# Long-Term Sustainability of Third-Party Facilitated Market Linkages: Evidence from the USDA Marketing Assistance Program in the Armenian Dairy Industry

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## 1. Introduction

The agribusiness and development literature has delineated the role of third-party external facilitation in creating market linkages through provision of various assistance programs (Glover & Kusterer, 1990; Kirsten & Sartorius, 2002; Porter & Phillips-Howard, 1997; Shepherd, 2007; World Bank, 2007). However, the experience shows that the withdrawal of third-party assistance very often results in a collapse of market linkages. Among the main reasons for high failure rate are inappropriate business models, artificial incentive structures, and inadequate contract enforcement mechanisms (Shepherd, 2007). The main focus of this paper is on the empirical examination of the long-term sustainability of third-party facilitated market linkages in the agri-food supply chain. The question we ask here is: What is the effect of private enforcement mechanisms on long-term sustainability of third-party facilitated linkages between agri-food producers and processors? Interest in this question is motivated by policy concerns, theoretical considerations, and problems facing individual decision makers.

From a policy perspective, a better understanding of the role of private enforcement mechanisms in improving the long-term sustainability of third-party facilitated supply chain linkages will assist in designing policies and programs that are more effective in linking producers to the market. From a theoretical perspective, the question we ask in this study instigates the examination of the predictive value of the probabilistic hold-up framework for explaining the underlying mechanisms in real world facilitation of contractual relationships (Klein, 1996; Gow, Streeter, & Swinnen, 2000). And finally, from an industry perspective, the

answers to this question will inform the managerial decisions regarding relationship-specific investments and contractual arrangements along the agri-food supply chain.

The study is grounded in a unique setting based on the USDA Marketing Assistance Program (MAP) in the Armenian dairy industry. The USDA MAP played a significant role in the establishment of supply chain linkages, after the complete breakdown of the Armenian dairy sector during early transition. Due to the absence of strong Foreign Direct Investment (FDI) influence, observed in other Central and Eastern European (CEE) countries, the case of the USDA MAP facilitation of dairy supply chain linkages in Armenia provides a relatively controlled environment for examining the long-term performance of the market linkages after the end of the USDA MAP facilitation.

The conceptual framework is based on the third-party facilitation model which utilizes probabilistic hold-up framework originally introduced by Klein 1996. According to this framework the presence of sufficient private enforcement capital can make the transaction more self-enforcing by balancing the costs and benefits from breaching the contractual arrangement. The magnitude of private enforcement capital is associated with the extent of relationship-specific assets and the reputation in the marketplace (Klein, 1996). Based on the theoretical framework and the case analysis, it is hypothesized that the third-party facilitation strategy pursued by the USDA MAP led to investment in private enforcement capital and the establishment of self-enforcing, long-term sustainable linkages along the dairy supply chain.

The data for testing the hypothesis comes from two farmer surveys, conducted in 2004 and 2009 in Armenia. It constitutes a balanced panel data with 344 total observations on milk

production, marketing, and household characteristics of 172 dairy farms before and after the end of the USDA MAP facilitation. The long-term sustainability of the USDA MAP facilitated market linkages is examined by comparing the changes in farm-level investment in relationship-specific assets. The difference in the number of cows of farms in formal and informal channels before and after the end of the USDA MAP facilitation is used as a proxy for assessing the linkage performance. Econometric analysis includes difference-in-difference and fixed effects estimation methods.

The reminder of the paper is organized as follows: Section 2 provides the context and background on Armenia and the USDA MAP facilitation of dairy supply chain; Section 3 discusses the conceptual framework and introduces the hypothesis; Section 4 describes the data for testing the hypothesis, the econometric models, and the results; and finally, Section 5 provides conclusions and implications for further research.

## 2. Context and Background

### *2.1 Transition in Armenian agriculture and the impact on dairy industry*

Due to series of economic shocks during the early 90's, Armenia faced one of the most difficult economic and social transitions of all the former Soviet Republics (World Bank, 2001). Independence from the Soviet Union, privatization, trade liberalization, war and resulting economic blockade by Azerbaijan and Turkey had a combined impact of a 60% decline in GDP between 1991 and 1993; in addition to widespread poverty and financial distress (FAO, 2000). The privatization in 1991 handed ownership and control of agricultural production to over 300,000 inexperienced and resource constrained household farmers. The agroprocessing

sector was privatized in the period of 1995-1996 through restitution to employees or direct sales to local buyers (FAO, 2000). The traditional business practices were no longer appropriate due to broken business relationships, constrained trade and market access, limited capital, and an inadequate legal enforcement system. This left the Armenian agri-food sector in a deep crisis.

By the mid 1990's the traditional government controlled dairy supply chain had collapsed (World Bank, 1995). Dairy processors were constrained by poor quality milk supply that arrived in inconsistent quantities, limited financial capital, inexperienced management stuck in a Soviet era mentality, poor sanitation, poor safety standards, and most importantly, inadequate or missing procurement relationships with farmers. These problems forced processors to either close or severely reduce output resulting in over a 90% drop in capacity utilization (World Bank, 1995).

At the farm level, transition had left farmers financially distressed, credit constrained and unprofitable due to increased input prices, decreased output prices, and limited market opportunities for selling their milk surplus. This adversely affected farmers' production and investment incentives and resulted in a 40% decrease in cattle numbers in five years between 1988 and 1993. Excess livestock were liquidated to access scarce capital resources and farmers retreated to subsistence agriculture and barter as a result. The overall consequence was a significant divestment in assets by both processors and producers leading to a suboptimal equilibrium characterized by high transaction costs in marketing and procurement.

*2.2 USDA MAP facilitation of market linkages in the Armenian dairy supply chain*

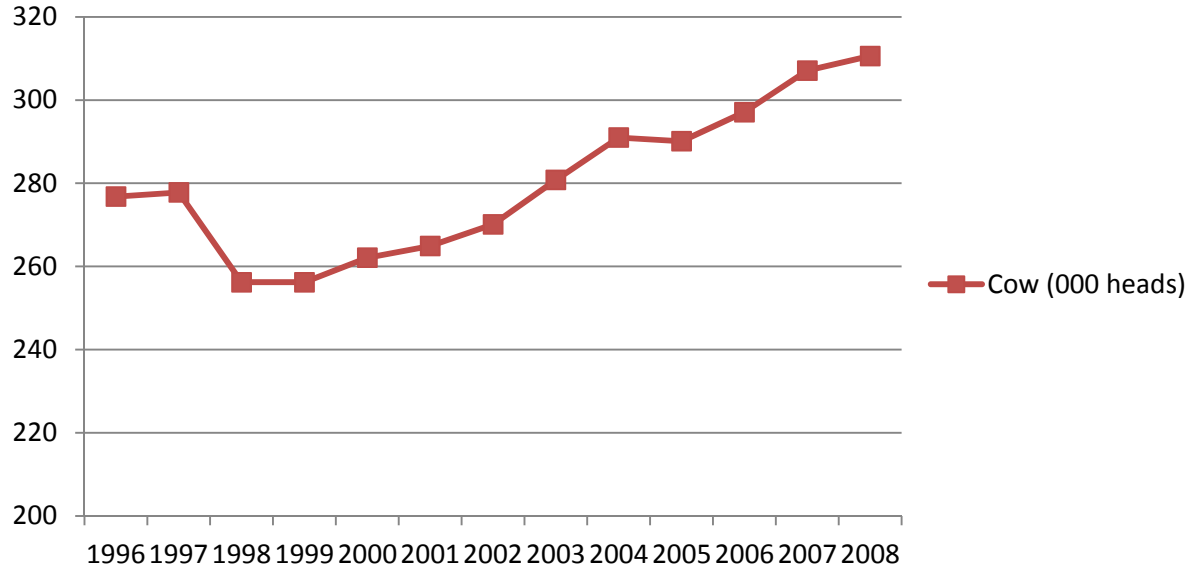
Beginning in 1998 the USDA MAP became actively involved in the Armenian dairy industry. Through its integrated supply chain facilitation strategy the USDA MAP was able to directly address systemic problems causing divestment and suboptimal equilibrium in the dairy supply chain. By providing a flexible and customizable package of financial, technical, and marketing assistance the USDA MAP stimulated investments in marketing and procurement relationships by producers and processors. On the processor level, investments were made to build milk collection centers and to improve milk transportation. On the producer level, this led to establishment of milk marketing associations and investments in improving milk production. As a result, the number of dairy farmers, who were previously limited to either subsistence farming or highly unstable spot market transactions, began supplying milk to dairy processors, either directly or through collections centers, and to milk marketing associations.

By the end of 2003, with the support of the USDA MAP, more than ten Armenian dairy processors were represented in various trade shows and product tasting in US, Russia, Ukraine, and Belarus (USDA MAP Client Annual Report, 2004). Six USDA MAP client companies were exporting their production to Russia, US, and Georgia. The proportion of exports ranged from 3% to 90% of the total value of their output. Fifteen new cheese varieties were introduced within both export and domestic markets. Concurrently, the USDA MAP facilitated establishment of fourteen milk marketing associations accounting for almost fourteen hundred members in twenty-four villages across Armenia (USDA MAP, 2006). By the end of 2005, seventeen milk producers' credit clubs were formed in seven regions of Armenia, providing access to capital to more than 380 dairy farmers. The access to capital through credit clubs

allowed dairy farmers to finance their investments in improving herd size, quality of cows, and improving housing and sanitation.

The result of the USDA MAP unique facilitation was the establishment of marketing and procurement linkages between Armenian dairy producers and processors based on substantial investments in relationship-specific assets by both parties. Farms linked to formal milk marketing channels were shown to have made significant investments in number of cows (Shanoyan, 2011). Figure 1 presents the number of cows in Armenia for the period from 1996 to 2008.

**Figure 1 Number of cows in Armenia for the period from 1996 to 2008 (1000 heads)**




*Source: Armenian Ministry of Statistics*

In 2005 the USDA Marketing Assistance Program in Armenia had officially ended. A local Armenian foundation called the Center for Agribusiness and Rural Development (CARD) was established to carry on the legacy of the USDA MAP. CARD's programs were focused mainly on

third-party service provision. The marketing, financial, and technical assistance to dairy processors and farmers was downscaled.

The case of the USDA MAP facilitation of supply chain linkages in the Armenian dairy industry provides a unique empirical setting for analyzing the long-term impact of third-party market linkage facilitation strategy. The significant role of the USDA MAP in the establishment of supply chain linkages, after the complete breakdown of the Armenian dairy sector during early transition, combined with the absence of FDI, provides a relatively controlled environment for examining the long-term sustainability of facilitated supply chain linkages. This paper focuses on the analysis of long-term performance of the market linkages after the end of the USDA MAP facilitation.

## 3. Conceptual framework

The conceptual framework is based on the third-party facilitation model (Shanoyan, 2011) according to which the establishment of self-enforcing sustainable market linkages between transacting parties can be facilitated by a third-party through programs that stimulate investments in and rearrangement of private enforcement capital. The magnitude of private enforcement capital is associated with the extent of relationship-specific assets and the reputation in the marketplace (Klein, 1996). Presence of sufficient private enforcement capital can make the transaction more self-enforcing by balancing the costs and benefits from breaching the contractual arrangement. Based on the theoretical framework and the case analysis, the following two general hypothesis were introduced: *H1 – The third-party facilitation strategy pursued by the USDA MAP has stimulated investment in and rearranged the*

*private enforcement capital between dairy producers and processors*; and *H2 – Third-party facilitation strategy pursued by USDA MAP led to the establishment of self-enforcing, long-term sustainable linkages along the dairy supply chain*.

The empirical analysis by Shanoyan 2011 provides evidence in support of the hypothesis that the third-party facilitation strategy pursued by the USDA MAP stimulated investment in private enforcement capital between dairy producers and processors. More specifically, findings reveal that farms linked to formal milk marketing channel facilitated by the USDA MAP had on average a 25% higher annual proportional increase in number of cows compared to farms in the informal channel (Shanoyan, 2011). This implies that over the first four years (1999-2003) of the USDA MAP facilitation of dairy supply chain, farms linked to the formal milk marketing channel have invested in approximately twice as many assets specific to milk production compared to farms in the informal channel. Therefore, these additional assets can be considered as dedicated assets to the formal marketing and procurement relationships with processors.

This paper focuses on the second hypothesis presented above by examining the changes in farm-level investments before and after the end of the USDA MAP facilitation. This analysis is based on the underlying assumption that if the market linkages continued to perform well after the end of the USDA MAP facilitation, then the farms linked to formal marketing channel would continue investments in, or at least not divest, assets specific to their relationship with processors. Alternatively, if the linkages were not sustainable, then farmers would likely try to divest assets specific to the relationship.

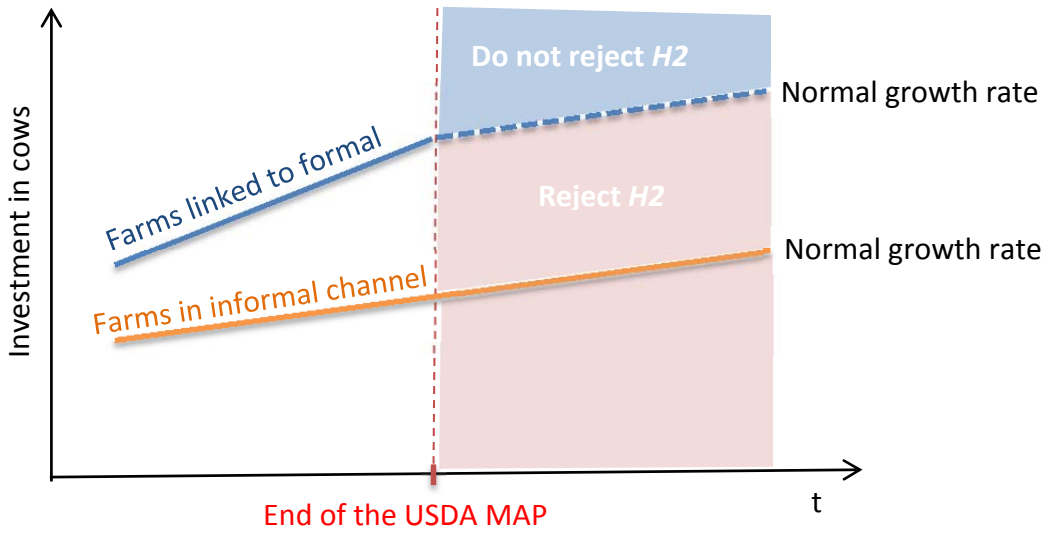
In the context of marketing and procurement relationships with processors, farm-level investments in relationship-specific assets include: i) investments in additional cows (a form of dedicated specific assets), and ii) investments in additional farm buildings such as cowsheds, barns, and milking facilities (a form of dedicated and physical specific assets) that have low liquidity and limited alternative use. Perhaps the most important type of asset specificity in this context is the dedicated asset specificity of the additional cows and the farm facilities designed to accommodate them. Dedicated asset specificity refers to investments in additional production capacity which would not have been undertaken if not a prospect of selling significant amount of product to a particular buyer (Williamson, 1983). The investments in additional number of cows contingent on the supply contract with processors would result in a significant excess capacity if the contract is terminated. Furthermore, in the context of the Armenian dairy industry during early transition, the only alternative use for a dairy cow was slaughtering it for meat which was a low profitability alternative to using it for the milk production. Additionally the redeployment of farm facilities designated for dairy cows would result in lower value realization.

It is possible that the linkage non-performance will take longer to result in observable divestment. This would be especially true in the presence of fixed assets such as cowsheds and other farm facilities which are less liquid and required more time to exhibit an observable divestment. However, the change in cow numbers can serve as a good indicator of the change in these fixed assets for two main reasons. First, an increase in cow numbers requires an increase in farm facilities to accommodate them. Second, since cows are a relatively liquid asset, a decrease in cow numbers can be observed even over the relatively short period of time.

It is reasonable to assume that the non-performance of marketing linkages (i.e. relationship hold-ups) after the end of the USDA MAP facilitation will lead to a decrease in farm revenues from milk sales and will force farmers to reduce their number of cows in order to minimize their variable costs. Thus, in this context, the change in number of cows is an adequate proxy for the change in farm-level investments and can provide evidence of the performance of market linkages after the end of the USDA MAP facilitation. To account for other factors affecting the change in cow numbers over time farms in the informal marketing channel are used as a comparison group.

Figure 2 presents a graphical representation of the logic of the analysis and conditions for rejecting the hypothesis: *H2 – Third-party facilitation strategy pursued by the USDA MAP led to establishment of self-enforcing, long-term sustainable linkages along the dairy supply chain*.

**Figure 2 The logic of the analysis based on the change in investment before and after the end of the USDA MAP**



Based on this framework, *H2* should be rejected if the observed level of investments in number of cows by formal marketing channel farmers is *below* the normal growth rate after the end of the USDA MAP facilitation. This level of investments is a signal that potential relationship hold-up issues exist after the end of the facilitation. For the purposes of this paper, the normal growth rate is assumed to be the equivalent of the growth rate of farms in the informal marketing channel.

Alternatively, if normal or superior investment growth rates are observed for farms in the formal channel after the end of the USDA MAP facilitation, this is an indication that the existing formal marketing relationships are sustainable and there is not sufficient evidence to reject *H2*. The normal growth scenario occurs where there is no significant difference in investment patterns between farms in the formal and informal channels. This will imply that farms in the formal channel continued investing in cows at normal rates after the end of the USDA MAP facilitation. The superior growth scenario assumes a higher rate of investment in cows is observed after the facilitation has ended that exceeds the normal growth rate found in the informal channel. Both scenarios imply a positive investment in relationship-specific assets after the end of the USDA MAP facilitation in which case there will be no significant evidence to reject *H2*.

## 4. Empirical Analysis

### *4.1 Data*

The data for the analysis comes from two farmer surveys, conducted in 2004 and 2009 in Armenia. It constitutes a panel data with 344 total observations on milk production,

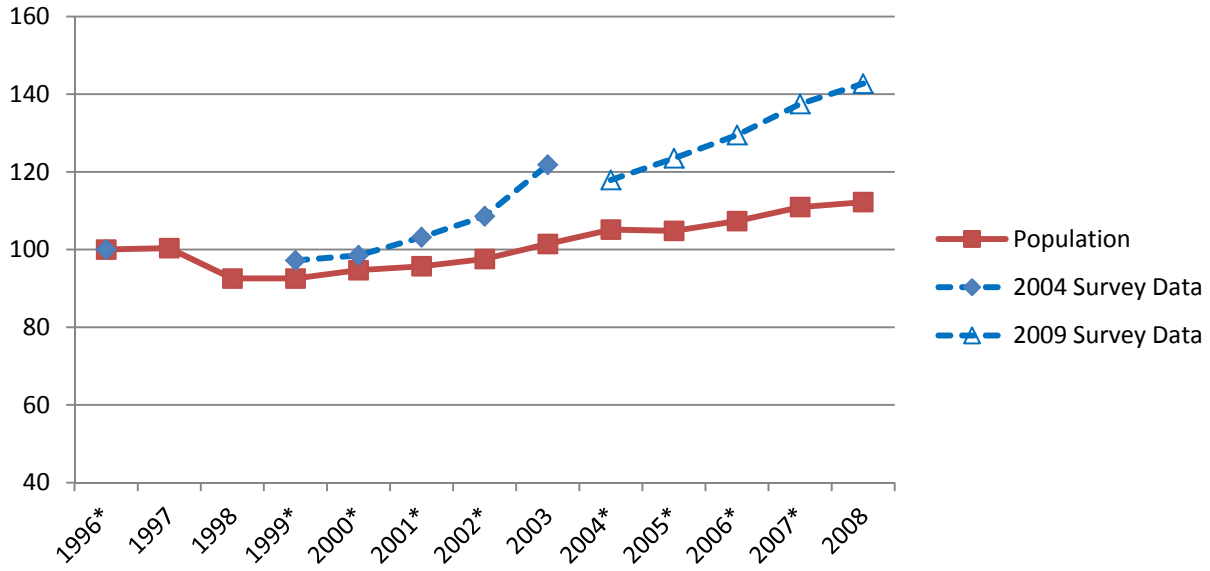
marketing, and household characteristics of 172 dairy farms over two time periods. The first survey was conducted as a part of the larger effort to assess the impact of the USDA MAP initiatives in Armenian agriculture. It provides detailed farm-level data for the period prior to the end of the USDA MAP facilitation. The second survey was designed and conducted by the authors to collect follow-up information on a sub-sample of farms four years after the end of the USDA MAP facilitation.

The survey instruments were designed to obtain information on household demographics, income generation, asset ownership and investment, production, finance, land use, marketing channel structure, and business relationships. Each survey individually provides a cross section data for 2003 and 2008 respectively, but they also include a series of retrospective information regarding household income, farm productivity, the number of cows, and the choice of marketing channel for each of the five years prior to each survey (1999-2003 and 2004-2008). Combined, this data constitutes a unique balanced panel dataset with observations on milk production, marketing, and household characteristics of 172 dairy farms before and after the end of the USDA MAP facilitation of supply chain linkages in Armenian dairy industry.

Approximately 58.1% of respondents in the sample were in the formal marketing channel in 2003. This means that they began supplying milk to dairy, either directly or through collection centers and cooperatives between 1999 and 2003 – during the USDA MAP facilitation of market linkages. The rest of the sample, approximately 41.9% of respondents, consists of farms in the informal channel which includes the local village market, traders and middlemen,

as well as subsistence farming and barter. Figure 3 and Figure 4 present the change in number of cows between 1996 (base year) and 2008 for the total sample and for the farms in formal and informal marketing channels respectively. The change in cow numbers of the total population of Armenian dairy farms is also included to allow comparison.

**Figure 3 Change in number of cows between 1996 (base year) and 2008, total sample**

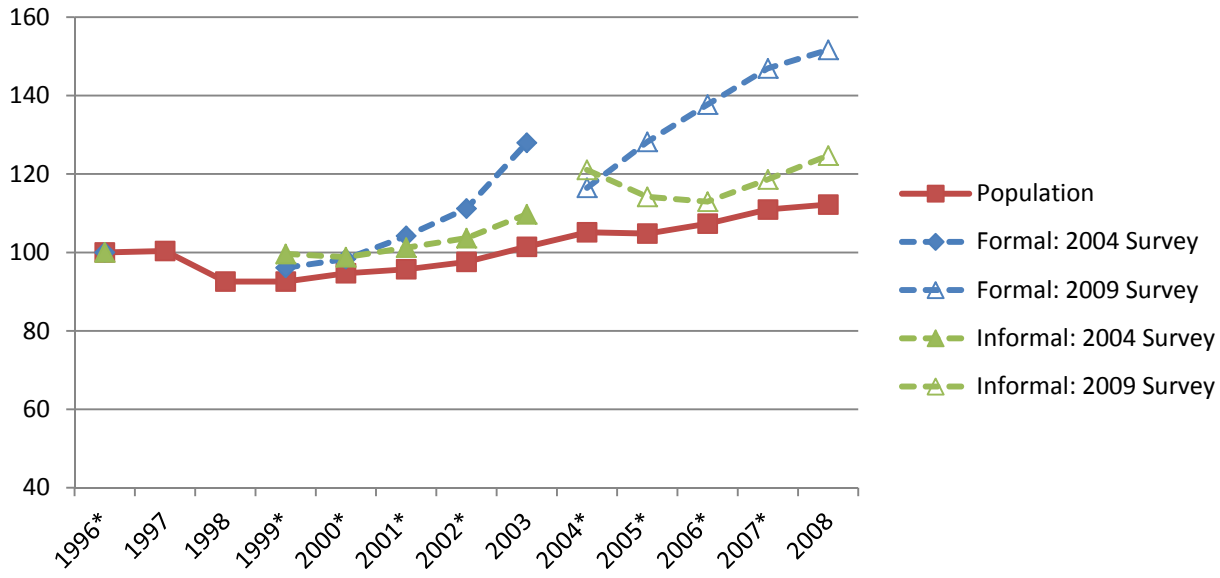



***Note:*** *Observations for years denoted by an * represent data that was recalled by respondents from over 1 year in the past at the time of data collection. Only observations from the most recent years for each survey (i.e. 2003 and 2008) are used in the data analysis for this paper.*

*Source for cow population data: Armenian Ministry of Statistics*

The data on population comes from the Armenian Ministry of Statistics. The sample data is based on respondents' recall of number of cows in each of the five years prior to each survey. In each cross section survey (conducted in 2004 and 2009) farmers were asked to report the number of cows they had in previous five years. Since both surveys were conducted in the summer, the most recent recall of number of cows is for the years 2003 and 2008.

**Figure 4 Change in number of cows between 1996 (base year) and 2008, farms in formal and informal channels**




*Source for population data: Armenian Ministry of Statistics*

The general trend in the change of cow numbers in the total sample (Figure 3) is similar to that of the population – confirming the overall representativeness of the sample. Some differences in trend can be explained by possibly lower proportion of farms linked to formal marketing channel in the population compared to the sample (i.e. lower than 58%). As can be seen in the Figure 4 the change in cow numbers of farms in informal channel resembles more closely that of the total population. Farms linked to formal milk marketing channel are the main population of interest for this study, and therefore are intentionally overrepresented in the sample to allow statistically valid inference.

*4.2. Difference-in-Difference method*

The most intuitive way to begin the analysis is to estimate the difference in the number of cows on farms in the formal and informal channels before and after the end of the USDA MAP facilitation. This can be done by using the Difference-in-Difference method which has been commonly used for policy analysis (Ashenfelter & Card, 1985; Meyer, 1995; Bertrand, Duflo, & Mullainathan, 2004; Hanson, 2007; Meyer & Mok, 2007; J. M. Wooldridge, 2007). It provides a simple but powerful tool for estimating the change in an outcome variable of population groups affected by an exogenous shock. In the context of this study the end of the USDA MAP facilitation is as an exogenous shock which could have an effect on the farms in the formal marketing channel (facilitated by the USDA MAP) and have no effect on the farms in the informal channel.

The model for analyzing the impact of the withdrawal of the USDA MAP facilitation on number of cows can be expressed by the following equation:

$$COWS = \beta_0 + \delta_0 AFTR + \beta_1 MFORM + \delta_1 AFTR \cdot MFORM + u \qquad (2.1)$$

Where *COWS* is the outcome variable of interest denoting the number of cows; *AFTR* is a period dummy variable equal to one for observations after the end of the USDA MAP facilitation; and *MFORM* is a dummy variable equal to one for farms in the formal marketing channel. The coefficient $\delta_0$ reflects the effect of aggregate factors that influence the number of cows over time in the same way for farms in both groups. The coefficient $\beta_1$ reflects the difference between the farms in formal and informal channel prior to the end of the USDA MAP

facilitation. The main coefficient of interest for this analysis is $\delta_1$ which reflects the change in the number of cows for farms in the formal channel after the end of the USDA MAP facilitation.

The underlying assumption for this method is that the number of cows of farms in both formal and informal channels did not change at different rates for other reasons. The OLS estimator, $\hat{\delta}_1$ , is the Difference-in-Difference estimator and is equivalent to subtracting the difference in the average number of cows between farms in formal and informal channels before the end of the USDA MAP facilitation, from the difference in average number of cows between groups after the end of the USDA MAP facilitation (Angrist & Pischke, 2009; J. M Wooldridge, 2002).

The estimated equation, with robust standard errors in parentheses, is presented below:

$$\widehat{COWS} = 2.708 + 0.375\ AFTR + 1.871\ MFORM + 0.475\ AFTR{\cdot}MFRORM \quad (2.2)$$
$$(0.188)\quad (0.329)\quad (0.913)\quad (0.498)$$

$$N = 344,\ R^2 = 0.021$$

The Difference-in-Difference estimator, $\hat{\delta}_1$ = 0.475 (t = 0.95), is positive but not statistically significant, which implies that the end of the USDA MAP facilitation of supply chain linkages in the Armenian dairy industry resulted in no statistically significant change in number of cows for farms linked to the formal marketing channel. This result is consistent with the normal growth scenario (Figure 8) and provides no evidence for rejecting *H2*. It suggests that the supply chain linkages established through the USDA MAP facilitation strategy were sustainable after the facilitation ended.

The $R^2 = 0.021$ indicates that the large part of the variation in the number of cows is still not explained by the model. Clearly, there are many other factors that can affect the number of cows, the *time* and *group* dummy variables explain only 2.1 % of variation. Given that the sample size is not very large, this could be the reason for not obtaining significant t-statistics. The Difference-in-Difference approach provides a good starting point for the analysis; however, more comprehensive analysis is required for a conclusive test of the hypothesis.

*4.3 Fixed Effects method*

The factors that can affect the change in number of cows in the individual farm include access to capital and labor, market conditions for raw milk, quality of cows (i.e. milk yield) as well as managerial and entrepreneurial abilities of an individual farmer or the household head. The effect of some of these factors can be accounted by including a series of control variables in the regression analysis. However certain individual characteristics affecting number of cows, such as farmer's ability, are impossible to observe directly. Moreover, it is likely that these unobserved factors are systematically related to the likelihood of the farm being in formal or informal marketing channel.

For example, more entrepreneurial farmers would be able to quickly realize and act upon the opportunities provided by the USDA MAP facilitation, by establishing or joining a milk marketing cooperative, and therefore have a higher probability of being in the formal marketing channel. Additionally, dairy processors, in their efforts to improve milk procurement facilitated by the USDA MAP, might build a milk collection center in a village with larger proportion of high productivity farms, hence making access to formal marketing channel easily

available to farmers with better farm management abilities. Consequently, the analysis using the usual pooled OLS method will produce inconsistent estimators. Assuming the unobserved entrepreneurial and managerial ability of an individual farmer is constant over a five year period, the fixed effects estimation method can be used.

The fixed effects method is widely used in panel data applications to explicitly allow for unobservable time-constant effects (unobserved individual heterogeneity) to be arbitrarily correlated with the explanatory variables including the variable of interest (Baltagi, 2005; Hsiao, 2003; Jeffrey M. Wooldridge, 2002). The model can be formally presented by the following equation:

$$y_{it} = \beta_0 + \delta_0 P_t + \delta_1 D_{it} + \sum_{j=1}^{m} \beta_j X_{itj} + a_i + u_{it} \qquad (2.3)$$

Where $y_{it}$ denotes the number of cows for farm $i$ in the time period $t$ ; $P_t$ is a time dummy equal to one for the period after the end of the USDA MAP facilitation; $D_{it}$ is a dummy variable equal to one for the farms that could be affected by the withdrawal of the USDA MAP facilitation; $X_{itj}$ is a vector of *m* control variables accounting for other observable factors that could affect number of cows; $a_i$ captures all the time-constant unobserved individual characteristics affecting number of cows; and finally $u_{it}$ is the idiosyncratic error incorporating time-varying individual unobserved effects.

Fixed effects method can consistently estimate the effect of the withdrawal of the USDA MAP facilitation on the number of cows, assuming that all explanatory variables including $D_{it}$ are uncorrelated with the idiosyncratic error $u_{it}$. It is reasonable to assume that the unobserved entrepreneurial ability of an individual farmer which can affect the number of cows and be possibly correlated with $D_{it}$ (and other explanatory variables) is roughly the same over five year period and therefore is capture by $a_i$. The fixed effects transformation removes time-invariant unobserved effects $a_i$ by time-demeaning the equation (2.3) which involves: first, averaging the equation, and then subtracting the averaged equation from the equation (2.3). The fixed effect estimator is the pooled OLS estimator from the regression of the time-demined equation. The main parameter of interest is $\delta_1$ which can be interpreted as the change in number of cows for the farms affected by the withdrawal of the USDA MAP facilitation.

Table 1 presents names and descriptions of variables included in the analysis followed by Table 2 which presents the summary statistics for the total sample and for groups of farms in formal and informal markets for both time periods. Period 1 corresponds to year 2003 and Period 2 corresponds to 2008. The list begins with the outcome variable (*COWS*) indicating the number of cows for each farm in the sample. Time trend is controlled by the variable *AFTR* which is a dummy variable equal to one for observations in Period 2 (2008) and zero otherwise. Variable *D* is a dummy variable indicating farms affected by the withdrawal of the USDA MAP facilitation. It is the main variable of interest capturing the change in number of cows after the end of the USDA MAP facilitation on the farms linked to formal marketing channel.

**Table 1 Names and descriptions of variables included in the analysis**

| Variable | Description |
|---|---|
| Dependent Variable | |
| *COWS* | Number of cows on an individual farm |
| Independent Variables | |
| *AFTR* | Equals 1 for Period 2* and 0 otherwise |
| *D* | Dummy indicating farms affected by the withdrawal of the USDA MAP facilitation: Equals to 1 if the farm is in formal channel in Period 2 and 0 otherwise |
| *INCLM* | Equals 1 if the household belonged to Lower Middle income category (annual income between 360.00 and 720.00USD) and 0 otherwise |
| *INCUM* | Equals 1 if the household belongs to Upper Middle income category (annual income between 720.00 and 1250.00USD) and 0 otherwise |
| *INCU* | Equals 1 if the household belonged to Upper income category (annual income over 1250.00USD) and 0 otherwise |
| *FLOAN* | Equals 1 if has a loan from a formal source (i.e. ACBA bank, other banks, and Credit Clubs) |
| *NONAGINC* | Equals 1 if has income from wages and non-agricultural businesses |
| *ARLAND* | Total area of arable land owned (in hectares) |
| *PMLAND* | Total area of pastures and meadows owned (in hectares) |
| *PPLHH* | Number of people in the household |
| *EDCOLLR* | Interaction term: dummy for college education with time period dummy |
| *OTHEROC* | Equals 1 if household head has a primary occupation other than farming (e.g. teacher, nurse, vet., accountant, plant worker, etc…) and 0 otherwise |
| *AIUSE* | Equals 1 if used Artificial Insemination for breeding |
| *MLKYLDS* | Average milk yield per cow per day in the summer season (liters) |
| *MPRICE* | Price of milk per liter in Armenian Drams (AMD) |
| Number of observations = 344, number of farms = 172 | |

* Period t = 1, 2 (corresponding to 2003 and 2008 respectivelly)

The list of control variables includes five dummy variables controlling for access to financial capital: *INCLM, INCUM,* and *INCU* indicate whether the farm belongs to lower-middle, upper-middle, and upper income categories respectively; *NONAGINC* indicates whether the farm received income from wages or non-agricultural businesses; FLOAN indicates whether the

farm has a formal loan from sources such as Agricultural Cooperative Bank of Armenia (ACBA)[1], Agricultural Production Credit Clubs founded by the USDA MAP, or from other banks.

Two variables, *ARLAND* and *PMLAND* are included in the analysis to account for the type and the size of farms' landholdings, representing the total area of arable land as well as pastures and meadows measured in hectares. The access to labor is controlled by a count variable *PPLHH* and a dummy variable *OTHEROC* indicating number of people in the household and whether the household head has a primary occupation other than farming. To control for the difference in the effect of college education on investments in number of cows across time periods an interaction term *EDCOLLR* is included in the analysis. It is an interaction of dummy variable equal to one if the household head has a college education and the time period dummy equal to one for Period 2.

Another important factor that can affect number of cows is the quality of the herd (i.e. milk yield per cow). On-farm investments aimed at increasing milk production may be directed on improving the quality of the cows rather than the number of cows. Hence, in order to obtain more precise estimates of the changes in herd size, the quality of the cows must be controlled. This is done by including the following two variables in the analysis: *AIUSE* – indicates whether the artificial insemination is used for breading; and *MLKYLDS* indicates average daily milk yield per cow during summer season, measured in liters. The final control variable is *MPRICE* which reflects the price of one liter of raw milk in local currency, Armenian

[1] Agricultural Cooperative Bank of Armenia is one of the major agricultural credit providers in Armenia

Drams (AMD). It will allow controlling for changes in number of cows due to possible changes in milk prices over time.

**Table 2 Summary statistics**

| Variables | Means with standard deviations in parentheses | | | | | |
|---|---|---|---|---|---|---|
| | Total sample | | Formal channel | | Informal channel | |
| | Period 1 | Period 2* | Period 1 | Period 2 | Period 1 | Period 2 |
| Dependent Variable | | | | | | |
| *COWS* | 3.796 (6.929) | 4.448 (8.165) | 4.580 (8.923) | 5.430 (10.294) | 2.708 (1.596) | 3.083 (3.094) |
| Independent Variables | | | | | | |
| *INCLM* | 0.209 | 0.256 | 0.240 | 0.290 | 0.167 | 0.208 |
| *INCUM* | 0.168 | 0.157 | 0.240 | 0.160 | 0.111 | 0.153 |
| *INCU* | 0.157 | 0.267 | 0.180 | 0.350 | 0.125 | 0.153 |
| *FLOAN* | 0.186 | 0.192 | 0.290 | 0.200 | 0.042 | 0.181 |
| *NONAGINC* | 0.314 | 0.331 | 0.340 | 0.340 | 0.278 | 0.319 |
| *ARLAND* | 0.822 (0.869) | 1.245 (2.260) | 0.905 (0.872) | 1.401 (2.661) | 0.707 (0.856) | 1.030 (1.533) |
| *PMLAND* | 0.675 (0.792) | 1.128 (1.523) | 0.758 (0.832) | 1.315 (1.704) | 0.559 (0.721) | 0.869 (1.193) |
| *PPLHH* | 5.407 (1.903) | 5.029 (1.852) | 5.370 (1.655) | 5.000 (2.030) | 5.458 (2.213) | 5.069 (1.586) |
| *OTHEROC* | 0.203 | 0.366 | 0.210 | 0.350 | 0.194 | 0.389 |
| *EDCOLLR* | 0 | 0.256 | 0 | 0.250 | 0 | 0.264 |
| *AIUSE* | 0.151 | 0.064 | 0.200 | 0.090 | 0.083 | 0.028 |
| *MLKYLDS* | 9.343 (4.504) | 10.186 (5.525) | 10.170 (4.625) | 11.100 (6.036) | 8.194 (4.089) | 8.917 (4.462) |
| *MPRICE* | 96.270 (19.075) | 99.350 (16.148) | 92.049 (11.061) | 97.635 (14.505) | 102.133 (25.411) | 101.735 (18.020) |
| Number of farms | 172 | 172 | 100 | 100 | 72 | 72 |
| Number of observati | 344 | | 200 | | 144 | |

* Period t = 1, 2 corresponding to 2003 and 2008 respectivelly

The results from the fixed effects analysis are presented in Table 3. Two columns, following the variable names, present the estimated coefficients with corresponding cluster-robust standard errors. The main parameter of interest – coefficient on dummy variable *D*, is

positive but not significant ( $\hat{\delta}_1$ = 0.2298, t = 0.50) which suggests that controlling for other factors the change in number of cows of farms linked to formal marketing channel is not significantly different from that of farmers in the informal channel after the end of the USDA MAP facilitation. This means that farms linked to formal marketing channel experienced normal growth after the end of the USDA MAP facilitation. This result is consistent with the result from the Difference-in-Difference estimation and likewise does not provide sufficient evidence to reject the hypothesis that the USDA MAP facilitation strategy in Armenian dairy industry led to the establishment of long-term sustainable marketing linkages between dairy producers and processors.

To check whether the unobserved individual effects are correlated with regressors, which is the key consideration for justifying the use of Fixed Effects (FE) estimator versus Random Effects (RE) estimator, the Hausman test is performed. The null hypothesis under this test is that the unobserved individual effects are uncorrelated with regressors, in which case the RE estimator is consistent (Hausman, 1978). The results of the Hausman test are included in Table 3 and lead to rejection of RE specification in favor of FE specification at the 5% significance level.

The coefficient on *AFTR* is positive and significant implying general increase in number of cows over time in both groups. This result is consistent with the positive time trend observed in the total population (Figure 1). Other factors found to have significant effect on number of cows in this analysis are consistent with the theory predictions and include access to financial capital, land and labor as well as the quality of the herd.

**Table 3 Fixed Effects estimation results**

Dependent variable: *COWS*
Number of cows in the individual farm

| Variable | Coef. | | Robust Std. err. |
|---|---|---|---|
| *AFTR* | 0.8581 | ** | 0.3905 |
| *D* | 0.2298 | | 0.4634 |
| *INCLM* | - 0.1078 | | 0.4041 |
| *INCUM* | 1.3502 | ** | 0.6142 |
| *INCU* | 1.6881 | *** | 0.5796 |
| *FLOAN* | - 0.6703 | | 0.6018 |
| *NONAGINC* | 0.1616 | | 0.5709 |
| *ARLAND* | 0.1725 | * | 0.0919 |
| *PMLAND* | - 0.2441 | | 0.1573 |
| *PPLHH* | 0.1923 | * | 0.1045 |
| *OTHEROC* | - 0.8575 | | 0.6162 |
| *EDCOLLR* | -1.1379 | *** | 0.4225 |
| *AIUSE* | -1.0636 | * | 0.6001 |
| *MLKYLDS* | 0.0035 | | 0.0381 |
| *MPRICE* | - 0.0118 | | 0.0111 |
| *Intercept* | 3.7986 | *** | 1.3378 |

Number of observations = 344
Number of farms = 172
$R^2$ within = 0.2221
Houseman test for random effects:
Chi.sq. (14) = 26.32 Prob. > Chi.sq. = 0.024
Number of farms = 172

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels

The estimated coefficients on *INCUM* and *INCU* are positive and significant indicating that the number of cows for farms in upper-middle and upper income categories was higher by on average 1.35 and 1.69 respectively, compared to farms in the lower income category. Results also indicate that the area of arable land owned by the farm has a positive effect on number of cows as indicated by the estimated coefficient on *ARLAND*. The coefficient on

*PPLHH* (0.1656, $p > 0.098$) indicates that the number of people in the household has a positive effect on the number of cows.

Interestingly, the results suggest significant reduction in number of cows between 2003 and 2008 of farmers with the college education, as indicated by the coefficient on interaction term *EDCOLR*. There are two hypotheses that can help explain this result. First hypothesis is that there was an increase in alternative non-dairy opportunities for farmers with higher education in 2008 which reduced their reliance on dairy farming as a main income source/occupation leading to reduction in number of cows. When considering this hypothesis it should be noted that the effect of non-farm occupation and non-agricultural income is controlled in the analysis and the estimated coefficients on both variables (*OTHEROC* and *NONAGINC*) are not statistically significant. Second hypothesis is that farmers with college education are likely to have better management abilities and could potentially focus their efforts on improvement of quality versus quantity of cows. Additional evidence of negative correlation between heard quality and head size is suggested by the negative coefficient on *AIUSE*. It implies that the farms which used artificial insemination for breeding have lower number of cows compared to farms which did not use artificial insemination. This supports the hypothesis that the on-farm investment efforts might have been focused not only on increasing the herd size but also on improving the herd quality.

In summary, results indicate that the farms linked to formal marketing channel experienced normal growth after the end of the USDA MAP facilitation of market linkages. There is no indication of divestments after the end of the facilitation which supports the

hypothesis that the USDA MAP facilitation strategy led to the establishment of long-term sustainable supply-chain linkages between Armenian dairy producers and processors. Other findings are consistent with the economic theory indicating that the access to capital, land, and labor has a significant effect on the level of on-farm investments.

## 5. Conclusion

The main focus of this paper is on the empirical examination of the long-term sustainability of third-party facilitated supply chain linkages. It is motivated by the policy concerns regarding the high failure rate of third-party facilitated supply chain linkages after the exit of the third-party and the withdrawal of the facilitation. It is also motivated by the practical implications of better understanding of appropriate business models, incentive structures, and enforcement mechanisms in the context of external facilitation of supply chain linkages.

The analysis in this is based on the third-party facilitation framework (Shanoyan, 2011). It examines the predictive power of the framework in the context of the USDA MAP facilitation of supply chain relationships between Armenian dairy producers and processors. The hypothesis regarding the long-term sustainability of USDA MAP facilitated linkages is introduced and tested using longitudinal analysis of linkage performance indicators after the end of the USDA MAP facilitation. In particular the change in number of cows before and after the end of the USDA MAP is examined across farms liked to the formal marketing channels and farms in the informal channel. Econometric analyses include difference-in-difference and fixed effects estimation methods using a unique balanced panel data with 344 total observations on

milk production, marketing, and household characteristics of 172 dairy farms before and after the end of the USDA MAP facilitation.

The main results provide no evidence of divestment after the end of the USDA MAP facilitation and suggest that farms linked to the formal marketing channel continued to invest in improving milk production. This supports the hypothesis that the USDA MAP facilitation strategy in Armenian dairy industry resulted in the establishment of long-term sustainable marketing linkages between dairy producers and processors. Combined with the findings from Shanoyan 2011, this indicates that the third-party facilitation strategies directed on stimulation of investments in private enforcement capital by transacting parties can lead to establishment of self-enforcing, long-term sustainable supply chain linkages.

This study contributes to the agribusiness and development literature in two important ways. First, due to the unique natural experimental settings this study contributes a valuable empirical evidence for examining the predictive value of probabilistic hold-up framework. Second, it provides important implications not only for policy makers and development agencies, but also for agri-food supply chain participants. On the policy and business development side, a better understanding of the role that private enforcement mechanisms play in external facilitation of supply chain relationships can assist in designing policies and programs that are more effective for linking producers to markets. On the agri-food industry side, the findings from this study provide insight on managerial decisions regarding relationship-specific investments and contractual arrangements for improving their procurement and marketing linkages.

This paper provides only an initial theoretical and empirical platform for building further research on the role of private enforcement mechanisms in third-party facilitation of market linkages along the agri-food supply chain. It still can be argued that the continuous positive performance of the market linkages may have been simply the result of the reestablishment of the formal marketing channel. Nevertheless, the results of the quantitative analysis provide compelling evidence that: firstly, the reestablishment of the formal marketing channel was accompanied by a significant rearrangement of private enforcement capital (Essay one), and secondly, the investment in private enforcement capital continued after the end of the facilitation (Essay two).

Moreover, additional qualitative evidence suggests that these rearrangements of private enforcement capital may have played an important role in preventing defection by processors after the unexpected change in market conditions due to the significant decrease in world milk price in late 2008 and early 2009 (FAO, 2009).

According to the manager of one of the largest dairy processors, his company refrained from breaching prior arrangements with farmers during the 2008-2009 price decline, even though, it would have been more profitable to import powder milk rather than procure fresh milk from local producers (Shanoyan, 2009, personal correspondence). He noted that the future returns on company's investments in milk collection centers in remote villages were the major consideration in that decision. He then explained that in the short-run the small-scale farmers' reaction to a sharp reduction in milk prices and the procurement volumes would have been "slaughtering the dairy cows" which would have affected the return on investments in

collection centers in the long-run. This is consistent with the predictions of the probabilistic hold-up framework, however, it is only anecdotal evidence and the true effect of investments in collection centers during 2009 price decline remains to be tested in further research. A better understanding of third-party market linkage facilitation strategies based on private contract enforcement mechanisms requires more comprehensive examination of supply chain linkages in the context of governance structures (i.e. cooperative vs. privately owned collection centers), types of investments (i.e. quantity- vs. quality-enhancing) and cross-industry differences (i.e. fixed capital intensity).

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