RURAL URBAN TERRITORIAL EFFECTS ON DAIRY FARMER INCLUSION IN MODERN MARKET CHANNELS: THE CASE OF COLOMBIA

By

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ABSTRACT

RURAL URBAN TERRITORIAL EFFECTS ON DAIRY FARMER INCLUSION IN MODERN MARKET CHANNELS: THE CASE OF COLOMBIA

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This article analyzes how rural territories anchored by secondary/tertiary cities, denominated rural-urban territories (RUT) in the Southwest part of Colombia introduce spatial and territorial heterogeneity in the participation of farmers in restructured dairy value chains. We look at how different sized RUTs (with an urban center between 15k-400k inhabitants) affect farmer participation in modern market channels (such as large milk processors) as well as the transitional market channel (informal traders) on two different time periods (2008-2012 and 2013-2018). All while controlling for farmer micro characteristics, as well as the level of rural territorial development (degree of violence, density of infrastructure, and urban proximity) and geographical differences. Using a panel multinomial logit approach, we are able to find that urban size effects are positively significant in the probability of selling to both market channels. Even so, other territorial characteristics such as violence levels are key in modern market participation. Additionally, we are able to find that agglomeration effects are evident but vary by market channel. We see that higher agglomeration levels have a significant effect (negative effect) on the odds of selling to the transitional market but are less significant on the odds of selling to the modern channel. As fewer farmers have access to modern chains in developing countries, measures to make value chains more inclusive to remote farmers can benefit them and the performance of the dairy sector in Colombia.

Dedicated to my parents, Felipe and Lisa and my sister Veronica.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

KEY TO ABBREVIATIONS

AVC Agrifood value chains

RTD Rural territorial development

RUT Rural urban territory

1. INTRODUCTION

This paper focuses on a triangle linking: (1) the participation of farmers in restructured agrifood value chains (AVC); (2) rural territorial development (RTD); and (3) the rise of secondary/tertiary cities and the catchment areas that surround them. Each of the three has an established literature in developing countries. However, there are important gaps in studying the links among them.

First, there have been a number of studies on the effects of the growth of primary cities (cities with more than 500k inhabitants) on the restructuring of value chains and the participation of farmers within them. Where restructured agrifood value chains (AVC) are the transformation in structure of value chains from traditional into intermediate, transitional and modern. These papers have made it evident that the rise of primary cities has speeded up the transformation of AVCs generating changes actors, transactions and prices. An example of one of these studies is Farina (2002), that shows the effects of the development of supermarkets in Sao Paulo and Rio de Jainero, Brazil, on the restructuring of dairy and horticultural value chains that supply them. They show that the development of urban demand within these cities has generated changes in value chain actor integration, product standards, and modernization of farmers. Another important example is Vandercasteelen, Minten and Tamru (2021) who analyze the effect of physical proximity of Ethiopian milk farmers to the capital, Addis Baba, on production decisions and participation within modern channels. The result being that there is a direct effect of proximity to this primary city on productivity, prices, input use, and market access for the farmers. However, there have been few studies on how the growth of secondary/tertiary cities (secondary cities have 100k-500k inhabitants and tertiary cities having between 15k-100k) and

rural towns affect the restructuring of their value chains. This is an important gap because, in Latin America, 79% of the urban population and 53% of the total population lives in cities with less than 500k inhabitants, and only 18% of urban population and 33% of total population live in cities with more than 2 million people (IADB, 2015).

Second, there have been a number of studies in the past decade on how secondary/tertiary cities affect their surrounding rural territories' general economic and social development. In fact, recent papers (Berdegue et al., 2015; Fergusson Hillier and Ibañez, 2018), introduced the concept of rural urban territories (RUT), which are cities of 15k-400k inhabitants and their catchment areas, and studied the economic and social development within them. Fergusson Hillier and Ibañez (2018) measured economic growth and social inclusion in RUTs and compared them to urban, metropolitan, and rural territories. They found that RUTs have higher levels of social inclusion and economic dynamism than purely rural territories, yet are still lagging behind urban and metropolitan territories. However, and related to the first point, there has been little empirical research on how RTD within RUTs affects the restructuring of AVCs.

Third, one could expect that RUT's direct effects on AVC restructuring, and indirect effects via their effects on RTD on AVC, differ by the size of the secondary/tertiary cities that "anchor" the RUTs. The only literature that we have found is Vandeplas, Minten, Swinnen (2013), that include the population size and distance of nearest towns to understand the probability and effects of selling milk to multinationals vs cooperatives. They find that the smaller the town's population, the higher the likelihood that milk producers sell their milk into informal channels, suggesting that the multinational and cooperative source more milk from larger villages with more milk surplus. Though this paper highlights the importance of including

city sizes when studying AVCs is does not systematically look at RUT and their catchment areas, nor include different levels of RTD.

Fourth, inversely, one could expect that that controlling for the size of the secondary/tertiary city as well as the differences in RTD in each of these territories (such as different density of infrastructure or levels of violence) would affect, on the one hand, AVC restructuring itself, and on the other, the inclusion of different sized farmers in restructured AVCs. These differences are expected to affect these two sets of outcomes for the following reasons. Higher incidence of violence can generate decreases efficiency and yield (Muñoz (2010) and Pacheco (2016)), hindering access to more modern markets. Specifically in Colombia, higher levels of violence have led farmers to cut back investments (Arias, Ibañez and Zambrano (2013), which hinders their access to modern markets.

Fifth, while there have been studies of how structured AVRs (though modernized food industry and export markets) affect participation of farmers in modern channels (e.g. Barrett et al. 2012), there have been few if any studies of the differences over sizes RUTs on that participation, especially controlling for characteristics of the RTD associated with those territories. Even more so, this literature does not account for spatial and geographical differences between actors. Most studies of farmer participation in modern market channels (such as large milk processors) only control for micro characteristics, such as farm size, but neglect to control for meso variables, such as city size and types of RTD. We do find exceptions as there are studies that control for hinterland versus peri urban zones (e.g., Barrett et al. 2012) and density of infrastructure such as distance from paved roads.

To address these gaps in the literature, we analysed the dairy value chain within 20 RUT in the southern region of Colombia in two different on two different time periods (2008-2013

and 2012-2018). Particularly, we focused on the determinants of farmers' choices of market channels – traditional, transitional (to local and national urban markets but via traditional processors and traders), and modern (to regional and national markets via modern processors like Nestle). The reason to focus on this decision will help us understand the level of AVC restructuring each of these territories has achieved. We propose that a higher number of farmers participating within a modern channel is an indicator of a more developed AVC. We will show that Colombia has already gone through value chain restructuring, yet its intensity (by the adoption of modern market channels) has differed between territories and different sized farmers. To understand why this intensity occurred heterogeneously, we analyzed how different sized RUT and their characteristics; degree of violence (a major issue in Colombia), and infrastructure (the density and quality of which varies a lot over mountain and plain environments in Colombia) affect the decision of milk farmers to participate in a market channel.
It is important to note that though we understand that the restructuring of AVC can have an effect on RTD as well as the growth of RUTs, in the case of Colombia we assume that there was first RTD and then AVC restructuring based on its history.

The analysis relies on primary survey data collected in 2018, a data set that can be said to be rare in Latin America. It consists of a panel data (generated by a cross section and recall data for the last 10 years) regarding several aspects of choice behaviors including household characteristics, use and property of land, dairy production and processing, sales, soil management, purchase and use of concentrate, fodder, minerals, fertilizers, pesticides and veterinary products, social and physical capital and exogenous shocks and distances. Furthermore, it included recall data for most of the categories mentioned, from the year before (2017), as well as 2013 and 2008.

This paper proceeds as follows. First, we discuss the context of the dairy sector and market transformation in Colombia with special attention to our study regions which fundamentally differ by degree of dairy market transformation. Second, we describe the sample and the survey methods and present descriptive statistics. Third, we present the regression model and estimation methods. Fourth, we present the regression results. Fifth we conclude with implications and a further research agenda.

2. THE GEOGRAPHY OF THE DAIRY SECTOR IN COLOMBIA AND STUDY REGION SELECTION

Milk is an important part of a Colombian's diet, as it is estimated that they consume 144 kg per capita per year of milk (measured in milk-equivalents), roughly half of EU and US levels, similar to those of Eastern Europe, and twice those of most Asian countries. Fresh milk, cheese, preserved milk and other milk products together represented 7.3% of total food consumption in 2018. This is similar to other important foods in the diet, such as rice, eggs, and meat which represent 8%, 3.6% and 7.3% of total food consumption respectively (World Bank, Global Consumption Data Base).

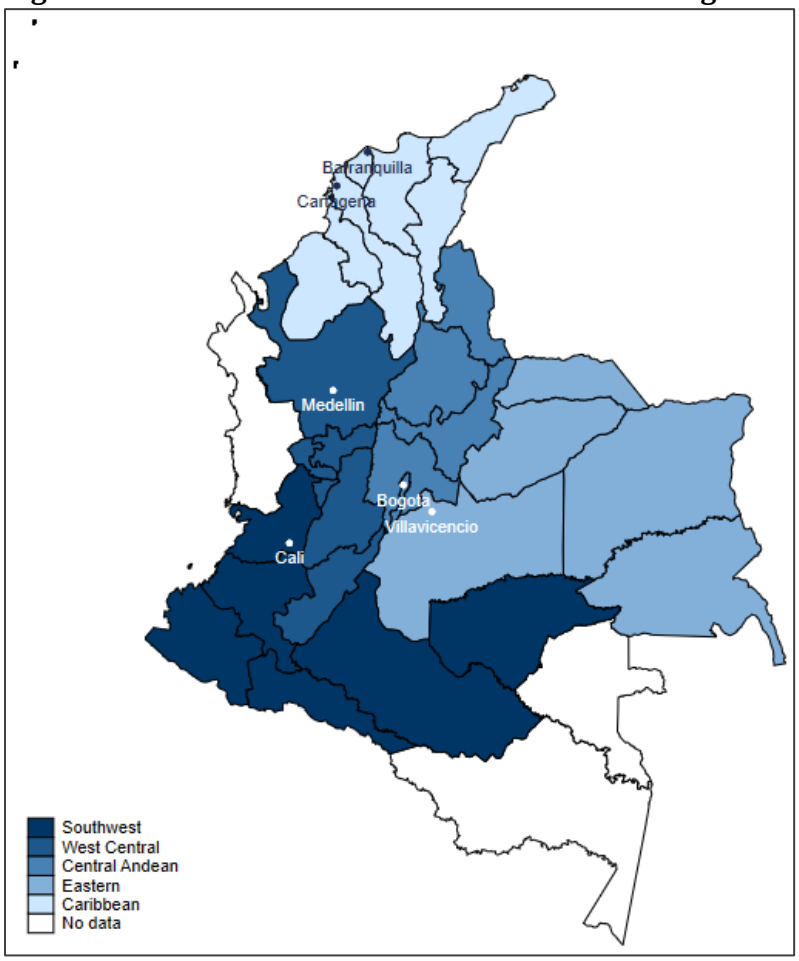
2.1 The dairy regions of Colombia mapped into three "dairy zones"

Dairy is a significant agricultural good within the country, representing 24.3% of the agricultural GDP (Vega, 2018). Dairy production is not limited to a particular area but rather is spread across geographic regions (sets of departments) of Colombia which below we map into three dairy zones.

Colombia is composed of 32 "departments", the equivalent of states or provinces in other countries. Figure 1 shows in shades of blue the departments that have significant dairy production and data on it; only the central west coast department has little dairy, and the extreme southeast is sparsely settled and there are no official dairy data on those departments. The different shades of blue delineate different regions that are administratively fixed sets of departments: (1) Southwest; (2) West Central; Central Andean; (4) Eastern; and (5) Caribbean. These five regions are heterogeneous in many ways, but for our purposes, we focus on dairy

sector characteristics. Above we listed the regions from most advanced to the least advanced in terms of dairy development. Dairy development is defined through volume of output, yields, intensification, and dairy market development which indicates how linked the area is to the national dairy market, and how "modernized" the dairy sector is in the area in terms of the share of large processors in the processing sector of that area.

Figure 1. Five milk zones in Colombia and their largest cities



We classify the five regions into sets of regions we call "zones" and then categorize the zones into most-advanced, intermediate, and least-advanced. The "most-advanced" zones within the map are the Central Andean region (the area around the capital, Bogotá) and the West

Central region (area around the second biggest city, Medellín). Dairy farming in this zone has the best access to large urban consumption centers, large and medium processors, and a plethora of collection centers. It operates in cool mountain areas that are suited for high-yield imported cow breeds and has intensive production on grasslands supplemented by feed (Martínez et al., 2005). In this zone operate mostly international firms such as Nestle and Parmalat as well as large domestic processors such as Alpina, Algarra, and Alqueria. Though there is a large presence of large and medium sized processors there are also more traditional processors (artisanal cheese makers or bakeries), that obtain the milk in an informal way (without testing the milk or registering the sale).

The "intermediate" zone includes two regions, the Caribbean and the Southwest. There are three large cities in this zone (Barranquilla, Cartagena, and Cali). Dairy output is growing fast and is undertaken over a heterogeneous area, including lowlands, uplands, and highland plateaus. The zone has a mix of intensive (using supplemental feed) and extensive (using pastures only) farming, as well as a variety of small, medium, and large farms, as well as tropical and European cow breeds. There is a rough correlation between intensive farming using European breeds and the upland, and extensive farming using tropical breeds and dual-purpose cows (i.e., produce milk and meat rather than being specialized in milk) in the lowland and highland plateaus (Martínez et al., 2005); meaning the "most advanced" zones have a higher number of European breeds, whereas the intermediate has more mixed cattle. In this zone, there are large international and national processors, albeit lesser number than the first zone, but a higher number of medium-sized processors and cooperatives, such as Colacteos and La Florida. The share of these medium firms and coops is much higher in this intermediate zone than in the advanced zone where the large processors dominate the purchase of milk. In fact, 62% of the

collection and processing centers of the large processors are located within the “most-advanced zones”, and only 33% are located in the “intermediate” zones.

The third wave is characterized for being mostly extensive production with grassland feed, and many dual-purpose farms, where density of farmers is mostly low. This third wave is located mostly within the eastern part of the country with the biggest city being Villavicencio. Still, milk from this area is also transported to the central region. It is important to note that this region is mostly composed of flat, humid grassland areas, with the amazon covering part of southern area. Within this wave we can still find and two major processors (Alqueria and Nestle) where each have one collection center in this zone, though at times one will halt reception.

2.2 Selection of one zone and one region in that zone

For the survey we selected the Southwest region in the “intermediate zone” discussed above. The zone was selected because it seems as though the AVC restructuring has not reached its final stage of modernization. In contrast, the advanced zone appears to be already in the modern stage, with a saturation of large processors and farming intensification already the norm; it has also been the area most studied by past surveys and case studies. Moreover, its dairy economy is overwhelmingly focused on supplying the two biggest cities in the country, seemingly eclipsing the roles of secondary and tertiary cities. By contrast, the least-advanced zone appears to be only at the stage of emerging transformation, with only minor penetration of large and medium processors, and still mainly in the extensive phase of farming on broad tropical grasslands; put simply, there does not appear to be a critical mass of transformation in that zone yet, to do a revealing analysis of the extent and determinants of transformation. Moreover, the least-

advanced zone is still mainly rural, speckled with small rural towns, without the secondary and tertiary cities important to our analysis.

However, the intermediate zone is neither in mature stasis nor emergence and offers rich possibilities for a window on dairy sector transformation. Secondary and tertiary cities dominate most of the areas in the zone; there is wide variation in the geography and farm structures and technologies over the numerous valleys and hillsides in the zone, and abundant penetration into the processing sector of both large and medium processors next to the usual set of smaller traditional processors.

Within the intermediate zone, we selected the Southwestern Region but not the Caribbean Region because the Southwest has a higher diversity in size and types of farmers, number of RUT, and social and geographical variations that allow us to test the effect of RUT on participation.

2.3. General characteristics of the study region, the Southwest, seen via the lens of its departments

2.3.1 The departments of the Southwest and our selection of a subset for the survey

The region is composed of six departments: Valle del Cauca, Cauca, Nariño, Putumayo, Caquetá, and Guaviare. Each is composed of municipalities (similar to "counties" in other countries); each municipality has a municipal capital city and other cities and rural towns. For the selection of departments for the survey, we would have chosen the universe of six departments but there was too much danger to conduct the survey in Cauca and Putumayo and so these were not selected.

This introduces some bias to the study as we expect that more violent areas have less penetration at least of modern milk channels. Two factors reduce the importance of the bias. The two dropped departments only account for 11% of the region's milk production. Also, in the four retained departments there were a number of RUTs with moderate violence, so the effect of violence could still be included in the regressions, an important analysis in the Colombian context.

2.3.2 Characteristics of the four selected departments (based on secondary data)

The Southwest region is incredibly heterogeneous in many aspects including levels of urbanization, geographical aspects such as temperature, rainfall and altitude, and levels of violence and insecurity. All of these characteristics are suspected to be important in determining the level of value chain transformation. Below we go into these characteristics in more depth.

The Southwest region is a mix of two departments with substantial urbanization with primary and secondary/tertiary cities, and two departments mainly populated by tertiary cities and rural towns. Table 1 shows that two departments (Valle del Cauca and Nariño) are much more urbanized than the other departments: (1) they have the highest share of all six departments of urban population in total population; (2) they have the highest number of RUTs and the correlated fact that they have most of the 34 counties (of 126 counties) in the region that have secondary and tertiary cities; (3) Valle del Cauca contains Cali, the only primary city in the region. By contrast, the other four departments (our two selected departments, Caquetá and Guaviare, and our two excluded, Cauca and Putumayo) are far less urbanized with most of their municipalities having municipal capitals that are usually just tertiary cities or rural towns.

Not only is the Southwest region heterogeneous in urbanization, but also within its on geography, a key factor in the type of breeds that used for milk production. Table 1 shows that the departments and municipalities differ substantially in topology and climate. The more urban and developed departments in our sample (Valle del Cauca and Nariño) have warm coastal areas and the rest is cool mountainous areas with fertile valleys good for dairy farming. Caquetá and Guaviare (and Putumayo) have less favorable areas for pure dairy production, but more suitable for dual purpose farming, consisting of low hot plains and the Amazon Forest.

Table 1.
Geographical, population and milk farmer density of departments in South west Colombia using national data

	Department 1 (Valle del Cauca)	Department 2 (Nariño)	Department 3 (Caquetá)	Department 4 (Guaviare)	Total
Urbanization information					
Total Population (in thousands)	4,756	1,809	496	116	7,177
% Of Urban Population	88%	50%	60%	60%	76%
Number of rural-urban territories before sample	10	8	2	2	22
Number of rural-urban territories retained in sample	9	7	2	2	20
Geographical Information					
Mean Altitude (meters above sea-level)	1,314	2,764	266	187	1,516
	[54.6]	[18.0]	[10.8]	[27.3]	[74.4]
Mean Annual rainfall (mm)	121	81	263	208	132
	[41.9]	[20.8]	[24.1]	[17.3]	[53.6]
Mean Temperature (C°)	22	14	26	26	20
	[21.9]	[18.9]	[1.69]	[3.4]	[29.1]

Table 1 (cont'd).

Milk Farmers					
Number of milk farmers	13,057	49,801	17,787	5,026	85,671

Coefficient of Variation in brackets

Source: DANE (2018), IDEAM (2016), Consejo Nacional Lácteo

Finally, it is important to note that Colombia has had a 50-year conflict among right wing and left-wing guerillas, non-guerrilla criminal groups, and the military. This has generated substantial violence and insecurity in the Southwest region (and other regions). However, the level of violence differed greatly over the municipalities. Recently the greatest concentration of violence has been in the Cauca and Putumayo departments; we note below that we eliminated those from a potential sample of departments due to this violence. Nevertheless, in the four remaining departments violence was still an issue, yet extreme cases occurred but in a small subset of municipalities; the latter tended to be correlated with more hinterland and mountain and jungle areas (usually far from the main dairy areas but sometimes mixed in with dairy farming areas).

2.4 Survey selection of RUTs and dairy farms in the four departments and descriptives of their characteristics

2.4.1 Selection of (nearly the full universe) of RUTs in the selected departments

The selection of RUTs in the four departments was as follows. Recall that the "RUT" (rural-urban territory) consists of a secondary/tertiary city (size between 15k-400k) and its immediate "market catchment area". We started by identifying all the RUTs of a department. To do so, we

did the following: first, and following the methodology presented in a paper by Fergusson, Ibañez and Hilliar (2018) and Berdegué et al (2017), each department was divided based on functional territories. Where a functional territory is place where a certain group of people live and where they conduct most of their social life; more formally: spaces that contain a high frequency of economic and social interactions among its inhabitants, organizations and firms. In other words, its territories whose mayor cities and catchment areas are defined not by administrative lines but by the intensity of social and economic relations. These functional territories' boundaries were located using stable satellite night lights and census data. Once the functional territories were identified, they were categorized based on the size of their biggest urban center. Where functional territories with city centers of more than 600k inhabitants were called metropolitan, 400k-600k urban, 15k-400k RUT, and those with less than 15k were called rural. We focused only on RUTs, enabling us to disregard those completely rural territories, as well as primary city centered territories, in order to understand the effect of secondary/tertiary cities on value chain transformation within their market catchment areas. We selected the universe of the 22 RUTs identified in the four departments with the exception of two which we had to drop because of high insecurity levels. It is important to note that because the catchment areas are focusing on social and economic relations, within the RUTs there is not only a secondary/tertiary city (the largest urban area in the RUT) but also there are rural towns and villages.

We expect the characteristics of the RUTs to differ over the size of the "anchor" city in each RUT. To explore this, we divided the RUTs into three sets. We refer to: (1) RUTs anchored by tertiary cities (15k-60k) as small RUTs; (2) by smaller secondary cities and bigger tertiary cities (60-120k) as medium RUTs, and (3) larger secondary cities (120k-400k) as large RUTs.

2.4.2 Selection of farm household sample

The farm household survey was based on a sample weighted by the number of dairy farms in the RUTs. To assemble a list of the universe of dairy farms per RUT, we used the National Dairy and Meat Account (Cuenta Nacional de Carne y Leche) and the Ministry of Agriculture's vaccination records per RUT; the latter represent 98% of dairy farms per RUT). Since this list includes milk farmers as well as meat farms, we focused only on those who reported having milk production or farmers with a herd composed of at least 80% cows. We found that the total number of milk farmers in the selected RUTs was 27,415. Our budget permitted selecting a sample of 1,188 milk farmers, which were distributed over RUTs, roughly in proportion to the share of the RUTs in the universe of dairy farmers, but assuring that each RUT had at least 30 milk farmers.

Next, in each RUT, we composed a list of all villages (veredas) with 10 dairy farms or more (to reduce travel costs for the survey) and eliminated farmers from the sample that did not live within these villages[1].

The 1,188 farm households were sampled proportionally to and randomly from the universe of dairy farms of the selected villages. The structured questionnaire was administered in-person to each household. The questions covered assets and behavior in the current (2018) and past year (2017), five years ago, and for certain variables, 10 years ago. The questions covered household characteristics, use and property of land, dairy production and processing, sales, soil management, purchase and use of concentrated feed, fodder, minerals, fertilizers, pesticides, and

[1] This caused the number of possible villages to fall by 30%, but farms that were in the sample fell by only 8.5%.

veterinary medicines; social and physical capital and exogenous shocks; and distances from the RUT main city and highways.

Finally, in order to control for the "meso" and geographical characteristics of each of the RUTs, we obtained information on the following: (1) urbanization; in this case we used a territorial survey that was undertaken in 2017 by Los Andes University to obtain the delimitation of functional territories. (2) Rainfall and temperature; used information published by the Colombian Environmental ministry and (3) as well as violence index that was composed of historical data on homicides, coca cultivation, forced immigration and number of terrorist attacks from the same territorial survey.

2.4.3 RUT characteristics derived from our farm survey data

Table 2 presents characteristics of the RUTs based on our farm household survey data, where we can highlight four major points.

First, as expected, the distribution of dairy farmers mirrors what we noted above about the distribution of sizes of RUTs (recall the RUT size is only a function of the size of the anchor city). Thus, in the departments with mostly large RUTs (Valle del Cauca), most of the dairy farms in the sample are in those large RUTs; in Nariño, where medium RUTs predominate, most of the dairy farms are in medium RUTs. And in the departments where small RUTs predominate (Caquetá and Guaviare), most of the farmers are in small RUTs.

Second, there is a negative correlation between the size of the RUT and the time it takes for farmers to reach a paved road, the nearest town/city and the nearest modern milk processor. Even the share of farmers who are more than 30 minutes away from any of those three (paved road, city/town, processor) drops as the RUT size (i.e., anchor city size) increases. This implies

that there is a strong correlation between anchor city size and ease of access of farmers to infrastructure and market facilities, and thus what appears to be a strong negative correlation between transaction costs facing farmers and the size of the city anchor in their RUT. This differs from what appears to be the common image that farmers near small towns find getting to markets easier; it is in fact the opposite.

Table 2.
Topographical and Geographical Information of territories and farmers from survey data

	Small RUTs	Medium RUTs	Large RUTs	Total
Number of milk farmers in sample	442	386	360	1188
% of farmers	37%	33%	30%	100%
% Valle del Cauca	19%	11%	70%	10%
% Nariño	18%	50%	32%	62%
% Caquetá	86%	-	14%	23%
% Guaviare	100%	-	-	4%
Distances				
Average distance to paved road (minutes)	19.6	18.2	17	18.3
	[81.3]	[75.1]	[81.8]	[79.8]
% farmers between 0-10 min	35%	27%	34%	32%
% farmers between 10-30 min	30%	45%	36%	37%
% farmer more than 30 min	36%	29%	30%	32%
Average distance to nearest town or city (minutes)	21.2	22.2	21.1	21.5
	[78.7]	[62.0]	[76.6]	[72.7]
% farmers between 0-10 min	32%	14%	28%	25%
% farmers between 10-30 minutes	28%	48%	31%	36%
% farmer more than 30 min	40%	38%	41%	40%
Average distance to nearest modern milk Processor	21.2	18.6	20.5	20.1
	[77.4]	[74.5]	[77.8]	[77.0]
% farmers between 0-10 min	31%	24%	30%	28%
% farmers between 10-30 min	30%	49%	31%	36%

Table 2 (cont'd).

% farmer more than 30 min	38%	27%	40%	35%
Topography				
% of farmers in Lowlands (elevation< 1000mts)	67%	3%	14%	30%
% of farmers in Uplands (elevation 1000-2000mts)	5%	0%	20%	8%
% of farmers in Highlands (elevation > 2000mts)	28%	97%	66%	62%
Temperature				
% farmers in cold areas (< avg 20°C)	32%	97%	80%	67%
% farmers in hot areas (>avg 20°C)	68%	3%	20%	33%
Rainfall				
% farmers in low rainfall (< 90mm/month)	27%	97%	66%	62%
% farmers in medium rainfall (90-200mm/month)	14%	3%	16%	11%
% farmers in high rainfall (>200mm/month)	59%	-	18%	28%
Violence Index				
% of farmers in high violence RUT (index <0)	65%	97%	-	56%
% of farmers in moderate violence RUT (Index 0<x<0.5)	1%	-	27%	8%
% of farmers in low violence RUTs (Index >1)	34%	3%	73%	36%

Table made from survey information
Coefficient of Variation in brackets

Third, there is a positive correlation between the size of the RUT and elevation and negative correlation with average temperature. That is, most farmers in small RUTs are in hot rainy flat lowlands (where milk yields are also less) and most farmers in medium and large RUTs are in less rainy and mountainous valleys (where grass is more nutritious because of less leaching from heavy rain than in lowlands, and European breeds can thrive, and so milk yields

are greater). Highland farmers have other advantages: the cooler days mean milk spoils less quickly post-harvest, and less rain means less storm damage to roads. This correlation is due to the historical (at least from Spanish colonization on) urban settlement patterns that favored the cooler and less diseased uplands and highlands (Zambrano and Bernard, 1993).

Fourth, there is a negative correlation between violence[2] and the size of the RUT. This means that the small RUTs, already mainly in the more rural departments, not only have worse yields, more milk spoilage, and higher transaction costs as we show above, but they are also "taxed" by violence which increases the costs and risk of accessing inputs, or selling milk, and even of peacefully farming. Various studies have demonstrated this "violence tax": In Colombia, Muñoz (2010) and Pacheco (2016) showed crop yields are lower in more violent areas; Arias et al. (2013) showed farm investments are lower in more violent areas. For Rwanda, Verpoorten (2008) showed that during wartime farmers sold their cattle to be able to buy food.

[2] Index has been coded so that less violence is positive and more violence is negative. This index was constructed by Fergusson, Hillier and Ibañez (2018) per functional territory. It is composed of: proportion of area in territory with cocaine cultivation; per capita average number of forcefully displaced people between 1984 and 2010 in territory, per capita average number of homicides between 1997 and 2005/2010 in territory; and per capita average number of terrorist attacks between 1997 and 2010 in territory.

3. FARM HOUSEHOLD CHARACTERISTICS AND BEHAVIOR PATTERNS

3.1 Survey selection of RUTs and dairy farms in the four departments and descriptives of their characteristics

Table 3 shows farm household characteristics by RUT size stratum (i.e., size stratum of the anchor city). Several results are salient.

First, there is a U-curve relation of herd size and farm size on the one hand, and the size of the RUT. Small RUTs (anchored by tertiary cities and rural towns) tend to have large dairy farms surrounding them with a small dispersion (meaning there are few small farms). Medium RUTs have smaller farms; large RUTs again have larger farms but also a higher dispersion of farm sizes (hence small and larger farms coexisting in large RUTs). This may be related to there being a bimodal pattern of milk yields over large farms. In areas with less access to supplementary feed and cattle breed suitable for production, it is necessary to have a large herd to compensate for the low milk yield per cow. Recall that the small RUTs are in the departments where the land is low and flat and the climate hot and wet and the yields are poor. By contrast, most large RUTs are in highland areas, where European breeds succeed and yields are high. As well, within these areas, the proximity to large processors and good roads serves as market incentives for substantial farm investments that have favored the spread of large dairy farms especially in the favorable valley bottoms; in these areas the Gini coefficient of milk output is high as large farms dominate supply. In the medium-sized RUTs are the denser areas where secondary cities crowd the farmland but the access to market and infrastructure combined with good yield conditions allow small to medium commercial farms to be viable. This pattern of a

dichotomy of low and high yielding large farms is common in the agricultural economics literature in developing regions, for example in India (Vandeplas et al. 2013).

Table 3.
Farmer characteristics from survey data

	Small RUTs	Medium RUTs	Large RUTs	Total
Farm Capital				
Average size of herd (# cows)	29	6	11	16
	[132.4]	[143.1]	[286.8]	[193]
GINI of cattle	0.573	0.505	0.671	0.66
Average size of land (ha)	67	8.3	22	34
	[131.5]	[455.39]	[253.4]	[205.2]
Average size of pastures (ha)	55	6.1	19	28
	[132.1]	[421.8]	[253.8]	[204.7]
% land on pastures	86%	92%	86%	88%
	[21.6]	[19.5]	[26.9]	[22.8]
% of land that has a property deed (of those who own land)	83%	85%	85%	84%
	[44.1]	[40.9]	[42.9]	[42.6]
Non-Farm capital				
Non-farm capital Index	2.1	2.2	2.3	2.2
	[57.9]	[55.6]	[59.1]	[57.7]
Household characteristics				
Average Age (of head of farm)	52	56	57	55
Gender (% of head of farm that are female)	16%	19%	19%	18%
Schooling (% of head of farm)				
None	8%	8%	5%	7%
Primary	73%	78%	79%	76%
High school	17%	14%	13%	15%
University-technical	2%	1%	3%	2%
Graduate school	0%	0%	0%	0%
Cow production characteristics				
Cows per ha	2.4	5.2	3.8	3.75
	[119.4]	[96.6]	[116.3]	[115.1]
Lts of milk per day/ cow	4.7	9.6	6.3	6.8
	[74.4]	[52.2]	[79.7]	[72.9]
% farmers that use feed	33%	85%	64%	59%
% of farmer that have >80% pure breeds	5%	14%	22%	13%

Table 3 (cont'd).

Pasture land characteristics				
% farmers reporting pastures on hills/mountainous	37%	61%	66%	52%
% farmers reporting pastures on valleys/plains	31%	35%	19%	31%
% farmers reporting having irregular terrain pastures	32%	3%	15%	17%

Table made from survey information
Coefficient of Variation in brackets

Second, 84% of farmers who own their farmland (91% of farmers own some or all of their land) possess a title deed; this share does not differ significantly over RUT sizes. This is surprising, as given the Colombian conflict, there are still many lands where the is a dispute for land titles, especially in zones with higher violence levels. Still, this phenomenon seems to be equal in all of the RUTs.

Third, cow density per hectare is higher on territories with smaller farms (which as we note above are mainly in the medium-sized RUTs). In small RUTs, the cow density per hectare is half that of the medium RUTs. The cow density is thus correlated positively with the quality of grass and negatively with the pasture size, as expected. By contrast, in the large RUTs where large farms dominate but there are also small and medium farms, the pattern in cow density is lower than in medium sized RUTs but higher than in small RUTs. Higher access to feed and more suitable breeds can lead farmers within this area to increase the number of cows per ha (as they would need less amount of grass per cows), yet still not enough to increase the density as in medium sized RUTs.

3.2 Farm households' marketing patterns in the year before the survey

Table 4.
Disaggregation of total Market Channel Choice per territory type

Market channel choice	Small RUTs	Medium RUTs	Large RUTs	Total
Traditional Market Channel (% sell to)	20%	6%	6%	32%
Artisanal cheesemaker	14%	4%	2%	20%
Store	0.2%	0.3%	0.3%	1%
Directly to the consumer	2%	1%	2%	5%
Only self-consumed	4%	1%	2%	7%
Transitional Market (% sell to)	13%	21%	19%	53%
Cooperative	2%	6%	2%	10%
Independent collection center	0%	0%	1%	1%
Local intermediary/trader	9%	13%	13%	35%
External intermediary/trader	1%	2%	3%	6%
Modern Market Channel (% sell to)	4%	6%	5%	15%
Big milk processors (>500K lt/day)	3%	3%	3%	10%
Small/medium milk processors	1%	2%	2%	5%
Total	37%	33%	30%	100%

Table made from survey information

In table 4 we have compiled all of the different outlets for the milk and classified them into three market channels. The modern market channel includes sales to formal processors, which means that they have a license to process milk and report quality and quantity of milk collected to government agencies. In Colombia, milk prices are set by the Ministry of Agriculture and depend on the quality of the milk (share of solids, fat and bacteria)[3] As well, formal processors are allowed to pay premiums beyond these prices if certain criteria are met such as: the milk is delivered cold, farmer provides transportation, or if the herd is certified against blackleg or foot and mouth disease. Any trace of antibiotics leads to dumping of the milk and written reprimand.

[3] This is established by resolution 017 from 2012, 077 from 2015 and 468 of 2015

Normally, the processors test the milk and report the quantity as well as quality to both the government and the farmer. Any milk sold that is not tested or reported is considered informal. This market channel many times offers contracts, and can set prices higher for famers that are consistent in their quality and quantity. Additionally, they may also loan farmers cold storage and provide transportation for the milk. Because of their necessity of high quality and high quantity, there may be a barrier to entry to smaller farmers who are not able to form cooperatives or farmers that live in zones with low grass quality.

The transitional market channel includes sales to: (1) milk traders and marketing cooperatives (that act as traders). Milk sold to these channels is informal, which means that the milk is not tested as thoroughly (many times the milk is weighed in order to determine its quality) and price is settled beforehand. Though prices on average are lower than those in the formal sector, when quality of the milk is taken into account, prices are actually higher. This market consists mostly of traders that will then sell the milk to informal processors, and to some local restaurants/bakeries that though have a license to operate do not report milk quantity nor quality.

The traditional market channel includes farmer sales: (1) directly to consumers; (2) to small stores; (3) to artisanal cheesemakers (low quality and low price). This market channel is considered an informal market, as the buyers do not register the sale, nor test the milk for different quality markers. This market tends to be composed many times of friends, neighbors or local smaller stores and informal processors. The prices of this channel are comparable or can be higher than that of the traders.

Table 4 shows that 53% of farmers sell to the transitional market channel, mainly to local traders. 32% of farmers sell to the traditional market channel (mainly to artisanal cheesemakers);

and 15% of farmers sell to the modern market channel (mainly to big milk processors, those that collect more than 500,000 liters per day). It is important to note that only 2.4% of farmers reported selling to more than one market channel, and in these cases, we classified them as selling to the highest type of market channel.

Moreover, the table shows that there is a positive correlation between the share of farmers selling to the transitional and modern market channels and the size of the RUT. However, the relation is not steep; for the modern market channel the share climbs slowly from 4% to 6% to 5% of farmers from small to large RUTs; for transitional, from 13 to 21 to 19%. The main, but small jump is from small RUTs to medium RUTs. It is probable that the small dip from the medium RUT to the large RUT is because the large RUT contains a number of small farms (possibly selling mainly to the local transitional and traditional markets) coexisting with a number of medium and large dominant farms.

The relation of size of farm and market channel, controlling for RUT size, is explored further in Table 5. The classification of farms into different sizes was done following classification by ANALC (the Colombian national milk association). Overall (without distinction of RUT size), smaller farmers tend to sell to the transitional (70%) and traditional channels (22%) whereas the bigger farmers tend to sell to the traditional (60%) and to the modern channel (26%). This is not surprising as smaller farmers may produce too little milk to interest the processors in the formal channels. In small RUTs, for all farm size strata (and surprisingly, not just for the larger farmers), the size of the RUT (i.e., the anchor city's size) is highly correlated with the share of farmers selling to the modern channel. This links to the discussion above noting that larger RUTs provide much easier access to paved roads, processors, and even time to city, than small RUTs. Specifically, in small RUTs, 5% (1/26) of the smallest farmers (fewer than 5

cows) sell to the modern channel whereas in large RUTs 10% (5/52) of small farmers sell to the modern channel. Among the next largest farmers (still small), with 5-19 cows, the shares selling to the modern channel are 9% in small RUTs and 23% in large RUTs; for the next stratum, farmers with 20-49 cows, the share is 13% to 43% in small versus large RUTs; for farmers with more than 50 cows, the share jumps from 23% in small RUTs to 43% in large RUTs.

3.3 Changes in Farm Household Marketing patterns over time

Table 5.
Market Channel Choice per territory type and herd size

	Traditional	Transitional	Modern	Total
Territories with small urban centers	54%	35%	12%	100%
Farmers <5 cows	7%	18%	1%	26%
Farmers 5-19 cows	15%	11%	2%	29%
Farmers 20-49 cows	19%	4%	3%	26%
Farmers >50 cows	13%	2%	4%	19%
Territories with medium urban centers	18%	65%	17%	100%
Farmers <5 cows	10%	40%	5%	55%
Farmers 5-19 cows	7%	25%	9%	40%
Farmers 20-49 cows	1%	1%	2%	3%
Farmers >50 cows	0%	0%	1%	1%
Territories with large urban centers	20%	61%	18%	100%
Farmers <5 cows	12%	36%	5%	52%
Farmers 5-19 cows	6%	22%	8%	36%
Farmers 20-49 cows	2%	3%	4%	8%
Farmers >50 cows	1%	1%	2%	4%
All territories	32%	53%	15%	100%
Farmers <5 cows	22%	70%	8%	100%
Farmers 5-19 cows	27%	54%	18%	100%
Farmers 20-49 cows	59%	18%	23%	100%
Farmers >50 cows	60%	14%	26%	100%

Table made from survey information

Table 5 showed patterns for 2018, the year before the survey. Table 6 shows what share of farmers changed market channels over 2008-2018 and when they made the changes (whether in 2008-2012 or 2013-2018, or both. In principle, a farmer could change his or her buyer but stay in the same market channel, or could change from a buyer in one market channel to a buyer in another market channel. Table 6 only shows the latter, where the change meant a change in market channels.

Table 6.
Shares of farmers that changed the type buyers per type of market and time period of change on each type of territory

Used to sell **Currently sells to**	2008-12	2013-18	Total over time	**Total (over RUT)**
Territories with small urban centers				
Used to sell to Traditional Market Channel				
Traditional Market Channel	20%	80%	100%	81%
Transitional Market Channel	63%	38%	100%	12%
Modern Market Channel	40%	60%	100%	7%
				100%
Used to sell to Transitional Market Channel				
Traditional Market Channel	23%	77%	100%	20%
Transitional Market Channel	45%	55%	100%	75%
Modern Market Channel	33%	67%	100%	5%
				100%
Used to sell to Modern Market Channel				
Traditional Market Channel	22%	78%	100%	60%
Transitional Market Channel	0%	0%	-	0%
Modern Market Channel	33%	67%	100%	40%
				100%
Territories with medium urban centers				
Used to sell to Traditional Market Channel				
Traditional Market Channel	70%	30%	100%	40%
Transitional Market Channel	40%	60%	100%	60%
Modern Market Channel	0%	0%	-	0%
				100%
Used to sell to Transitional Market Channel				

Table 6 (cont'd).				
Traditional Market Channel	33%	67%	100%	10%
Transitional Market Channel	50%	50%	100%	74%
Modern Market Channel	56%	44%	100%	16%
				100%
Used to sell to Modern Market Channel				
Traditional Market Channel	60%	40%	100%	28%
Transitional Market Channel	89%	11%	100%	50%
Modern Market Channel	50%	50%	100%	22%
				100%
Territories with large urban centers				
Used to sell to Traditional Market Channel				
Traditional Market Channel	63%	37%	100%	76%
Transitional Market Channel	60%	40%	100%	20%
Modern Market Channel	100%	0%	100%	4%
				100%
Used to sell to Transitional Market Channel				
Traditional Market Channel	40%	60%	100%	8%
Transitional Market Channel	45%	55%	100%	84%
Modern Market Channel	30%	70%	100%	8%
				100%
Used to sell to Modern Market Channel				
Traditional Market Channel	25%	75%	100%	17%
Transitional Market Channel	60%	40%	100%	21%
Modern Market Channel	40%	60%	100%	63%
				100%
All territories				
Used to sell to Traditional Market Channel				
Traditional Market Channel	36%	64%	100%	71%
Transitional Market Channel	50%	50%	100%	24%
Modern Market Channel	50%	50%	100%	5%
				100%
Used to sell to Transitional Market Channel				
Traditional Market Channel	32%	68%	100%	11%
Transitional Market Channel	47%	53%	100%	78%
Modern Market Channel	47%	53%	100%	11%
				100%
Used to sell to Modern Market Channel				
Traditional Market Channel	30%	70%	100%	38%
Transitional Market Channel	79%	21%	100%	19%
Modern Market Channel	39%	61%	100%	43%
				100%

Table made from survey information

Overall, 47% of the farmers changed their channel over the two periods. Most of the more recent changes (2013-2018), especially in shifts toward the modern channel, occurred in the smaller RUTs, while most of the earlier changes (2008-2012) occurred in the larger RUTs. This makes sense as the larger RUTs provided more favorable conditions for farmers to adopt the modern channel as medium and large processors tended to develop or to locate in the large RUTs as they have a larger catchment area for throughput of milk, and lower transaction costs than the small RUTs.

Moreover, while many farmers in the large RUTs shifted to the modern channel early on, a number of farms in the large RUTs actually shifted into the traditional channel in the second period. This could be a bifurcation in farms, such as the larger, better equipped farms entering and staying with the modern channel as it pays more and they are able to meet its requirements; moreover, the modern channel begins to dominate the formal milk market locally, reducing the share in the market of the local traders serving the medium processors. The latter would imply that the small farms would have found a waning outlet via the local traders, yet the small farms may not have been able to meet the requirements of volume and quality and consistency of the large processors, so they were driven to shift to the vestige of the local traditional market to sell their milk.

By contrast, in the medium RUTs with many small farms, there was also a shift by the more endowed small/medium farms toward transitional and modern, but again, as in the large RUTs, the small/marginal farms could not make that shift and sought out the traditional channel as a means of selling their milk.

Finally, in the small RUTs, there was an increase over the two periods in the shift to transitional. This could be because the growth in milk volumes attracted milk traders to the areas,

a process that had probably occurred some years before in the medium and larger RUTs. The traders then competed with the traditional buyers of milk and created a favorable condition for farmers to sell to traders, particularly because they provided collection of the milk as opposed to many informal processors.

Below, we control for farm size and RUT to test the hypotheses for the drivers of the shifts within market channels.

4. METHODS AND RESULTS

4.1 Regression model explaining farmer market channel choice using panel data

We use a panel multinomial logit model to explain farmer market channel choice (traditional, transitional and modern) for two periods, between 2008-2012 and the period between 2013-2018. The general form of the model follows approaches by Train (2002), Rabe-Hesketh and Skrondal (2005), and Alem, Beyene, Köhlin, and Mekonnen (2015). The panel approach allows us to account for individual heterogeneity (following Nguyen-Van et al, 2017 and Haan and Uhlendorff, 2006).

Farmer i's utility (V) in any particular time period (t) will depend on the market channel to which it sells (j, where j=1 is the traditional, j=2 is the transitional and j=3 is the modern market channel). Its utility can be expressed as:

$$V_{ijt} = X_{it}\beta_j + \alpha_{ij} + \varepsilon_{ijt}$$

Where X_{it} refer to individual farmer and territorial characteristics that affect utility and vary across individuals over time; ε_{ijt} is the time specific farmer unobserved error, which are assumed independently and identically distributed as N (0,1). The α_{ij} are the unobserved individual effects that are time constant and assumed to be mutually independent as well as independent from the X_{it} and normally distributed, N(0,1).

The RUT characteristics include:

a) the size of the RUT as defined above (hence the category of anchor city size) in which farmer i lives;
b) the degree of RUT agglomeration based on the number of cities and towns above 15k in the RUT;

c) the incidence of violence in the RUT
d) the interaction between violence in the RUT and distance to nearest urban center; most violent attacks on farmers happen in the most rural areas. In order to account for possible differences in violence between farmers we included this variable;
e) average monthly rainfall of the RUT;

As well we had created a variable that would describe the number of formal traders within each territory, yet it presented a correlation of 0.98 with the degree of RUT agglomeration, so this variable was left out as to avoid a multicollinearity problem.

Consistent with the discussion in the descriptive section, we expect that farmers in larger RUT's, with greater urban agglomeration in the RUT, a lower incidence of violence, lower monthly rainfall and higher altitude, to be associated with a propensity to choose the modern market channel or the transitional channel, rather than the traditional channel.

The individual and household characteristics include:

a) head of household's or owner's age;
b) head of household's owner’s gender;
c) head of household's or owner's education level;
d) the logarithm of the size of the farm in owned land;
e) household herd size as well as squared herd size; as the literature suggests that smaller and larger farmers are more efficient and therefore more capable of producing higher quality milk (and therefore selling to modern markets) than farmers that lay somewhere in the middle (Feder, 1985, Helfand and Levine, 2004);

f) the non-farm assets (as an index) of the household[4];

g) the distance of the farm to the nearest formal milk processor;

h) the distance of the farm from the nearest paved road;

i) a binary variable representing if the farmer had their own transportation (car or motorcycle);

j) a binary variable representing if the farmer or anyone in their family was part of a cooperative or an association;

Consistent with the discussion in the descriptive section, we expect that farmers with larger farms, that are closer to paved roads and cities and processors, to be more apt to choose the modern market channel or the transitional channel and less apt to choose the traditional channel. We propose that personal characteristics such as age, male gender, and education would increase the probability of selling to the modern market. The reasons for this are that we assume age as a proxy for experience, that males are culturally favored in the local economy and society for business dealings, and more education help the farmer to navigate the requirements of business relationships. Additionally, we hypothesize that having own transportation as well as being part of an association or cooperative are going to increase the probability of selling to the modern market. In general, being able to deliver the milk makes it easier to sell to processors of all sizes; and being part of a cooperative means small famers can produce jointly with other farmers and gain access into formal markets.

[4] We created an asset-based index following Howe et al. (2008). Using a list of 15 assets (cellphone, stove, TV, etc.), we first determined if each farmer had the asset, and then we created a weight for each of the assets using an inverse proportion of the households that own the asset. The idea is that the assets that are owned in less proportions by households are an indicative of wealth, and therefore these got a higher weight. We then created an index for each household, where the higher the index the more non-farm capital was owned by the farmer

Farmer i can choose between three market alternatives (traditional, transitional and modern) in each time period. Thus, y_{it} refers to the market channel choice (j) for farmer i in period t. The probability of making choice j in time t conditional on farmer and RUT characteristics can be seen in a general form of:

$$\Pr\left(y_{it}=j\right)=\begin{cases}\Pr(y_{it}=1|X_{it},\alpha_i)=\dfrac{1}{1+\sum_{j=1}^{J=3}\exp\left(X_{it}\beta_j+\alpha_{ij}\right)} & for\ j=1\\ \Pr(y_{it}=j|X_{it},\alpha_i)=\dfrac{\exp\left(X_{it}\beta_j+\alpha_{ij}\right)}{1+\sum_{j=1}^{J=3}\exp\left(X_{it}\beta_j+\alpha_{ij}\right)} & for\ j=1{,}2\end{cases}$$

Where X_{it} are the farmer and RUT characteristics (described above) that vary across individuals over time and α_i are the unobserved individual effects that are time-constant. Since we have established that the log-likelihood function will depend on the individual heterogeneities (α_{ij}), we have to first integrate them using a simulated log likelihood method described by Hern (2007) and Nguyen-Van et al (2017). This results in a random effects model with the following associated log likelihood function:

$$\ln L=\sum_{i}^{n}\ln\left[\frac{1}{H}\sum_{h=1}^{H}\prod_{t=1}^{T}\prod_{j=1}^{J}\left\{Pr\left(y_{it}=j\middle|X_{it},\alpha_{ij}\right)\right\}^{d_{ijt}}\right]$$

Where d_{ijt} =1 if the farmer chooses alternative j at time t and zero otherwise. For each α_{ij}, we draw a number of pseudo random draws H, in this case we chose 50.

4.2 Regression results

Table 7 presents the regression results for the determinants of dairy farmer market channel choice over two-time periods (2008-2012 and 2013-2017). The table shows: (1) the coefficients

for the multinomial logit, interpreted as the odds ratios of each the explanatory variables on the probability of selling to the transitional and the modern market channel; (2) the average marginal effects, which allow us to determine the effect of the regressors on the probability scale. It is important to note that there is no relation between the significance of coefficients given in (1) and (2).

Table 7.
Results for market channel choice of milk farmers on panel data

Multinomial logit panel estimation: marketing channel determination (base category: traditional market channel)				
	Selling to Transitional Market		Selling to Modern Market	
	Average Marginal effects	Coefficient	Average Marginal effects	Coefficient
Territorial Variables				
Urban Size (base= small RUTs)				
Medium RUTs	0.133*	1.308***	0.086***	1.735***
	[0.080]	[0.464]	[0.050]	[0.555]
Large RUTs	0.064	1.018***	0.136***	1.892***
	[0.046]	[0.274]	[0.039]	[0.398]
Agglomeration (base: low agglomeration)				
Medium	-0.127	-1.695**	-0.010	-1.469
	[0.124]	[1.022]	[0.120]	[1.438]
High	-0.376***	-2.809***	0.162	-0.931
	[0.101]	[0.928]	[0.104]	[1.271]
Years (base=2008)				
2013	0.007	-0.180	-0.042	-0.206
	[0.031]	[0.204]	[0.028]	[0.272]
Distances				
Distance to paved road (min)	-0.002**	0.014***	3.400E-05	0.010
	[7.56E-04]	[0.004]	[0.001]	[0.006]
Distance to nearest milk processor (min)	-0.001	-0.013***	-0.001	-0.014**

Table 7 (cont'd).

	[7.44E-04]	[0.005]	[0.001]	[0.006]
Geographical Characteristics				
Average monthly rainfall	0.002**	-0.02	-1.677E-02	-0.015
	[0.001]	[0.005]	[0.001]	[0.007]
Violence Index	0.562***	4.122***	-0.059	2.398**
	[0.177]	[1.081]	[0.124]	[1.209]
Violence Index x distance to nearest urban center	0.002	0.01	-0.001	-0.006
	[0.001]	[0.010]	[0.002]	[0.015]
Household Characteristics				
Education (base=no education)				
Some Education	-0.072	-0.399	0.033	0.041
	[0.046]	[0.304]	[0.037]	[0.460]
Age head of household	0.001	-0.010	-0.001	-0.016**
	[0.001]	[0.006]	[0.001]	[0.008]
Female (male=0)	0.017	0.161	-0.010	0.149
	[0.030]	[0.204]	[0.024]	[0.268]
Farm/ Non-farm assets				
Size of herd	-0.008***	-0.003	0.012***	0.106***
	[0.003]	[0.004]	[0.002]	[0.016]
Size of herd2	8.590E-05	1.800E-06	-1.20E-04	-0.001***
	[1.58E-05]	[1.07E-05]	[2.20E-05]	[2.07E-04]
log of owned land	-0.103**	-0.700**	0.042	-0.308
	[0.049]	[0.354]	[0.035]	[0.434]
Asset Index	-0.014	-0.071	0.01	0.020
	[0.010]	[0.065]	[0.007]	[0.079]
Own transportation (no=0)	-0.082**	-0.266	0.068***	0.431
	[0.032]	[0.209]	[0.026]	[0.286]
Part of an association (no=0)	0.148***	1.308***	0.02	0.274***
	[0.032]	[0.235]	[0.022]	[0.274]
Constant		4.610***		1.197
		[1.328]		[1.837]

* Significant at P=0.10; ** significant at P=0.05; *** significant at P=0.01

Brackets represent standard errors

Table made from survey information

Loglikelihood: -1031.1603

Five key findings emerge in both the odds ratios as in the marginal effects. First, and looking only at odds ratios, the size of the RUT affects farmer market choice. That is, relative to being in a small RUT (thus with a small anchor city), the odds of a farmer's selling to the modern market channel increase only by a factor of 1.735 by the farmer's being in a medium RUT and 1.892 in a large RUT with a significance level of 1%. The average marginal effect result shows that the probability of selling to a modern channel is only significant and large when the farmer is located in a large RUT (compared with the default of a small RUT). To be more precise, the probability of selling to the modern market increase by 0.136 if a farmer is located in a large RUT. This an important result for both policy and industry, as access of farmers to more modern markets need to be addressed differently based on the size of urban centers.

Second, urban density inside the RUTs (agglomeration effects depicting the urban share in the total population of an RUT) reduce the odds of a farmer's selling to the transitional market channel by a factor of 1.695 in medium agglomeration territories and by a factor of 2.809 in territories with higher agglomeration, On the other hand, there is no significant effect on selling to the modern channel. The reason for agglomeration's having a negative effect on transitional channel choice per se could be because of a combination of two phenomenon's: (1) a higher presence of formal channels within the higher agglomeration territories. We had said before that there is a high correlation between the presence of large formal processors and agglomeration itself. This availability may lead farmers to depend less on traders. (2) Distances between farmers and markets are smaller in more agglomerated territories, making it easier for farmers to obtain inputs and transport their own milk.

Third, the higher the RUT's violence index (hence the safer the RUT) the greater the probability of the farmers' selling to the transitional market and traditional channel. Still, we see

that the violence index does not have as big of an effect on the probability of selling to the modern market. This is the first time in the literature that this differential market effect of violence is identified. The results make sense for two reasons. (1) Selling to the modern channel usually involves selling to a collection center near the farms or trucking the milk into the nearby city to the big processor. The exposure to rural violence especially in the more hinterland hillside areas or in remote glens is less of an issue. Modern channel buyers such as large processors thus usually only locate in safer urban areas. So, variation in violence over RUTs is mainly correlated with the size and "rurality" of the RUTs, with some exceptions. Of course, this correlation between even having access to modern channel buyers and the violence index is negative, so that farmers in more rural and small RUTs are less apt to have a choice of selling to large processors and the few that do are probably nearer the town. (2) Selling to local traders, as in the transitional channel, is much more vulnerable to violence than is either selling to big processors or very local cheesemakers. This is because of the transaction costs for the farmer or the trader to meet and exchange. The trader has to drive his truck along windy small roads into the hills and forests and in remote glens; it is reasonable to think that they avoid unsafe areas and so farmers in those cannot easily sell to them. This might be related to the fact that the modern channels are known in each region, so in territories with higher violence level selling to traders might generate even more uncertainty than selling to the modern channels.

Fourth, the effects of the period on market channel choice are in general much less than one would have expected if one assumed that the market channels' access was changing radically over the 10 years of the two periods. However, we found in key informant interviews that for over more than a decade most of the large processors were already in place; they did not locate in these areas in the recent half-decade. This goes hand in hand with the findings in Table 6, where

more than 60% of the farmers that used to sell to the transitional market, that changed to the traditional market, did so after 2012. This suggests that the factors driving changes were either increases in violence, or decreases in the size of the transitional market as large processors gain local market share (as we suggested above), or both.

Fifth, consistent with the expectation, larger farms and herds are correlated increase the probability of selling modern market channels. But the effects are much smaller than expected: the regression results show that an increase in herd size is associated with an increase of 0.012 in the probability of selling to the modern channel and, as expected, but weakly, the reduction of the probability of selling to a local trader (transitional market) by .008 if everything else is left unchanged. In this case, we believe that larger farmers would not need to consolidate their milk with other farmers and can sell it directly to artisanal and bigger processors, while small farmers need to consolidate through cooperatives and traders in order to be able to sell the milk.

Sixth, the household's having their own transportation increases as expected the probability of selling to the modern channel and decreases the probability of selling to the transitional channel. This is consistent with the fact that the purpose of traders is to pick up the milk from farmers, and then sell it, whereas farmers that are able to transport their own milk receive a higher price if the milk is delivered to both the formal and informal processors. This result is also important for policy, as it seems that farmers that have higher transportation assets have less barriers when it comes to selling to formal channels. Particularly, one could argue that having transportation reduces the risk of milk spoilage, and allows farmer to potentially invest more in quality.

Seventh, being part of an association increases the chances of selling to the transitional and modern market channels. We believe that these signs are capturing the effects of two

different types of associations. On one hand, many associations serve exclusively as traders, which are the essence of the transitional market. On the other, many associations are either processors themselves or help small farmers combine milk and then sell it to the modern market. These types of cooperatives test the milk and assess farmers in better practices. For this paper, these types of cooperatives were included within the modern market channels.

Seventh, surprisingly, farmer distance to the nearest milk processor had a very small and negative effect on market channel choice. This is consistent with findings in India (Vandeplas et al, 2013). In the Colombian case, the interpretation of this could be as follows: with different sized RUTs the availability of buyers changes and so the availability of transportation. Meaning that the decision to sell to a market channel is not determined by the distance to the buyers but the availability of buyers themselves.

5. CONCLUSIONS

The main objective of this paper was to provide insights on how territorial characteristics can affect value chain transformation through mapping market channel choice for milk farmers in the southwest part of Colombia. Within our study we included a dynamic model, where we look into the change of market channel choice within two time periods and include both farmer level as well as territorial level variables. We believe that these outcomes highlight (3) important factors that need to be included not only in future research, but also in determining policy.

One: we have seen that territorial characteristics seem to play a huge role within market channel choice, particularly urbanization and agglomeration patterns. In recent years, agricultural policy in Colombia has tended to be one-size-fit-all, where milk farmers are considered to be exactly the same (i.e., the determination of milk price is the same for all of the country). This can be a crucial mistake, as it is clear that farmers in less urbanized territories are more in need of infrastructure to be able to access modern markets and therefore higher milk prices and benefits. Though this paper has not discussed the effect of AVC restructuring on RTD, our results to indicate that less urbanized territories have a higher share of informal milk being sold. So, it can be hypothesized that if most milk farmers are not linked to the modern channels, their milk is not being tested for bacterial count or the presence of antibiotics. This means that more rural areas are then consuming milk that can potentially harm their health, helping increase developmental gaps between the rural and urban territories. Future research should include this analysis.

Second: though food system transformation has been mostly thought of as a linear process, going from traditional, to transitional, to modern markets, what we have seen is that it is non-linear and mostly U-shaped. Where, as urbanization grows farmers opt for the transitional market, yet at

a certain level urbanization, farmers then divide into two groups, one that continues to develop and sells to the modern market and one that reverses and sells to the traditional market. Additionally, this also goes hand in hand with the size of farmers, as there also seems to be a non-linear relationship between farmer size and market channel choice. This can be crucial for policies regarding the inclusion of farmers within the most modern markets.

Third, this paper provides some insights on the relationship between violence and market channel choice. We conclude that there is a differential effect between choosing the transitional and the modern market channels. It is clear that as violence levels go up, farmers will sell to the traditional channels. If Colombia continues its course in looking for a peaceful transition, it will have to understand the dynamics of farmers that have been located in historically violent territories.

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