What's So Spatial about Diversification in Nigeria?

PAUL CORRAL [a] and NATALIA RADCHENKO [b,*]

[a] *World Bank, Washington, DC, USA*
[b] *American University, Washington, DC, USA*

Summary. — Many households in developing countries allocate their productive assets among various income generating activities in order to develop a portfolio of income from occupations with different degrees of risk, expected returns and seasonal and liquidity constraints. The push and pull factors influencing diversification decisions of households are widely discussed in the literature; however, no study to date has taken into account spatial interdependence of household decisions in spite of various channels of neighborhood effects such as information flow, learning from others, social networks and agglomeration economies. This paper fills in the gap by incorporating spatial dependence in the choice model of diversification using a spatial auto-regressive probit model and an advanced Bayesian strategy to its estimation.
Empirical analysis is run taking advantage of the Nigerian General Household Survey Panel, 2010–11 providing GIS coordinates for the surveyed households. The results imply endogeneity of the neighbors' decisions to allocate their productive assets among various occupations and signal the importance of social learning and agglomeration effects favoring the spillover of diversification activities through neighbors' networks and local markets. The households' decisions respond to local environment factors such as weather shocks or infrastructural constraints. As shown by the regional differences, taking into account spatial interdependence is particularly important in the event of a wide divide of the data available into different zones, as for example in case of the Nigerian northern region where the states are larger.
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1. INTRODUCTION

The importance of income diversification in developing economies is increasingly being recognized (Barrett, Reardon, & Webb, 2001; Davis, Winters, Reardon, & Stamoulis, 2009). The diversification practice is frequent among African farmers and consists of engaging into various income generating activities differentiated by returns, degrees of risk, and constraints. Many studies report various positive effects of diversification and consider it as a poverty reduction practice: non-farm income positively affects farm production and expenditures on inputs (Davis *et al.*, 2009; Oseni & Winters, 2009), as well as nutritional outcomes and child anthropometric measures (Babatunde & Qaim, 2010).

A large body of the diversification literature has been developed over 1990–2000s. The literature of the early 2000s conceptualized diversification practice by suggesting several diversification measures and framing diversification incentives commonly classified as push and pull factors (Barrett *et al.*, 2001; Reardon, Berdegue, Barrett, & Stamoulis, 2007). It gave rise to a large body of empirical literature using various data sets to analyze the determinants of the household's choice and capacity to diversify (some examples are Barrett, Clark, Clay, & Reardon, 2005; Corral & Reardon, 2001; De Janvry, Sadoulet, & Zhu, 2005; Escobal, 2001; Lanjouw, 2001; Liu & Lan, 2015; Senadza, 2012; Weldegebriel, Folloni, & Prowse, 2015).

Despite the large literature developed, no study to date has taken into account spatial dependence or the "neighborhood effect": the literature have been focusing on the effects of demographic characteristics and households' and communities' assets. Yet, spatial dependence relates to both push and pull factors driving households toward diversifying activities and can play a considerable role in the household's diversification outcome via information flow, social networks, and agglomeration economy effects. Thus, studies to date are potentially missing a critical aspect of the household's decision

process. Moreover, ignoring spatial relations may lead to biased or inconsistent estimates of the effects relating to various observed determinants of diversification choice. This paper fills in the gap by extending the literature on the determinants of diversification among farming households through incorporating spatial dependence in the choice model. Explicitly, the paper seeks to answer whether or not diversification among farming households is linked to the decisions of neighboring households.

The contribution of the paper is multifaceted. From the economic perspective, we add to the literature by modeling the neighborhood effect relating to numerous diversification factors exhibiting spatial dependence. The overall methodology is beyond the methods traditionally used not only in the literature on income diversification but more broadly in the literature applying discrete choice models to the household decision making in developing economies. Indeed, empirical analysis allowing for spatial interdependence is mostly adopted by regional sciences, real-estate, geographical, and transportation economics. In agricultural economics, it is mainly advanced on the topics of land use and land markets (Brady & Irwin, 2011; Breustedt & Habermann, 2011; Holloway, Lacombe, & LeSage, 2007), and spatial distribution

of agricultural production and practices (Holloway & Lapar, 2007; Schmidtner et al., 2012). Yet, despite an appealing context of developing economies, empirical studies using spatial econometrics at household level and applied to developing economies remain scarce and confined to land use (De Pinto & Nelson, 2007) and precision agriculture (Nelson, 2002).

From the empirical perspective, we use an innovative approach when studying the decision to diversify. It consists of applying a Spatial Auto-regressive Probit model which allows us to incorporate the spatial interdependence in the choice model and an advanced Bayesian estimation strategy offered by LeSage and Pace (2009). The methodology used allows for efficient empirical implementation of the spatial dependence of the binary outcomes related to different agents.

The empirical analysis is run using the first wave of the Nigerian General Household Survey Panel (GHS-Panel), 2010–11. The GHS-Panel is an ongoing survey with the first two waves published by the time of the present study. Crucially for our study, the data contain GIS coordinates for the surveyed households [1] which allows us to define a spatial network and to expand the empirical model to incorporate spatial dependence between diversification outcomes of different households. Nigeria represents a good case study for examining the spatial nature of rural non-farm activities not only because of GIS data availability at the household level, but also because of wide diffusion of diversification in the country: according to the GHS-Panel (2010–11), about 60% of Nigerian farming households diversify with non-farm enterprise being the most popular activity. Statistically balanced subsamples of diversifying and non-diversifying households along with spatial variation are advantageous in terms of data variation and model identification. Finally, since agricultural employment in Nigeria accounts for about 60% of the working population with two-thirds of the total agricultural production provided by traditional smallholders that use basic technologies, the Nigerian case is instructive in terms of the behavior of farming households in the framework of a developing economy with a strong rural component.

The paper is organized as follows. Section 2 introduces the main concepts of the analysis. Sections 3 and 4 outline the country background and specify the data respectively. Section 5 outlines the spatial auto-regressive probit model and its outcomes (the main steps of the Bayesian estimation approach and the simulation technique used for its empirical application are provided in Appendix A). Section 6 presents national-level and regional results. Section 7 summarizes findings and concludes in terms of the policy implications perspective.

2. CONCEPTUAL FRAMEWORK

(a) Concepts

Diversification incentives. The literature (see Barrett et al., 2001; Davis et al., 2009) suggests that there are two kinds of factors at play when an agent decides to diversify: "push" and "pull" factors.

Push factors relate to needs and income desperation of the farming household, and/or market imperfections that farming households face. These factors include risk associated with uncertainty about agricultural outcomes and related consumption shocks, low marginal productivity of labor on the farm and liquidity constraints. For example, Babatunde (2012) and Oseni and Winters (2009) show that off-farm [2] income may relax liquidity constraints for farming households. They

also suggest that off-farm income may have positive spillovers to agricultural production. Using Nigerian data, Oseni and Winters (2009) find that non-farm income has a positive effect on expenditures for inputs while Babatunde (2012) finds that participation in off-farm activities complements own agricultural production.

Pull factors relate to local factors that create a positive environment for diversification and attract households toward diversification. Their components are strategic complementarities between activities and comparative advantage drawn from diversification (Barrett et al., 2001); households may be pulled toward diversifying by higher returns provided by various activities (Escobal, 2001). Pull factors might be effective in the areas of economic growth and highly developed infrastructure: growing agricultural zones or a sector development such as mining or tourism can generate demand for non-farm goods, services and stimulate development of the rural non-farm sector with higher wages. Developed infrastructure is a strong pull factor since it induces lower transport and transaction costs raising households' profits from off-farm activities and opens additional non-farm and/or cash-cropping options representing comparative advantages for farming households.

Barriers to entry. When engaging into diversified activities, households face strong uncertainty about the returns. Indeed, it is possible that there is no positive effect on income. The push factors could lead a household toward low-return activities (Barrett et al., 2005) resulting in a negative effect on agricultural production if the lost farm labor outweighs the benefit from investment in diversified activities. Risk aversion might therefore discourage engagement into diversification activity.

Not only profit maximization is uncertain under the diversification choice, but also entry into diversified activities might be uncertain or unavailable to many (Barrett, Bezuneh, & Aboud, 2001; De Janvry et al., 2005). Indeed, off-farm entrepreneurship and job, as well as cash crop adoption, require some human, social, financial, and infrastructural capital. This implies that there may be barriers at the household and community level for households with no endowments and assets.

(b) Incentives and capacity variables

The above discussion translates into a set of variables commonly available from household and community data, and traditionally employed as explanatory variables of the diversification process among the households. The variables relate to push and pull incentives as well as the capacity to access diversification activities.

Household landholding is one of the important diversification determinant associated with both incentive factors and the capacity to diversify. On the one hand, a small farm size is a push factor inducing households to complement their earnings and food necessities by seeking diversification (Reardon et al., 2007), while large farmland is associated with greater opportunity costs of undertaking activities outside of the household farm reducing their comparative advantages for larger landholders. On the other hand, land can enable rental income in the event of a functioning credit market empowering households with financial capital and increasing their capacity to overcome barriers to entry and undertake a higher return off-farm activity; in this case, acreage can be positively correlated with diversification. Larger landholding can also favor cash crop adoption (Goldstein et al., 2013). Further, in the presence of functioning land markets, land can be sold to gain financial capital or on the contrary acquired along with other agricultural assets using capital gained from