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From theory to empirical verification: challenges to use regional economic theories for the analysis of structural change in rural Latin America.

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ABSTRACT

In the last years, rural population has declined. At the same time, more evidence has been gathered about the relevance of non-agricultural activities in rural areas. I look at these facts from two perspectives. First, I review selected theoretical papers about structural change and regional development. Second I ask whether these theories may be used to explain the two facts using current available data. The aim of this paper is to describe a gap that originates from theories and data for Latin America.

In terms of theoretical literature, the study of structural change contributes to the understanding of the reasons for the decline in the share of agriculture in total employment. Regional development literature, from which I select papers on new economic geography as well as papers inspired in Ricardian ideas, is devoted to the study of why some regions are more successful than others in attracting population. The attention there is on transportation costs, technology, natural amenities, congestion costs, and knowledge spillovers as drivers of agglomeration.

In analysing structural change and decline of rural population in developing countries, we need to consider the economic connections among regions. The theories above call upon an improvement in

three data related objectives: (a) use a definition of rural and urban that corresponds closely to the concept of regions, (b) measure trade flows among regions, and (c) collect data about transportation costs. The changes observed in rural areas require theories in which “rural” is not equivalent to “agriculture”, “farmer” is not equivalent to “non-skilled immobile labor” and “agriculture” is not equivalent to “unproductive sector”

Keywords: Structural change, Regional, urban and rural analyses, Latin America.

1. Motivation

In developing countries, in the last years, labor devoted to non-agricultural activities in rural areas has increased, while rural population has continued to decline. I look at these facts from two perspectives. First, I review selected theoretical papers about structural change and regional economics. Second, I ask whether these theories may explain those two facts using current available data.

In rural areas in Latin America, the percentage of labor devoted to agriculture has declined. Rodríguez and Meneses (2011) document this process with census data from around 1990 to 2000, and household survey data from around 2000 to 2008.¹ One clear consequence of this structural change is the dissociation between the notions of rural and agriculture: agriculture continues to be important in rural areas, but rural areas are more than agriculture (Dirven, 1997). If in the past, rural development was closely linked to agricultural markets, agricultural policies and farmers’ decisions, structural change implies rural development is also linked to non-agricultural sectors, as well as decisions of both farmers and non-farmers.

In the study of structural change, a macro perspective may complement a micro perspective. Research in individual and household decisions about farm/off-farm labor, as well as migration informs welfare analysis and policy making. Usually, these individual decisions are analysed as if they do not affect markets’ equilibrium. However, in the aggregate, equilibrium will change and therefore to understand the direction of the aggregate changes we need to look at the macro processes, which in this context means to consider the interrelations with other regions.

The interest in structural change also comes from the idea that inter-sectoral allocation of labor in rural areas may be linked to cross country differences in income. Two indirect empirical observations support this idea. First, countries with relatively low productivity in agriculture have relatively low income (Adamopoulos (2011)). Second, the gap between agriculture and non-agriculture productivity is greater in poorer countries (Lagakos and Waugh (2010)). It is natural to ask: If agriculture has relatively low productivity, why does labor not move from agriculture to non-agriculture in poor countries? Lagakos and Waugh find the gap in productivities may be consistent with consumers that require a minimum amount of food to survive. In contrast, Adamopoulos argues the existence of high transportation costs in poor countries is the reason. In this paper, we will be discussing theoretical explanations related exactly to that question and displaying a greater set of possible answers.

In this paper, theoretical approaches to thinking about structural change from the macro perspective are introduced. In particular, the interest is on general equilibrium models. The main questions

¹ In both cases, countries differs in the period for which data is available.

addressed are the following: Are these theories relevant to study structural change in rural areas? What are the main determinants of structural change according to these theories? Can we find evidence in publicly available data for Latin America supporting these theories? The final aim is to describe a gap that originates from theories and data for Latin America. Additionally, answers to these questions may contribute to the formulation and evaluation of rural, urban and national policies.

This paper is organized in four Sections, including this. In section 2, general equilibrium theories of structural change are described. In section 3, I discuss data from fourteen countries in Latin America, relevant for understanding structural change. The paper finishes with a critical analysis of the gap between theories and data, in section 4.

2. Theories of structural change and rural-urban migration

The key to understanding the theories I am introducing in this section is to keep in mind those theories allow for a full adjustment of markets, as well as full movement of labor among sectors and regions. I start with the simplest explanations that are pertinent if we think of a rural area as isolated economy. After that, I describe models with at least two regions.

2.1. Structural change in a closed economy

Theories about structural change are organized around two possible explanations for the movement of labor from agricultural to non-agricultural sectors. The first explanation is related to preferences and the second has to do with technology. Before I describe them, it will be useful to discuss what are the questions addressed by the theories of interest in this subsection.

For the moment, we imagine a region as a closed economy with no trade in goods or migration. There are two sectors: agriculture and non-agriculture. Labor is a homogeneous factor of production that can move freely between sectors. Starting from an equilibrium of the economy, characterized by wage, prices, and a distribution of labor among sectors, theoretical models of interest in this section try to understand what are the possible determinants of structural change.

The framework of interest is general equilibrium. In the simplest example, there are only two goods: one agricultural good and one non-agricultural good. A general equilibrium model considers simultaneously the equilibrium of three markets: agriculture, non-agriculture and labor. If two of these markets are in equilibrium, so is the third market. In what follows, I will consider only the markets of agriculture and non-agriculture.

One of the important aspects of general equilibrium theories is that we are interested in a full adjustment. For instance, a change that affects initially one market and seems to lead to some new equilibrium can be reverted by the adjustment in the other market. We may get misleading conclusions about the magnitude and direction of some change if we do not consider the full adjustment.

Going back to structural change, the explanation based on preferences is linked to the demands in the two markets, and economic growth. It has been observed that, as the GDP of a country increases, the share of labor in agriculture declines. To obtain this result, a raise in income must increase the demand for non-agricultural good more than the demand of agricultural good.

One modelling alternative to get a larger income elasticity for the demand of non-agricultural good is to assume that there is a minimum amount of consumption of the agricultural good that a consumer requires to survive. Under this assumption, the income elasticity of the demand of the agricultural good is lower than one, while the respective elasticity for non-agricultural good is greater than one. When income increases in one per cent, the demand of agriculture rises less than one per cent and the demand of non-agriculture increases more than one per cent.²

In this explanation, growth is either ultimately fuelled by accumulation of capital or is exogenous. The important intuition is that a region with income below some level will consume mainly agricultural goods locally produced. When income increases, the demand for non-agricultural goods increases and then the structure of the economy starts to change. The model explains a transition from a pre-industrial economy to an industrial economy. Recent examples of this explanation are in Echevarria (1997), Laitner (2000), Kongsamut, Rebelo and Xie (2001), and Lagakos and Waugh (2010).

The second explanation is linked to the supply side. Matsuyama (1992) formalizes the explanation in a model in which an improvement in the technology of the agricultural good releases labor. In the agricultural good market, supply increases and price decreases. The question is how does the non-agricultural good's market adjust? Reallocation of labor from agriculture to non-agriculture occurs if the non-agricultural good demand rises so that more labor is needed in the latter. For this to be the case, agricultural and non-agricultural goods should be complements. Baumol (1967), Nga and Pisarrides (2007) and Guerrieri and Acemoglu (2008) are examples of papers using similar explanation.

In this explanation growth of the industrial sector is fuelled by the release of labour from agriculture: industrialization happens in societies when agriculture becomes more productive and industrialization fails to happen when agriculture is unproductive.

In summary, closed economy theories provide two possible explanations for the decline in agricultural labor in a region: an increase in income, and an improvement in the productivity of agriculture. Applying this explanation to regions has a limitation, because regions are usually connected by trade, and labor migration.

2.2. Regional migration and domestic trade: New economic geography

Since rural areas rarely exist in isolation, migration and domestic trade could invalidate both explanations above. Once we imagine a country with at least two regions, one rural and the other urban, an improvement in agricultural productivity does not necessarily leads to a decrease of the labor share in agriculture in the rural region. Instead with trade between two regions increase in agricultural productivity may lead to further specialization of the region in agriculture.³ Moreover (On other side), migration of the released agricultural labor may keep the share of labor in agriculture from decreasing. With migration, structural change may actually happen in the region that has not experienced a raise in agricultural productivity.

Similarly, the demand side explanation may not work. For instance, if economic growth leads to an increase in (the) demand for the non-agricultural good, the non-agricultural labor share may rise in the urban region, instead of the rural. This may happen either because the non-agricultural good is produced in the urban region and exported to the rural region, or because wealthier rural consumers

² In this explanation preferences are non-homothetic and agriculture is an inferior good.

³ This conclusion follow directly from Yi and Zhang (2009) applied to regions instead of countries.

migrate to the urban region, or a combination of both. In this subsection and the following, I briefly describe models that develop these ideas.

New economic geography (NEG) is a good candidate as a theoretical approach to thinking about these interactions in the context of a general equilibrium model. Fujita, Krugman and Venables (1999, Chapter 4 and 5) describe what I am going to call the “*basic NEG model*”. This model has two features of interest for this paper. First, the economy is formed by two sectors, agriculture and non-agriculture, and two regions. Second, one equilibrium of the model is a center-periphery configuration that resembles an urban-rural spatial organization of the country.

The basic NEG model also incorporates domestic trade and migration. Trade in goods is possible, with no cost in the case of agriculture, and a positive cost in the case of non-agricultural good. The transportation cost is iceberg type, meaning that costs are measured as output lost. Labor is the only factor of production, but the labor market is segmented. Farmers are employed in the agricultural sector and cannot move among regions. Skilled labor can freely move among regions and it is employed in the non-agricultural sector.

Additionally, NEG has an important ingredient: increasing returns of scale in the non-agricultural sector. With increasing returns of scale, it is profitable to produce only sufficiently large amounts. Moreover, once the adequate scale of production is met, producing additional units of the good entails lower marginal cost of production. Agglomeration in cities (or urban regions) creates a relatively large non-agricultural goods market, as well as a relatively large labor market. Introduction of increasing returns of scale is the condition that makes creation of cities endogenous in NEG models (Fujita, Krugman and Venables, Duranton and Puga (2004), and Head and Mayer (2004)).

Fujita, Krugman and Venables model increasing returns of scale as internal to firms. The cost of production includes fixed costs and decreasing marginal cost. The market structure is monopolistic competition. The demand side is modeled by a structure in which agricultural and non-agricultural goods are substitutes. The latter is an aggregation of a number of non-agricultural goods, that are known as varieties. The aggregation is the one introduced by Dixit and Stiglitz (1977), with constant elasticity of substitution, among varieties, and love of variety. Without going into the modeling details, the particular setting in Fujita, Krugman and Venables, and later extensions, implies that consumers prefer as many differentiated non-agriculture varieties as possible. Also, in an equilibrium, one firm produces only one variety and the number of firms is endogenous.

As in subsection 2.1, the concept of equilibrium refers to prices, quantities produced of the goods and wage in every sector. NEG adds two other variables to be determined: number of firms and proportion of skilled labor in one region. In equilibrium, the number of firms is determined by the size of the final market. Regional difference in the real wage of skilled labor leads to migration of labor.

The basic NEG model has only two stable equilibria. Starting in a situation in which regions are identical, so that they have exactly the same number of farmers, there is a symmetric equilibrium, in which every region has equal share of the skilled labor. Additionally, prices and outputs are the same in both regions. The symmetric equilibrium is stable for high transportation cost. In the second equilibrium, skilled labor is fully agglomerated in one region. The latter case will happen when transport costs are relatively low. Then one region (the urban region) specializes in the production of the non-agricultural good and export it to the other region (Fujita, Krugman and Venables).

The basic NEG model is not adequate to understand structural change. The main reason is the segmentation of the labor market. From the point of view of the country, the amount of labor in the non-agricultural sector is exogenous and it does not change when skilled labor migrates. Labor is

not mobile among sector. From the point of view of the regions, skilled labor share in the rural region may take only two values: the one in the symmetric equilibrium and zero.

Mobility between the two sectors is essential in order to explain structural change. Puga (1999) introduces a modification of the basic NEG model with integrated labor market, and a fixed factor of production in agriculture. The possible equilibria are basically the same as in the basic NEG model. Again, in the asymmetric equilibrium, in the rural region (or periphery) all labor works in agriculture.

Murata (2008) introduces preferences with a minimum consumption of agricultural goods, and links structural change to decreasing transportation cost. The explanation modeled in this paper is similar to the demand side explanation mentioned in relation to the closed economy. However, the contribution of Murata resides in the analysis of structural change in a model with two regions and costly domestic trade.

Murata shows the existence of three possible equilibria. When transport costs are high, there is an equilibrium with no production of non-agricultural good. For intermediate transportation cost; the equilibrium is symmetric: both regions produce both goods. In the third possible equilibrium, transport costs are low and one region fully specializes in the non-agricultural good. Again, there is a similarity between the predictions of the model, and the historical transition from pre-industrial to industrial economies.

In sum, NEG introduces new elements to the list of possible determinants of structural change. First, NEG adds transportation costs. Second, considering a segmented labor market attracts attention to factors that make movement of labor between sectors costly. Third, the role of firms' mobility in determining labor structure is also considered. Finally, it is noteworthy how the engine of agglomeration in NEG creates an effect of cumulative causation. In other words, agglomeration is a cause for more agglomeration (Duranton and Puga).

However, NEG models do not have an equilibrium in which the rural (or periphery region) has a greater share of labor in agriculture than the urban region, but has a positive share of non-agricultural labor. It also does not include service sector and the potentially important diversification of the productive structure of the rural region.

2.3. A Ricardian approach to regional trade and migration

Structural change has also been analysed in the framework of new Ricardian trade models, in which patterns of trade are determined by comparative advantages and productivities are stochastic, like in Eaton and Kortum (2002). Michaels, Rauch and Redding (2011) use a two sectors model with "supply side" driven structural change. In essence, this is a model of trade among several regions in which costless labor mobility among regions is incorporated.⁴ In contrast with NEG, the analysis is not constrained to only two possible equilibria. In this model, in equilibrium, share of labor in every sector and region is a continuous function of parameters in the model.

Findings in Michaels, Rauch and Redding can be organized in two sets. In the first set, data from 1880 to 2000 in United States is used to analyse patterns of migration and structural change. In the second set, the mentioned model is calibrated. In both cases, the evidence seems to indicate that structural change determined(s) the patterns of migration.

⁴ Other papers with regional models based on the same approach are in Donaldson (2010), and Tombe(2011)

The first set of findings arises from analysing population growth, changes in labor shares and population density in minor civil divisions (MCD), which are sub county units, in the years 1880 and 2000. The results are also verified with data for counties, in the same period, but with observations every twenty years. The main conclusion is that locations experiencing an increase in population are those with intermediate population density in 1880. Agricultural employment declines in the locations with intermediate population density which suggests a relation between population growth and structural change.

By calibrating the mentioned model, Michael, Rauch and Redding corroborate that an increase in the productivity of agriculture is a plausible explanation behind the observed patterns of migration. In the second set of results, the authors calculate that an improvement in agricultural productivity happened between 1920 and 1960.

The calibration exercise in Michaels, Rauch and Redding has two important limitations. The first limitation is the mismatch between the concept of regions in the model, which is related to the labor market, and the empirical use of counties or MCD. It is likely that counties and MCD are part of are bigger geographic units with a common labor market.

The second limitation is related to the role of domestic transportation costs. In the calibration those costs are fixed. However, in the long period under analysis, it is likely than transport costs decline in most places in United States. In the Ricardian model used, transport costs can affect movement of labor among sectors and regions (as in Murata). In conclusion, keeping the transport cost fixed in the calibration may lead to a wrong conclusion about the relative weight of technological change as a determinant of both structural change and migration.

The theoretical approach in Michaels, Rauch and Redding differs from NEG in the following modelling issues:

- In NEG, models usually have at most three regions, or they impose strong assumptions that simplify the geography. In contrast, Ricardian models have flexibility to include many regions.
- In a Ricardian model, regions are intrinsically different, for instance in attributes as technology and land. If regions are identical, there is no agglomeration. We already discuss how in NEG models there is one equilibrium with full agglomeration, even if regions are identical.
- The reason for agglomeration in Ricardian models is the local nature of free technology. In other words, to have access to a technology, labor should move to the region where the technology is available. In accordance with this assumption, markets are of perfect competition. In contrast, in NEG models, agglomeration is related to increasing returns of scale and market exhibits monopolistic competition

3. Data about structural change in rural Latin America

In the previous section, I briefly discuss several models about structural change. In this section, I start with the evidence of a process of structural change happening in rural areas in fourteen countries in Latin America that may be linked to migration and urbanization. I also present the trend in a set of variables closely related to the possible explanations in the theory and find evidence of

the relevance of some of the implications of the theories. The empirical evidence is weak for data limitation.⁵

3.1. Evidence of structural change

As mentioned before, the main interest of this paper is on structural change in rural regions in Latin America. This subsection presents data on labor shares in three sectors, agriculture, manufacture and services, and two regions, urban and rural. Structural change is a process whose trend is best described by looking at long periods of time. Comparable data for 14 countries about sectoral labor shares is available in ECLAC only for a period between 2001 and 2009, with differences between countries in the period covered. The analysis in this section is strongly constrained by the lack of data for a longer period of time.

In Table 1, I present rural, urban and national shares. To some extent, I find evidence of structural change in rural areas. The graph of labor shares in the first year of the sample period (around 2002) versus the last year (around 2007) shows a decline in the share of agriculture (observations are below the 45 degree line) and an increase in the share of services (observations are above the 45 degree line). El Salvador, Dominican Republic and Colombia are exceptions to these patterns (see 1.2).

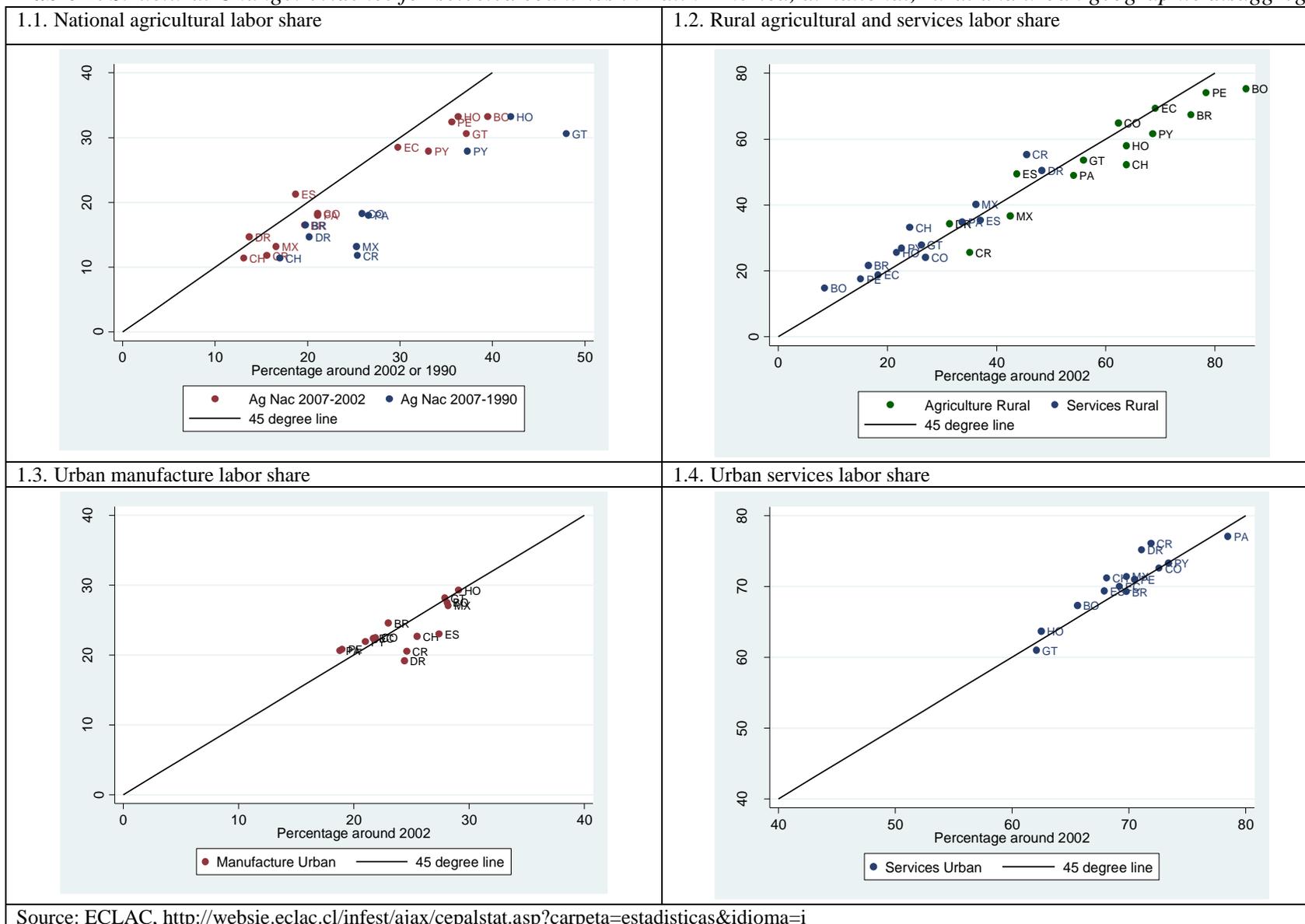
Looking at a period of time this short may lead to an underestimation of structural change. In the graph in 1.1., national labor shares of agriculture are shown for two periods of time, 2002-2007 and 1990-2007.⁶ The national data indicates that a good part of the structural change takes place before 2000. Therefore, to have a good sense of the changes happening in rural areas we ideally need a longer time series (period of time).

Another piece of information to take from Table 1, is that urban areas have not been as dynamic in terms of sectoral labor composition after 2000 as before 2000. In 1.3 and 1.4, I graph manufacture and services shares, respectively. Structural change could imply a positive change in the share of labor in services and either a positive or negative change in the labor share in manufacture. In three countries (Colombia, Ecuador and Paraguay), the shares are almost the same in both sectors. In Paraguay, Guatemala and Brasil, the share of services declines, even though in the last country the change is close to zero.

⁵ In fact, empirical verification of the theories in section 2 requires a completely different approach than the one in this section (See for example Head and Mayer for a discussion about empirical verification of NEG models). It is not an objective of this paper to achieve that kind of verification, but to show how theories are relevant.

⁶ In both cases, we are taking data around every one of the limits in the time intervals.

Table 1: Structural Change: evidence for selected countries in Latin America, at national, rural and urban geographic disaggregation level.



Source: ECLAC, <http://websie.eclac.cl/infest/ajax/cepalstat.asp?carpeta=estadisticas&idioma=i>

3.2. Possible determinants of structural change

Guided by the theoretical models reviewed in section 2, I present data related to some possible forces determining simultaneously the direction and the magnitude of structural change in rural areas. I start by discussing indicators of agricultural productivity. After this, evidence of a broader process of geographical transformation, taking the form of urbanization and rural-urban migration, is described. Finally, I introduce a weak indicator of transport cost is introduced.

With respect to productivity, I first consider the use of three inputs, fertilizers, machinery and land, in Table 3. In tables 3 and 4, I plot the ratio of value of the variable in the first period to the value in the second period for each country versus the change in the agricultural productivities on logarithmic scale. For instance, for the variable “rural share of labor in agriculture”, the observation in first year (y_0) and last year (y_1) are used to calculate a new variable, ly , with the following definition:

$$ly = \log(y_1 / y_0) \quad (1)$$

The new variable is referred as the “change in the rural share of labor in agriculture”. The same transformation is performed to each one of the variables on the x-axis. This transformation is equivalent to using a rate of growth. A variable that grows in time has a ratio (y_1 / y_0) greater than one and the logarithm is greater than zero. If the variable decreases, the logarithm value is below zero.

In Tables 2 and 3, the y axis is the change in rural labor share in agriculture (ly) and the x-axis is change (lx) in a variable closely related to agricultural productivity. Greater values of lx , i.e. greater intensity in the use of fertilizers, may appear to be related to a release of labor from agriculture if ly takes lower values. In this case, a negative correlation is expected.

In every graph a solid line represents fitted values of a simple OLS regression between both variables. The regression is only illustrative, because we cannot estimate a regression with only 14 observations; neither can we expect that any one variable has potential to explain labor shares alone.

With respect to fertilizer and machinery as inputs, I think is a good hypothesis that both inputs are substitutes for labor to some degree. However, graphs in 3.1 and 3.2 do not show a clear negative relation. In Table 2, correlations between every one of the variables and change in the rural labor share in agriculture are shown. For use of fertilizer the correlation is close to zero, while is negative but not high for use of machinery.

With respect to land as agricultural input, the possible relationship between the percentage of land used in agriculture and the share of labor is not very clear. An increase in the productivity of labor in agriculture may lead to an increase or decrease in the percentage of land in agriculture. It may also imply a decrease or increase in the share of labor in agriculture depending on the extent of substitutability between land and labor, as well as the availability of unused land or forest, that may be converted to agricultural land.

Table 2: *Correlation between selected indicators of productivity and change in rural labor share in agriculture (ly)*

Change in...	Correlation	Change in...	Correlation
Use of fertilizer (tractors/100 km ² arable land)	-0,01	Food index (2000-2008)	-0,07
Use of machinery (tractors/ha of arable land)	-0,26	Food index (1970-2008)	-0,17
Ag land as perc. of total land (2000-2008)	-0,59	Value added per worker (2000-2008)	-0,14
Ag land as perc. of total land (1969-2008)	0,15	Value added per worker (1980-2008)	-0,47

Source: Own estimation with data from ECLAC and World Bank.

It is important to notice models that include land as a factor of production (Murata and Michaels et al.) assume land is fixed and full used. All or part of this assumption may be inadequate to analyse structural change in rural areas in Latin America, where we may expect the amount of arable land is not independent from the structural changes taking place in the economy. Then, this feature of the data is not accommodated by the models.

In graphs 3.3 and 3.4, I explore what data reveals about the relationship between the change in the amount of agricultural land and change in labor. The relation seems to be negative and with high absolute value of correlation, if we look at land data after 2000. In contrast, the correlation is positive but not high when a longer period of time is considered (see Table 2).

Table 3: Scatter graphs of change in urban labor in agriculture and change in agricultural inputs (changes expressed as logs)

<p>3.1 Change in the use of fertilizer (kg/ha) between 2008 2002</p>	<p>3.2 Change in use of Ag machinery (tractors/100 km²) between 1990 1980</p>
<p>3.3 Change in % agricultural land between 2008 and 2000</p>	<p>3.4 Change in % agricultural land between 2008 and 1969</p>

Source: share of ag labor in rural areas, ECLAC (<http://websie.eclac.cl/infest/ajax/cepalstat.asp?carpeta=estadisticas&idioma=i>), and inputs, World Bank (<http://data.worldbank.org/>). Note: Both use of fertilizer and machinery are calculated as the ratio by area of arable land

Table 4: Scatter graphs of change in urban labor in agriculture and change in indicators of agricultural productivity (changes expressed as logs)

4.1. Change in food index production 2008-2000	4.2. Change in food index production 2008-1970
4.3. Change in Ag value added per worker 2008 and 2000	4.4. Change in Ag value added per worker 2008 and 1980
<p>Source: share of ag labor in rural areas, ECLAC (http://websie.eclac.cl/infest/ajax/cepalstat.asp?carpeta=estadisticas&idioma=i), and inputs, World Bank (http://data.worldbank.org/).</p>	

In Table 4, indicators of agricultural productivity are plotted against the change in rural labor share in agriculture. The food index measures the production of food. The value added per worker is in constant dollars so it does measure productivity too. When a short period of time is considered, as in 4.1 and 4.3, the correlation is close to zero. In contrast, when I introduce a longer period of time in the explanatory variable (4.2 and 4.3) the correlation is negative and in this case of value added is also high in absolute terms (over 40%). In sum, these last graphs give some support for the supply side explanation. However, this is a weak evidence for several reasons that will be discussed in detail in Section 4, as well as the mismatch between periods of reference of the occurrence of the changes that should be noticed.

In section 2, I discussed theoretical considerations leading to conclude that treating every single region as a closed economy, with no migration, may distort the complete picture of structural change in rural areas. Table 5 shows information about the dynamics of population in urban and rural areas and one indicator of rural-urban migration.

Table 5: Indicators of urbanization and rural-urban migration, for 14 countries in Latin America.

Countries	Code country	Urban Population			Yearly Growth of population		Pop cities > 1 million hab		Rural-Urban Migr over Urban pop growth	
		(1)			(2)		(3)		(4)	
		Percentage of total			Percentage		Percentage of total		Percentage for female pop.	
		1950	1980	2000	1950-2000 Urban	1950-2000 Rural	1980	2000	1980-1990	1990-2000
Bolivia	BO	33,9	n.d	62,4	3,2	0,9	n.d	31	65,3	30,4
Brasil	BR	36,5	67,6	81,2	4,0	-0,1	28	34	42,8	35,9
Chile	CH	60,7	82,2	86,6	2,6	-0,3	35	36	11,9	19,8
Colombia	CO	42,7	67,2	76,0	3,3	0,7	31	34	n.d	n.d
Costa Rica	CR	33,5	44,5	59,0	4,2	2,1	n.d	27	46,8	47,4
Dominican Rep.	RD	23,9	52,0	63,6	4,5	1,2	23	25	n.d	n.d
Ecuador	EC	28,5	49,0	61,1	4,1	1,4	15	29	49,1	38,8
El Salvador	ES	36,5	n.d	62,7	2,9	1,1	n.d	19	54,3	n.d
Guatemala	GT	25,0	32,7	46,1	3,8	2,0	19	19	44,0	59,1
Honduras	HO	31,0	38,7	45,5	3,8	2,6	n.d	n.d	n.d	n.d
Mexico	MX	42,6	66,3	74,7	3,8	1,0	27	30	32,4	32,1
Panama	PA	36,0	50,4	62,2	3,7	1,5	n.d	43	41,3	54,4
Peru	PE	35,3	65,2	75,9	3,3	0,7	27	31	34,9	n.d
Paraguay	PY	34,6	42,8	56,7	3,6	1,8	n.d	31	58,4	n.d

Source: For (1) to (3), the source is ECLAC, <http://www.eclac.cl/celade/depualc/>, while (4) is from Rodríguez Vignoli, J. (2004) Table 25, page 120.

Data on urban population shows an important transformation of countries between 1950 and 2000. The percentage of urban population increases in all countries. It is also worth to notice that the percentage of urban population increases faster from 1950 to 1980 than it does from 1980 to 2000. Only in two countries the reverse is true: Paraguay and Guatemala. In Costa Rica and Honduras, the absolute change is similar in both periods. If urbanization and structural change in rural areas are related, it is relevant to analyse the process of structural change since 1950. However, the data available does not allow us to do that.

In every country the rate of growth in urban population is bigger than the rate of population growth in rural areas. Where does the new urban population come from? There are three possible sources: net natural growth (births minus deaths), rural-urban migration, and growth of urban area. Net

natural growth of population is usually greater in rural areas, with higher rates of fertility (Rodríguez Vignoli, (2004)), so in fact the other two sources should compensate this one that goes against urbanization.

In table 5 I present the proportion of urban female population growth that is explained by rural-urban migration as estimated in Rodríguez Vignoli. Only a portion of the rate of growth of urban population is explained by migration from rural areas. The proportion for male population is similar, but lower, so I use only one of the figures. There are two points I want to remark in these estimations from Rodríguez Vignoli. First, rural-urban migration explains at most two thirds of the growth of urban population. Second, rural-urban migration explains less than 50% in most of the cases. In the first period (1980-1990), of eleven countries with data, 8 have a proportion below 50%. In the second period, six countries out of a total 8 have proportions below 50%.

Another source of urban population growth is the extension of urban areas. As an indirect evidence of that, population in cities with population of more than 1 million of habitants increases at a slower pace than urban population (see variables (1) and (3) in Table 5). In words, part of the increase in the percentage of urban population is happening in smaller cities or because towns are becoming cities. Additionally, the definition of what is urban and rural changes over time in some countries.

In sum, we can anticipate that urbanization reduces the amount of labor moving from agriculture to non-agricultural sectors in two very different ways. On one hand, it is possible that labor previously released from agriculture moves to an urban place. In this case, structural change in urban areas is linked to changes in productivity or demand happening in rural areas. On the other hand, it is possible that a rural location, for instance a town, changes in terms of its labor shares and other dimensions such as density or infrastructure, so the whole locality is moved into the “urban” category. In the last case, the statistical definition of what is urban leads to a misrepresentation of the structural change happening in rural areas.

Finally I lay out some empirical observations about transportation costs as a possible determinant of structural change. As an indicator, I use the logistic performance index, from the World Bank. The index is constructed using data from a survey of individuals and companies working in international logistics. The dimensions considered are: “efficiency of customs clearance process, quality of trade- and transport-related infrastructure, ease of arranging competitively priced shipments, quality of logistics services, ability to track and trace consignments, and frequency with which shipments reach the consignee within the scheduled time”.⁷ The index is closely related to transportation cost for international trade. I am using it here as a rough approximate of domestic transport costs as this indicator is comparable across countries.

I find positive correlation between urban population in 2000 and the logistic performance index in 2006. The reasoning behind this selection of variables to calculate the correlation is that urbanization may be related to domestic transport costs, according to NEG models. Additionally, the index was calculated in 2006 and 2007, so to calculate a correlation similar to the one in Table 2, with respect to *ly* may have been less informative. The correlation coefficient is 0,61, which means that countries with lower transportation cost have a greater percentage of population living in rural areas.⁸ However, the evidence is very weak because we have few observations, and the index is not necessarily a good approximation of domestic transport costs.

⁷ <http://data.worldbank.org/indicator/LP.LPI.OVRL.XQ>

⁸ The index takes greater values when logistic services are better.

4. Discussion about the gap between theory and data

This section starts with a discussion about the differences between the concept of regions, in models in section 2, and the concept of urban and rural in section 3, which may be a reason creating a difficulty to verify the theories. In the rest of the section, I describe in turn the main sources of a gap between theory and data.

With respect to the definition of regions, in relation with rural and urban, theories introduced share aspects of a concept of region that is implicitly defined, as is common in regional models (Behrens and Thisse (2007)). The implicit definition includes at least five aspects that are the following:

- i. Every region is a single labor market, in the sense that a worker should live in a region in order to work there.
- ii. Transportation cost is the same in all the places that are part of the region.⁹ The practical meaning of this assumption is that consumers in the region face (the) same prices.
- iii. Firms and consumer in a region have access to a pool of factors that are not mobile (unskilled labor, land and technology), so they cannot be employed or consumed from another region.
- iv. Regions form the country. In other words, all the places are in one region or other and there is not a place from which labor and or goods can come, which is not part of a region.¹⁰
- v. When analysing whether a change in a possible determinant leads to some particular sectoral and regional distribution of labor, regions are fixed.

Out of these five aspects, the first is fundamental, because it is related the definition of borders used in migration analysis. Aspects (ii) and (iii) are less restrictive from the empirical point of view. For example, once the borders of a labor market is drawn, a price index for the region can be calculated. Also, within those borders, some immobile natural and physical capital are going to be part of the region. With the technology it is less clear, but the Ricardian model can easily be extended to include simultaneously regional and national technology.

The definition of urban and rural in the data in Section 3 does not correspond to the implicit definition of a region in the theoretical models. In my opinion understanding in which aspects statistical definition fails the five criteria would enable us to better distinguish what are the relevant questions to be answered and empirical evidence to be analysed about structural change. Based in the analysis about the definition of urban and rural in Dirven et al. (2011), the relevant differences are the following: (a) urban and rural may aggregate each several labor markets, especially in big countries, like Mexico and Brasil; (b) places that are classified as rural may actually be part of a urban labor market that is located nearby; and (c) the definition of rural and urban is not fixed in time.

The proposal in this paper is to analyse structural change with data for regions, and to classify regions as “urban” or “rural”, using as criteria for the classification multiple dimensions that have been measured for smaller geographical units. Similar recommendations are discussed in Rodríguez and Murillo (2009), Dirven et al, and Rodríguez and Meneses. This empirical approach may help to

⁹ Following Behrens and Thisse, I am thinking regions are formed by smaller units, called “places”. Essentially, what I am saying is that all “places” share point (i)-(v), but they may be different in other aspects.

¹⁰ This may seem a very obvious part of the definition, however, in some cases, an analysis can be conducted in which this is not a desirable feature. One good example is in the research of cities that ignores other places that form the country.

better identify the determinants of structural change. Using regions additionally fixes the problem of a definition of rural that changes over time.

The second part of this section is about data. There are two important limitations. The first was extensively discussed in section 3: the span of the data series is short to understand a process that usually takes many years. The second limitation is the scarce or inexistent data on transport costs and trade flows among regions (or among urban and rural areas) is scarce. Because, trade may be a substitute for migration and it can shape labor distribution, my second recommendation is to include at least a proxy of transport cost, when analysing empirical evidence of structural change.

The third and last part of this section is about theories. One limitation of theories is related to technological innovation in agriculture. Theories omit potentially interesting interrelations between innovation and structural change, because inputs are substitutes. In consequence, technological innovation is always labor saving. However, it is conceivable that innovation may be labor intensive.

The treatment of land as a fixed and fully employed resource is closely related to this concern. Data clearly reveals some countries in Latin America are incorporating unused land or former forest to the production. Both limitations call for the introduction of a more complex production function of agriculture. In any of the models analysed in section 2, a modification in this direction may pose some difficulties.

Theories also seem short in the modelling of labor mobility. Sectoral and regional mobility can be costly. The inclusion of any of those costs will not change the influence of other variables, but it will attenuate the impact of any change on the final reallocation of labor.

Other aspect of interest to be incorporated in the theoretical models is international trade. In preliminary simulation results, Saborío-Rodríguez (2011), shows international trade affects labor distribution among sectors and regions. Once international trade is incorporated, structural change may be affected by trade policy, as well as changes in technology and or demand happening in other countries.

Finally, theoretical models of regional economics described consider services as part of “non-agriculture”. Combining services and manufacturing into one sector may be inadequate to describe some of the trends in the data in section 3. In national data, it has been observed that over time manufacture share of labor increases and then decreases, while the share in services steadily rises (see for instance the discussion in Kruger and Xi and Zhang). Then, a distinction between the sectors could be relevant to analyse patterns of sectoral specialization in regions.

In summary, the existing gap between theories and data related to structural change in rural areas can be partially closed with adjustments on both sides. On the data side, three issues are salient: (a) implement a definition of rural and urban that corresponds closely to the concept of regions, (b) measure trade flows among regions, and (c) collect data about transportation costs. On the other side, we need theories in which “rural” is not equal to “agriculture”, “farmer” is not equal to “non-skilled immobile labor” and “agriculture” is not equal to “unproductive sector”. Misrepresentations in theory may be alleviated with modifications in the production function of agriculture, the inclusion of costs of moving between sectors and regions, and a separate emphasis in the dynamics of services.

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