected that it will substantially change in the near future, and so welfare losses, as in the case of the Rincão dos Maia village, can be expected in the future. The traditional wisdom that increased agricultural production consequently increases household income has been revisited by this study, showing that social protection programs need to be combined with agricultural development programs to reduce the negative effects on household welfare produced by agricultural development programs.

7 Summary, conclusion and policy implications

7.1 Summary of the study

Many initiatives around the globe arise to improve the living conditions of poor farmers, especially in developing countries. Different modalities of intervention have been deployed, such as financial support to productive and non-productive rural activities, special credit lines and crop insurance schemes, and access to markets, as well as cash-based programs, especially targeting poor rural households. These programs can be divided into agricultural development, and social protection programs. The former programs focus on improving productivity in crops and improving access to markets, influencing the composition and scale of crops, affecting farm production and productivity, and finally farm income. Social protection programs aim to reduce socio-economic risks, vulnerability, extreme poverty and deprivation, but also stimulate investment in agricultural inputs, and thus improving farm production.

The assessment of program impacts has grossly focused on direct effects produced on beneficiary households, and little attention has been given to the effects of concomitant program implementation in rural areas. Most of the studies fail to analyze the economy-wide impacts produced by the programs. The econometric approach often used comes short of analyzing the impact of programs on non-participants, given the economic linkages among economic sectors, and fails to simulate the impact of policy changes.

The same can be said about the Brazilian rural credit program PRONAF, and the social protection programs *Bolsa Família* and rural pension programs. The reviewed literature on the public programs clearly shows that PRONAF produces positive impacts on farm productivity and production, and on farm income of participating farms. Furthermore, *Bolsa Família* and rural pension programs undoubtedly positively affect household income and food security, especially of poor and vulnerable participating households. However, scrutiny reveals that all reviewed studies focused on beneficiaries, while spillover effects as well as impact on economic linkages remain understudied. Hence, this study applied a methodology to assess the economy-wide impacts generated by public programs implemented in rural areas.

For that scope, first we determined representative households according to their role in the village economy. The choice of not relying on program participation for grouping households was based on the absence of clear-cut homogeneous participant household groups for the different programs. Furthermore, given out interest in assessing the economy-wide impacts of program implementation in a rural economy, it seems reasonable to assess the effects of public programs on household groups based on the activities they are engaged in to make their living.

With the representative households at hand, we followed with building a social accounting matrix of the Rincão dos Maia village, a rural community in Southern Brazil. The SAM was constructed using the data collected from 101 households, and covered all of the most important and representative village activities. With the SAM, we described the structure of the village economy, giving attention to the village activities, commodity and factor markets, and household income and expenditure, as well as savings and foreign trade. Additionally, the estimation of the village SAM enabled us to estimate and present the results of the SAM multipliers, which are important to understand the transmission of exogenous shocks throughout the economy.

Finally, a village CGE model was calibrated using the STAGE CGE model, based on the information systematized previously in the SAM. The CGE allows to integrate nonlinearities in the model, such as for the consumption of goods by households or in the production decisions by farmers, inserting constraints on resource availability (e.g. land or labor), and letting prices playing a role in the transmission of policy shocks throughout the economy. Furthermore, as CGE models allow to simulate the effects of policy changes, seven simulations were implemented, in which the effects of the implementation of different program combinations, were assessed.

7.2 Empirical findings

The empirical findings of this research is a summary of the findings discussed at the end of every chapter. Special attention is given to the results of the village CGE model.

First of all, the literature review clearly revealed a gap in (i) assessing of indirect effects produced by PRONAF, *Bolsa Família* and rural pension programs, and in (ii) assessing the effects of concomitant program implementation in rural economies. The reviewed literature on the public programs shows that PRONAF produces positive impacts on farm productivity and production, and on farm income of participating farms. Furthermore, *Bolsa Família* and rural pension programs undoubtedly positively affect household income and food security, especially of poor and vulnerable participating households. However, the complete silence about indirect program effects, and the timid efforts to analyze the outcomes of concomitant program implementation fail, by far, to assess properly the impacts of policies implemented in rural Brazil.

Second, the analysis of livelihood strategies revealed that there are four heterogeneous groups of households in the Rincão dos Maia village. The four groups are (i) poor and mostly landless households, (ii) peach and livestock producers, (iii) mostly tobacco producers, and (iv) elderly households. Beyond the differences in income-generating activities executed by each household, upon which the livelihood strategy was estimated, the household groups also differ in their engagement in local commodity and labor markets, as well as in public program participation. The beneficiaries of rural credit (PRONAF) are mostly among the members of the peach, livestock and tobacco producers, and *Bolsa Família* beneficiaries are especially concentrated in the group of poor and mostly landless households, with few beneficiaries among the tobacco producers. The pension beneficiaries are spread across all household groups, but logically among the elderly household group. Therefore, even though we declined from splitting households according to their program participation, the livelihood strategy strongly explains the choice on household participation on public programs.

Third, the estimation of the village SAM allowed the systematization of flows and interlinkages among economic sectors and village households. The village economy is highly dependent on agriculture, with crop production playing a central role in the generation of wealth, especially through tobacco and peach cultivation. Moreover, most of the village household engage in production activities for home consumption, either in the form of crop or livestock activities, or

through homestead gardening. Some crop products are also produced and used for feeding animals, especially maize, but with many other crop products also used as intermediate goods in livestock production. The big majority of crop products is exported to the regional markets, especially tobacco and peach. Livestock sales are mostly directed to the local slaughterhouse, which in turn sells exports most of the processed meat to households from the neighboring villages. The demand for village production factors is especially high for exchanged and off-farm labor by village crop activities. Family labor is the single highest contributor to household income across all household groups, while off-farm labor contributes significantly to income of poor households. Household income is complemented by government transfers through the *Bolsa Família* and the rural pension programs, the former targeted especially towards the poorest households, and the latter to the senior household group. The following SAM multiplier analysis revealed that the linkages among village activities are weak, especially due to the high demand of imported intermediate inputs in the agricultural activities, with very low involvement of other village activities in its production and/or retail. The multiplier effects of village activities on household income is smaller than one in regard of crop production, retail, and the slaughterhouse, while it is greater than one for all other activities. Especially in the case of crop production, which is by far the most important economic activity in the village, these results hints at the limited potential of cropping activities to foster growth in the village economy. An increase in household income generate varying outcomes: while an increase in poor and senior households' income produce multipliers greater than one in the demand for commodities, an increase in the income of cash crop producing households result in an increase in demand commodity demand slightly smaller than unity. Furthermore, household income also weakly affect village activities, as in increase in income results only in an increase in the demand for village activities smaller than 0.5, and is especially low for cash-crop producing households. Nevertheless, the increase in activity demand is translated into a higher demand for village production factors, affecting factor, and finally household income, especially of poor and senior households. Overall, an increase in direct household transfers through the social protection programs produce the highest impacts on the demand for commodities, on household income, and overall GDP growth. An increase in PRONAF subsidies induce the

highest impacts on the demand for village activities, especially in crop production, but does not produce better GDP outcomes, given the weak linkages between the village activities and other economic sectors. Remarkably, no combination of increase in program budget produces a better outcome as compared with the increase in the budget of the individual programs.

Finally, the CGE calibration and policy shock simulations confirmed the results of the scenarios tested under the SAM multiplier analysis done previously, showing that the cash transfer programs, especially the rural pension program, generates the higher outcome in terms of commodity consumption, household income, and finally on village GDP. Additional budget for *Bolsa Família* produces slightly lower results as compared with the rural pensions, but clearly benefits the poorest group of households, which concentrates most of *Bolsa Família* beneficiaries. The policy simulations considering additional budget for PRONAF had the highest effect on activities, especially on the ones that were originally receiving the PRONAF subsidies. However, given the weak linkages between village activities and other economic sectors (especially households), the overall economic effects remained small, and were the smallest among the tested simulations. There was no combination of program implementation, which earned better results as compared with the results earned by the additional budget for the individual programs. This clearly shows that there are no synergies among the public programs tested in this research.

Against our initial hypothesis, there are no synergies whatsoever in any combination of program implementation in Brazilian rural areas. The effects produced by the individual programs on the labor and commodity markets, as highlighted in this economy-wide analysis, clearly show that the production and consumption linkages influenced by the public programs are relatively weak. Furthermore, while the simulated policy changes affect the household commodity and labor demand and supply, they do not necessarily enter the local market, such as in the case of subsistence production and family labor. As such, the combination of weak linkages of household production for and consumption from the local market, and the strong subsistence production and reliance on family labor, limit the potential of creating synergetic

outcomes from the simultaneous implementation of PRONAF, *Bolsa Família* and rural pension/BPC.

7.3 Policy implications

The impacts produced by concomitant implementation of public programs assessed in this research have high policy relevance, as they bear the potential to adjust public program implementation as to optimize the use of public funds. Moreover, it allows for the configuration of policy changes as to potentially increasing outcomes for the target population and for rural economies. Overall, four policy implications resulting from this study are identified.

First of all, PRONAF subsidies should target activities linked to the provision of commodities destined for local sales and for household subsistence. As it is now, regardless of the formal prohibition in the use of PRONAF loans for tobacco production, most of the farming households accessing the rural credit, and therefore benefitting from subsidized interest rates, are activities strongly linked to tobacco production. Given the high reliance on foreign trade for the supply of intermediate goods (crop inputs and investment demand) and for export of crop commodities, the benefits of PRONAF subsidies to the local economy are relatively low. Furthermore, the subsidies have a strong negative effect on the production of livestock and homestead gardening goods, which are highly important commodities for household consumption. Thus, PRONAF loans should be targeted to activities, which have stronger linkages to other economy sectors and direct links to household consumption, especially livestock and homestead gardening production.

Second, the increase in direct transfers to households through the social protection programs have a strong effect on household consumption, especially of processed food and general household consumption goods, which are supplied through imports. As such, the “dutch disease” effect induced by the weak linkages between village activities and household commodity consumption limits the potential of widespread economic gains from greater household income. Though village production increases due to the programs, it is not large enough to counterbalance the impact on price due to the increase in demand. It affects

especially households not participating in any of the programs, which will therefore need to pay higher prices for demanded goods without a corresponding increase in household income. Therefore, village activities producing commodities demanded by local households should be supported in order to reduce local price increases, positively affecting overall village welfare.

Third, the support of village activities producing goods consumed by village households would need to be accompanied by strengthening food processing activities. Most of the unprocessed commodities consumed by households are already produced locally, especially through agricultural production for households' subsistence. However, processed goods are mostly imported, so non-farm small enterprises need to be introduced and fostered to create stronger linkages between local producers and consumers. For instance, processing local crop products, either for household consumption (e.g. beans or conserved vegetables) or for intermediate demand (e.g. maize) can potentially cover part of the domestic demand, thus inducing incentives for investment and unleashing higher intra-economy linkages.

Finally, market channels need to be created and supported to better connect producers and consumers in the village. The increase in the domestic demand for locally sold crop commodities across all simulations can be further increased if appropriate market channels are created. One such channel could be establishing period farmers' markets in the village, in which local producers can offer their goods for local consumers. Another possibility is to gear public food procurement for the local school towards the village, as commodities already produced by local farmers can cover most of the school food demand. As such, the public sector can directly engage in changing the local food system by demanding local food commodities, and therefore, substituting imported school food.

7.4 Study limitations

Regardless of the importance of the results produced and analyzed throughout this work, they surely need to be interpreted with caution. First of all, the use of static economy-wide models, like the STAGE model, enabled us to simulate short-run impacts produced by the concomitant implementation of rural development programs in the Rincão dos Maia village. However, it

does not allow any conclusions on the long run impacts produced on welfare, poverty and income inequality over a long period of time. Especially the absence of behavioral relationship in savings across the economy ignores the potential of today's savings for tomorrow's consumption, which have clear effects of future policy outcomes and are ignored in our results. Therefore, a dynamic economy-wide modelling, together with the consideration of adopting behavioral relationship on savings, should be applied in future research to fill this research gap.

Further study limitations reside in the design and assumptions made in this CGE model. Even though literature suggests that the choice of model closures and model elasticities does not affect substantially the direction of policy changes, they do influence the magnitude of impacts. Furthermore, this CGE model assumes perfect working markets, and not imperfect markets in which households make clear distinctions between tradables and non-tradables, as commonly found in rural areas of developing countries. Therefore, alternative model statements and assumptions can potentially earn different results.

Villages in Brazilian rural areas are highly heterogeneous in terms of income-generating activities, agricultural cropping methods, natural resource endowment, human capital, infrastructure, among others. As such, the villages may have completely diverse economic systems, and therefore transmit the impacts produced by policy changes throughout the village economies differently. Thus, the results on policy changes generated for the Rincão dos Maia village should be carefully used when applied to other rural village economies in Brazil. Therefore, future research should particularly focus to account for such differences among villages.

Lastly, the programs analyzed in this research only represent a relatively small portion of the public programs implemented in rural areas. In order to assess the full spectrum of policy alternatives and their potential impacts on rural economies, it is important to assess the impacts of the individual programs and the impacts of different combinations of programs of a greater spectrum of existing programs being implemented in Brazilian rural areas. Further research in the assessment of policy alternatives will allow policymakers to find better solutions over the full range of policy instruments at hand.

8 Appendix

8.1 SAM balancing technique

The SAM is normally unbalanced at the initial stage. This is due to many factors, such as measurement errors, inconsistent data, incomplete knowledge about both row and column sums and flows within the SAM. For instance, sampled households in a village may sell more of a specific commodity to the local market than they purchase, leading to an imbalance between revenues and expenditures on a given commodity. Therefore, the SAM needs to be balanced, and many techniques are available to carry it out. Applying the principles of double-entry accounting system, the total receipts (income) and expenditure of each account must be balanced. As such, every row sum must equal the corresponding column sum which means that total income is equal to total expenditure in each account, as can be shown in equation **[8.1]**.

$$Y_i = \sum_j T_{ij} = \sum_i T_{ji} \quad [8.1]$$

where *Y* is total income or expenditure of account *i, T* refers the value in each cell of the SAM.
Assume T as the transactions matrix within the SAM, where T_{ij} is a payment from column account *j* to row account *i*. A SAM coefficient matrix, *A*, is computed from T by dividing the value of each cells in each column of T by the column sums:

$$A_{ij} = \frac{T_{ij}}{Y_j} Y_i \quad [8.2]$$

It is known that all the column sums of A must equal one, so the matrix is singular. Since column sums must equal row sums, it also follows that:
$Y = AY$
Each element in matrix T is indicated $t_{ij,}$ where i is the row index (i = 1, 2, 3,…, n;) and j is the column index (j = 1, 2, 3,…, n;). Therefore, column and row sums are represented as shown in equations [**8.3]** and [**8.4]** , respectively:

$$Y_j = \sum_{i=1}^{n} t_{ij} \text{ and} \quad [8.3]$$

$$X_j = \sum_{i=1}^{n} t_{ij} \quad [8.4]$$

For any account in the SAM, spending is equal to earnings represented by the equality of sum of row and column accounts, as shown below in equation [**8.5]**:

$$\sum_{i=1}^{n} t_{ij} = Y_i, \sum_{i=1}^{n} t_{ij} = X_i \quad [8.5]$$

$A = (a_{ij})_{nxn}$ refers a SAM matrix, where $a_{ij} = \frac{t_{ij}}{Y_j}$, and $\sum_i a_{ji} = 1$

And *Y = AY* that is

$$\sum_{j=1}^{n} a_{ij} Y_j = Y_i \quad [8.6]$$

The matrix of columns coefficients, *A,* provides raw material for much economic analysis and modelling. For example, the intermediate-input coefficients (commodity, activity account) are Leontief input-output coefficients. The coefficients for primary factors are "value-added" coefficients and give the distribution of factor income. Column coefficients for the commodity accounts represent domestic and import shares, while those for the various final demanders provide expenditure shares. The data also provide the starting point for estimating parameters of nonlinear, neoclassical production functions, factor-demand functions, and household expenditure functions (Robinson et al., 2001).

There are two methods to balance a SAM: The Residual Allocation System (RAS) and the cross entropy (CE) methods. The RAS methods works well when row and column totals are known with certainty as a result of macroeconomic data, and can be easily used to update new row and column totals on old existing SAMs. As this is not the case for this village economy, we use the cross entropy method.

8.1.1 The cross-entropy balancing technique

The starting point for the cross entropy approach is information theory (Shannon, 1948), which later became adapted to economics (Theil, 1967). If we consider a set of n events $E_1, E_2, \dots E_n$ with probabilities $q_1, q_2, \dots q_n$ (prior probabilities). With an update on the information, we can set the new probabilities as being $p_1, p_2, \dots p_n$, and therefore the information received is equal to $-\ln p_i$. However, as each E_i has its own prior probability q_i, and the "additional" information from p_i is given by:

$$-ln\frac{p_i}{q_i} = -[lnp_i - lnq_i] \quad [8.7]$$

Taking the expectation of the separate information values, we find that the *expected information* value of a message (or of data in a more general context) is

$$-I(p:q) = -\sum_{i=1}^{n} p_i \, ln\frac{p_i}{q_i} \quad [8.8]$$

Where $I(p:q)$ is the Kullback-Leibler measure of the "cross entropy" (CE) distance between two probability distributions.

The cross entropy formulation is used to estimate the coefficients in an input-output table (Golan et al., 1994). They set up the problem as finding a new set of *A* coefficients which minimizes the entropy distance between the prior $\bar{A}$ and the new estimated coefficient matrix. The minimization aims at minimizing the expected information value of additional data given the information that is already known (Robinson et al., 2001).

$$min\left[\sum_i \sum_j a_{i,j}\, ln \frac{a_{i,j}}{\bar{a}_{i,j}}\right] \quad [8.9]$$

Subject to:

$$\sum_j a_{i,j} y_j^* = y_i^* \quad [8.10]$$

$$\sum_j a_{j,i} = 1 \; and \; 0 \leq a_{j,i} \leq 1 \quad [8.11]$$

The solution is obtained by setting up the Lagrangian for the above problem and solving it, according to the formula below:

$$a_{i,j} = \frac{\overline{a_{i,J}} \exp\left(\lambda_i, y_i^*\right)}{\sum_{i,j} \overline{a_{i,J}} \exp\left(\lambda_i, y_j^*\right)} \quad [8.12]$$

Where λ_i are the Lagrange multipliers associated with the information on row and column sums, and the denominator is a normalization factor.

An analogy can be made with Bayesian estimation, given that the CE approach can be seen as an efficient Information Processing Rule (IPR) whereby we use additional information to revise an initial set of estimated values (Zellner, 1988). In this approach, an "efficient" estimator satisfies what is called as the "Information Conservation Principle": the estimation procedure should neither ignore any of the input information nor inject any false information (Zellner, 1988). Additionally, it can be shown that the CE estimators are consistent and, given assumptions about the form of the underlying distribution, have maximum likelihood properties (Golan et al., 1996).

8.2 SAM multiplier analysis

Following Pyatt & Round (1979), the rows and columns of the SAM can be divided into endogenous and exogenous, with *N* representing the matrix of SAM transactions between endogenous accounts, *X* the matrix of injections from exogenous into endogenous accounts, *L* the matrix of leakages of SAM transactions between exogenous accounts.

The village SAM transaction matrix is converted into a matrix of average expenditure propensities by dividing each element in the SAM by its respective column total (J E Taylor & Adelman, 1996). This procedure produces a matrix of average shares, *S*. Let *X* denote the exogenous income flows into the rows corresponding to the endogenous accounts of the SAM. Deleting the exogenous rows and columns from *S* yields a sub-matrix of endogenous shares, *A*. This matrix (equation **[8.13]**) of structural coefficients has the following structure.

$$A_n = \begin{bmatrix} A_{11} & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & A_{33} \end{bmatrix} \quad [8.13]$$

Where A_{11} shows the input-output coefficients, A_{13} stands for the coefficients of the household consumption, A_{21} represents the coefficients for the factors of production, A_{32} shows the coefficients of factor income of consumers, and A_{33} depicts inter-households' transfers.

Following Subramanian & Sadoulet (1990), the endogenous accounts are segregated under three blocks, where commodity and activity accounts form one block, factor accounts another, and the rest forms the third block. Let $\tilde{A}_n$ be given by equation **[8.19]**:

$$\widetilde{A_n} = \begin{bmatrix} A_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & A_{33} \end{bmatrix} \quad [8.14]$$

Following the transaction matrix A_n, shown in equation [**8.13**], each endogenous total income y_n can be represented as below (equation **[8.15]**).

$$Y_n = A_n * Y_n + X \quad [8.15]$$

Endogenous income Y_n is the product of the injection X and a multiplier M_a. The matrix considered as accounting multiplier matrix since it clarifies the results obtained in the SAM. If some exogenous change *X* is applied, the effect on endogenous accounts in the village, *Y*, is determined by a multiplication, as shown in the equation **[8.16]**:

$$Y_n = (I - A)^{-1} * X = M * X \quad [8.16]$$

The matrix *M* is called the accounting multiplier matrix, or the Leontief matrix, because it contains estimated total direct and indirect effects of exogenous factors on the endogenous accounts in the village SAM (J E Taylor & Adelman, 1996). Each cell m_{ij} quantifies the change in total income of account *i* as a result of a unitary increase in the exogenous component of account *j*. Linkages between production and factors, between factors and households, and between households and production shape the impact of exogenous changes on the village economy (J E Taylor & Adelman, 1996).

From equation **[8.16]** it follows that for any matrix $\tilde{A}_n$ of the same size as A_n and such that $\left(I - \tilde{A}_n\right)^{-1}$ exists, Y_n can be written as in [**8.17**] or in **[8.18]**.

$$Y_n = \left(A_n - \tilde{A}_n\right)Y_n + \tilde{A}_n Y_n + X \text{ or} \qquad [8.17]$$

$$Y_n = A^* Y_n + Y_n + \left(I - \tilde{A}_n\right)^{-1} X \qquad [8.18]$$

Where $A^* = \left(I - \tilde{A}_n\right)^{-1}\left(A_n - \tilde{A}_n\right)$, so that, in matrix notation, it can shown as follows (equation **[8.19]**):

$$A^* = \begin{bmatrix} 0 & 0 & (I - A_{11})^{-1}A_{13} \\ A_{21} & 0 & 0 \\ (I - A_{33})^{-1}A_{31} & (I - A_{33})^{-1}A_{32} & 0 \end{bmatrix} \qquad [8.19]$$

From equation **[8.19]** it can be observed that the pattern of zero and non-zero cells of *A* corresponds to a circular permutation matrix. Accordingly, if Y_n is partitioned with A_n, then the structure of **[8.18]** implies that the partitions of Y_n are related to each other as points on a closed loop. In Figure 8.1, these points are the circles (Y_1, Y_2 *and* Y_3).

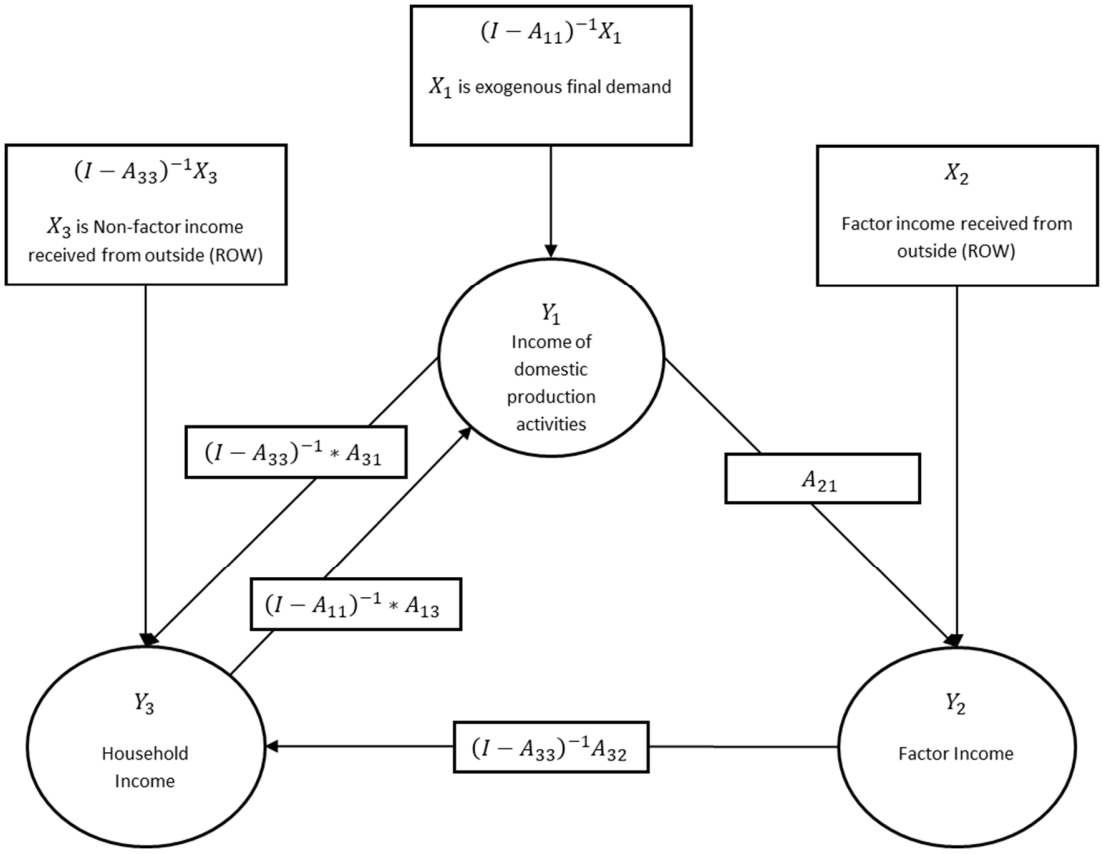

Figure 8.1: Multiplier process among endogenous SAM accounts
Source: adapted from Pyatt & Round (1979)

A detailed analysis of SAM multipliers of equation [**8.13**] can be shown in different circuits of interdependence (Pyatt & Round, 1979). Let us assume that matrix B and C represent sub-matrices of equation [**8.13**] and are specified as following (equations [**8.20**] and **[8.21]**):

$$B = \begin{bmatrix} 0 & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & 0 \end{bmatrix} \quad [8.20]$$

$$C = \begin{bmatrix} A_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & A_{33} \end{bmatrix} \quad [8.21]$$

In the expression indicated in equation [**8.13**], total SAM multiplier has three multiplicative components that give different economic interpretations. After matrix algebra is applied, the first sub-matrix M_1 could be written as equation **[8.22]**.

$$M_1 = \begin{bmatrix} (I - A_{11}) & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & (I - A_{33})^{-1} \end{bmatrix} \quad [8.22]$$

The equation **[8.22]** captures the net effect of a group of accounts on itself, through direct transfers within accounts. Transfer effects capture the direct effects resulting from interactions within each category of accounts, such as the intersectoral input-output elements or the transfers among households (Sadoulet & De Janvry, 1995). This further shows that the transmission shown in M_1 responds to the effects of inter-activity linkages and the effects of the interconnection between households in the village.

The matrix M_2 in equation [8.23] captures all net effects initiated by the accounts on the other parts of the economy. Therefore, the effects on the other income circuits of the system further shows that the main diagona is unitary and the off-diagonal elements are positive. As such, M_2 presents the open-loop multiplier effects between any two different groups of endogenous accounts. It also shows the effects on the rest of accounts of a shock received by one particular account, for example, from production activities on factor income, from factor income on household revenues, or from household revenues on production.

$$M_2 = \begin{bmatrix} I & (I - A_{11})^{-1} * A_{13} * I * A_{32} & (I - A_{11})^{-1} * A_{13} \\ A_{21} & I & A_{21} * (I - A_{33})^{-1} * A_{13} \\ (I - A_{33}) * A_{32} * A_{21} & (I - A_{33})^{-1} * A_{32} & I \end{bmatrix} \quad [8.23]$$

Finally, matrix M_3 captures the net effect of circular income multipliers among endogenous accounts (equation [8.24]). As such, M_3 shows the circular effects on the accounts that are affected by change in exogenous components, which are known as the closed-loop effects of circular flow caused by exogenous shocks. Closed-loop effects show the full circular effects of an income injection traveling through the system back to its point of origin, e.g. from production activities to factors, which reward

households, and then back to activities in the form of consumption demand (Sadoulet & De Janvry, 1995).

$$M_3 = \begin{bmatrix} [I-(I-A_{11})^{-1}A_{13}(I-A_{33})^{-1}A_{32}A_{21}]^{-1} & 0 & 0 \\ 0 & [I-A_{21}(I-A_{11})^{-1}A_{13}(I-A_{33})^{-1}A_{32}]^{-1} & 0 \\ 0 & 0 & [I-(I-A_{33})^{-1}A_{32}A_{21}(I-A_{11})^{-1}A_{13}]^{-1} \end{bmatrix} \quad [8.24]$$

The three components of the accounting multipliers can be interpreted either in multiplicative or in additive terms. The latter is preferred given its easier interpretation. The formula is presented below ([8.25]).

$$M = M_3 * M_2 * M_1 = I + (M_1 - I) + (M_2 - I) * M_1 + (M_3 - I) * M_2 * M_1 \quad [8.25]$$

Where I refers to the initial income injection, out of which the entire process starts. $(M_1 - I)$ represents the transfer net own effect, $(M_2 - I)$ shows the open-loop net effects, and $(M_3 - I) * M_2 * M_1$ stands for the closed-loop multipliers among endogenous accounts.

8.3 The STAGE model

8.3.1 Transaction relationships of the STAGE model

The possibility of assessing price and quantity relationships due to policy shocks are the main advantage of using CGE models to measure the impacts of policy changes. Therefore, in this section, we detail the pathways followed by the STAGE model to determine the price and quantity relationships for commodities and activities in a given economy (also presented graphically in Figure 8.2 and Figure 8.3).

The supply prices of the composite commodities (PQS_c) are the weighted averages of the domestically produced commodities that are consumed domestically (PD_c) and the domestic prices of imported commodities (PM_c). These import prices are defined as the products of the world prices of commodities (PWM_c) and the exchange rate (ER), uplifted by ad valorem import duties (TM_c). These weights are updated in the model through first order conditions for optima. The average prices exclude sales taxes, and hence must be uplifted by (ad valorem) sales taxes (TS_c) (as well as by possible trade and transport margins). Together, they reflect the composite consumer price (PQD_c). The producer prices of commodities (PXC_c) are similarly defined as the weighted averages of the prices received for domestically produced commodities sold on domestic and export (PE_c) markets. These weights are updated in the model through first order conditions for optima. The prices received on the export market are defined as the products of the world price of exports (PWE_c) and the exchange rate (ER) less any exports duties due, which are defined by ad valorem export duty rates (TE_c) (McDonald, 2015). In the Rincão dos Maia village, import taxes (TM_c) are inexistent, and the exchange rate is fixed to one, as all the transactions with the rest of the world are conducted with the same currency (BRL).

The average price per unit of output received by an activity (PX_a) is defined as the weighted average of the domestic producer prices ($PXAC_{a,c}$), where the weights are constant or variables according to the model configuration. After paying indirect taxes on activities (which here are the subsidies received through the PRONAF credit program) (TX_a), this is divided between payments to aggregate value added (PVA_a), i.e., the amount available to pay primary inputs, and aggregate intermediate inputs ($PINT_a$). Total payments for intermediate inputs per unit of aggregate intermediate input are defined as the weighted sums of the prices of the inputs (PQD_c). The prices of domestically consumed (composite) commodities are defined as PQD_c, and they are the same regardless of the stakeholder involved in the purchase of the commodity (McDonald, 2015).

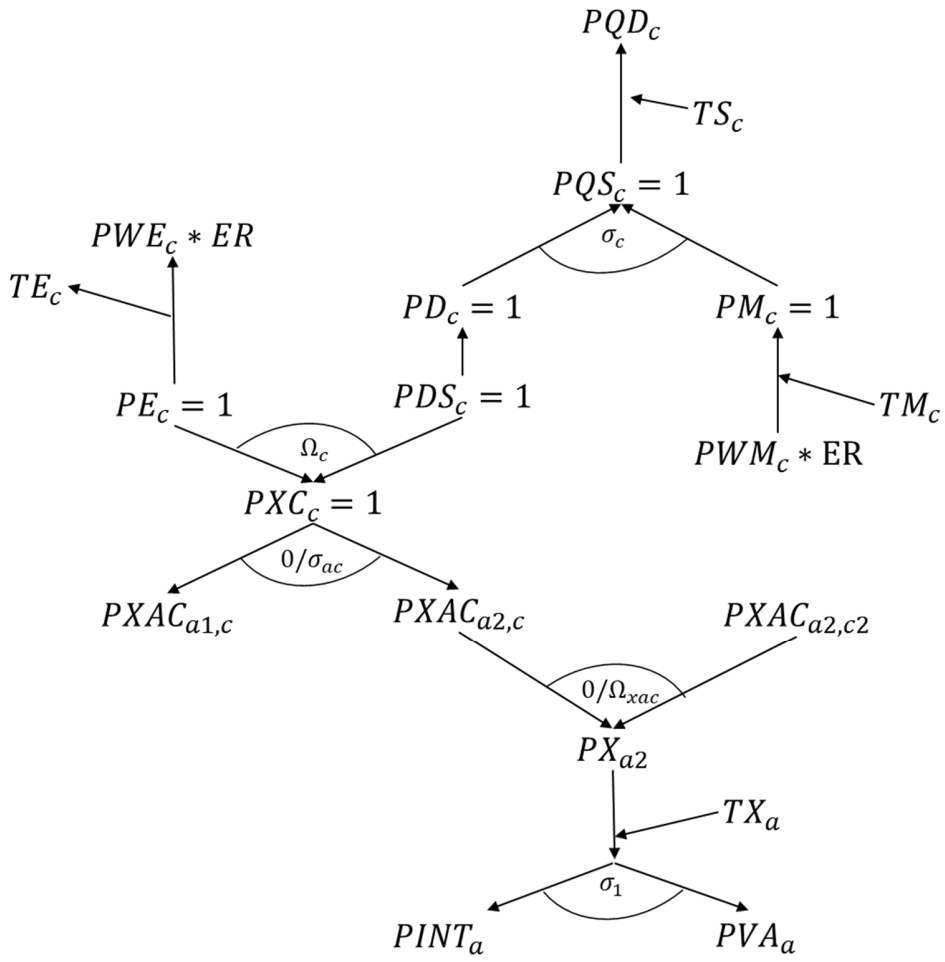

Figure 8.2: Price relationships of the STAGE model
Source: adapted from McDonald (2015)

Total demand for the composite commodities (QQ_c) is compiled from the demands for intermediate inputs ($QINT_c$), consumption by households (QCD_c), enterprises ($QENTD_c$), and government (QGD_c), gross fixed capital formation ($QINVD_c$), and stock changes ($dstocconst_c$). Commodity consumption by enterprises and government are inexistent in the Rincão dos Maia village. Supplies from domestic producers (QD_c), plus imports (QM_c), meet these demands; equilibrium conditions ensure that the total supplies and demands for all composite commodities equate. Commodities are delivered to both the domestic and export (QE_c) markets subject to equilibrium conditions that require all domestic commodity production (QXC_c) to be either domestically consumed or exported.

The presence of multiple product activities means that domestically produced commodities can come from multiple activities, i.e., the total production of a commodity is defined as the sum of the amount of that commodity produced by each activity. Hence the domestic production of a commodity (QXC_c) is a CES aggregate of the quantities of that commodity produced by a number of different activities ($QXAC_{a,c}$), which are produced by each activity in activity specific fixed proportions (a Leontief - fixed proportions - aggregate of the output of each activity QX_a.

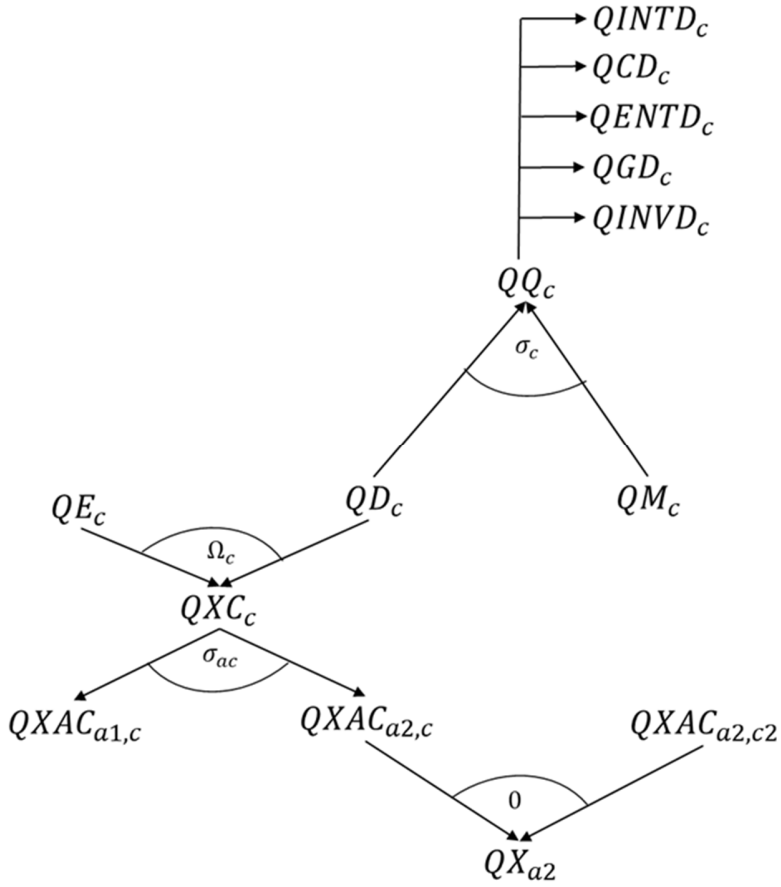

Figure 8.3: Quantity relationships in the STAGE model
Source: adapted from McDonald (2015)

Domestic production activities receive average prices for their output (PX_a), that are determined by the commodity composition of their outputs. In addition to intermediate inputs, activities also purchase primary inputs ($FD_{f,a}$), for which they pay average prices (WF_f). To create greater flexibility, the model allows the price of each factor to vary according to the activity that employs the factor.

Factors of production could be either from the village or the rest of the world. Hence, the village production activity can hire either local or foreign factors. Since most factors of production are owned by the households, the payment for factors of production after deducting depreciation ($deprec_f$) and income tax (TF_f) goes to the owners as disposable factor income ($YFDIST_f$). The disposable factor income will be further distributed to the village and the rest of the world owners of factors, depending on the share of factor contribution.

Households receive incomes from factor rentals and/or sales ($INSVASH_{h,f}$), inter-household transfers ($hohoconst_{h,h}$), from the government ($hogovconst_h$), and remittances from the rest of the world ($howor_h$), which are determined in the local currency. In the Rincão dos Maia village, inter-household transfers and remittances from the rest of the world are nil. Household expenditures consist of direct/income taxes (TY_h) and saving rates (SHH_h), which is fixed exogenously in the base configuration

of the model. The residual household income is then divided between inter-household transfers and consumption expenditures, with the pattern of consumption expenditures determined by the household utility functions (McDonald, 2015).

The government income (YG) is mainly from taxes and transfers ($govwor$). The government allocates its income between saving and expenditure (EG). In this work, government expenditures regard the programs *Bolsa Família*, PRONAF and the pension system. The government saving is the left over amount of income from its spending. The government transfers to other institutions (households) is held constant.

Domestic investment demand consists of fixed capital formation ($QINVD_c$) and stock changes ($dstocconst_c$). The comparative static nature of the model and the absence of a capital composition matrix underpin the assumption that the lack of information means that stock changes are assumed to be invariant. In the base version of the model, domestic savings are made up of savings by households, government (internal balance) and foreign savings. The various closure rules available within the model allow for different assumptions about the determination of domestic savings.

Expenditures by the domestic economy in the rest of the world ("imports") consist of the values of imported commodities and factor services. Incomes to the domestic economy from the rest of the world ("exports") consist of the values of exported commodities and net transfers by institutional accounts. The exchange rate does not play a role in income and expenditure, as all transactions are done in the local currency. The individual relationships just described are presented in the Table 8.1.

Table 8.1: Transaction relationships for the standard model

	Commodities	Activities	Factors	Households	Government	Capital	RoW	Total
Commodities	0	$(PQD_c * QINTD_c)$		$(PQD_c * QCD_c)$	$(PQD_g * QGD_c)$	$(PQD_c * QINVD_c)$ $(PQD_c * dstocconst_c)$	$(PWE_c * QE_c * ER)$	$(PQD_c * QQ_c)$
Activities	$(PXC_c * QXC_c)$ $(PX_a * QX_a)$	0	0	0	0	0	0	$(PX_a * QX_a)$
Factors	0	$(WF_f * FD_{f,a})$	0	0	0	0	$(factwor_c * ER)$	YF_f
Households	0	0	$\sum_f INSVASH_{h,f}$	$(\sum_{hh} hohoconst_{hh,h})$	$(hogovconst_h * HGADJ)$	0	$(howor_h * ER)$	YH_h
Government	0	0						EG
Capital	0	0	0	$(SSH_h * YH_h)$	$(YG - EG)$	0	$(CAPWOR * ER)$	$TOTSAV$
RoW	$(PWM_c * QM_c * ER)$	0	$(\sum_f INSVASH_{w,f})$	0	0	0	0	Total Expenditure abroad
Total	$(PQD_c * QQ_c)$	$(PX_a * QX_a))$	YF_f	YF_h	YG	INVEST	Total income from abroad	

Source: adapted from McDonald (2015)

8.3.2 Algebraic statement of the CGE STAGE model

8.3.2.1 Trade Block Equations

Trade relationships are modeled using the Armington assumption of imperfect substitutability between domestic and foreign commodities. The set of eleven equations are split across exports and imports. In particular, these equations allow for traded and non-traded commodities while simultaneously accommodating commodities that are produced domestically (or not) and are consumed domestically (or not).

We assume that the village economy is completely open. In our village model, households are engaged mainly in agriculture (crop and livestock production). The village is also undertaking trading activities with the rest of the country or with the neighboring villages. Moreover, in the village CGE model, the price of commodities produced and sold in the village is equal to the domestic price of imported commodities. The supply price of commodities produced and sold domestically is equal to the domestic export price of commodities. The exchange rate is also held to be one since the village makes transactions with the same currency.

8.3.2.1.1 Export Block

The domestic price of export commodities is defined as the product of the world prices of exports (PWE), the exchange rate (ER) and one minus the export tax rate, and only applies for the exported commodities (subset *ce*). This represents the price received by local exporters when they sell their products in the export market. The equation is shown in equation [8.26].

$$PE_c = PWE_c * ER * (1 - TE_c) \; \forall \; ce \qquad [8.26]$$

Commodities produced in the village (QXC_c) are either exported (QE_c) or sold in the village market (QD_c). The allocation of village outputs between these two markets is shown in the commodity transformation function in the equation below ([8.27]). The equation is only defined for commodities that are both produced and demanded domestically (*cd*) and exported (*ce*). Imperfect substitution in the two markets is assumed.

$$QXC_c = \; at * \left(\gamma_c * \; QE_c^{\rho t_c} + \; (1 - \; \gamma_c) * \; QD_c^{\rho t_c}\right)^{\frac{1}{\rho t_c}} \forall \; ce \; \boldsymbol{AND} \; cd \qquad [8.27]$$

where γ are commodity share parameters in the two markets, ρt are elasticity parameters, at are shift/efficiency parameters, cd commodities produced and demanded in the village, ce commodities produced in the village and exported.

The optimum allocation of village commodities in export and village market is computed by the first order condition of the commodity transformation function (above) with respect to quantity in the two markets (domestic and export markets). This behavioral relationship is expressed in the equation [8.28].

$$\frac{QE_c}{QD_c} = \left[\frac{PE_c}{PD_c} * \frac{(1 - \gamma_c)}{\gamma_c}\right]^{\frac{1}{(\rho t - 1)}} \forall\ ce\ \boldsymbol{AND}\ cd \quad [8.28]$$

Commodities produced and consumed in the village and those produced and exported from the village are also modeled in the equation [8.29].

$$QXC_c = QDC_c + QE_c \forall\ (cen\ AND\ cd)\ \boldsymbol{OR}\ (ce\ AND\ cdn) \quad [8.29]$$

where ce are commodities exported and cd are commodities produced and demanded in the village, cdn are commodities not produced or not demanded in the village.

The equations above are sufficient for a general model of export relationships when combined with the small country assumption of price taking on all export markets, which applies for the village economy which is going to be analyzed in this work.

8.3.2.1.2 Import Block

The domestic price of imported commodities is computed by the product of the world prices of imports (PWM_c), the exchange rate (ER) and one plus the import tariff rate (TM_c). This relationship works only for commodities which are imported, and the equation is shown below [8.30].

$$PM_c = PWM_c * ER * (1 + TM_c) \forall\ cm \quad [8.30]$$

The domestic supply equations are modeled using Constant Elasticity of Substitution (CES) functions and associated first order conditions to determine the optimum combination of supplies from domestic and foreign (import) producers.

Moreover, the available composite commodities (QQ_c) in the village are either from the village production (QD_c) or imported (QM_c) and exhibits constant elasticity of substitution (CES). The equation is shown below [8.31].

$$QQ_c = ac * (\delta_c * QM_c^{-\rho_c} + (1 - \delta_c) * QD_c^{-\rho_c})^{\frac{1}{\rho_c}} \forall\ cm\ AND\ cx \quad [8.31]$$

where δ are shift parameters, ρ the elasticity of substitution parameters and ac shift/efficiency parameters, cx commodities produced domestically and cm commodities imported into the village.

In the village market, the optimum allocation of commodities from the village and from the import market is calculated by first order partial derivatives of the CES function [8.31] with respect to quantities from village production and imported commodities. The optimum combination of commodities is determined by relative prices in the two markets, and is shown in equation [8.32].

$$\frac{QM_c}{QD_c} = \left[\frac{PD_c}{PM_c} * \frac{\delta_c}{(1 - \delta_c)}\right]^{\frac{1}{(1 + \rho_c)}} \forall\ cm\ AND\ cx \quad [8.32]$$

where δ are share parameters, ρ the elasticity of substitution parameters, PM_c prices of imported and PD_c domestically supplied commodities.

If commodities are produced domestically but not imported, then domestic supply of domestically produced commodities (QD) is equal to domestic commodity demand (QQ). Alternatively, if commodities are not produced domestically but are demanded on the domestic market, then commodity supply (QQ) is equal to commodity imports (QM). These cases are captured in equation [8.33].

$$QQ_c = QD_c + QM_c \; \forall \; (cmn \; AND \; cx) \; or \; (cm \; AND \; cxn) \qquad [8.33]$$

where cmn are commodities not imported, cx commodities produced in the village, cxn commodities not produced in the village, cm imported commodities.

Therefore, for commodities produced in the village but not imported, equation [8.33] would be $QQ_c = QD_c$. Similarly, for commodities not produced in the village but imported, the same equation would be $QQ_c = QM_c$.

8.3.2.2 Commodity Price Block

The supply prices for commodities are defined as the volume share weighted sums of expenditure on domestically produced (QD) and imported (QM) commodities. Equation [8.34] is implemented for all commodities that are imported (*cm*) and for all commodities that are produced and consumed domestically (*cd*). The relationship is derived using the first order partial derivative of quantity equation with respect to domestically produced and imported commodities.

$$PQS_c = \frac{(PD_c * QD_c) + (PM_c * QM_c)}{QQ_c} \; \forall \; cd \; OR \; cm \qquad [8.34]$$

The supply price of domestic products, either directed to export or domestic consumption, is also computed from the proportion of domestically supplied and exported commodities from the total expenditure, as expressed in equation [8.35].

$$PXC_c = \frac{PD_c * QD_c + (PE_c * DE_c) * ce}{QXC_c} \; \forall \; cx \qquad [8.35]$$

where cx are domestically produced commodities, and ce are exported commodities.

Domestic agents consume composite commodities (*QQ*) that are either produced domestically or imported. Their price (*PQD*) is computed from supply price and commodity taxes, as specified in equation [8.36].

$$PQD_c = PQS_c * (1 + TS_c + TEX_c) \qquad [8.36]$$

8.3.2.3 Numéraire Price Block

The price block is complete by two price indices that can be used for price normalization. The Consumer Price Index (CPI) is defined as a weighted sum of composite commodity prices (*PQD*) in the current period, where the weights are the shares of each commodity in total demand ($comtotsh$). The equation is shown below [8.37]:

$$CPI = \sum_{c} comtotsh_c \, (PQD_c + (1 + TV_c)) \quad [8.37]$$

The domestic producer price index (PPI) is defined by reference to the supply prices for domestically produced commodities (*PD*) with weights defined as shares of the value of domestic output for the domestic market ($vddtotsh$), and is shown in equation [8.38].

$$PPI = \sum_{c} vddtotsh_c * PD_c \quad [8.38]$$

8.3.2.4 Production Block Equation

The price of domestically produced commodities is computed from the purchase prices on the domestic market. Allowing for the possibility that the optimal output mix produced by an activity can vary according to the relative prices paid for the commodities produced by each activity means that the weighted average activity prices (*PX*), where the weights are quantities of each commodity produced by each activity ($IOQXACQX$), as shown in equation [8.39].

$$PX_a = \sum_{c} ioqxacqx_{a,c} * \ PXC_c \quad [8.39]$$

where $ioqxacqx$ is the proportion of supply price of commodities' activity price.

The model considers a two-stage production function where either CES or Leontief functions are considered. In a CES production function, the value of commodities can be computed by the summation of value of intermediate and primary (value added) inputs and deduction of production tax, as put in equation [8.40]. The value of intermediate factors can be calculated using I-O coefficient share in the total price of intermediate inputs. Value of primary factors is also calculated from the price of value added inputs and quantity of inputs employed in each activity.

$$PX_a * (1 - \ TX_a) * \ QX_a = (PVA_a * \ QVA_a) + \ (PINT_a * \ QINT_a) \quad [8.40]$$

The following equation [8.41] presents the computation of prices of intermediate inputs. It is considered as the proportion of domestic price of domestic commodities, which is calculated from the I-O model coefficients.

$$PINT_a = \sum_{c} \left(ioqtdqd_{c,a} * PQD_c \right) \quad [8.41]$$

where $\boldsymbol{ioqtdqd_{c,a}}$ are the intermediate input-output coefficients.

The model assumes adjustments and scaling factors to change the value of various variables during the simulation. The equation [8.42] indicates how the efficiency parameter is computed from adjustment factors.

$$ADX_a = [(adxb_a + dabadx_a) * ADXADJ] + (DADX * adx01_a) \quad [8.42]$$

where ADX_a is an efficiency/shift factor, $adxb_a$ are the base values, $dabadx_a$ is an absolute change in the base value, $ADXADJ$ is an equi-proportionate (multiplicative) adjustment factor, $DADX$ is an additive adjustment factor, and $adx01_a$ is a vector of zeros and non-zeros used to scale the additive adjustment factor.

Equation [8.43] indicates the first stage in production relationship that exhibits CES function between value added and primary factors.

$$QX_a = AD_a^x * \left({}_a^x * QVA_a^{-\rho_a^x} + (1 - \delta_a^x) * QINT_a^{-\rho_a^x} \right)^{-\frac{1}{\rho_a^x}}, \forall aqx_a \quad [8.43]$$

where AD_a^x is an efficiency/shift factor, δ are share parameters, and ρ is the elasticity of substitution.

The optimum combination of the intermediate and primary factors is computed by the first order partial derivative of quantity equation with respect to the amount of each input. It is determined by the relative prices of the two inputs and their share in the production function, as depicted in equation [8.44].

$$\frac{QVA_a}{QINT_a} = \left[\frac{PINT_a}{PVA_a} * \frac{\delta_a^x}{(1 - \delta_a^x)}\right]^{\frac{1}{1+\rho_a^x}} \forall aqx_a \quad [8.44]$$

If the Leontief production function is considered, a fixed share of primary and intermediate inputs in the production function are taken, as shown in the equations [8.45] and [8.46].

$$QVA_a = ioqvaqx_a * QX_a \; \forall aqxn_a \quad [8.45]$$

where $ioqvaqx_a$ is the (fixed) proportion of primary inputs in the production function.

$$QINT_a = ioqintqx_a * QX_a \; \forall aqx_a \quad [8.46]$$

where $ioqintqx$ is the (fixed) proportion of intermediate inputs in the production function.

The production relationship in the second stage considers the CES function among primary factors. Similar to the first stage of production function, the efficiency of shift parameter is computed from adjustment and scaling factors, as depicted from equation [8.47].

$$ADVA_a = [(advab_a + dabadva_a) * ADVAADJ] + (DADVA * adva01_a) \quad [8.47]$$

In the second stage value added production factors are nested and exhibits CES function, as shown in equation [8.48].

$$QVA_a = AD_a^{va} * \left[\sum_{f\$\delta_{f,a}^{va}} \delta_{f,a}^{va} * ADFD_{f,a} * FD_{f,a}^{-\rho_a^{va}}\right]^{-\frac{1}{\rho_a^{va}}} \quad [8.48]$$

where δ_a^{va} is the share parameter, ρ_a^{va} is the substitution parameter, and AD_a^{va} is the efficiency factor.

The associated first order conditions for profit maximization determines the wage rate of factors (WF_f) with respect to factors of production in each activity and the price of commodities. Hence, the wage rate is equal to the marginal value product of the factor. It also accounts the wage distortion factor to accommodate the wage difference for heterogeneous production factors, as shown in equation [8.49].

$$WF_f * WFDIST_{f,a} * (1 + TF_{f,a}) = PVA_a * AD_a^{va} * \left[\sum_{f\$\delta_{f,a}^{va}} * ADFD_{f,a} * FD_{f,a}^{-\rho_a^{va}}\right]^{-(\frac{1+\rho_a^{va}}{\rho_a^{va}})} * \delta_{f,a}^{va} * FD_{f,a}^{(-\rho_a^{va}-1)} \quad [8.49]$$

where $WFDIST_{f,a}$ is the wage distortion factor.

Furthermore, the production function captures the intermediate inputs in Leontief production function in the second stage. The demand for intermediate inputs is the product of input coefficient in each activity and amount of intermediate inputs for the corresponding activities as specified in equation [8.50].

$$QINTD_c = \left(\sum_a ioqtdqd_{c,a} * QINT_a\right) \quad [8.50]$$

Where $ioqtdqd_{c,a}$ are input coefficients of demand for commodity c by activity a.

The composite supplies of each commodity (*QXC*) are aggregates of the commodity ouputs by each activity (*QXAC*). The default assumption is that a commodity can be produced by various production activities, and so it can be differentiated by reference to the activity that produces the commodity. This relationship is represented using CES aggregate of the quantities produced by each activity. This is shown in the equation below [8.51].

$$QXC_c = adxc_c * \left[\sum_{a\$\delta_{a,c}^{xc}} \delta_{a,c}^{xc} * QXAC_{a,c}^{-\rho_c^{xc}}\right]^{-\frac{1}{\rho_c^{xc}}} \forall cx_c \; AND \; cxac_c \quad [8.51]$$

The price of each commodity produced by each activity is computed by the first order partial derivative of the quantity equation, where $PXAC$ are the prices of each commodity produced by each activity (equation [8.52]).

$$PXAC_{a,c} = PXC_c * adxc_c * \left[\sum_{a\$\delta_{a,c}^{xc}} \delta_{a,c}^{xc} * QXAC_{a,c}^{-\rho_c^{xc}}\right]^{-\left(\frac{1+\rho_c^{xc}}{\rho_c^{xc}}\right)} * \delta_{a,c}^{xc} * QXAC_{a,c}^{(-\rho_c^{xc}-1)}$$

$$= PXC_c * QXC_c * \left[\sum_{a\$\delta_{a,c}^{xc}} \delta_{a,c}^{xc} * QXAC_{a,c}^{-\rho_c^{xc}}\right]^{-\left(\frac{1+\rho_c^{xc}}{\rho_c^{xc}}\right)} * \delta_{a,c}^{xc} * QXAC_{a,c}^{(-\rho_c^{xc}-1)} \; \forall cxac_c \quad [8.52]$$

where $adxc_c$ is the shift parameter, $\delta_{a,c}^{xc}$ is the share parameter and ρ_c^{xc} is the elasticity parameter.

However, there are circumstances where perfect substitution may be amore appropriate assumption given the characteristics of either of both of the activity and commodity accounts. The following equation [8.53] aggregates the commodity outputs by each activity (*QXAC*) to form the composite supplies of each commodity (*QXC*) when commodities produced by different activities are modeled as perfect substitutes.

$$QXC_c = \sum_a QXAC_{a,c} \; \forall \; cx_c \; AND \; cxacn_c \quad [8.53]$$

Finally, the quantities of each commodity produced by each activity need to be determined. There are two basic assumptions included in the model: (i) secondary commodities are produced with pure by-product technologies (fixed ratio to the principle product); and (ii) activities can adjust their output mix in response to changes in the prices of the commodities they produce. The function for by-product assumption is that fixed shares of products ($IOQXACQX$) are produced by each activity according to its level of total output (QX). The commodity supplies each commodity produced per unit of output of each activity is shown in equation [8.54].

$$QXAC_{a,c} = IOQXACQX_{a,c} * QX_a \; \forall \; IOQXACQX_{a,c} \; AND \; acetn_a \quad [8.54]$$

where $IOQXACQX_{a,c}$ is the proportion of each commodity in the total output of each activity.

8.3.2.5 Factor Block Equations

Factors earn their income from value added from village production (domestic value added) or the rest of the country if factors are working outside the village. Factor incomes (*YF*) are therefore defined as the sum of all income to the factors across all activities (equation [8.55]).

$$YF_f = \left(\sum_a WF_f * WFDIST_{f,a} * FD_{f,a}\right) + \left(factwor_f * ER\right) \quad [8.55]$$

The equation below [8.56] indicates disposable factor income after clearing factor income tax (TYF_f).

$$YFDISP_f = YF * (1 - TYF_f) \quad [8.56]$$

The endogenous determination of factor incomes requires the definition of variables that control that distribution. The key assumption is that the shares of factor income ($FSISH$) distributed to institutions ($insw$) are defined by the shares of factor ownership (FSI). The factor incomes distributed to each institution ($INSVASH$) are also calculated explicitly. Both are shown in the equation [8.57] and [8.58], respectively:

$$FSISH_{insw,f} = \frac{FSI_{insw,f}}{\sum_{insw} FSI_{insw,f}} \quad [8.57]$$

$$INSVASH_{insw,f} = FSISH_{insw,f} * YFDISP_f \quad [8.58]$$

8.3.2.6 Household Block Equations

8.3.2.6.1 Household income

Households receive their income from factor incomes distributed to households as fixed proportions ($INSVASH_{h,f}$), inter-household transfers ($HOHO_{h,hp}$) and real transfers from the government ($hogovconst_h$) that are adjustable using a scaling factor ($HGAGJ$) and transfers from the rest of the world ($howor_h$) as shown in equation [8.59].

$$YH_h = \left(\sum_f INSVASH_{h,f}\right) + \left(\sum_{hp} HOHO_{h,hp}\right) + (hogovconst_h * HGAGJ * CPI) + (howor_h * ER) \quad [8.59]$$

The formula implemented for this village model departs slightly from the default formula above in which the government transfers $hogovconst_h$ is split into $hobfconst_h$ and $hopenconst_h$, which stand for the government transfers to household through the *Bolsa Família* and the pension programs, respectively. The scaling factor $HGADJ$ has also been adjusted accordingly. These changes were necessary to implement the experiments for each of the programs separately, which is not possible in model's original version.

8.3.2.6.2 Household expenditure

Inter-household transfers ($HOHO_{h,hp}$) can be computed as fixed share of household income (YH) after payment of tax and savings, as depicted in equation [8.60].

$$HOHO_{h,hp} = hohosh_{h,hp} * (YH * (1 - TYH_h) * (1 - SHH_h)) \quad [8.60]$$

The income left over inter-household transfer and saving would be allocated for consumption expenditure ($HEXP_h$), as shown in the equation below [8.61].

$$HEXP_h = \left(\left(YH_h * (1 - TYH_h)\right) * (1 - SHH_h) - \left(\sum_{hp} HOHO_{hp,h}\right)\right) \quad [8.61]$$

Households are then assumed to maximize utility subject to Stone-Geary utility functions, in which household consumption demand captures both subsistence demand ($qdconst_{c,h}$) and non-subsistence ($beta_{c,h}$).The discretionary demand is defined as the marginal budget shares (beta) spent on each commodity out of the subsistence, i.e., household total consumption expenditure minus expenditure on subsistence demand, as shown in equation [8.62].

$$QCD_c = \frac{\left(\sum_h \left(PQD_c * (1 + TV_c) * qcdconst_{c,h}\right) + \sum_h beta_{c,h} * \left(HEXPH_h - \sum\left(PQD_c * (1 + TV_c) * qcdconst_{c,h}\right)\right)\right)}{PQD_c(1 + TV_c)} \quad [8.62]$$

where $beta_{c,h}$ is the marginal budget share of commodities. If the Frisch parameters are set to minus 1 and all the income elasticities of demand equal to one, the utility function turns out to be a Cobb-Douglas function.

8.3.2.7 Government Block Equations

8.3.2.7.1 Government income

Total government revenue (Y_G) is computed from revenues from taxes, factors and transfers from the rest of the country, as shown in equation [8.63].

$$Y_G = \sum_{f \varepsilon F} \left(tf_f * YF_f\right) + \sum INSVASH_{g,f} + (govwor * ER) \quad [8.63]$$

In the Rincão dos Maia village, government income were basically the incomes from sales, export and indirect taxes. The indirect taxes, as resulting from the subsidies paid by PRONAF, were computed as negative entries.

8.3.2.7.2 Government expenditure

Total government expenditure (EG) can be defined as equal to the sum of expenditure by government on consumption demand at current prices and transfers to households ($hogovconst_h$), as shown in equation [8.64].

$$EG = \left(\sum_c QGD_c * PQD_C\right) + \left(\sum_H hogovconst_h * HGADJ * CPI\right) \quad [8.64]$$

The adjustments referring to households transfers ($hogovconst_h$ and $HGADJ$) were implemented here similarly as done for household income, where we split the transfers among the programs in order to ease the implementation of the policy simulations.

8.3.2.8 Capital Block Equations

8.3.2.8.1 Investment Block

The total value of investment expenditure ($INVEST$) is equal to the sum of investment demand valued at base prices plus the base priced value of stock changes ($dstocconst_c$), defined as being fixed. The relationship is shown in equation [8.65].

$$INVEST = \sum_c \left(PQD_c * \ (QINVD_c + \ dstocconst_c)\right) \quad [8.65]$$

8.3.2.8.2 Savings Block

The saving rates for households (SHH_h) are defined as variables using adjustment factors to allow the user to vary the saving rates for households. This is important when the macroeconomic closure conditions require increases in savings by domestic institutions (see equation below [8.66]).

$$SHH_h = \ \left((shhb_h + \ dabshh_h) * SHADJ * SADJ\right) + \ (DSSH * DS * shh01_h) \quad [8.66]$$

where $shhb_h$ is the savings rate in the base solution, $dabshh_h$ is the absolute change in the base rate, $SHADJ$ is the multiplicative adjustment factors, $DSSH$ is additive adjustment factors, and $shh01$ is a vector of zeros and non-zeros that scale the additive adjustment factors. $SADJ$ and DS are two additional adjustment factors, which enable changing the saving rates for households.

Total savings in the economy ($TOTSAV$) is computed by shares of households' savings (SHH_h) after tax income (TY_h), summed by depreciation at fixed rates ($deprec_f$), the government's deficit/surplus ($KAPGOV$) and the current account deficit ($CAPWOR$). The complete equation is depicted in the equation [8.67] below.

$$TOTSAV = \sum_h \left((YH_h * \ (1 - TYH_h) * \ SHH_h)\right) + \sum \left(YF_f * \ deprec_f\right) + \ KAPGOV + \ (CAPWOR * ER) \quad [8.67]$$

8.3.2.9 Foreign Institutions Block of Equations

The economy also employs foreign owned factors whose services must be recompensated. It is assumed that they receive constant share of the factor income, as shown in the equation [8.68].

$$YFWOR_f = \sum_w INSVASH_{w,f} \quad [8.68]$$

8.3.2.10 Market Clearing Block of Equations

The market clearing equations are required to assure that all markets in the model are cleared simultaneously. In the present model, the "Commodity", "Factor", "Rest of the world" and "Capital" accounts are supposed to be cleared simultaneously.

The equation below [8.69] shows that the commodity market is cleared in that the demand and supply of composite commodities (QQ) are balanced. The total composite commodity available in the economy is distributed to meet various demands, such as intermediate demand ($QINTD$), as well as final demand categories, including households (QCD), government (QGD), investment ($QINVD$) and stock changes ($dstocconst$).

$$QQ_c = QTTD_c + QINTD_c + \sum_h QCD_{c,h} + QGD_c + QINVD_c + dstoccont_C \quad [8.69]$$

Adopting an initial assumption of full employment, which the model closure rules will demonstrate can be easily relaxed, amounts to requiring that the factor market is cleared by equating factor demands (FD) and factor supplies (FSI) for all factors (see equation [8.70]).

$$\sum_{insw} FSI_{insw,f} = \sum_a FD_{f,a} \quad [8.70]$$

Making savings a residual for each account clears the two institutions accounts not cleared elsewhere: (i) government and (ii) the rest of the world. Thus, the government account clears by defning government savings ($KAPGOV$) as the difference between government income and expenditures, i.e. the residuals (equation [8.71]).

$$KAPGOV = YG - EG \quad [8.71]$$

The rest of the world's market clears by balancing the capital account ($CAPWOR$) as the difference between expenditures on imports, on commodities and factor services, and total income from the rest of the world, which includes export revenues and payments for factor services, transfers from the rest of the world to the household and government. The relationship is expressed in equation [8.72].

$$CAPWOR = \left(\sum_c PWM_C * QM_c\right) + \left(\sum_f \frac{YFWOR_f}{ER}\right) - \left(\sum_c PWE_c * QE_c\right) - \left(\sum_f factwor_f\right) - \left(\sum_h howor_h\right) - govwor \quad [8.72]$$

8.3.2.10.1 Slack

The final account to be cleared is the capital account. Total savings ($TOTSAV$) is defined within the model, and has the implicit presumption that it equals the total value of investment ($INVEST$). This is

presented in the equation [8.73]. This market clearing condition includes a term called *WALRAS*, which is a slack variable that returns a zero value when the model is fully closed and all markets are cleared.

$$TOTSAV = INVEST + WALRAS \quad [8.73]$$

8.3.2.10.2 GDP

The calculation of GDP is included, and is calculated from the expenditure side, i.e., domestic absorption (value at purchaser prices) plus exports (valued at basic prices) subtracted from the imports (valued at basic prices). The equation is presented in [8.74].

$$GDP = \sum_c PQD_c * \left(\sum_h \left(QCD_{c,h} * (1 + TV_c) \right) + QGD_c + QINVD_c + dstocconst_c \right) + \left(\sum_c PE_c * QE_c \right) - \left(\sum_c PM_c * QM_c \right) \quad [8.74]$$

8.4 Questionnaire

In cooperation with Federal University of Rio Grande do Sul (UFRGS)

Project title

Impacts analysis on village's economy of family farmers' programs in Brazil

Interviewer's name:_____
Telephone number:_____

1 Household characteristics

A 1. Total number of household members		A 2. Distance to municipality seat	

A 3. Member #	A 4. Name	A 5. Gender 1. Female 2. Male	A 6. Age	A 7. Relationship to head 1. Household head 2. Wife/husband 3. Son/daughter 4. son/daughter-in-law 5. Grandchild 6. Parent 7. Brother/sister 8. Grandparent 9. Others	A 8. Marital status 1. Single 2. Married 3. Divorced 4. Widowed 5. Separated	A 9. Current education status 1. Below school age 2. No degree 3. Primary school incomplete 4. Primary school complete 5. Secondary school incomplete 6. Secondary school complete 7. Vocational training 8. University incomplete 9. University complete 10. Higher degree	A 10. Type of formal occupation 1. Farmer 2. Pension 3. Civil servant 4. Own business 5. Employment 6. Land rental 7. Off-farm informal work 8. House rental	A 11. Total non-farm income in the last 12 months?	A 12. Does the household receive any cash transfer (Bolsa Familia)? If yes, how much?
1									
2									
3									
4									
5									
6									
7									
8									

A 13. Does any share of the household income go to any other household?	BRL		

1.1 Family Time Use Module

For the weekdays (Monday to Friday)

	Morning			**Afternoon**				
A 14. Family member #	**A 15. At what time do you wake up normally during the weekdays?**	**A 16. At what time do you leave to work/school in the morning?**	**A 17. At what time to you come back from work/school in the morning?**	**A 18. How long is your lunch break?**	**A 19. At what time do you leave to work/school in the afternoon?**	**A 20. At what time to you come back from work/school in the afternoon?**	**A 21. How many hours do you spend going out during the week?**	**A 22. At what time do you go to sleep normally?**
1								
2								
3								
4								
5								
6								
7								
8								

A 23. Is your routine on Saturdays different from the other weekday? YES NO

For the weekend (Saturday and Sunday)

A 24. Family member #	**A 25. At what time do you wake up normally on…?**		**A 26. How many hours do you work on…?**		**A 27. How many hours do you spend in church weekly?**	**A 28. How many hours do you spend practicing sports weekly?**	**A 29. How many hours to you spend going out during the weekend?**	**A 30. At what time do you go to sleep?**
	Saturday	**Sunday**	**Saturday**	**Sunday**				
1								
2								
3								
4								
5								
6								
7								
8								

2 Module C: Agricultural production

2.1 Land holdings and agricultural production

C 1. Total amount of land owned	ha	**C 2. Total amount of land rented**		ha
C 3. If you were to sell this land, how much could you sell it for?	BRL	**C 4. How much do you pay for using it?**	**In Kind**	BRL

C 5. Total Land used for agricultural production	ha	**C 6. Total land used as grassland**	ha
C 7. Total land under forest/wood production	ha	**C 8. Total land under no agricultural use (degraded, under protection, unusable, etc.)**	ha

C 9. Have you harvested any… in the last 2 cropping seasons? 1. yes 2. no		**C 10. How big was the area under production for each crop?**	**C 11. How much did you harvest in the last 2 cropping seasons?**	**C 12. How much of the crop you harvested during the last 2 cropping seasons was sold, and at what unit price?**		**C 13. How much of the harvest, which was not sold, has been stockpiled? And where?** 1. At the farm 2. Rincao dos Maia 3. Outside village		**C 14. How much of the harvest was used as feed for animals?**		**C 15. Where did you sell it?** 1. Rincao dos Maia 2. Cangucu 3. Other municipality		**C 16. How much of the amount sold has been sold using Fiscal Documents (Modelo 15) over the last 2 cropping seasons?**
Crop	**Code**	**Ha**	**Amount**	**Amount**	**Unit price (BRL)**	**Code**	**Amount**	**Amount**	**Animal type**	**Code**	**Name**	**Amount**
Maize												
Tobacco												
Rice												
Beans												
Soybeans												
Cassava												
Potatoes												
Lettuce												
Other Leafy vegetables												
Tomatoes												
Squash												
Other non-leafy vegetables												
Oranges												
Bananas												
Peaches												
Other fruits												

Tree for wood												

2.2 Labor inputs

2.2.1 Household labor for agriculture

Crop	**C 17. How many hours per labor day were invested in these crops from household members?**								**C 18. How many labor days did any household member work invest in any farming activity outside the farm (for other farmers)?**				**C 19. What salary did you receive for each worked day?**
	Season 1				**Season 2**				**Season 1**		**Season 2**		
	Preparing	**Applying inputs**	**Weeding/pruning**	**Harvest**	**Preparing**	**Applying inputs**	**Weeding/pruning**	**Harvest**	**Rincao dos Maia**	**Outside**	**Rincao dos Maia**	**Outside**	
Maize													
Tobacco													
Rice													
Beans													
Soybeans													
Cassava													
Potatoes													
Lettuce													
Other Leafy vegetables													
Tomatoes													
Squash													
Other non-leafy vegetables													
Oranges													
Bananas													
Peaches													
Other fruits													
Tree for wood													

2.2.2 Hired labor

Crop	**C 20. Did you hire any labor for Season 1?** 1. yes 2. no	**C 21. How many labor days were hired in total for each crop?**				**C 22. What salary did you pay for each labor day?**	**C 23. Did you hire any labor for Season 2?** 1. yes 2. No	**C 24. How many labor days were hired in total for each crop?**				**C 25. What salary did you pay for each labor day?**
		Season 1						**Season 2**				
		Preparing	Applying inputs	Weeding/pruning	Harvest	BRL (day)	Code	Preparing	Applying inputs	Weeding/pruning	Harvest	BRL (day)
Maize												
Tobacco												
Rice												
Beans												
Soybeans												
Cassava												
Potatoes												
Lettuce												
Other Leafy vegetables												
Tomatoes												
Squash												
Other non-leafy vegetables												
Oranges												
Bananas												
Peaches												
Other fruits												
Tree for wood												

2.3 Input purchases and sources

List of crops	C 26. How much did you spend in buying inputs for the crops?					C 27. From whom did you buy it?						C 28. Where did you buy the inputs?			
						1. Rincao dos Maia 2. Cangucu 3. Outside municipality						Write the name of the place where you bought it			
	Fertilizer	**Manure**	**Herbicide**	**Fungicide**	**Seeds**	**Fertilizer**		**Manure**		**Herbicide**		**Fungicide**		**Seeds**	
Crop	BRL	BRL	BRL	BRL	BRL	Code	Name	Code	Name	Code	Name	Code	Name	Code	Name
Maize															
Tobacco															
Rice															
Beans															
Soybeans															
Cassava															
Potatoes															
Lettuce															
Other Leafy vegetables															
Tomatoes															
Squash															
Other non-leafy vegetables															
Oranges															
Bananas															
Peaches															
Other fruits															
Tree for wood															

2.4 Input expenditures

C 29. Did your household purchase any of this equipment during the last 12 months? 1. yes 2. no		**C 30. How much did you spend in the last 12 months?**			**C 31. Where and from whom did you purchase them?**	
					1. Rincao dos Maia 2. Cangucu 3. Outside municipality	Write the name of the place where you bought it
Inputs	**Code**	**Units**	**Unit price**	**Total price (BRL)**	**Code**	**Name**
Bags/sacks						
Boxes/crates						
Rope						
Plastic sheets						
Gasoline/oil						
Electricity						
Renting farm animal						
Renting farm machinery						

2.5 Public programs

C 32. Did you access PRONAF Custeio in the last years?	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**
C 34. What were the crops funded by PRONAF each year?					
C 36. What were the amounts funded (approx.)?					
C 38. Where did you issue the projects for Custeio 16/17 and 17/18?					
C 39. Did you take any PRONAF Investimento (Mais Alimentos)?	**YES**		**NO**		
C 40. If yes, when did you take it, how much (BRL) and to buy what?					

C 33. Did you participate in the Troca-troca program in 2016?	
C 35. If yes, how much did you receive in the 2016?	
C 37. If yes, how much did you pay back?	

C 41. Did you receive any support to purchase irrigation material?	Yes	No
C 42. If yes, when and how much?		
C 43. What crops do preferentially receive irrigation?		

2.6 Farm capital inventory

C 44. Does your household own any… ? 1. yes 2. no			**C 45. How old are the…?**	**C 46. Does your household own any equipment jointly with any other household?** 1. yes 2. no	**C 47. Did your household provide any service with the equipment? Payment received?** 1. yes 2. no			**C 48. Did your household buy/build any during the last 12 months?** 1. Yes 2. No			**C 49. Where did you buy it/buy the construction material?** 1. Rincao dos Maia 2. Cangucu 3. Outside	**C 50. How much did you spend on maintenance over the last 12 months?**	**C 51. Where did you hire maintenance?** 1. Rincao dos Maia 2. Cangucu 3. Outisde	**C 52. If you were to sell this equipment today, how much could you sell it for?**
Type of equipment	**Amount**	**Code**	**Years**	**Code**	**Share**	**Code**	**BRL**	**Code**	**Units**	**BRL**	**Code**	**BRL**	**Code**	**BRL**
Large tractor (>12 hp)														
Small tractor (<12 hp)														
Animal pulled plow														
Mechanical water pump														
Sprinkler														
Pipes for irrigation														
Motorized thresher														
Hand thresher														
Machine to process livestock feed														
Motorized pesticide pump														
Hand pesticide pump														
Ox cart														
Grain mill														
Structures/buildings														
Chicken house														
Livestock barn														
Fences														
Storage house														
Granary														
Barn														
Pig stall														

2.7 Livestock

C 53. Does any member of the household own livestock? 1. yes 2. no		**C 54. How many animals does the household currently own?**	**C 55. If you sold one of those animals today, how much money would you get for it?**	**C 56. Did you sell any product?** 1. yes 2. no	 1. eggs 2. milk 3. meat 4. honey 5. manure		**C 57. Where and to whom did you sell it?** 1. Rincao dos Maia 2. Cangucu 3. Outside	Write the name of place where you bought it
Animal	**Code**	**Amount**	**BRL**	**Code**	**Product**	**BRL**	**Code**	**Name**
Beef								
Dairy cows								
Breeding bulls								
Calves								
Pigs								
Sow								
Piglets								
Chicken								
Horses								
Sheep								
Bees								
Fish								

2.8 Labor inputs for livestock

Animal	**C 58. How many hours per day were invested by household members?**			**C 59. Did you hire any labor?** 1. yes 2. no	**C 60. How many labor days (hours per day) were hired?**			**C 61. What salary did you pay for each labor day (labor hour)?**
	Feeding	**Collecting products**	**Cleaning**	**Code**	**Feeding**	**Collecting products**	**Cleaning**	**BRL**
Beef								
Dairy cows								
Breeding bulls								
Calves								
Pigs								
Sow								
Piglets								
Chicken								
Horses								

Sheep								
Bees								
Fish								

2.9 Input purchases and sources for livestock

Animal	**C 62. What inputs are used?** 1. kg 2. liter 3. bag 4. Tons						**C 63. Where did you buy the inputs?** 1. Rincao dos Maia 2. Cangucu 3. Outside municipality					
	Feed			**Veterinary services**		**Medicines**	**Feed**		**Veterinary services**		**Medicine**	
	#	Code	BRL	Unit	BRL	BRL	Code	Name	Code	Name	Code	Name
Beef												
Dairy cows												
Breeding bulls												
Calves												
Pigs												
Sow												
Piglets												
Chicken												
Horses												
Sheep												
Bees												
Fish												

2.10 Craftsmanship and other activities

Ask man and/or woman

C 64. Do you carry out any craftsmanship activity? If yes, which one?	**C 65. If yes, what are the inputs used?**	**C 66. Where do the inputs come from?** 1. farm 2. neighbors 3. Outside	**C 67. How much do you pay for the inputs for each unit produced?**	**C 68. How much labor hours are invested every week in this activity?**	**C 69. How many units do you produce per week?**	**C 70. What is the price of the unit sold?**	**C 71. Where do you sell the products?** 1. Rincao dos Maia 2. Cangucu 3. Outside

3 Module B: Food consumption over the last 2 weeks

Questions about the purchases made for the household, regardless of which person made them. Questions shall be made to the person responsible for preparing the meals.

3.1 Food purchases

	B 1. How much of the following items did you buy over the last 2 weeks? Please, enter the units	**B 2.Where did you purchase it?** 1. Rincao dos Maia 2. Cangucu 3. Outside	1. Local Market/supermarket 2. Food truck 3. Other farming HH 4. Other	**B 3. How much did you spend?**	**B 4. What products do you have in your home garden?**	**B 5. How much of what you consumed in the last 2 weeks came from the home garden?** Please, enter the unit	**B 6. How much came from gifts and other sources?** 1. Neighbors 2. Family members 3. Government 4. Others		**B 7.Do you remember receiving any food item from your neighbors in the last 12 months?**	**B 8. Do you remember giving any food item to your neighbors in the last 12 months?** 1. Yes 2. No
Item	**Amount**	**Code**	**Code**	**BRL**	**Check**	**Amount**	**Code**	**Amount**	**Amount**	**Amount**
Cereals or grains										
Wheat flour										
Maize flour										
Rice										
Bread										
Biscuits										
Spaghetti										
Roots or tubers										
Cassava										
Sweet potato										
Irish potato										
Pulses										
Black beans										
Colored beans										
Lentils										
Groundnut										
Other										
Vegetables										
Onion										
Cabbage										
Other cultivated green leafy vegetables										
Pumpkin										

Other vegetables										
Meat and animal product										
Eggs										
Chicken										
Pork										
Beef										
Fish										
Milk and products										
Cow milk										
Goat milk										
Butter										
Powdered milk										
Cheese										
Fruits										
Banana										
Citrus										
Papaya										
Apple										
Peach										
Cooked food from vendors										
Meal eaten at restaurant										
Snacks at bars										
Meat (cooked)										
Sugar, fats										
Sugar										
Cooking oil										
Animal fat										
Beverages										
Tea										
Coffee										
Fruit juice										
Soft drinks										
Beer										
Wine										
Liquor										
Spices and miscellaneous										
Salt										
Spices										

Yeast, baking soda										
Tomato sauce										
Jam, jelly										
Sweets, chocolate										
Honey										
Other										

	B 9. Over the past one week (7 days), how many days did you or others in your household consume any…?
	Number of days
Cereal, grains and cereal products *Maize or wheat flours, rice, bread, pasta, other cereals*	
Roots and tubers *Cassava flour, sweet or Irish potatoes, other tubers*	
Nuts and pulses *Bean, groundnut, other nuts/pulses*	
Vegetables *Onion, cabbage, lettuce, tomato, cucumber, other vegetables/leaves*	
Meat, Fish and animal products *Egg, Fish, beef, pork, poultry, other meat*	
Fruits *Banana, citrus, peaches, other fruits*	
Milk/milk products *Fresh or powdered milk, cheese*	
Fats/Oil *Cooking oil, butter, margarine, other fat/oil*	
Sugar/Sugar products/Honey *Sugar, honey, jam, sweets, chocolate*	
Spices/condiments *Salt, spices, tomato sauce, other spices*	

3.2 Non-food expenditures

3.2.1 ONE MONTH RECALL

B 10. Has the household bought, spent money on for any item during the last month? 1. Yes 2. No		**B 11. How much did you spend in total?**	**B 12. Where did you buy it?** 1. Rincao dos Maia 2. Cangucu 3. Outside	**B 13. Write the name of the place where you bought it?**
Item	**Code**	**BRL**	**Code**	**Name**
Shampoo				
Clothes soap				
Bar soap				
Toothpaste				
Toilet paper				
Skin creams				
Other personal care items (razor blades, shampoo, etc)				
Napkins, garbage bags, etc.				
Cosmetics				
Personal services (haircuts, manicure, etc.)				
Magazines or newspapers				
Cigarettes or tobacco				
Public transport (bus, taxi, etc)				
Light bulbs, plugs				
Gasoline or Diesel				
Batteries				
Expenditures on pets				
Postal expenses				
Lottery tickets				
Cell phone fees				

3.2.2 THREE MONTH RECALL

B 14. Has the household bought, spent money on in any item during the last 3 months? 1. Yes 2. No		**B 15. How much did you spend?**	**B 16. Where did you buy it?** 1. Rincao dos Maia 2. Cangucu 3. Outside	**B 17. Write the name of the place where you bought it?**
Item	**Code**	**BRL**	**Code**	**Name**
Clothes				
Infant clothing				
Diapers				
Boy's clothing				
Men's clothing				
Girl's clothing				
Lady's clothing				
Boy's shoes				
Men's shoes				
Girl's shoes				
Lady's shoes				
Sewing material				
Laundry/tailoring fees				
Kitchen				
Bowls, glassware				
Plates				
Silverware				
Pots				
Stirring spoons				
Napkins, garbage bags, etc.				
Cleaning utensils (brooms, brushes, etc)				
Small kitchen appliances (blender, mixer, etc.)				
General				
Umbrella				
House decorations				
Stationery items				

Books				
CD or DVD				
Tickets for entertainment events				
Drugs				
Doctor fees				

3.2.3 12 MONTH RECALL

B 18. Has the household bought, spent money on in any item during the last 12 months? 1. Yes 2. No		**B 19. How much did you spend?**	**B 20. Where did you buy it?** 1. Rincao dos Maia 2. Cangucu 3. Outside	**B 21.Write the name of the place where you bought it?**
Item	**Code**	**BRL**	**Code**	**Name**
House				
House repair and maintenance				
House improvements				
Construction timber				
Cement				
Bricks				
Household linens (towels, sheets, blankets, etc.)				
Mattresses				
Carpet, curtains				
General				
Sports and hobby equipment				
Toys				
Musical instruments				
Taxes and fees				
Membership fee – Church				
Membership fee – association				
Income tax				
Land tax (INCRA)				
Land tax (ITR)				
Housing and property taxes				
Fines				
Insurances				

Car insurance				
Property insurances				
Health insurance				
Social events				
Excursion Holiday				
Remittance to family member (university e.g.)				
Marriage, birth, other ceremonies				
Funeral expenses				
Donations				
Repair				
Motor vehicle repair or parts				
Bicycle repair or parts				
Repair and maintenance of household articles				
Other				
Cash losses				
Legal or notary services				

3.3 Durable goods

B 22. Does your household own any of the following items? 1. Yes 2. No			**B 23. Since how many years do you have it?**	**B 24. If you want to sell it today, how much would you get for it?**	**B 25. Did you purchase any item in the last 12 months?** 1. yes 2. No	**B 26. How much did you pay for it?**	**B 27. If you bought it, where did you buy it?** 1. Rincao dos Maia 2. Cangucu 3. Outside	
Item	**Amount**	**Code**	**Years**	**BRL**	**Code**	**BRL**	**Code**	**Name**
Stove								
Refrigerator								
Mixer								
Blender								
Coffee machine								
Water boiler								
Washing machine								
Dryer								
Sewing machine								
Fan								
Air conditioner								
Computers								
Television								
Bed								
Table								
Chairs								
Satellite dish								
Video player								
CD player								
Radio								
Camera, video camera								
Cell phone								
Bicycle								
Motorcycle								
Car								
Truck								

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