111 EAAE-IAAE Seminar 'Small Farms: decline or persistence'

University of Kent, Canterbury, UK

26th-27th June 2009

Non-Traditional Export Crops and Household Livelihood Strategies: Panel Data Evidence from Guatemala

Talip Kilic
[Corresponding Author]
Development Research Group World Bank 1818 H Street NW, Washington DC, 20433, USA
Phone: 1-202-458-5892; Fax: 1-202-522-1153; Email: tkilic@worldbank.org.

Calogero Carletto
Development Research Group, World Bank 1818 H Street NW, Washington DC, 20433, USA
Phone: 1-202-473-1377; Fax: 1-202-522-1153; Email: gcarletto@worldbank.org.

Abstract

This study uses a unique panel dataset that spans a 20-year period (1985-2005), and estimates the effect of household non-traditional agricultural export (NTX) adoption on changes in livelihood orientation and participation in non-farm employment in Santiago Sacatepéquez municipality of Guatemala. Given the heterogeneity in adoption patterns, it provides differential impact estimates based on a classification of households that takes into account the timing and duration of NTX adoption. Our findings suggest that over time, household reliance on off-farm income and access to non-farm employment, particularly self-employment and blue collar work, increased in the surveyed communities, irrespective of snow pea adoption. However, the extent of change varied across groups. Although the magnitudes of increase in the aforementioned outcomes among early long-term adopters and late adopters were not statistically significant with respect to the trends among non-adopters, early adopters who withdrew from NTX production in the medium-term exhibited greater and statistically significant increases in the same livelihood outcomes with respect to any other category.

Keywords: Smallholders, Non-Traditional Export Crops, Long-Term Livelihood Changes.

1 INTRODUCTION

Increased commercialization of agriculture and diversification into high-value, labor-intensive non-traditional export crops (NTXs) has often been advocated as a viable strategy for developing countries to stabilize balance of payments, stimulate growth in the agricultural sector, lower unemployment and alleviate poverty. Proponents assert that resource-poor smallholders have a comparative advantage in NTX production through substantial cost savings as labor-intensive production processes can absorb abundant family labor at below market wages. The utilization of family labor on small farms would also be subject to fewer agency problems in ensuring a high-quality effort from workers and farm management (Binswanger et. al., 1995). International donors, policy makers and researchers, who have perceived the spread of NTX adoption as a viable rural development strategy, have traditionally propagated the expectation that relatively higher prices for NTXs and cost-effective production process on small farms would combine to foster increases in rural living standards, and that NTX production would generate local employment directly on farms and indirectly through forward and backward linkages and multiplier effects of increased incomes spent on local goods and services (von Braun et al., 1989a; Barham et al., 1995, Carter and Barham, 1996).

However, the adoption of capital-intensive, high-risk, high-reward crop technologies among smallholders may be constrained due to their limited risk-bearing ability, access to information and credit, asset position, and level of human capital and management skills (Carter and Barham, 1996). A well-studied experience that, at least initially, appeared to overcome various obstacles to NTX adoption is the diffusion of snow peas cultivation among smallholder members of the *Cuatro Pinos* agricultural cooperative in Guatemala's Santiago Sacatepéquez municipality. Thanks to strong foreign demand for NTXs and extensive financial and technical support provided by the cooperative, the area under investigation experienced a significant boom in NTX production in the 1980s. Snow peas cultivation, at the onset, translated into substantial improvements in consumption levels and noteworthy positive spillovers in staple food production among adopters (von Braun et al, 1989). However, throughout the 1990s, a wide range of agronomic, market-based, and institutional problems led to a significant drop in the profitability of snow pea production and caused a sizeable number of resource-poor farmers to withdraw from export crop production.

The *medium-term* woes associated with the production and marketing of snow peas went parallel to increasing importance of non-farm income generating activities in the livelihood strategies of resource-poor households of Santiago Sacatepéquez. This is line with the worldwide trends in the rural development literature which has consistently shown that income diversification at the household and local level has evolved to be the norm**,** with agriculture still constituting a crucial sector of employment in the rural economies for which evidence is available (Davis et al., 2008). The widely quoted empirical evidence available for a number of developing countries indicates that rural non-farm income accounts for 35 percent and 50 percent of total income in Africa, and Latin America and Caribbean, respectively (Haggblade et. al., 2007). The latest effort to estimate comparable income shares for a sample of developing and transition economies puts the global figure at approximately 58 percent, with some countries exhibiting shares as high as 75 percent of total income (Davis et. al., 2008). The levels of participation by rural households in non-farm

activities are even higher, with the vast majority of rural households in many developing countries involved in some form of non-farm income generating activity.

More than 20 years from the onset of the NTX boom in the area, the socio-economic make-up of Santiago Sacatepéquez appear to have changed dramatically. Qualitative evidence indicates that a sizeable number of resource-poor snow pea farmers, whose risk bearing ability could not meet the challenges of growing price uncertainty and volatility in agricultural incomes, either placed greater emphasis on the production of traditional vegetables and increased their reliance on non-farm income or abandoned agriculture altogether and sought off-farm employment in nearby urban centers. While the changes in household livelihood strategies were partly driven by the *medium-term* trends in NTX production and marketing, they were also fostered by the emergence of alternative non-farm employment options that have increased the opportunity cost of family and hired labor in a stagnant agricultural sector. Although non-farm wage labor options until the late 1980s were mainly in the construction and security sectors for men, and in weaving, petty trade and domestic service sectors for women, the alternatives were enriched with the establishment of *maquilas*, i.e. factories that assemble previously manufactured parts of various exports, including textiles and electronics (Goldin, 2001), along the Pan-American Highway, in the nearby area of Manzanales and municipalities of San Pedro Sacatepéquez, San Lucas Sacatepéquez, and Santa Lucia Milpas Altas (Katz, 1995; Saenz de Tejada, 2002).

Furthermore, the only study that used the same data set employed here and attempted to estimate the *long-term* welfare effects of NTX/snow pea adoption concluded that although welfare levels improved in the surveyed communities irrespective of timing and duration of NTX adoption, the extent of improvement varied across non-adopter and NTX-adopter groups. In spite of some early gains, long-term adopters registered, on average, the smallest increase in the period of 1985-2005, while early adopters that withdrew from NTX production after reaping the benefits of the boom period, i.e. early adopter leavers, recorded greater and statistically significant improvements in durable asset position and housing conditions than any other category (Carletto et. al., 2009).

In view of the empirical evidence on the *long-term* welfare impact of NTX cultivation and the emergence of alternative non-farm activities in the region concurrent with the *medium-term* developments that tested the sustainability of NTX production by smallholders, it is important to analyze the formulation of household economic portfolios in relation to NTX adoption. This would allow a better understanding of the alternative pathways that may have been taken by non-adopters and former NTX adopters, and test whether NTX production might have accelerated the "inevitable" process of household diversification into off-farm income generating activities. The preliminary findings from the 2006 ENCOVI suggest that poverty rates are lowest among households relying on nonfarm sources of income and that agriculture alone is often insufficient to lift people out of poverty in Guatemala. Hence, the observed waves of withdrawals from NTX production may not necessarily represent undesirable outcomes, as several successful NTX farmers may have utilized the higher initial returns to NTX production to invest into alternative non-farm activities that proved to offer greater profitability and less income volatility.

In this respect, this study takes advantage of a unique panel dataset, spanning a 20-year period (1985-2005), and employs difference-in-differences estimation to investigate the effect of snow

pea adoption on changes in household livelihood orientation and participation in alternative non-farm income generating activities in Santiago Sacatepéquez. The NTX of interest is snow pea given that from early on, the crop emerged as the main product promoted and marketed by *Cuatro Pinos*. While many farmers have succeeded in continuing to grow snow peas over the years, many more have abandoned its cultivation. Others have entered snow pea production significantly later, with mixed success. Over 80 percent of the farmers in the sample adopted snow pea at some point, and the majority of ever-adopters adopted within the first few years of exposure, primarily due to the credit, technical assistance and marketing support provided by *Cuatro Pinos*. By 1985, 62 percent of the sample, or close to three-quarters of ever-adopters, had already adopted. However, less than 40 percent of the early adopters have continued to produce snow peas over the past two decades. The vast majority grew snow peas only for a few years, and most had withdrawn from production by the mid 1990s. Given diverse adoption patterns, we explore the heterogeneity of impact based on a classification of households that takes into account the timing and duration of snow pea adoption.

Our findings suggest that over time, household reliance on off-farm income and access to non-farm employment, particularly self-employment and blue collar work, increased in the surveyed communities, irrespective of snow pea adoption status. However, the extent of change varied across groups. Although the magnitudes of increase in the aforementioned outcomes among early long-term adopters and late adopters were not statistically significant with respect to the trends among non-adopters, early adopters that withdrew from NTX production after reaping the benefits of the boom period exhibited greater and statistically significant increases in the same livelihood outcomes of interest with respect to any other category. These results support the hypothesis that early adopter leavers may have shown greater improvements in living conditions over time as they may have been able to better take advantage of the emerging, relatively profitable off-farm opportunities by relying on the assets accumulated in the NTX-boom era. The notable closing of the gap in welfare levels between 1985 and 2005 between non-adopters and early long-term adopters may also be linked to the ability of non-adopters to better position themselves in the relatively well-paying occupations of the growing non-farm sector in comparison to early long-term adopters that sustained their reliance on relatively volatile farm income.

The paper is organized as follows. Section 2 offers a brief history of agricultural commercialization and non-farm employment in the surveyed communities. Section 3 describes the data and descriptive statistics. Section 4 outlines the empirical strategy and section 5 presents the results. Concluding remarks are provided in section 6.

2 AGRICULTULTURAL COMMERCIALIZATION AND NON-FARM EMPLOYMENT IN SANTIAGO SACATEPEQUEZ

Cuatro Pinos was founded in 1979 with financial and technical assistance from a coalition of Swiss development organizations that initially arrived in Guatemala for the purpose of rebuilding ravaged villages following the 1976 earthquake (Saenz de Tejada, 2002). The cooperative was set out to provide field-level extension, input credit, and agricultural produce collection, processing, storage and marketing services for small holders engaged in the production of new export crops (von Braun et al., 1989). From early on, snow pea emerged as the main crop

promoted and marketed by the cooperative, which also started promoting the cultivation of broccoli, cauliflower, and parsley by 1985 (von Braun et al., 1989). Contrary to previous agro-export booms in Guatemala[1], NTX cultivation spread among all types of farmers but the very smallest, potentially surfacing as an effective, nearly all-inclusive poverty alleviation mechanism. The cooperative membership increased from 177 in 1979 to 1,600 by 1989[2], and between 1980 and 1985, the area under export vegetable production quadrupled (von Braun and Immink, 1994). *Cuatro Pinos* attempted to counteract production risks with the management of a price band system and provided insurance through limited liability on loans (Carletto et al., 1999). The 48-member cooperative board was also renewed every 2 years, allowing a sizeable number of members to have management and leadership experience (Saenz de Tejada, 2002). In 1985, *Cuatro Pinos* began channeling 10 percent of its annual profits for the provision of basic education and health services for its members. As part of its *sector social* activities, the cooperative set up night schools for its members to complete elementary education, awarded scholarships to its members' children for the completion of secondary education, and kept a team of four physicians giving consultations in villages where the cooperative was active. The provision of educational incentives for the members' children was in part for the purpose of counteracting reliance on child labor in NTX production (Saenz de Tejada, 2002).

The multifaceted support provided by *Cuatro Pinos* was instrumental in enabling smallholders to escape information asymmetries about marketing opportunities and overcome financial and human capital constraints that would have otherwise hampered NTX adoption. The competitiveness of smallholders of Santiago Sacatepéquez was also due to their familiarity with horticultural production (von Braun et. al., 1989) and the highly fragmented pre-boom land distribution that has insulated them from direct competition from larger farms (Carter and Barham, 1996). They were also able to utilize available family labor in NTX production, which required close to 600 person-days per hectare over a four month period (von Braun et al., 1989).

At least initially, NTX production led to large increases in earnings among cooperative members whose total expenditures were 20 percent higher than those of non-members (von Braun et. al., 1989). On a per capita basis, cooperative members were found to spend more on both food and nonfood items, and the average value of their consumption of own-production was also higher than the comparable figure for non-members. The positive spillover effects of NTX adoption on staple food production, mainly through higher fertilizer and labor use per hectare, seemed temporarily to put to rest concerns over the potentially negative impact of NTX production on food security.

Starting in the late 1980s, however, farm-gate prices for NTXs started to decline in real terms due to increased regional competition and high rates of domestic inflation. As seen in Figure 1, this trend continued throughout the 1990s and into recent years. In particular, the 2005 survey

[1] Williams (1986) documents cotton and cattle booms that proved to be devastating to the rural poor.

[2] Following the establishment and expansion of Cuatro Pinos, a number of intermediaries, locally known as *coyotes*, emerged to take advantage of the booming industry. *Coyotes* followed lower quality standards, hosted auctions in Santiago and surrounding communities, and paid immediately in cash. Despite their commitments to the cooperative, it was common for *Cuatro Pinos* farmers, even board members, to sell to *coyotes*, especially when the prices offered by *coyotes* were higher than the price guaranteed by the cooperative (Carter and Barham, 1996). This presented an on-going problem for the *Cuatro Pinos* management who were at times forced to buy produce from *coyotes* at higher prices to comply with its agreements with export companies.

indicates that close to 60 percent of the former adopters cited uncertain and low prices as their primary reason to stop cultivating snow peas. Production costs also surged in the medium-term, in part due to the currency devaluation and elimination of implicit import subsidies for agricultural inputs (Immink et. al., 1995). The excessive use of pesticides led to increased pesticide resistance that required more pesticide applications, leading to a substantial increase in the cost of NTX production. Excessive agrochemical use also contributed to increasing soil degradation and lower productivity which, paradoxically, led to the curtailing of plot rotation practices – a natural method to eliminate pest and increase yields – resulting in even lower productivity.

In addition, Guatemalan NTX shipments were detained 3,081 times between 1990 and 1994 due to pesticide residue violations. Given the highly perishable nature of export crops, the detentions resulted in aggregate losses close to US$ 18 million. 1,755 detentions took place in 1993 alone, almost entirely due to the presence of an unregistered pesticide (chlorothalanil) used in snow pea production. Inevitably, the crop losses left the snow pea farmers of Santiago Sacatepéquez shortchanged, and led many of them to suspend or permanently abandon NTX production. The developments also underlined the importance of accurate marketing information transmission to smallholders that already faced high risks associated with high-value agricultural export production and could generally not afford crop losses in the magnitudes that were witnessed in the 1990s. Subsequent to the pesticide residue crisis, the Guatemalan government required residue analyses to be conducted prior to export shipments (Thrupp et. al., 1995), and the U.S. imposed an automatic quarantine on all Guatemalan snow pea imports (Julian et. al., 2000). The quarantine lasted until April 1997 and further exacerbated price and agricultural income volatility. Since the ability of smallholders to accommodate the fixed costs of ensuring accepted levels of pesticide residues was limited, export companies increasingly started distancing themselves from contract-farming arrangements with smallholders (Barham et al., 1995).

Although the rise in agronomic problems, input costs and the U.S. phytosanitary standards should have prompted the *Cuatro Pinos* leadership to be pro-active in shielding the members from growing risks associated with NTX production, the cooperative was dealing with untimely problems of its own. Throughout the 1990s, waning support from international donors, inefficient management practices, and increased default on agricultural credit due to crop losses from agronomic problems and detentions at the U.S. ports led to a near-bankruptcy of *Cuatro Pinos*, a general management crisis and unrest among its members. The provision of technical and marketing assistance, credit, and social services, which was indisputably critical for the initial success of NTX farmers, was subsequently scaled back (Carletto et. al., 1999).[3] *Cuatro Pinos* was also ineffective in promoting environmentally sustainable agricultural practices, diversifying marketing outlets and enriching its product portfolio in search of more profitable export crops that the snow pea farmers could rapidly embrace. The resulting institutional vacuum was not filled by any other arrangement.

In line with the worldwide trends and driven by the growing woes in Guatemala's smallholder-based NTX sector, the surveyed households have moved away from primary reliance on

[3] Carletto et. al. (1999; 2007) show that adverse institutional and market environment in the late 1980s, global process of growing toxicity and crowding out at village level, and snow peas price deterioration are among the factors increasing the pre-adoption spell as well as the rate of withdrawal subsequent to adoption.

agricultural by 2005, and diversified their livelihood strategies with non-farm earnings to a significant degree, regardless of snow pea adoption status. Saenz de Tejada's (2002) qualitative study in two of the communities that also inform our analysis reveals important insights about changing livelihood strategies, and the conditions under which households were able to maximize their earnings from NTX production. According to the locals, (i) early adopters, (ii) farmers that utilized their earnings to purchase more land and expand NTX production, (iii) producers with adequate capital base, who were able to withstand crop failures and losses, (iv) growers that later evolved into *coyotes*, and (v) those that were "smart-enough" to abandon NTX production at the first signs of insurmountable market conditions and increase their reliance on off-farm activities. In this respect, it was common to witness former early adopters who have taken advantage of the assets accumulated throughout NTX production; primarily pick-up trucks, deserted commercial farming, and started their own NTX-intermediation businesses, perceiving the profit potential in trading to be higher than in farming.

From a theoretical standpoint, there are several reasons for rural households to diversify their economic portfolios by being involved in the rural non-farm economy (RNFE). Beyond the conventional pull factors of potentially lower risk and higher returns to labor and/or capital in the RNFE, limited risk-bearing capacity due to imperfections in credit, insurance, labor, input and/or land markets may push farm households to participate in the RNFE to manage risk more effectively. This is especially true in the presence of low covariate risk across agricultural and non-agricultural sectors. Non-farm earnings can also finance farm investments in the absence of functioning credit markets, particularly in high-potential regions where agriculture provides adequate returns to household capital and labor. Moreover, facing agro-climatic shocks and/or market failures that limit agricultural production and induce food production shortfalls, farm households may utilize non-farm income to stabilize aggregate income flows and preserve food security (Reardon et. al., 1992; 1994). In principle, household resource allocation across agricultural and non-agricultural sectors is a function of off-farm versus on-farm opportunity costs of family labor, household labor endowment, physical, human, financial and social capital, and liquidity from sources such as cash cropping (Davis et. al., 2009). The rural non-farm sector may harbor high productivity activities in which household resources would receive higher returns and pave an alternative path out of poverty (Lanjouw, 1999, 2001; Reardon et. al., 2001; Ferreira and Lanjouw, 2001).

While the massive *medium-term* agronomic, market-based and institutional risks tested the risk bearing ability of resource-poor snow pea growers in the central highlands of Guatemala and required them to restructure their economic portfolios, the livelihood transitions were nurtured concurrently by the manifestation of alternative non-farm employment opportunities in and around Santiago Sacatepequez in the early 1990s. As stated above, a major source of non-farm wage employment emerged as *maquilas*. According to VESTEX (2008), there are an estimated 100,413 workers and 172 manufactures in Guatemala's assembly export sector, and that assembly exports were valued at US$ 567 million in 2007. 60 percent of the industrial capital is owned by Korean ventures, approximately 92 percent of manufacturing companies located in or close proximity to Guatemala City, and 82 percent of the production is destined to the U.S.

The findings from Goldin's (2001, 2005) fieldwork in Santiago Sacatepéquez and Chimaltenango indicate that while workers often complain about the demanding work

environment that is marked by long hours and limited opportunities for organized labor, the idea of the closing of a *maquila* is daunting for many and that they generally appreciate the access to such employment. The employees' choice of factory work is partially fueled by widespread and persistent problems in the agricultural sector that have led to significant reduction in the profitability of non-traditional export crops. In addition, younger generations are increasingly reluctant to engage in farming since they perceive the industrial experience with the potential to pave their path to independence. For them, the life that they could build around the factory work constitutes a promising alternative to and a clear break from the trying agricultural past that belonged to their parents. Relative income stability, seemingly limitless opportunities for new friendships, optimistic expectations for skill acquisition and ensuing prospects for career advancement, unattractive nature of alternative non-farm employment options and the sense of control on the part of workers over their performance underlie the relative satisfaction with *maquila* employment in comparison to agricultural endeavors. It is also reported that the youth of the central highlands, who have been surrounded by those that presumably enjoy the benefits of *maquila* employment, are eager to leaver school and join the industrial workforce, indicating the low perceived returns to education.

With the waning importance of NTX production and increasing emphasis on off-farm employment as part of household livelihood strategies, there is also qualitative evidence that the surveyed communities have witnessed a significant decline in the supply of agricultural labor and that it is becoming increasing difficult for export crop producers to find day laborers or permanent field workers at reasonable wage levels (Saenz de Tejada, 2002). Fieldwork conducted in other communities of Santiago Sacatepéquez and Chimaltenango reveals similar findings (Goldin, 2001). The survey data also indicates that on the whole, while the share of households deriving income from agricultural labor was 27 percent in 1985, the comparable figure was only 16 percent by 2005. Similarly, the average of agricultural income as a share of total household income declined from 12 to 7 percent between 1985 and 2005.

The production and marketing of traditional vegetables has traditionally been and still remains the responsibility of women who commonly sell these products in Guatemala City markets. In addition to these retail traders, there are wholesalers in Santiago who supplement their own-produce with locally produced goods and sell to intermediaries working in Guatemala City markets (Katz, 1995; Saenz de Tejada, 2002). Another off-farm employment option, mostly preferred by women, is to either work at produce packing plants, such as the *Cuatro Pinos* facility, or operate small-scale stores that produce tortillas and/or sell goods for everyday needs. Furthermore, weaving, which is a labor-intensive, often part-time occupation with limited capital requirements, has been an important source of off-farm income for women in Santiago and other Maya communities. Since it can be relatively easily incorporated into daily activities around the house, it has been a preferred choice of women with young children. While earnings from weaving, on average, are similar to agricultural wage labor, they constitute only a fraction of what could be earned in a *maquila* (Katz, 1995; Saenz de Tejada, 2002).[4] Lastly, qualitative studies indicate that the practice of domestic or international out-migration continues to be limited in the communities of interest. Although the amount of international remittances received

[4] Since all home-based production is grouped under one category in our data, we cannot specifically assess the relative stance of average earnings from weaving in comparison to those from agricultural wage and/or *maquila* labor.

by Guatemala in 2007 amounted to be 10 percent of its GDP (Ratha and Mohapatra, 2009), international migration is not accessible by many in Santiago Sacatepéquez, considering the high fixed-costs associated with the reliance on *coyotes*, and if it is practiced, it is often temporary in nature.[5]

3 DATA

Our analysis is based on a unique panel dataset spanning over a 20-year period. The second wave of the survey, conducted in 2004/05 by the authors, revisited the same households of a 1985 study by the International Food Policy Research Institute (IFPRI) and Instituto de Nutrición de Centro América y Panama (INCAP) on a sample of NTX adopters and non-adopters.[6] The 1985 survey was administered to 399 households from six communities in the municipality of Santiago Sacatepéquez, and collected information on household composition, education, health and anthropometric measurements, employment, dwelling conditions, consumption and income, land holdings, cultivation patterns, cooperative membership, and technical assistance. The six communities served by *Cuatro Pinos* were Pachalí, San José Pacúl, Santa Maria Cauqué, San Mateo Milpas Altas, El Rejón, and Santiago, where the cooperative is located. The region's proximity to the Pan-American Highway is notable, as access to infrastructure has not been a constraint on the sustainability of NTX production by smallholders.

Prior to the follow-up, extensive fieldwork was carried out in 2004 in the *Cuatro Pinos* communities of interest in order to locate original sample households and identify the names and locations of each original household member for a follow-up interview.[7] Subsequently, 314 original-households were located, and the sample used for this study includes 293 original-households.[8] The 2004 listing operation also revealed that the vast majority of the individuals that have left original-households since 1985 and formed separate households were living in the same or surrounding communities. Hence, in addition to original-household interviews, the 2005 survey was administered to one "split-off" household, randomly chosen among former household members still living in the survey communities.

[5] Since the 1985 survey did not differentiate among different types of transfers, we cannot assess the changes in household reliance on migration and remittances over time.

[6] See von Braun, Hotchkiss, and Immink (1989) for the original survey design.

[7] The full listing exercise was necessary, since with the exception of the household head, the names of each member of the original household were missing from the dataset, and paper questionnaires were no longer available. For these individuals, the information was available only on the age, gender and relation to the household head, which required tracking and collection of the missing names prior to the survey fieldwork.

[8] Out of the original sample of households, 15 could not be identified since neither the name of the household head nor address information were recorded in the 1985 survey. In 54 cases, the heads of households had died, and another 16 were known to have moved from the community. Only the original households with original heads are used for this study. Further data cleaning eliminated households with insufficient or suspect information, yielding a final sample size of 293. To test for the existence of endogenous attrition, we follow Galasso et. al. (2004) and regress the attrition indicator, which is a dichotomous variable equal to 1 if an observation was not resurveyed in 2005, on the 1985 value of any outcome of interest and other baseline characteristics of the household pertaining to location, demographics and human capital. The test for attrition bias is equivalent to testing whether the baseline value of the outcome of interest is statistically significant. Following this approach, we were not able to detect any sign of attrition bias. The results, which are available upon request, were not sensitive to the choice of OLS vs. Probit to fit the model of the attrition indicator.

While the same set of 1985 modules were administered in 2005 to ensure comparability, additional recall modules on full histories of cooperative membership, NTX cultivation, land transactions, agricultural and durable assets, and perception of economic wellbeing were also included.[9] Information for a money-metric welfare indicator and several non-monetary welfare measures were available in both surveys. Following to the same time frame for the administration of the 1985 survey, the 2005 fieldwork was conducted between November 2004 and February 2005 in order to eliminate seasonality effects that may affect over-time comparisons. In order to differentiate the impact of NTX production based on timing and duration of adoption, we rely on 1985 and 2005 production figures and retrospective information collected in 2005 concerning annual NTX cultivation patterns dating back to 1979 to define adoption categories. Table 1 presents the distribution of the sample households according to their snow pea adoption status.

Adoption is defined by having cultivated snow peas for at least 2 agricultural seasons in the period of 1979-2005, and *early adoption* is equivalent to snow pea adoption by the 1984-1985 agricultural season, i.e. the season on which the baseline survey collected data and by when the majority of smallholders had already adopted. We further distinguish between e*arly adopter leavers*, i.e. early adopters that have not cultivated snow peas in the two seasons preceding 2005, and *early adopter stayers,* who adopted snow peas by 1985 and continued its production through 2005.[10] Henceforth, we refer to early adopter stayers and early adopter leavers as stayers and leavers, respectively.[11]

Tables 2 through 6 present descriptive statistics by household snow pea adoption status. *Never* refers to non-adopters, *Ever* accounts for snow pea adoption at any point between 1979 and 2005 for at least 2 years, and *Late* identifies late adopters. Table 2 depicts household involvement in NTX production over time. We observe that, on average, early adopters started cultivating snow peas by 1981. While the average years of cultivation among stayers exceeded 20 years in the period of 1979-2005, the comparable figure was just above 13 years for leavers, who, on average, left snow pea production by 1994. For late adopters, the average figure for the first year of snow pea cultivation was 1988. Trends in cooperative membership often mirror NTX adoption histories, particularly in the early years when NTX adoption was possible almost exclusively through the coop. While withdrawal from snow pea production generally implied severance from the cooperative, consistent cultivation of the crop, generally reflected sustained involvement in *Cuatro Pinos* and good relations with, or participation in, its management.

Table 3 presents the changes in household livelihood orientation. *Farm-orientation* is defined by having *on-farm* (*crop* and livestock) *income* account for more than 75 percent of total household income; *off-farm orientation* is equivalent to having the sum of *non-farm labor* (*wage* and *self-employment*), *farm wage,* and *non-farm non-labor* (*transfer* and *rental*) *income* account for more

[9] In addition to the careful design of all recall modules, all enumerators were trained extensively on collecting recall data in order to minimize the impact on our results of inevitable errors of recollection.

[10] If a similar rule to distinguish between leavers and stayers is imposed among late adopters, approximately two-thirds of the late adopters would belong to the late adopter leaver category, potentially rendering the size of the late adopter stayer sample too restrictive for meaningful comparisons. Hence, we choose not to distinguish between leavers and stayers within the group of late adopters.

[11] In order to respond possible concerns about a degree of discretion introduced by this classification, we tried different thresholds with no substantive changes in the results.

than 75 percent of total income, and *diversified orientation* implies having no income source account for more than 75 percent of total income. The incidence of farm-orientation and diversification declined on the whole, and among all adopter groups between 1985 and 2005. While close to two-thirds of all households were either farm-oriented or diversified in 1985, the comparable figure was just over 30 percent by 2005. Conversely, the average incidence of off-farm orientation increased from 39 to 69 percent during the same period. Most of the upsurge was fuelled by the changes in the livelihood strategies of leavers, as the 48 percentage point increase in off-farm orientation among them was also statistically significant in comparison to the trends in the non-adopter category. While the average upsurge in the incidence of off-farm orientation was notable and amounted to be 25 and 22 percentage points among stayers and late adopters, respectively, the differences between them and non-adopters were not statistically significant.

The decline in farm-orientation among stayers was likely due to the reduction in real farm earnings, rather than participation in agriculture. Table 4 supports this hypothesis, and reports the changes in household participation in farm vs. off-farm occupations that were *roughly* differentiated according to levels of skill requirement.[12] Since the incidence of high-skilled white collar employment was fairly rare in the surveyed communities, we chose to combine *low-skilled* and *high-skilled white collar employment* under the single heading of *white collar employment*. We see that overall, the average share of households involved in agriculture declined marginally in the period of 1985 and 2005. While household agricultural participation reached 100 percent among stayers and increased marginally within the late adopter category, the opposite was true concerning leavers and non-adopters. On the whole, household participation in all off-farm occupational categories increased in the surveyed communities. As non-adopters branched out to white collar (mostly retail or wholesale traders of agricultural produce) and high-skilled blue collar (often own-account skilled workers working as barbers, mechanics, painters, etc., or skilled factory laborers) professions, they decreased their participation in low-skilled blue collar sector (generally dominated by domestic workers, security guards, day laborers and unskilled factory workers). Conversely, household access to low-and high-skilled blue collar work surged among all adopter groups. While the change in the access to low-skilled blue collar professions was highest among stayers, leavers exhibited the largest increase in high-skilled blue collar

[12] The income/employment module was administered to all individuals at least 10 years of age at the time of the surveys. The respondents that were employed but not working on a household farm were asked to state whether they were employers, own-account workers or wage laborers. Those that were employers or own-account workers were classified as "self-employed." In addition, both surveys used the same list of occupations to collect data on primary and secondary jobs held by individuals. The list included the options of (0) not working, (1) landless farmer, (2) farmer engaged in basic grain/subsistence production, (3) farmer engaged in vegetable production, (4) farmer engaged in basic grain/vegetable/fruit production, (5) agricultural day laborer, (6) housewife, (7) student, (8) non-farm day laborer, (9) domestic worker, (10) home-manufacturing laborer, (11) trader of household agricultural and livestock products, (12) trader of household's and other agricultural/livestock products, (13) trader of household manufactured goods, (14) itinerant trader, (15) trader fixed in the community, working possibly as a mill operator, shop keeper, or butcher, (16) trader employed at *Cuatro Pinos*, (17) unskilled worker in the factory or on-farm, working possibly as a packer/shipper or tractor operator, (18) skilled factory worker, (19) independent (own-account) skilled worker, working as a truck driver, barber, stylist, mechanic, painter, or cobbler, (20) security guard, (21) specialized (skilled) public or private sector wage employee, (22) professional, (23) sick, (24) retired, and (25) other. Complying with the OECD (1998) occupational category definitions based on the International Standard Classification of Occupations, we grouped the categories (i) 1 through 4, (ii) 5, 8 through 10, 17 and 20, (iii) 18 and 19, (iv) 11 through 16, and (v) 21 and 22 under *agricultural*, *low-skilled blue collar*, *high-skilled blue collar*, *low-skilled white collar*, *high-skilled white collar employment*, respectively.

participation. Only 3 percent of leavers had access to high-skilled blue collar employment in 1985, and the comparable figure was 43 percent by 2005.

Table 5 presents the variations in household access to income sources over time. Between 1985 and 2005, the share of households with non-farm labor income increased by 78 percent. The surge was fuelled by the changes in economic portfolios of leavers, among whom the number of households with non-farm labor income doubled in the same period. We see that much of the rise in household access to non-farm labor income on the whole and across adoption groups was fostered by considerable surges in the incidence of self-employment. The number of households engaged in self-employment more than tripled in the surveyed communities between 1985 and 2005. Nearly 40 percent of non-adopters were self-employed in 2005, while the comparable figure was 64 and 48 percent among leavers and stayers, respectively. While leavers exhibited the highest self-employment participation rate in 2005, the nature of self-employment among them was also different with respect to any other adopter category. Looking at individual occupational distributions before aggregation at the household-level, we observed that among those that were self-employed in 2005 and resided in leaver households, the share of individuals that either owned a micro-enterprise in the community or were involved in trading agriculture produce, separate from the sales of household production, was close to 60 percent. Conversely, the comparable figures for the self-employed in each of the other household categories did not exceed 30 percent. The overwhelming majority of the self-employed that resided in non-adopter, late adopter or stayer households were own-account laborers. In this respect, self-employment among leavers may be considered more of a success which may have its roots in their snow pea production in the boom era. Lastly, as also noted by the qualitative studies, we observe that the share of households with farm wage income declined on the whole and across all categories. This result materialized parallel to the decline in NTX production in the region which initially offered farm wage opportunities for the landless and near-landless.

Finally, Table 6 depicts the changes in household income shares in the period of 1985-2005. Consistent with the findings above, we find that the share of farm income declined, on average, by 33 percent in the surveyed communities, from 33 to 22 percent. While early adopter stayers increased their reliance on farm income, the opposite was true for early adopter leavers and late adopters. Conversely, the share of non-farm labor income more than doubled, on average, among early adopter leavers. Although the increases in the average share of non-farm labor income were also notable among early adopter stayers and late adopters, they were not statistically significant in comparison to the trends in the non-adopter category. The findings in Table 5 and 6 indicate that the rise in off-farm orientation observed on the whole and across groups, particularly among leavers, in Table 4 was driven by the increase in household reliance on non-farm labor income, as opposed to farm wage or non-farm non-labor income generating activities.

4 MODEL

Given the non-random nature of snow pea adoption and the panel nature of our dataset, we employ a difference-in-difference (DD) model that compares changes in outcomes over time, allows for selection bias due to time-invariant and additive unobservable differences among adoption groups between 1985 and 2005, and controls for potential observable differences in 1979. The model is specified linearly as follows:

$$y_i = \alpha + \theta\, t + \beta_1\, stayer_i + \Gamma_1\, t{*}stayer_i + \beta_2\, leaver_i + \Gamma_2\, t{*}leaver_i + \beta_3\, late_i + \Gamma_3\, t{*}late_i + \gamma\, Z_i + \varepsilon_i$$

where *i* denotes household, *y* is the welfare outcome of interest; *Z* is a vector of exogenous observable covariates[13]; *t* is a dummy variable equal to 1 if the survey period is 2005, θ captures changes the occur over time that are independent of snow pea adoption; *stayer*, *leaver* and *late* are dummy variables accounting for a household's snow pea adoption classification[14]; their respective coefficients capture the initial differences in *y* between non-adopters and adopter groups; the coefficients on the interactions of *t* with *stayer*, *leaver*, and *late* are expected to isolate the effect of each adoption path on *y* between 1985 and 2005.[15] While considering the impact of snow pea adoption on changes in household livelihood orientation and participation in alternative non-farm employment opportunities, we focus on several dichotomous outcome variables. The first set of outcomes accounts for household farm, off-farm, and diversified orientation, as defined above. Since the likely driver of the expected surge in off-farm orientation is non-farm income generating activities, the second set of outcomes measure household access to income from overall non-farm, non-farm wage, and non-farm self-employment. The third group of outcomes account for household participation in non-farm employment opportunities that are broadly categorized into low-skilled blue collar, high-skilled blue collar and white collar, according to the general level of skill required to perform them.

5 RESULTS

Table 7 reports the results from the DD models of snow pea adoption effects on household livelihood orientation and occupational participation.[16] Focusing on the findings reported in Panel 1, the βs from the model of farm orientation imply that snow pea adopters were more likely to be farm-oriented in 1985 with respect to non-adopters. While the differences in terms of

[13] *Z* includes community-fixed effects with Santiago being the reference community. In addition, it contains other controls that are defined with respect to 1979; the first year that NTXs were introduced in the region. These variables include age and years of education of household head as well as his/her spouse; the number of household members that are below the age of 6; total amount of land owned in hectares and its squared term; amount of land owned in hectares that is considered as good quality for snow peas production and its squared term; and two-way interactions of all covariates with variables pertaining to the age and years of education of household head and his/her spouse.

[14] Although the NTX adoption classification in this paper is based on the cultivation histories of snow peas, which was one of the first and certainly the most representative NTX for most of the period under consideration, we also constructed an alternative classification based on both snow peas and string beans, i.e. the two export crops for which full adoption histories were collected as part of the 2005 survey. In this process, we assumed that being an adopter (stayer) of one crop overrides being a non-adopter (leaver) of another, leading a household classified as an adopter (stayer). After this assumption is enforced, being an early adopter of one crop would override being a late adopter of another. As a result, the distribution of households across NTX adoption categories was only marginally different than the one reported in Table 1, and running all our regressions according to the alternative classification yielded virtually identical results, which are available upon request.

[15] If benefits from having snow peas in the community after 1985 exhibit strong spillover effects, these would be captured by θ, underestimating the impacts for growers.

[16] As demonstrated by Ai and Norton (2003), the coefficient of the interaction term in nonlinear discrete choice models, such as Probit or Logit, is not equivalent to the marginal effect that is calculated by the statistical software. We estimated the marginal effects of the interaction terms reported in Table 7 using the *inteff* command in Stata and obtained results that were qualitatively similar to those from the linear probability models. These results are available upon request.

initial likelihood to be farm-oriented among stayers and leavers are not statistically significant, the differences between the estimated β coefficient for late adopters and each respective coefficient for stayers and leavers are statistically significant. The highlighted DD estimates indicate that the impact of each snow pea adoption trajectory on the probability of being farm-oriented was negative and statistically significant. The decline in the outcome was the largest among leavers and the associated coefficient is statistically significant in comparison to the respective estimates for stayers and late adopters.

In contrast, early adoption and withdrawal exerted a positive and statistically significant effect on increasing the probability of being off-farm oriented. The DD estimate for leavers is also statistically different than the estimated coefficients for stayer and late adopter indicators. In comparison non-adopters and other adopter group, the statistically significant increase in the likelihood of heavy reliance on off-farm activities between 1985 and 2005 among leavers confirm our expectations based on the qualitative evidence pertaining to the interactions between household livelihood choices and snow pea adoption trajectories.

Given across-the-board reductions in average farm wage and non-farm non-labor income shares presented in Table 6, we expected the changes in household propensity to work off-farm to be driven by the variations in access to non-farm employment opportunities. Substantiating our claims, the findings from the model of household access to non-farm employment in Panel 2 suggest that while households witnessed an increase in the access to non-farm employment in the period of 1985-2005, irrespective of timing and duration of snow pea adoption, being a leaver had a positive and statistically significant impact on increasing the likelihood of household non-farm employment. Although the DD estimates for stayer and late adopter status are positive, they fail to be statistically significant.

Estimating separate regressions for non-farm wage- vs. self-employment shows that the changes in the overall participation in non-farm employment were driven by the trends in non-farm self-employment. While the estimated coefficients for snow pea adoption indicators are positive from the non-farm wage employment model, they are not statistically significant, with the exception of the coefficient associated with the late adopter indicator.[17] In terms of self-employment, we observe that leaver status actually had a positive and statistically significant effect on increasing the probability of self-employment. These findings are consistent with the qualitative evidence suggesting that former early adopters, who may have taken advantage of the assets accumulated throughout the NTX-boom period, were more likely to abandon commercial farming, and either founded micro-enterprises or started agricultural-intermediation businesses, perceiving the profit potential in trading to be higher than in farming.

The third set of models constitutes our attempt to take a closer look at the association between household involvement in NTX and off-farm activities that are broadly differentiated by skill requirements. Compared to non-adopters, the likelihood of low-skilled blue collar employment

[17] When we differentiate between leavers and stayers within late adopters, we see that the positive and statistically significant impact of late adoption on the probability of non-farm wage employment is driven only by the trends among late adopter leavers. Moreover, late adopter leaver indicator in the non-farm self-employment model assumes a positive and statistically significant coefficient, while the respective statistic for late adopter stayer status is positive but statistically insignificant.

rose considerably among all adopter categories. While the DD estimates for stayers and leavers are not statistically different from each other, we find the difference between Γ_1 for stayers and Γ_3 for late adopters to be statistically significant. Moreover, household participation in high-skilled blue collar employment improved over time, regardless of snow pea adoption, and that the effect was statistically significant. While being a stayer or a late adopter does not exert a statistically significant positive effect on increasing the probability of the outcome between 1985 and 2005, the opposite was true for leavers. It should also be noted that the differences in high-skilled blue collar employment trends between leavers and stayers were also statistically significant, as indicated by the test of the null hypothesis of $\Gamma_1 = \Gamma_2$. These results may suggest that leaver household heads and their family members may have taken advantage of various skills that they have acquired through their involvement with *Cuatro Pinos* to better position themselves in the growing non-farm economy with respect to stayers that remained involved in snow pea production and late adopters that may have been lured into NTX production in the post-boom era with the expectation that the marketing and institutional constraints were going to be short-lived.

6 CONCLUSION

This study takes advantage of a unique panel dataset that spans a 20-year period (1985-2005), and estimates the effect of NTX/snow pea adoption on changes in household livelihood orientation and participation in non-farm income generating activities. Given the heterogeneity in adoption patterns across households, it provides differential impact estimates based on a classification of households that takes into account the timing and duration of snow pea adoption. The area under investigation is the Guatemalan municipality of Santiago Sacatepéquez, which emerged as a major hub for non-traditional export vegetable production in the early 1980s. The communities of interest experienced a significant boom in NTX/snow pea production throughout the 1980s, and initially witnessed substantial improvements in consumption levels among NTX adopters. These developments materialized thanks to the strong foreign demand for NTXs and the extensive marketing, financial, and technical assistance provided by the *Cuatro Pinos* agricultural cooperative. Throughout the 1990s, however, a host of agronomic, market-based, and institutional problems generated a significant drop in the profitability of snow pea production, intensified price uncertainty and agricultural income volatility, and caused a considerable number of resource-poor farmers to withdraw from export crop production.

The *medium-term* woes associated with the production and marketing of snow peas went parallel to households' increasing reliance on off-farm income generating activities. While the changes in household livelihood strategies were partly driven by the realities of NTX production and marketing, they were also made possible by the emergence of alternative non-farm employment options in and around the municipality. Moreover, the only available study on the *long-term* welfare effects of NTX/snow pea adoption in Santiago Sacatepéquez showed that although welfare levels improved in the surveyed communities irrespective of timing and duration of NTX adoption, long-term adopters registered, on average, the smallest increase over time, in spite of some early gains. Conversely, early adopters who withdrew from NTX production after reaping the benefits of the boom period recorded greater and statistically significant improvements in durable asset position and housing conditions with respect to non-adopters and other adopter categories (Carletto et. al., 2009).

In view of the evidence on the *long-term* welfare impact of NTX cultivation, and the emergence of alternative non-farm activities concurrent with the *medium-term* developments, this study was interested in exploring whether and how NTX adoption impacted the inevitable process of increasing reliance on off-farm income generating activities among households that have resided in a region that has been subject to intense waves of agricultural commercialization. Our findings suggest that over time, household reliance on off-farm income and access to non-farm employment, particularly self-employment and blue collar work, increased in the surveyed communities, irrespective of snow pea adoption. However, the extent of change varied across groups. Although the magnitudes of increase in the aforementioned outcomes among early long-term adopters and late adopters were not statistically significant with respect to the trends among non-adopters, early adopters who withdrew from NTX production in the medium-term exhibited greater and statistically significant increases in the same livelihood outcomes with respect to any other category. These results support the hypothesis that leavers may have shown greater improvements in living standards over time as they may have taken better advantage of the emerging, relatively profitable off-farm opportunities by relying on the assets accumulated in the NTX-boom era. The notable closing of the gap in welfare levels over the last two decades between non-adopters and early long-term adopters may also be linked to the ability of non-adopters to better position themselves in the relatively well-paying occupations of the non-farm sector in comparison to early long-term adopters that sustained their reliance on relatively volatile farm income.

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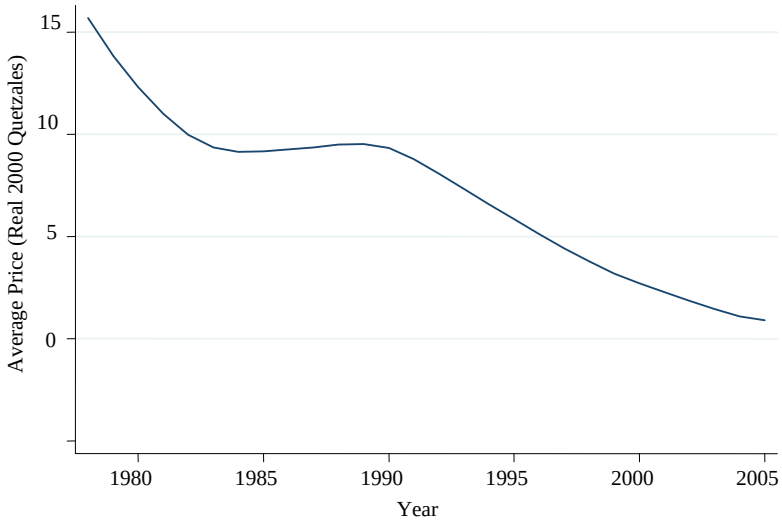
ANNEX

Figure 1: Annual Average Snow Pea Prices (1978-2005)



Note: Average prices were constructed using data from daily/weekly port prices for Miami - a primary destination for Guatemalan snow peas - collected by the U.S. Department of Agriculture. Yearly averages were derived from the average of the high and low price each week. The snow peas price data were available starting in the late months of 1987. Consequently, the 1987-2005 prices were used to predict the prices dating back to 1978. The prices were first predicted in US dollars and then adjusted for exchange rate and inflation, yielding results consistent with anecdotal evidence of especially-high prices as Guatemalans first entered the market, followed by high prices in the 1980s and declining prices in the 1990s. The original data were converted into real Quetzales per pound (indexed to year 2000) using the exchange rates and Consumer Price Index from the IMF's International Financial Statistics Yearbook (2005).

Table 1: Distribution of Sample Households by Snow Pea Adoption Status

	Obs	Share
Non-Adopter	47	16.0%
Early Adopter - Stayer	71	24.2%
Early Adopter - Leaver	110	37.5%
Late Adopter	65	22.2%
TOTAL	293	100.0%

Table 2: HH NTX Involvement by Snow Pea Adoption Status

	Overall	*Never*	*Ever*	*Leaver*	*Stayer*	*Late*
Ever cultivated snow peas Δ	0.85	0.09	1.00	1.00	1.00	1.00
Years of snow pea cultivation	12.3	0.1	14.6	13.3	21.0	9.9
Year of snow pea adoption	1983	1990	1983	1981	1981	1988
Last year of snow pea cultivation	1998	1990	1998	1994	2004	1997
Ever cultivated string beans Δ	0.67	0.06	0.78	0.75	0.89	0.74
Years of string beans cultivation	6.8	0.1	8.0	8.2	9.9	5.6
Year of string beans adoption	1987	1997	1987	1984	1987	1991
Ever cooperative member Δ *	0.67	0.00	0.80	0.76	0.96	0.68
Cooperative member, 1985 Δ	0.46	0.06	0.53	0.63	0.77	0.09
Cooperative member, 2005 Δ	0.25	0.00	0.30	0.09	0.75	0.17
Years of cooperative membership	11.5	0.0	13.7	12.4	21.4	7.6
Ever member of junta directiva Δ *	0.38	0.00	0.46	0.42	0.69	0.26
Good relations with junta directiva, 2005 Δ	0.49	0.00	0.58	0.53	0.85	0.38
Good relations with cooperative management 2005 Δ	0.46	0.00	0.55	0.55	0.75	0.34

Note: Δ denotes a dummy variable; Non-adopters could have cultivated snow peas, given the two-year threshold for ever-adoption; * indicates that the variable is from the 2005 survey; There is slight under-recall of coop membership among those with brief membership.

Table 3: HH Livelihood Orientation by Snow Pea Adoption Status

	Overall	*Never*	*Ever*		*Leaver*		*Stayer*		*Late*	
Farm Oriented, 1985	0.30	0.04	0.35	***	0.41	***	0.37	***	0.23	***
Farm Oriented, 2005	0.13	0.09	0.14		0.08		0.25	**	0.11	
Change(2005-1985)	-0.17	0.04	-0.21	***	-0.33	***	-0.11	*	-0.12	**
Off-Farm Oriented, 1985	0.39	0.77	0.31	***	0.25	***	0.25	***	0.48	***
Off-Farm Oriented, 2005	0.69	0.87	0.66	***	0.74	*	0.51	***	0.69	**
Change(2005-1985)	0.31	0.11	0.35	**	0.48	***	0.25		0.22	
Diversified, 1985	0.31	0.19	0.34	**	0.34	*	0.38	**	0.29	
Diversified, 2005	0.18	0.04	0.20	***	0.18	**	0.24	***	0.20	**
Change(2005-1985)	-0.14	-0.15	-0.13		-0.15		-0.14		-0.09	

Common Notes for Tables 3 through 6: *Never* is the reference category used for the tests of average differences; */**/*** indicate significance at the 10/5/1 percent level, respectively.

Table 4: HH Occupational Participation by Snow Pea Adoption Status

	Overall	*Never*	*Ever*		*Leaver*		*Stayer*		*Late*	
Agriculture, 1985	0.87	0.77	0.89	**	0.94	***	0.93	**	0.78	
Agriculture, 2005	0.83	0.64	0.87	***	0.81	**	1.00	***	0.83	**
Change(2005-1985)	-0.04	-0.13	-0.02		-0.13		0.07	**	0.05	
Low-Skilled Blue Collar, 1985	0.32	0.66	0.25	***	0.22	***	0.14	***	0.43	**
Low-Skilled Blue Collar, 2005	0.44	0.51	0.42		0.38		0.42		0.49	
Change(2005-1985)	0.12	-0.15	0.17	***	0.16	***	0.28	***	0.06	*
High-Skilled Blue Collar, 1985	0.05	0.15	0.04	***	0.03	***	0.01	***	0.08	
High-Skilled Blue Collar, 2005	0.35	0.34	0.35		0.43		0.23		0.37	
Change(2005-1985)	0.30	0.19	0.32		0.40	**	0.21		0.29	
White Collar, 1985	0.24	0.13	0.26	*	0.30	**	0.28	*	0.17	
White Collar, 2005	0.37	0.32	0.38		0.48		0.31		0.29	
Change(2005-1985)	0.13	0.19	0.12		0.18		0.03		0.12	

Notes: All are dichotomous variables equal to 1 if a household had any member with a job in a given occupational group, as defined in footnote 25.

Table 5: Access to Income Sources by Snow Pea Adoption Status

	Overall	*Never*	*Ever*		*Leaver*		*Stayer*		*Late*	
On-Farm, 1985	0.87	0.77	0.89	**	0.94	***	0.93	**	0.78	
On-Farm, 2005	0.83	0.64	0.87	***	0.81	**	1.00	***	0.83	**
Change(2005-1985)	-0.04	-0.13	-0.02		-0.13		0.07	**	0.05	
Off-Farm Labor, 1985	0.74	0.83	0.72		0.72		0.70		0.75	
Off-Farm Labor, 2005	0.85	0.85	0.85		0.90		0.73		0.89	
Change(2005-1985)	0.11	0.02	0.13		0.18	*	0.03		0.14	
Non-Farm Labor, 1985	0.45	0.57	0.42	*	0.44		0.39	*	0.43	
Non-Farm Labor, 2005	0.80	0.77	0.80		0.89	**	0.70		0.77	
Change(2005-1985)	0.35	0.19	0.38	**	0.45	***	0.31		0.34	
Non-Farm Wage, 1985	0.55	0.66	0.53	*	0.57		0.58		0.40	***
Non-Farm Wage, 2005	0.61	0.60	0.61		0.64		0.59		0.58	
Change(2005-1985)	0.06	-0.06	0.08		0.06		0.01		0.18	**
Non-Farm Self-Employment, 1985	0.17	0.17	0.17		0.21		0.14		0.15	
Non-Farm Self-Employment, 2005	0.53	0.38	0.56	**	0.64	***	0.48		0.52	
Change(2005-1985)	0.36	0.21	0.39	*	0.43	**	0.34		0.37	
Farm Wage, 1985	0.27	0.45	0.24	***	0.22	***	0.17	***	0.35	
Farm Wage, 2005	0.16	0.34	0.13	***	0.06	***	0.08	***	0.29	
Change(2005-1985)	-0.11	-0.11	-0.11		-0.15		-0.08		-0.06	
Non-Farm Non-Labor, 1985	0.35	0.32	0.35		0.36		0.39		0.29	
Non-Farm Non-Labor, 2005	0.41	0.38	0.41		0.42		0.41		0.40	
Change(2005-1985)	0.06	0.06	0.06		0.05		0.01		0.11	

Notes: All are binary variables equal to 1 if a household had any earnings from a particular income source; Off-farm labor income covers non-farm labor income and farm wage earnings; Non-farm labor income includes from non-farm wage- and self-employment earnings; Non-farm non-labor encompasses transfer and rental income.

Table 6: Income Shares by Snow Peas Adoption Category

	Overall	*Never*	*Ever*		*Leaver*		*Stayer*		*Late*	
On-Farm, 1985	0.33	0.14	0.37		0.44	**	0.34		0.30	**
On-Farm, 2005	0.22	0.12	0.24	*	0.19		0.39	***	0.17	
Change(2005-1985)	-0.11	-0.01	-0.13		-0.25	*	0.05		-0.13	
Off-Farm Labor, 1985	0.51	0.73	0.47	*	0.42	***	0.47		0.57	**
Off-Farm Labor, 2005	0.71	0.78	0.69		0.75		0.56	***	0.72	
Change(2005-1985)	0.19	0.06	0.22		0.33	**	0.09		0.16	
Non-Farm Labor, 1985	0.34	0.45	0.32		0.32		0.32		0.33	
Non-Farm Labor, 2005	0.61	0.62	0.61		0.70		0.51		0.57	
Change(2005-1985)	0.27	0.17	0.29		0.38	*	0.19		0.24	
Non-Farm Wage, 1985	0.31	0.43	0.29		0.29		0.30		0.28	**
Non-Farm Wage, 2005	0.42	0.45	0.41		0.47		0.36		0.37	
Change(2005-1985)	0.10	0.02	0.12		0.18		0.06		0.08	
Non-Farm Self-Employment, 1985	0.08	0.05	0.08		0.06		0.12		0.07	
Non-Farm Self-Employment, 2005	0.23	0.20	0.24		0.29		0.17		0.22	
Change(2005-1985)	0.16	0.15	0.16		0.23		0.05		0.15	
Farm Wage, 1985	0.12	0.25	0.10	***	0.06	***	0.05	***	0.21	
Farm Wage, 2005	0.07	0.13	0.05	**	0.02	***	0.03	**	0.14	
Change(2005-1985)	-0.06	-0.12	-0.05		-0.05		-0.02		-0.07	
Non-Farm Non-Labor, 1985	0.08	0.03	0.09		0.09		0.15		0.03	
Non-Farm Non-Labor, 2005	0.07	0.09	0.07		0.05		0.05		0.11	
Change(2005-1985)	-0.01	0.06	-0.02		-0.04		-0.10		0.08	

Table 7: DD Models of Snow Pea Adoption Effects on HH Livelihood Orientation and Occupational Participation

	Panel 1			**Panel 2**			**Panel 3**		
	Farm Orientation	*Off-Farm Orientation*	*Diversification*	*Non-Farm Employment*	*Non-Farm Wage Employment*	*Non-Farm Self-Employment*	*LS Blue Collar Employment*	*HS Blue Collar Employment*	*White Collar Employment*
t (θ)	0.043	0.106	-0.149**	0.191**	-0.064	0.213**	-0.149	0.191**	0.170*
	(0.053)	(0.080)	(0.067)	(0.095)	(0.097)	(0.086)	(0.092)	(0.087)	(0.088)
Early Adopter-Stayer (β_1)	0.330***	-0.544***	0.214**	-0.196**	-0.102	-0.073	-0.529***	-0.168***	0.135*
	(0.067)	(0.082)	(0.085)	(0.094)	(0.090)	(0.074)	(0.085)	(0.056)	(0.078)
t*Early Adopter-Stayer (Γ_1)	**-0.155***	**0.147**	**0.008**	**0.118**	**0.078**	**0.125**	**0.431*****	**0.020**	**-0.170**
	(0.092)	**(0.111)**	**(0.101)**	**(0.122)**	**(0.124)**	**(0.111)**	**(0.119)**	**(0.101)**	**(0.115)**
Early Adopter-Leaver (β_2)	0.381***	-0.535***	0.155**	-0.192**	-0.117	-0.022	-0.445***	-0.145**	0.163**
	(0.061)	(0.077)	(0.076)	(0.087)	(0.086)	(0.072)	(0.079)	(0.057)	(0.073)
t*Early Adopter-Leaver (Γ_2)	**-0.370*****	**0.375*****	**-0.006**	**0.263****	**0.127**	**0.215****	**0.313*****	**0.209****	**-0.043**
	(0.076)	**(0.100)**	**(0.089)**	**(0.110)**	**(0.116)**	**(0.105)**	**(0.110)**	**(0.100)**	**(0.108)**
Late Adopter (β_3)	0.177***	-0.306***	0.129	-0.139	-0.305***	-0.023	-0.286***	-0.095	0.077
	(0.066)	(0.087)	(0.083)	(0.096)	(0.092)	(0.075)	(0.091)	(0.061)	(0.077)
t*Late Adopter (Γ_3)	**-0.166****	**0.109**	**0.057**	**0.147**	**0.248****	**0.156**	**0.210***	**0.101**	**-0.078**
	(0.083)	**(0.114)**	**(0.101)**	**(0.121)**	**(0.126)**	**(0.114)**	**(0.126)**	**(0.109)**	**(0.114)**
Observations	586	586	586	586	586	586	586	586	586
R2	0.183	0.261	0.098	0.248	0.151	0.240	0.178	0.242	0.099
Adjusted R2	0.129	0.213	0.039	0.198	0.095	0.190	0.124	0.192	0.040
P-values from Wald Tests									
H_0: $\beta_1 = \beta_2 = \beta_3$	0.021	0.004	0.560	0.753	0.022	0.641	0.010	0.154	0.470
H_0: $\beta_1 = \beta_2$	0.491	0.896	0.426	0.959	0.832	0.392	0.181	0.379	0.690
H_0: $\beta_1 = \beta_3$	0.054	0.003	0.298	0.498	0.012	0.455	0.003	0.057	0.433
H_0: $\beta_2 = \beta_3$	0.006	0.003	0.733	0.507	0.016	0.984	0.037	0.205	0.223
H_0: $\Gamma_1 = \Gamma_2 = \Gamma_3$	0.016	0.010	0.806	0.233	0.296	0.610	0.150	0.028	0.415
H_0: $\Gamma_1 = \Gamma_2$	0.020	0.019	0.886	0.128	0.624	0.333	0.218	0.008	0.191
H_0: $\Gamma_1 = \Gamma_3$	0.915	0.734	0.651	0.791	0.130	0.762	0.054	0.328	0.374
H_0: $\Gamma_2 = \Gamma_3$	0.014	0.009	0.517	0.213	0.244	0.548	0.327	0.187	0.717

Note: */**/*** indicate significance at the 10/5/1 percent level, respectively; Constant term and the coefficients for all baseline controls in the vector of Z estimated but not reported; Robust standard errors in parentheses; LS and HS denote "Low-Skilled" and "High-Skilled," respectively.